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Recommendations for Improving Earthquake Damage Assessment Methods: Insights Drawn from the Türkiye Kahramanmaraş Earthquakes of February 06, 2023

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Abstract

The devastating earthquakes in Kahramanmaraş, Türkiye, on February 06, 2023, caused widespread destruction. In the aftermath, damage assessments were conducted to evaluate the structural condition and habitability of buildings. However, many property owners appealed the initial evaluations, requiring second assessments and slowing the post-disaster recovery process. This study aims to identify factors that can improve the accuracy and reliability of initial damage assessments to prevent unnecessary appeals. Damage data from 21 provinces were analysed, and buildings with changed and unchanged damage statuses were evaluated through expert opinions of civil engineers and architects. The experts were selected from public institutions who were not directly involved in the Kahramanmaraş earthquake assessments but were chosen based on their experience in damage evaluation. In this context, ethics committee approval was obtained from the relevant university. To determine the building sample, 62,983 appealed cases were reviewed via the e-Government platform, and only those with adequate visual documentation were selected. Expert evaluations revealed that photographic assessment alone is insufficient and emphasized the importance of on-site inspections. The findings underscore the need to systematically integrate visual data such as detailed photographs and videos into the assessment process to improve the clarity, traceability, and reliability of initial evaluations.

Keywords
Earthquake, Damage Assessment, Visual Damage Assessment, Kahramanmaraş Türkiye

Deprem Hasar Tespit Yöntemlerinin Geliştirilmesine İlişkin Öneriler: 6 Şubat 2023 Kahramanmaraş Depremleri Üzerinden Elde Edilen Çıkarımlar

Özet

6 Şubat 2023 tarihinde meydana gelen yıkıcı Kahramanmaraş depremleri, Türkiye genelinde geniş çaplı yıkıma yol açmıştır. Afet sonrasında, binaların yapısal durumu ve kullanılabilirliği değerlendirmek amacıyla kapsamlı hasar tespit çalışmaları yürütülmüştür. Ancak, birçok mülk sahibi ilk değerlendirmelere itiraz etmiş, bu durum ikinci değerlendirmeleri gerekli kılmış ve afet sonrası iyileşme sürecini yavaşlatmıştır. Bu çalışma, gereksiz itirazların önüne geçebilmek için ilk hasar tespitlerinin doğruluk ve güvenilirliğini artırabilecek faktörleri belirlemeyi amaçlamaktadır. Araştırma kapsamında, 21 ildeki hasar verileri incelenmiş ve hasar durumu değişen ve değişmeyen binalar, inşaat mühendisleri ve mimarlardan oluşan uzman görüşleriyle değerlendirilmiştir. Uzmanlar, Kahramanmaraş depremine ilişkin hasar tespitlerinde doğrudan görev almamış, ancak hasar değerlendirmesi konusunda deneyimli kamu kurumu çalışanları arasından seçilmiştir. Bu bağlamda, uzman görüşlerinin toplanması için ilgili üniversiteden etik kurul onayı alınmıştır. Bina örneklemini belirlemek amacıyla e-Devlet platformu üzerinden 62.983 itiraz vakası incelenmiş ve yalnızca görsel dokümantasyonu yeterli olanlar seçilmiştir. Uzman değerlendirmeleri, yalnızca fotoğraflara dayalı analizlerin yetersiz olduğunu ortaya koymuş ve yerinde incelemelerin kritik önemini vurgulamıştır. Bulgular, hasar tespit sürecine detaylı fotoğraflar videolar gibi belgelemeye yönelik unsurların entegre edilmesi gerekliliğini ortaya koymaktadır.

Anahtar Sözcükler
Deprem, Hasar Tespiti, Görsel Hasar Değerlendirmesi, Kahramanmaraş Türkiye

1. Introduction

In the period soon after a disaster in Türkiye, parallel to the search and rescue operations, building-scale damage assessment studies are also conducted to ensure the safety and continuity of citizens' lives. Based on the post-earthquake damage assessments, buildings are classified into categories as undamaged, slightly damaged, moderately damaged, severely damaged, urgently demolished and ruined. These assessments determine whether citizens can continue to reside in their residences or not. Undamaged or slightly damaged buildings allow citizens to continue living in their residences.

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Moderately damaged buildings allow citizens to continue residing in their residences, provided certain measures are taken, such as the implementation of structural reinforcement. However, buildings assessed as having severe damaged, urgently demolished or ruined are deemed unsuitable for continued residential occupancy. The results of the damage assessment evaluations are publicly available, and homeowners are given a period of time to appeal the damage assessment results (Disaster and Emergency Management Authority (Disaster and Emergency Management Authority, n.d.).

According to data obtained from the Damage Assessment Query and Appeal Procedures page on the e-Government website of the Ministry of Environment, Urbanization and Climate Change between May 01, 2023, and May 31, 2023, a total of 1,977,512 buildings were filed for damage assessment appeals. Among these appeals, 122,592 buildings underwent secondary damage assessment (approximately 6% of the total number of appealed cases). Damage assessments involve a lengthy and arduous process encompassing multiple stages. Especially in rural areas, many structures are realized by local builders and craftsmen, instead of by professionals who adhere to a specific design methodology and receive architectural and engineering services, consider the regional conditions and existing construction. In rural areas, buildings are commonly classified related to their structural systems as either masonry (load-bearing) or frame construction (Budak et al., 2004). The region consists of the buildings which are constructed with masonry, timber frame, reinforced concrete, and various other building systems, including additions without a formal construction method. This situation not only creates difficulties due to the post-disaster conditions, but also complicates the damage assessment process. Determining the earthquake-related damage to buildings without a specific construction system and built without architectural or engineering services is quite challenging. The damage assessment process should take these factors into account and incorporate the unique characteristics of the local built environment. It is believed that the initial damage assessment was difficult to conduct, and the damage could not be accurately determined due to various reasons, such as unsystematic construction, buildings consisting of multiple additions, and the inability to access certain parts of the buildings, for the buildings where the damage status was appealed and the damage status changed in the second evaluation.

