A Business Continuity Perspective on Losses and Recovery Processes in Organized Industrial Zones After 2023 Kahramanmaras Earthquakes

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Abstract

February 6th, 2023, Kahramanmaras Earthquakes with magnitudes of Mw7.7 and Mw7.6 occurring 9 hours apart caused enormous damage and loss of lives in an extensive area in Turkiye. The industrial facilities in the region suffered from structural and non-structural damage, and business continuity was disrupted consequently. Facilities in the organized industrial zones (OIZ) located in the disaster area, especially Kahramanmaras, Gaziantep and Iskenderun, had various levels of earthquake damage, and some facilities became completely unusable. Labor losses caused immediate disruptions in industrial activities and considerably hindered business continuity. This study presents the survey outcomes held in the OIZ of disaster area to identify the problems arising after the earthquake, the effect of structural damages, damage estimation process and retrofit studies on business activities, and recovery situation one year after the earthquake. The solutions derived by the business owners and OIZ managements are investigated, and the function of business continuity plans are discussed to contribute reducing future disaster impact risks. In cooperation with the Gaziantep Branch of the Chamber of Civil Engineers, a workshop was organized with stakeholders, namely OIZ management, local authorities, civil engineers and business owners, to discuss the problems experienced during and after the earthquake and the function of business continuity plans for better recovery.

Key words: 6 February 2023 Kahramanmaras Earthquakes, Business Continuity Plan, Disaster Resilience, Disaster Recovery

1. Introduction

6 February 2023 Mw7.7 and Mw7.6 Kahramanmaras earthquakes caused devastating damage and loss of lives in 11 provinces of Turkiye as Kahramanmaras, Hatay, Gaziantep, Malatya, Diyarbakir, Kilis, Sanliurfa, Adiyaman, Osmaniye, Adana and Elazig. According to official records, 50,783 people died, 115,353 people were injured and 37,984 buildings were destroyed due to the earthquake[1)]. Industrial activities were highly affected due to various reasons, one of which was mostly migration from disaster area to the unaffected cities in the neighborhood. The reasons for business continuity disruption need to be investigated for identifying the damages and losses and developing strategies of preventing economic losses in the future.

Business continuity plans can be defined as a prevention and recovery procedure against potential threats that an industrial facility or company may face[2)]. They include impact analysis, post-impact recovery strategies, testing procedures and efforts to ensure their sustainability[3)]. The international standard for Business Continuity Management Systems (ISO 22301) defines the business continuity as “the ability of an organization to continue to provide products and services within acceptable time periods at a predefined capacity in relation to any interruption” [4)]. These definitions are concepts that need to be well understood to work on the planning deficiencies revealed by the production losses in the disaster area in Turkiye, after the 2023 Kahramanmaras earthquakes.

In this study, surveys were carried out with the officials of the Kahramanmaras Turkoglu, Gaziantep and Iskenderun Organized Industrial Zones (OIZ) in order to provide guidance to the establishments affected by the

Kahramanmaras earthquakes due to business continuity disruption and to find out the main reasons for the losses, and to obtain information on the situation of production capacity one year after the earthquake. On the other hand, when developing business continuity plans, one of the most essential resources required for the priority activities of the industrial facility is water and wastewater services. Since interruptions due to damage of infrastructure systems will affect business continuity, alternative structures or backup resources must be planned beforehand. For this reason, meetings with Hatay Metropolitan Municipality General Directorate of Water and Sewerage Administration (HATSU) officials were held to discuss the infrastructure damage caused by the earthquake and the current situation of the water and wastewater systems.

2. Survey in Organized Industrial Zones

Meetings were held with officials from the management of Kahramanmaras Turkoglu, Gaziantep and Iskenderun Organized Industrial Zones on 5-7 March 2024 to discuss their losses and recovery processes in business continuity perspective.