The paper focuses on improving earthquake damage assessment methods in the aftermath of natural disasters like earthquakes. Enhancing earthquake damage assessment methods can help minimize objections to the assessments, thereby reducing the necessity for secondary damage assessments. While appealing for the damage assessment is the legal right of building occupants, preventing unnecessary appeals for buildings that were accurately assessed in the initial evaluation would contribute to a smoother process for the users. However, it should not be overlooked that errors may occur in damage assessments under disaster conditions. Misclassifying a moderately or severely damaged building as slightly damaged or undamaged poses a significant risk to life safety. Conversely, misclassifying a slightly damaged or undamaged building as moderately or severely damaged, may prevent residents from meeting their housing needs and may lead to the loss of their residence. Therefore, it is of great importance that appeals should be made against inaccurate damage assessments for the affected buildings. However, avoiding re-appeals for the buildings where the initial damage assessment was accurate would help to accelerate the process for the benefit of the users. One of the most basic requirements which has the greatest importance is about providing shelter following the disasters like earthquakes. The damage assessment process must be carried out in a timely and reliable manner. The necessity for secondary damage assessments means that homeowners are unable to use their residences during this period. The Kahramanmaraş earthquakes resulted in 122,592 damage assessments being re-evaluated.

This paper aims to propose a method to reduce the number of buildings that require secondary damage assessments. For this purpose, the paper examined case studies of buildings that underwent both initial and secondary damage evaluations, as well as those that received only a single assessment, through interviews with relevant experts. The visual data needed for expert opinion was obtained by using the photographs of the buildings declared for damage on the Ministry of Environment, Urbanization and Climate Change's e-Government platform. The findings suggest that incorporating a more comprehensive approach, including detailed structural assessments and consideration of local construction practices, can lead to more reliable initial damage evaluations and reduce the need for secondary assessments.

2. Conceptual Framework

2.1. Structural Damages Related to Earthquakes

According to the "Principles for Buildings to be Constructed in Earthquake Zones", appendix of the Building Earthquake Regulations in Türkiye, rules for earthquake-resistant design of reinforced concrete buildings have been established. These rules have been presented in different ways, especially for the earthquake-prone regions. The damage assessment process following a major earthquake is a crucial task that determines the safety and habitability of buildings (MoEUCC, 1975).

Based on the observations and research on earthquakes in Türkiye, the damages caused by the earthquake can be primarily attributed to three groups: Design flaws (soft story, short column, strong beam-weak column connections, etc.), Reinforcement issues (inadequate confinement, insufficient or improper anchorage, etc.), and Construction defects (poor workmanship, inadequate supervision, etc.) (Yüksel, 2008).

The basic reasons of the damage in reinforced concrete buildings are typically: Shear errors in columns in basement floors that create a short column effect, design choices that lead to weak and soft story irregularity in commercial spaces, insufficient use of stirrups at column-beam connections resulting in hinge formation at connections, inadequate concrete strength, discontinuity of vertical load-bearing elements across floors causing a reduction in stiffness, insufficient shear and bending capacity, discontinuity of vertical load-bearing elements, improper anchoring, low concrete quality, and problems with concrete placement. Masonry structures are classified according to their reinforcement as either reinforced or unreinforced, and based on their material as brick, stone, concrete block, timber-frame with mud-brick infill, or adobe. In masonry structures, damage is typically concentrated in cantilevered walls and in structures composed of masonry walls with reinforced concrete tie beams.

Post-earthquake damage in masonry structures often includes vertical and diagonal cracks above windows and doors, diagonal cracks in walls, local crushing, horizontal cracks at the upper and lower portions of walls, vertical cracks at the intersections of perpendicular walls, material spalling at wall and window openings, separation at building corners, damage or debonding of tie rods, horizontal cracks at floor levels, and separation and spalling of wall layers (Akbaş & Çalışkan, 2023; İlki et al., 2019). For instance, diagonal cracking patterns are frequently observed around openings, while vertical cracks may develop at wall intersections or due to stiffness differences.

In addition, certain structural irregularities, such as soft-story formations and short-column effects, are known to increase vulnerability under seismic loads (İlki et al., 2019; MoEUCC, n.d.). In some cases, columns modified or partially removed for functional or commercial purposes may lead to unfavourable structural behaviour. Furthermore, variations in construction practices and the presence of unengineered or incrementally modified buildings may complicate the interpretation of observed damage patterns. These conditions may contribute to increased uncertainty in post-earthquake damage assessment processes.

2.2. Legal Process after an Earthquake

Türkiye produced its first earthquake zone map in 1932, initiated its first earthquake mitigation efforts in 1939, and published its first Turkish Building Earthquake Regulation in 1947 (Disaster and Emergency Management Authority, n.d.). Building Earthquake Regulations in Türkiye have been updated over time to reflect advancements in technology, materials, and construction techniques, with various revisions (Disaster and Emergency Management Authority, n.d.). Along with these updates, the laws and implementation regulations have also come to the agenda of administrations with the earthquakes that have occurred, and decisions have been made. In the 1980s, Rehabilitation Reconstruction Plan applications were implemented, and since the 2000s, regional-scale urban transformation discussions have emerged. Following the 2011 Van Earthquake, urban transformation gained further prominence, and in 2012, it was legalized through Law No. 6306 on the Transformation of Areas under Disaster Risk (Ağın Gözükızıl & Tezcan, 2024). These administrative changes and legal regulations are important steps to prevent loss of life and property in future disasters that may occur. The regulations and demolition and reconstruction or strengthening of risky structures are pre-disaster mitigation measures. The primary goals of post-disaster efforts are to minimize loss of lives and property, and to facilitate a swift return to normal daily life (Ağın Gözükızıl & Tezcan, 2024).

Determining the safety and habitability of buildings is a crucial task in the aftermath of major disasters, such as earthquakes, which can lead to loss of life and property. The process following such events must be clearly defined through legal regulations to minimize the impacts of the disaster. In this context, Law No. 7269 (1959) on Precaution and Aid against Disasters Affecting Common Life, dated 1959, is one of the regulations made after earthquakes. The act relates to the measures to be taken and the aid to be provided in case of disasters like earthquakes, fire, floods, earthfalls, or snowslides in which buildings and public facilities are damaged or damaged to the extent that they affect general life. With the second article of the law, a "Disaster Region" has been declared. According to the regulation, a disaster region is declared in situations where deaths and serious injuries occur, at least one-third of agricultural products are damaged, livestock perishes, the construction season is shortened due to climatic conditions, public facilities become unusable or inoperable, and transportation services are limited.

Damage assessments following the disaster were carried out within the scope of Laws No. 7269 (1959) and 5902 (2009). According to the definition of the Ministry of Environment, Urbanization and Climate Change, damage assessment is "the process of observationally evaluating the damage caused by the earthquake to the building by a technical committee consisting of architects and engineers after disasters like an earthquake and classifying it as undamaged, slightly damaged, moderately damaged, severely damaged, urgently demolished and ruined" (MoEUCC, n.d.). When previous damage assessment studies were examined, it was seen that some damage assessments had been evaluated in the upper dangerous group due to the fear of the building collapsing in a possible aftershock or earthquake. Beyond post-earthquake assessments, it is possible to assess the structure before the earthquake. However, the official determinations must be specific to that earthquake. In the damage assessment, attention should be paid to the damage which was not caused by the earthquake, plaster cracks on structural elements, and damage to non-structural elements (İlki et al., 2019). The damage assessment results made by experts are suspended for 30 days in the Local Authority's office and/or in the district governor's office. During this period, homeowners can submit their objections to the damage assessment results through petitions to the Disaster and Emergency Management Authority Provincial Directorate or district governorships. For this objection, a different technical committee is assigned for observing the damage assessment (MoEUCC, n.d.). The post-earthquake process is schematically described in Figure 1.

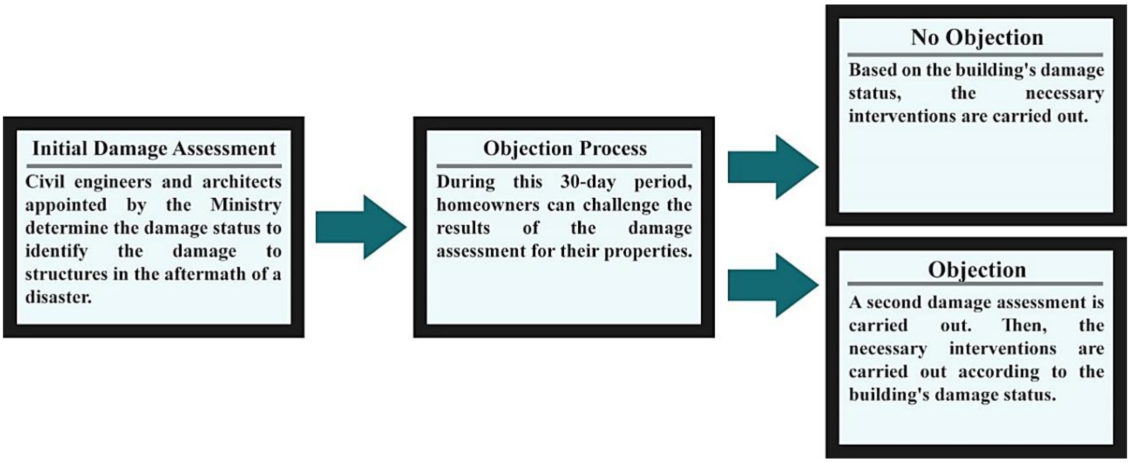

Figure 1: Post-earthquake process (Created by the authors)

2.3. Damage Assessment Classification after Earthquake

The Ministry carries out a damage assessment after earthquakes. In this process, the damage on the structure caused by the earthquake is evaluated, rather than the building's pre-existing defects or prior damage. Based on the assessment results, buildings are classified into different damage categories. These classifications vary across countries, regulations, and references. The classification system used in this study is the official damage classification applied in Türkiye (MoEUCC, n.d.; Grünthal et al., 1998; İlki et al., 2019).

Undamaged: Buildings that have no visible structural or non-structural damage.

Slightly damaged: There is no structural damage but there are slight or negligible damage. This group contains thin cracks on plaster, paint, or walls, fine shear cracks visible on concrete surfaces, and plaster falling from walls.