2.1 Gaziantep OIZ

In our meetings with Gaziantep OIZ Technical Works Manager Architect Selim Sancili, we received information about the situation and the recovery process in the OIZ after the earthquake (**Fig. 1**).

Fig. 1 Gaziantep OIZ Technical Works Manager Architect Selim Sancili and the project team (from left to right: Asst. Prof. Dr. Ahmet Anil Dindar, Asst. Prof. Dr. Ceren Ozer Sozdinler, Prof. Dr. Selcuk Toprak, Architect Selim Sancili, Prof. Dr. Bulent Akbas).

Gaziantep OIZ is the largest one in Turkiye having 1,250 companies of various sizes and business sectors. Due to the Kahramanmaras earthquakes, there were no facilities destroyed but 22 buildings had moderate damage. It was reported that there was no electricity or water outage due to the earthquake within the OIZ. They only had natural gas outage due to the problem in the natural gas pipes bringing natural gas to the Gaziantep city for about 5 days. After the earthquake, OIZ management employees and their families temporarily sheltered in the OIZ premises for a week to have heating and food. In addition, OIZ also served food to about 5,000 residentials using the gas remaining in the large-diameter pipes even though the natural gas is cut off. Production of industrial facilities was interrupted for one week, and after that the facilities gradually resumed production, and came back to the pre-earthquake conditions within 15 days.

2.2 Kahramanmaras Turkoglu OIZ

Interviews were held with Regional Manager Civil Engineer Ömer Sağlam of Kahramanmaras Turkoglu OIZ, which was more affected by the earthquake and experienced permanent problems compared to Gaziantep OIZ, and details was obtained about losses and production problems (**Fig. 2**). There are 15 companies and approximately 2,000 employees within the OIZ generally in the sectors of textile, plastic, metal, recycling and air separation.

Fig. 2 Visit to Kahramanmaras Turkoglu OIZ and meeting with Regional Manager, Civil Engineer Omer Saglam (with the participation of the project team, students and Japanese researchers Prof. Mayumi Sakamoto and Dr. Yohei Chiba).

Turkoglu is one of the most damaged OIZs in the disaster region. During the earthquake, one prefabricated building under construction, an idle reinforced concrete building (roof trusses fell off) and a storage unit of a facility were destroyed. While five facilities were found to be slightly damaged, the remaining facilities were found to be moderately and heavily damaged and in urgent need of demolition (**Fig. 3**). After the damage assessment studies, there was a change from heavy

Fig. 3 Structural damage at precast reinforced concrete buildings in Kahramanmaras Turkoglu OIZ due to Kahramanmaras Earthquakes.

to moderate damage in some facilities that used their right to object to the decision. The court processes are continuing in some facilities to date.

The infrastructure systems in Kahramanmaras city suffered major damage due to the earthquake where there was no electricity supply for the first two days. Fortunately, neither natural gas nor water outages occurred in the OIZ.

In the first month after the earthquake, only one company was in operation, which was an air separation plant having an automation production system in production without any need for labor. While three companies were operating until the end of four months after the earthquake, 7-8 companies started production in the 6th month.

In order to support the workers and families who lost their homes due to the earthquake, 30 containers and many tents were established by Superorganized Industrial Zones Organization (OSBUK) in cooperation with the OIZs outside the disaster area. Financial aid was collected through OSBUK and forwarded to the Presidency of Turkiye, and financial support was provided to affected OIZs. Simultaneously, a sister OIZ initiative was led by OSBUK, designating two sister OIZs outside the earthquake zone to support each OIZ affected within the earthquake zone. This system accelerated the recovery of the damaged OIZs.

The most important problem experienced in OIZ after the earthquake is the workforce loss. The reason for this is not loss of residents or migration to unaffected regions, but the transition of workers working in OIZ facilities to the construction sector with the beginning of the restructuring process in the region. For this reason, the facilities that repaired their damages and started production could not return to their pre-earthquake production capacity. Although various incentive plans were being made to reintegrate employees into the industry, no concrete implementation has been made until the date this report was prepared. A few organizations are trying to get back to production levels by bringing workers from different cities to their facilities.