Moderately damaged: There is light structural and moderate non-structural damage. It includes cracks in the building's columns, beams, and structural walls, cracks in partition and infill walls, falling of fragile coating and plaster, wide cracks observed on the surface, and mortar falling from the joints of wall panels. There are certain requirements for the use of buildings in this group. It is undesirable to use the decrease in the bearing capacity of the structure without improving it by repairing or reinforcing it.

Severely damaged: There is severe structural damage. It includes cracks at the column, beam-column joints, and shear wall joints of the building, large cracks in the partition and infill walls, broad and widespread shear fractures and spilled rust in the bearing elements, compression failure of concrete, cracks formed in structural elements as a result of the breakage of rebars. There is a loss of bearing capacity in buildings that cannot be repaired. They represent irreversible damage in terms of durability and economy. It is undesirable to use these structures identified in this group.

Urgently demolished: These refers to very severe structural damage. This includes the collapse of the ground floor or parts of the building, as well as the permanent displacement of load-bearing elements. The buildings identified in this group cannot be entered or used.

Ruined: There is total or partial destruction of buildings.

The earthquake damage assessments can be divided into two main categories. The undamaged and slightly damaged buildings belong to the non-interventional category, as they have no structural damage. The moderately damaged buildings can be reused if they are strengthened. The severely damaged, urgently demolished, and ruined buildings, however, cannot be reused (Figure 2).

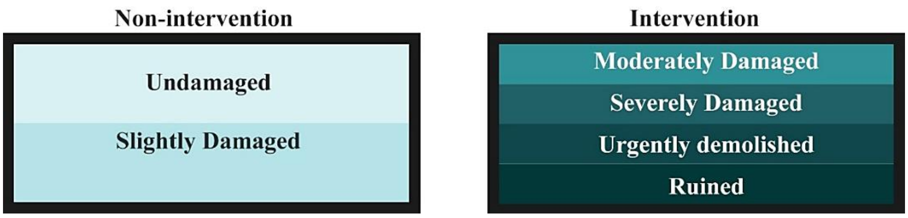

Figure 2: Damage Assessment Classification (Created by the authors)

3. February 06, 2023 Kahramanmaraş Earthquakes

According to the 2018 risk management index, Türkiye is classified as a "high-risk" country (Disaster and Emergency Management Authority, 2018). Between 1901 and 2020, 176 significant earthquakes occurred in Türkiye, resulting in the loss of 94,428 lives and 623,454 buildings (Ağın Gözükızıl & Tezcan, 2023). The region where the February 06, 2023 Kahramanmaraş Earthquakes took place is a region with high seismic potential (Biricik & Korkmaz, 2013). Two major earthquakes in the history of the country (1513 and 1874) affected Kahramanmaraş and its surroundings (Sandal & Karademir, 2013).

Two earthquakes with magnitudes of Mw 7.7 and Mw 7.6 occurred on February 06, 2023, at 04.17 in Kahramanmaraş's Pazarcık district, and on the same day at 13.24 in the Elbistan district of the same province as the epicentre (Disaster and Emergency Management Authority, 2023; Ağın Gözükızıl & Tezcan, 2023; Istanbul Technical University, 2023). The death toll exceeded 50 thousand by March 20, 2023 (Yılmaz, 2023). According to the UNICEF 2023 report, approximately 15 million people, including 13.5 million Turkish citizens and 1.7 million immigrants, were affected by these earthquakes. On March 05, 2023, a total of 1,728,000 buildings had been examined, and 227,027 of them were found to require demolition or urgent demolition due to major damage (Bloomberg HT, 2023). After the earthquake, seventeen provinces affected by the disaster were declared as "Disaster Region" Kahramanmaraş, Adıyaman, Malatya, Osmaniye, Adana, Gaziantep, Hatay, Diyarbakır, Elazığ, Batman, Şanlıurfa, Kilis, Tunceli, Kayseri, Mardin, Bingöl and Niğde (Disaster and Emergency Management Authority, 2023). In addition to the seventeen provinces declared as a "Disaster Region", the provinces of Erzurum, Erzincan, Van, and Sivas were also affected by the earthquake, resulting in a total of twenty-one provinces being influenced by the disaster (MoEUCC, n.d.).

3.1. Damage Assessment and Formal Objections at February 06, 2023 Kahramanmaraş Earthquakes

According to the information published by the Ministry via e-Government, damage assessments were conducted for 1,977,512 structures in twenty-one provinces, based to data between May 01, 2023 and May 31, 2023 (Ağın Gözükızıl & Tezcan, 2023). Following the earthquake, 122,592 objections were made to the first damage assessment results which were conducted between May 01, 2023 and May 31, 2023, according to the information announced by the Ministry through the e-Government platform. When a total of 122,592 objections made in 10 provinces are analysed, it is observed that the damage status of 59,609 buildings has not changed. However, it is observed that the damage status of 62,983 buildings has changed with the examinations made as a result of the objection (Figure 3).