The material suppliers to the OIZ companies are mainly established in the USA for textiles, and OIZ companies' customers are in Europe and the Middle East. Since they are outside the earthquake zone, there was no production loss due to suppliers and customers.

The highway used to access the OIZ was damaged, creating additional challenges for the organizations. To diversify transportation options, studies on connecting OIZs to ports are underway across the country. These connections can include alternatives such as rail systems.

There are no facilities among OIZ member organizations that have a business continuity plan. OIZ management participated in the meetings organized by AFAD before the earthquake and discussions were held on disaster preparedness plans. However, no plan could be put into practice after the Kahramanmaras Earthquakes due to various factors.

Turkish government has initiated a large investment plan in Turkoglu OIZ to compensate for the losses experienced after the earthquake and to contribute to its development. For this purpose, The Turkish Aircraft Industry Joint Stock Partnership (TUSAS) facility was established to create a positive environment for the OIZ management and employees.

2.3 Iskenderun OIZ

Iskenderun Organized Industrial Zone management was visited to discuss the problems experienced in the industrial facilities after the Kahramanmaras Earthquakes, the recovery process and the current situation (**Fig. 4**). There are 45 industrial facilities within Iskenderun OIZ where the majority of them were on iron and steel production as well as energy systems.

There was no power outage due to the earthquake; the water and natural gas outage was short-lived and had no negative impact. After the earthquake, the OIZ management organized and provided tents and containers very quickly. Employees and their families solved their housing problems in the first place.

Production started gradually 2 weeks after the earthquake. There were losses of up to 50% in production capacities in the first months. Since the third month after the earthquake,

Fig. 4 Visit to Iskenderun OIZ management and an industrial facility producing metal.

Fig. 5 Meeting with HATSU officials and a view of earthquake damage in Hatay.

capacity has increased, and production levels have now returned to pre-earthquake levels. In this case, the high effort and individual efforts of the workers were very effective.

Approximately 300 people who were working in the OIZ lost their lives in the earthquake and about 30,000 people migrated from Iskenderun. On the other hand, many people from Hatay moved to Iskenderun due to the devastation caused by the major earthquakes. There was an overall decrease in the population by 3,000 people. However, immigration and deaths did not cause a loss of workforce in this OIZ, because the high wages in heavy industry producing iron and steel and the employers supporting their employees with additional wages prevented the loss of workforce. This situation was the opposite in Turkoglu OIZ, where the textile sector with lower wages was dominant.

3. Earthquake-induced Infrastructure Damages in Hatay

Officials from Hatay Metropolitan Municipality General Directorate of Water and Sewerage Administration (HATSU), as being the responsible authority for water service and sewerage systems in Hatay, provided information about the damage and losses in infrastructure systems after Kahramanmaras Earthquakes (**Fig. 5**). Due to the Kahramanmaras Earthquakes, serious damage occurred in the steel transmission pipelines in Hatay. Additional information on the structural performance of the pipelines can be found at Toprak *et al.*, 2024 [5, 6]. While there was no damage in ductile pipes, damage occurred in old asbestos cement pipelines. It was observed that ductile and polyethylene pipes were resistant to earthquakes effects observed in the province. For example, in Kirikhan, one of the most severely damaged towns in Hatay, there were no water outages in the areas where the network was renewed.

There was slight earthquake damage to the dam and water purification facilities, while serious damage occurred in the wells. Water service gradually started to be provided 5 days after the earthquake.