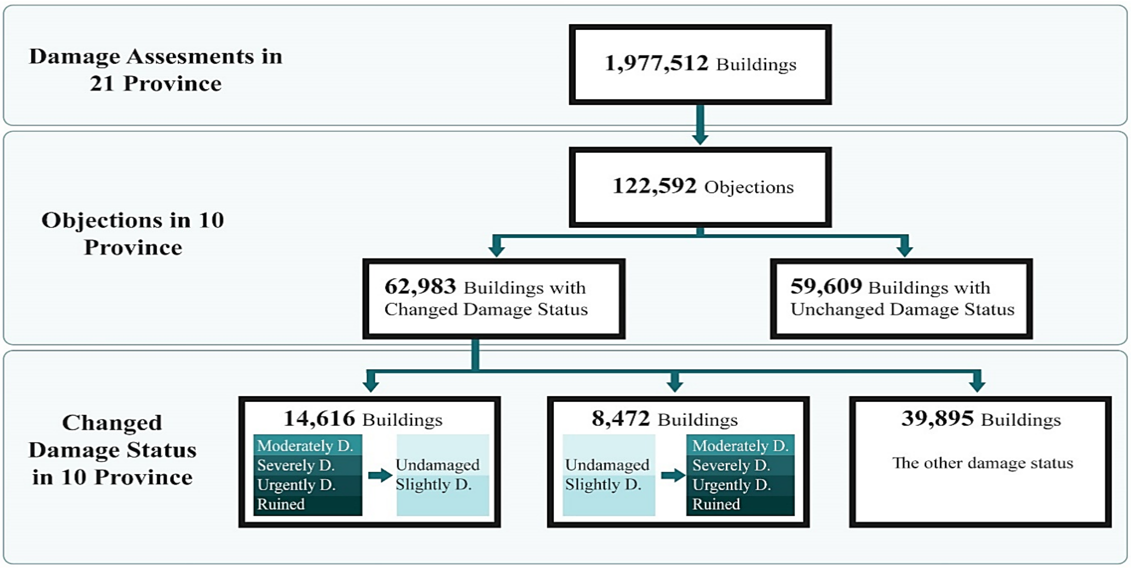

Figure 3: Damage Status (Created by the authors)

4. Methodology

In Türkiye, civil engineers and architects within the Ministry of Environment, Urbanization and Climate Change have been tasked with assessing building damage after disasters such as earthquakes. For events leading to damage exceeding expectations, like the Kahramanmaraş earthquake, civil engineers and architects from other public institutions (e.g., municipalities, universities) have also been nominated. This study interviewed architects and engineers from these other public institutions, none of whom were directly involved in the damage assessments for the Kahramanmaraş earthquake. The expert group for the study was composed of 10 professionals, comprising 5 architects and 5 civil engineers. The 5 architects were municipal employees in Istanbul, while the 5 civil engineers were from a public university in Izmir. Except for one of the architects, all participants had previous experience in construction supervision, site management, or similar field-related roles. Two civil engineers and one architect had experience as expert witnesses on various subjects. Five civil engineers had experience in post-earthquake damage assessments of university buildings. The architects consulted for expert opinions, however, they had not been involved in post-earthquake damage assessments. The study focused on 18 buildings that were affected by the February 06, 2023 Kahramanmaraş earthquakes. The experts were shown photographs of the buildings for which damage assessments were conducted after the Kahramanmaraş earthquakes and were asked to provide their interpretations. The photographs were presented to the experts without any time limitation, allowing them to examine the images as long as they deemed necessary. Ethics committee approval was obtained from the relevant university for the methodology involving expert interviews.

In the paper, the photographs of damage assessment cases, shared by the Ministry of Environment, Urbanization and Climate Change through e-Government, were used. As stated in the paper, these photographs are publicly accessible via the e-Government platform, allowing users to review the damage assessment results. However, the limited availability of visual data, either due to the absence of photographs for many buildings or the lack of sufficiently descriptive images, affects both the evaluation and objection processes.

The paper scanned all 62,983 buildings where the damage status changed from requiring intervention to not requiring intervention, or vice versa. These 23 buildings do not constitute a deliberately selected sample; rather, they represent all cases for which visual data were available among the 62,983 reviewed cases. To gather the necessary data for the study, each of the 62,983 buildings was examined individually from the e-Government platform over approximately a 4-month period. Due to the limited availability of photographs shared under the "Damage Assessment Information" section on the e-Government platform, the selection of examples was also quite restricted. After this detailed review, the photographs of only 23 buildings were accessible, where the damage status changed from requiring intervention to not requiring intervention, or vice versa. The paper selected 6 examples from a total of 23 buildings in ten provinces. The selected examples had photographs from both the interior and exterior of the buildings, allowing a clearer understanding of the damage status. Among these 23 buildings, only 6 cases included both interior and exterior photographs, allowing a more comprehensive interpretation of damage conditions; therefore, these cases were used in the study. Subsequently, a further review was conducted, and 6 buildings with unchanged damage status and 6 buildings with no objections to their damage status were randomly selected. Consequently, 18 buildings were chosen to be assessed by expert opinion (Figure 4).

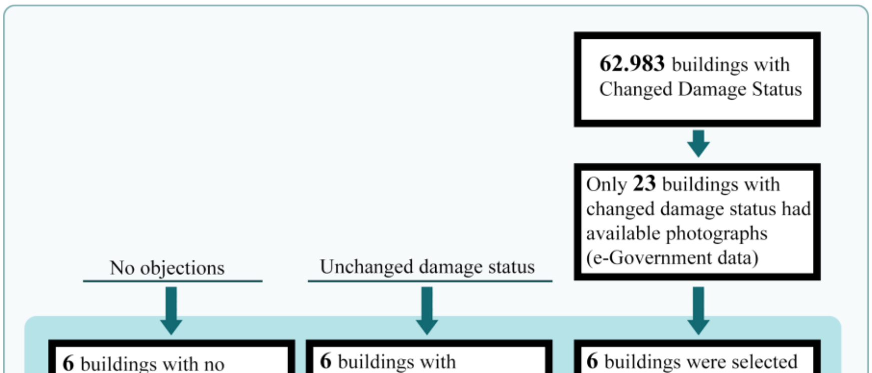

Figure 4: Building Selection Process for Expert Evaluation (Created by the authors)

The experts were not informed about any building-specific information regarding the damage status or whether there were objections to the damage status or not. After the photos of each sample were shown, the experts were asked to determine the damage status. Only written notes were taken during the evaluation process. The photographs were presented in a mixed order without providing any information about the damage status of the buildings or whether their damage status had changed (with photographs belonging to the same building grouped together).

5. Results

5.1. Buildings with no objections raised against the damage assessment result

In buildings without damage appeals, the experts' opinions are consistent with the damage assessment results. Based on the expert opinions, for Building 4, all participants except for one indicated that the building had slight damaged or was undamaged. For Buildings 1 and 6, all participants except for two stated that the buildings had slight damage or were undamaged. For Buildings 2 and 5, all participants agreed that the buildings had slight damaged or were undamaged, and therefore, no intervention was required. In Building 3, all participants agreed that the building had damage requiring intervention. The experts' opinions align with the Ministry's damage assessments in all 6 buildings where there were no appeals to the damage determinations (Table 1).

Table 1: No objection to damage assessment result (Created by the authors)

		Building 1	Building 2	Building 3	Building 4	Building 5	Building 6
Assessment by experts	Architect 1	Un.	Un.	MD.	SD.	SD.	SD.
	Architect 2	Un.	Un.	MD.	SD.	Un.	SD.
	Architect 3	Un.	Un.	MD.	MD.	Un.	SD.
	Architect 4	SD.	Un.	SevD.	SD.	Un.	MD.
	Architect 5	Un.	Un.	MD.	SD.	Un.	SD.
	Civil Engineer 1	SD.	Un.	SevD	SD.	Un.	Un.
	Civil Engineer 2	MD.	Un.	SevD	SD.	Un.	MD.
	Civil Engineer 3	SD.	Un.	SevD	SD.	Un.	SD.
	Civil Engineer 4	MD.	Un.	SevD	SD.	Un.	Un.
	Civil Engineer 5	SD.	Un.	SevD	SD.	Un.	SD.
Assessment by ministry experts	First Detection	Un.	Un.	MD.	SD.	Un.	Un.
	Second Detection	-	-	-	-	-	-

Damage categories are abbreviated as follows: Undamaged: Un
Slightly Damaged: SD
Moderately Damaged: MD
Severely Damaged: SevD

Based on the expert opinions on the buildings without any objections:

- About Building 1, the participants who assessed it as moderately damaged stated that the photographs were insufficient and it was unclear whether the crack was a plaster crack or a structural one.
- For Building 2, all participants indicated that it was undamaged.
- In Building 3, the participants had the same opinion about the need for intervention.
- About Building 4, the participant who assessed it as moderately damaged stated that the crack on the wall could not be understood and there might also be damage to the load-bearing elements.
- In Building 5, one participant indicated that although it was not a structural issue, there was damage in the areas where the plaster was missing.
- For Building 6, the experts who assessed it as moderately damaged stated that the damage might be in the load-bearing element.

Buildings 1–6 are presented in Figure 5.

Figure 5: No Objection Buildings

5.2. Buildings with no change to the damage assessment result

The experts agreed with the Ministry of Environment, Urbanization and Climate Change about these buildings whose damage was assessed for the second time and the damage status was the same in both evaluations (Table 2). For Buildings 8 and 9, all experts agreed that the buildings were undamaged and did not require intervention. For Buildings 11 and 12, all experts shared the opinion that the buildings required intervention because of the damage. For Building 7, except for one, all participants indicated that the building had damage requiring intervention. However, the participants noted that the roof damage and suggested there could be unobserved severe damage to the load-bearing system. One participant, by focusing on the roof damage, indicated that the load-bearing system could be damaged due to roof damage, and specifically evaluated it as severely damaged. For Building 10, most of the participants stated that interior photos were needed, as the visible crack from the outside could be a shear crack which could cause severe damage, and more photos would be important for accurate assessment.

Table 2: No change to the damage assessment result (Created by the authors)

		Building 7	Building 8	Building 9	Building 10	Building 11	Building 12
Assessment by experts	Architect 1	SD.	Un.	Un.	SD.	SevD	SevD
	Architect 2	SD.	Un.	Un.	Un.	SevD	SevD
	Architect 3	Un.	Un.	Un.	Un.	SevD	SevD
	Architect 4	SD.	Un.	Un.	Un.	SevD	MD.
	Architect 5	Un.	Un.	Un.	Un.	MD.	MD.
	Civil Engineer 1	SevD	Un.	Un.	Un.	SevD	SevD
	Civil Engineer 2	SD.	Un.	Un.	Un.	SevD	SevD
	Civil Engineer 3	SD.	Un.	Un.	SD.	SevD	SevD
	Civil Engineer 4	Un.	Un.	Un.	Un.	SevD	SevD
	Civil Engineer 5	SD.	Un.	Un.	SD.	SevD	SevD
Assessment by ministry experts	First Detection	SevD	Un.	SD.	SevD	SevD	SevD
	Second Detection	SevD	Un.	SD.	SevD	SevD	SevD

•In Building 7, roof damage was the primary issue highlighted by the participants. It was noted that it was unclear from the photos whether the load-bearing system had been damaged or not. The building's poor quality was also mentioned.