Currently, 190 container cities have been set up in Hatay city, for which providing water service requires a lot of workloads and costs. At this stage, new infrastructure works are carried out under the coordination of State Hydraulic Works, Ilbank (state-owned development and investment bank subordinated to the Ministry of Environment, Urbanization and Climate Change) and General Directorate of Highways. Afterwards, HATSU takes over and operates the system. International funds and financial resources will also be used for new infrastructure works in Hatay. One of the most important problems experienced in the region was the increase in water and sewage capacity needs in small villages and neighborhoods due to immigration and population change. Since there was no advance planning for new water networks in rural areas and the population increased very rapidly, serious water and infrastructure problems occurred in these regions. The municipality has been directing its workforce to work on capacity increase to meet the most increasing demand.

There were no business continuity plans in either HATSU or Hatay Metropolitan Municipality; but a large-extended coordination and earthquake drill was held a month before the earthquake. All the components of disaster emergency

and response such as evacuation, response to demolitions and first aid were tested. However, these plans could not be implemented during the earthquake because the entire plan was based on mobile phone communication which extensively failed or inefficient. One of the most important lessons learned was the use of alternative communication channels, independent of the telephone network, such as radio systems or satellite phones.

4. Questionnaire for Industrial Organizations in OIZs

In this study, a questionnaire consisting of 10 questions was prepared aiming to examine the earthquake damage, losses and problems that occurred in industrial facilities after the 6 February 2023 Kahramanmaras Earthquakes in terms of business continuity. The survey, which was sent digitally to Turkoglu and Gaziantep OIZ managements, was requested to be shared with the officials of the member industrial organizations without asking any institutional or personal information. However, only three companies were willing to participate in the survey due to the fact that they might be tired and psychologically worn out after the earthquake, and therefore they would not want to hold further discussions on the issue after they start production.

All three facilities are of precast reinforced concrete structures, two of which were determined to be moderately damaged and one to be severely damaged. In one of the three facilities, a re-examination was made after the damage determination of the Ministry of Environment, Urbanization and Climate Change, and the damage level was changed.

Due to loss of lives or forced migration after the earthquake, there was a loss of workforce at a level that would affect production at high, medium and low levels in these industrial facilities. Two of the industrial facilities stated that they had an earthquake emergency plan before the 6 February 2023 Kahramanmaras Earthquakes, while one facility did not. None of them had a business continuity plan in the industrial facility before the earthquake.

Retrofit works were carried out after detecting structural damage to two industrial facilities. In one of them, building performance analysis and retrofit were carried out, and then a permit was obtained from the Ministry of Environment, Urbanization and Climate Change for starting the industrial activities at the facility. It was stated that production activities in all three industrial facilities could return to pre-earthquake levels in less than one month after the earthquake.

5. Discussion of Outcomes and Conclusions

The survey outcomes obtained throughout the research period are summarized below:

(1) Business continuity plans, which allow production facilities or companies to prepare for and prevent potential damages that may arise from natural disasters and aim to prevent production losses, are not yet widely implemented in Turkiye. Within the scope of this study, no industrial facility or OIZ member organization that had business continuity plans or implemented post-earthquake plans could be identified in the disaster area affected by the Kahramanmaras Earthquakes.

(2) OIZ managements do not instruct their member organizations to prepare emergency action plans or business continuity plans. However, various precautions were taken, and drills are carried out against potential effects (e.g. fire, chemical pollution, etc.) within the borders of the OIZ.

(3) Considering the destruction, losses and structural damage caused by the Kahramanmaras Earthquakes in an extensive area, most industrial facilities in the region recovered in a much shorter time and returned to pre-earthquake production levels compared to other examples in the world. The most common reasons for the companies to show a rapid recovery process are: i) the individual efforts of the employees, ii) the material/financial aid and moral support provided by the employer to its employees, and iii) the support of OIZ sister-organizations. Companies that provide financial support to their employees have been able to prevent migration and workforce loss to some extent by ensuring that their basic needs are met.

(4) While making precautionary and rescue preparations such as business continuity, disaster preparedness, emergency action or coordination plans, it is vital to base the operation of the plans on uninterrupted communication channels instead of channels that may be interrupted due to an earthquake, such as mobile phones, internet, landline, etc. It will not be possible to implement the plans prepared without rapid communication after the disaster.