•In Building 8, all participants reported no observable damage.

•In Building 9, while the participants stated that the building was undamaged, they noted the difficulty in making a conclusive assessment due to the absence of interior photos.

•In Building 10, the evaluations indicated undamaged or slightly damaged. However, the participants emphasized that the crack visible from the outside should also be inspected from the inside, since there could be unseen damage.

•In Building 11, one participant assessed it as moderately damaged, while the others classified it as severely damaged. The building's poor quality and the unclear construction system were the main issues discussed.

•For Building 12, all experts shared the opinion that the building required intervention because of the damage.

Buildings 7–12 are presented in Figure 6.

Figure 6: Unchanged Damage Assessment Buildings

5.3. Buildings with a change to the damage assessment result

In buildings where there were objections to the damage assessment and the second evaluation differed from the first one, the opinions of the experts were also quite different (Table 3). In Building 13, the expert opinion aligns with the second assessment, not the first. However, in the other five buildings, the expert opinions are in agreement with the first assessment.

Table 3: Change to the damage assessment result (Created by the authors)

		Building 13	Building 14	Building 15	Building 16	Building 17	Building 18
Assessment by experts	Architect 1	SD.	SD.	SD.	SD.	MjD	MD.
	Architect 2	SD.	SD.	SD.	MD.	MjD	SD.
	Architect 3	SD.	MD.	MD.	MD.	MjD	SD.
	Architect 4	MjD	MjD	MD.	MjD	MjD	MjD
	Architect 5	SD.	MD.	SD.	MD.	MD.	MD.
	Civil Engineer 1	SD.	MjD	Un.	MjD	MjD	MjD
	Civil Engineer 2	SD.	MjD	SD.	MjD	MjD	MjD
	Civil Engineer 3	SD.	SD.	MD.	MjD	MjD	SD.
	Civil Engineer 4	SD.	MjD	SD.	MjD	MjD	MjD
	Civil Engineer 5	SD.	MjD	SD.	MjD	MjD	MD.
Assessment by ministry experts	First Detection	MjD	MjD	SD.	MjD	MjD	MjD
	Second Detection	SD.	SD.	MjD	SD.	SD.	SD.

In buildings, where the damage assessment changed after the second evaluation, expert opinions at the building scale vary among themselves for each structure.

•In Building 13, the participant who assessed it as severely damaged stated that there was damage to the load-bearing wall and the roof. Those, who assessed it as slightly damaged, think that the damage was limited to the infill walls and did not cause any damage to the load-bearing system.

•In Building 14, those who assessed it as slightly damaged suggested that the vertical crack seen in the free-standing column which was suspected to be the part of an addition made later, was probably a plaster crack. Those who rated it as moderately damaged did so because the damage appeared to be limited to a single column in the photo. Those who assessed it as severely damaged believed there was damage to the load-bearing system and that there could also be unseen damage not visible in the photos.

•In Building 15, participants who considered it undamaged or slightly damaged reported no visible damage to the load-bearing system. Those who assessed it as moderately damaged mentioned that there might be damage not visible in the photos, such as cracks that appeared in the walls. Structural issues like the building's poor quality and the thickness of the slab were also noted.

•In Building 16, participants who rated it as moderately or severely damaged pointed out damage to the load-bearing system, particularly at the beam-column joints. Those who assessed it as severely damaged noted visible reinforcement, shear cracks, plastic hinges, and a compromised frame system.

•In Building 17, the damage was reported by participants as severe with visible reinforcement, deformed stirrups, and other reinforcements, indicating the structure had been significantly stressed.

•In Building 18, participants who rated it as slightly damaged believed that the damage, because it is located in the terrace area, did not affect the structure. Those who rated it as moderately damaged thought the damage at the top of the column could be resolved with reinforcement. Those who assessed it as severely damaged suggested that there might be load-bearing damage elsewhere in the structure. The building quality, materials, and construction techniques were again emphasized as important factors.

Buildings 13–18 are presented in Figure 7.

Figure 7: Changed Damage Assessment Buildings

6. Evaluation

Damage assessment is the process of classifying the damage to buildings caused by disasters. It is a preparatory step for implementing post-disaster measures such as emergency aid, rental assistance, entitlement determination, and site selection following the disaster. The damage assessment does not include an evaluation of the resilience of the building or its strength before or after the disaster (Disaster and Emergency Management Authority, n.d.). Although the proportion of cases subjected to a second damage assessment is approximately 6% (122,592 out of 1,977,512 buildings), this ratio should be interpreted with caution. Even a limited number of misclassifications may have critical consequences, as damage assessment outcomes directly affect decisions regarding the continued use of buildings. Therefore, the significance of the issue should not be evaluated solely based on numerical ratios. In this context, the distinction between cases with and without objections provides a useful basis for understanding how users interpret damage assessment outcomes.

The study is categorized into three groups: Buildings with no objections, buildings where the damage assessment changed after an objection, and buildings where the assessment remained unchanged after an objection. The experts were asked to reassess buildings in these three categories based on the damage photos available.

The evaluations are based on the experts' opinions and assessments as follows: they were considered both individually and in terms of the consistency and divergence among expert interpretations.

- When the methods they would recommend for the damage assessment were asked, participants emphasized the importance of conducting the damage assessments through on-site observation. Considering the post-earthquake conditions, the experts stated that the damage assessment should begin immediately after the disaster.
- Some participants indicated that it is possible to document with the photographs related to the buildings which are moderately damaged and severely damaged. However, it is not possible to document the absence of structural damage for slightly damaged and undamaged buildings by photographs. Nevertheless, structural damage can be photographed in many buildings. Thus, it will be possible to reduce the number of future objections for moderately and severely damaged buildings.
- Another important issue expressed by the participants is the need for scaling in the photos to make the size of the cracks more understandable. Scaling cracks would improve the clarity of the photographs.
- According to the experts, in addition to taking photographs, video recording is an important piece of evidence in determining the damage to a structure. This indicates that the level of visual detail directly affects users' trust in the assessment results. The guide (2023) published by the Ministry of Justice after the February 06, 2023 Earthquake also emphasizes the importance of high-quality and detailed photography, while also mentioning the importance of video recording. The benefit of using a drone for this video recording has also been emphasized.
- The most significant conclusion to be drawn from the differences in damage assessments is the necessity of improving building quality. Another issue is construction quality and the possibility that the damage is not caused by an earthquake. Many experts have noted the need for additional information. The subject of building quality and the possibility that the damage may not be earthquake-related were also mentioned.
- It was observed that the expert opinions about the buildings without objections to the damage assessment aligned with the assessments made by the initial inspection team. In buildings where there were objections but the first and the second evaluations were the same, the expert opinions matched the damage assessment results in the four cases. In the buildings where there were objections and the second evaluation differed from the first one expert opinions were mostly

varied. This illustrates the reasons for the objections. The expert evaluations for the buildings in this category showed significantly different results from each other.

In this paper, the photographs were obtained from the Ministry's publicly accessible website. However, after acquiring the general data on the buildings, the authors proceeded to obtain visuals related to the objections from the system. During this process, it was observed that the visuals for the buildings with objections were very limited on the pages. This limitation also restricts the comparability of cases and highlights the dependency of assessment processes on available visual data. This situation required selecting buildings with available photos for each category, rather than choosing them according to the categories of the study for each objected building. Many of the buildings in the region, where the selected samples are located, were constructed by homeowners by themselves without receiving any architectural or engineering services, consisting of poorly constructed and makeshift buildings with low construction quality. Determining the damage after disasters such as earthquakes, is very difficult for the buildings that were not built using scientific methods. This fact again shows the importance of constructing the buildings in accordance with the architectural and engineering services, following the rules of science, art, and regulations.

The participants, whose expert opinions were consulted, stated that the photos were insufficient for damage assessment and emphasized the importance of on-site observation. One of the main reasons for this is the possibility of unseen damage. In these examples, it can be said that the photos documenting the damage more comprehensively could potentially prevent objections to the initial assessments. These findings highlight that the challenge in damage assessment is not solely related to technical accuracy, but also to how assessment outcomes are communicated and interpreted by users, which directly influences objection dynamics.

7. Conclusion

The Kahramanmaraş Earthquakes, which occurred on February 06, 2023, and affected a vast region, became one of the most devastating earthquake in Türkiye's disaster history, due to the destruction and loss of lives they caused. The outcomes of this earthquake have become a significant field of observation in terms of long-standing efforts in disaster management, urban transformation, awareness of disaster and the prevention of potential disaster outcomes. It is crucial that damage assessments are conducted accurately and quickly. The study focuses on cases where undamaged or slightly damaged buildings are classified as moderately or severely damaged, and vice versa, where moderately or heavily damaged buildings are classified as undamaged or slightly damaged. Assessing damage incorrectly, especially when buildings requiring intervention (moderately or severely damaged) are categorized as undamaged or slightly damaged, causes significant safety risks. On the other hand, incorrectly classifying undamaged or slightly damaged buildings as moderately or severely damaged can lead to financial losses. When the importance of housing is taken into account after a disaster, the necessity of accurate assessments becomes even clearer. The examples in the study, for which objections were raised and the damage classifications were changed reveal that various factors can lead to incorrect assessments during the damage evaluations. These cases demonstrate that misinterpretation may arise not only from technical factors but also from limitations in documentation and communication.

In such cases, homeowners play a crucial role in ensuring the proper functioning of the process by filing objections. On the other hand, examples where the damage status did not change or where no objections were raised show that proper documentation can reduce the likelihood of objections to damage assessments. This reflects the user-centred nature of the assessment process, where perception and interpretation influence decision-making. Including photos that adequately explain the damage and an accompanying report in the initial damage assessment will prevent the need for a second assessment. Therefore, improving the clarity and comprehensiveness of visual documentation becomes a key factor in enhancing the overall effectiveness of the assessment process. This will eliminate the need for civil engineers and architects from different cities to revisit the earthquake zone for further assessments, thus saving labour resources. Homeowners can continue using their undamaged or slightly damaged buildings, addressing the housing needs of many earthquake survivors. Intervention in moderately damaged buildings can be expedited, while heavily damaged buildings can be demolished quickly. Damage assessments across the earthquake zone can proceed more efficiently. The conclusions drawn from the damage assessments following the Kahramanmaraş earthquake offer valuable guidance for future disasters. The responses of the experts were also considered in terms of their consistency, and while minor differences in interpretation were observed, the overall evaluations showed a general convergence. These findings have been interpreted qualitatively rather than through a numerical agreement analysis. In this context, the study contributes to the literature by approaching damage assessment from a user-oriented perspective and by emphasizing the role of communication and interpretation in reducing objection processes.

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