(5) The participants of training workshop on the impact of damages and losses after the Kahramanmaras Earthquakes on business continuity stated that they benefited from the presentations and that it is very important to repeat the seminars on similar subjects.

(6) Water, sewage and natural gas infrastructure systems being resistant and equipped against earthquakes shortens the recovery and reconstruction processes after major earthquakes. In addition, migration after major earthquakes and unforeseen population growth in small settlements cause infrastructure systems to become inadequate, which brings additional workload to local governments. Such situations should be taken into consideration as potential negative impacts during disaster preparedness studies and business continuity

plans.

(7) The earthquake damage evaluation of structures with precast bearing systems must be different from the evaluation of residential type structures. During the initial post-disaster evaluation process of earthquake performance in precast buildings, disruption in business continuity in some industrial facilities occurred as a result of inconsistent assessment. For avoiding this situation, it may be possible to practically determine the amount of vertical bending in the column axis and use the ratio of the bent columns to the total number of columns, as a more realistic and measurable approach. At the same time, determining the rotation values in the column-beam region according to the column is recommended as another damage quantification method.

(8) When it is desired to have an effect throughout the building system in retrofit works, it is possible to add elements that provide rigidity to the column edge plane and column-beam region to increase the existing rigidity. Rigid facade coverings can be added to the frame system with special connections, or slender steel elements preventing from buckling can be connected in-plane in successive axes. Another method may be adding devices that provide damping and stiffness at the beam-column connection point.

(9) The low number of participants in the questionnaire may be explained with the employers being exhausted and psychologically worn out due to the problems struggled after the earthquake. Another reason is that employers who have restarted production after various difficulties believe that the threat of a major earthquake has passed in the region and the probability of it happening again is low in the near future.

(10) The presence of a small number of typical elements in precast structures provides an advantage, allowing strengthening methods to be arranged quickly and easily. This makes it possible to ensure business continuity and control the social reflection of material and moral losses. The experience that the Kahramanmaras earthquakes brought to Turkish engineering knowledge and literature in terms of earthquake performance and reinforcement applications in precast structures is of great importance.

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2023 年カフラマンマラシュ地震における工業地帯の損失と復旧プロセスに関する事業継続の視点

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要　旨

2023 年 2 月 6 日, マグニチュード Mw7.7 と Mw7.6 の揺れが 9 時間間隔で発生したカフラマンマラシュ地震はトルコの広範囲に甚大な被害と人命の損失をもたらした．この地域の工業施設は構造的・非構造的な被害を受け，事業の継続性に支障が生じた．特にカフラマンマラシュ，ガズィアンテップ，イスケンデルンなど，被災地に位置する工業団地（Organized Industrial Zone, OIZ）の施設はさまざまなレベルの地震被害を受け，一部の施設は完全に使用不能となった．労働力の損失は産業活動に直接的な混乱をもたらし，事業継続に大きな支障をきたした．本研究では，地震後に発生した問題点，構造物被害の影響，被害想定プロセス，事業活動への耐震調査，地震から 1 年後の復旧状況を明らかにすることを目的に，被災地の OIZ で実施した調査結果を報告する．さらに，事業主や OIZ 管理者が導き出した解決策を調査し，将来の災害影響リスクの低減に貢献するための事業継続計画の機能について議論する．土木技術者協会ガジアンテップ支部（the Gaziantep Branch of the Chamber of Civil Engineers）の協力を得て，OIZ 管理者，自治体，土木技術者，事業主などの関係者を集めたワークショップを開催し，地震発生時および地震発生後に経験した問題や，より良い復興のための事業継続計画の機能について議論した．

キーワード：2023 年 2 月 6 日カフラマンマラシュ地震，事業継続計画，災害レジリエンス，災害復旧