**Case Study: Implementation of GACRFNI Algorithm**

The role of HSCs is vital in mitigating the effects of natural disasters and preventing humanitarian crises. Consequently, designing resilient HSCs is of paramount importance to ensure efficient recovery and long-term sustainability, both during and after such events. This study highlights the effectiveness of the GACRFNI algorithm in addressing a wide range of challenges associated with resilient HSC design with viability consideration.

In addition to theoretical validation, it is essential to demonstrate the algorithm’s effectiveness in a real-world setting. To this end, a case study from Yılmaz et al. (2023) has been adapted for the design of an HSC. The case study includes 10 collection center alternatives 8 warehouse alternatives , and 20 demand points , with product demand ranging from 45,000 to 150,000 units. Figure 1 illustrates the HSC network structure in the northeastern part of the Black Sea region of Türkiye, where the HSC plays a critical role in meeting medical needs during a disaster.

harita, metin içeren bir resim

Açıklama otomatik olarak oluşturuldu

**Figure 1** A case study including collection centers, warehouses, and demand points

To ensure high-quality solutions, 200 scenarios are generated based on the scenario generation method detailed in Section 5.1, as prior analysis confirmed that 200 scenarios are sufficient. The dataset, including distances between collection centers, warehouses, and demand points, along with other relevant information, can be accessed at [https://github.com/data-re/MSCresilience].

Table 1 presents a comparison between the values obtained from the current policy implementation and those achieved using the GACRFNI approach at a 0.8 risk aversion level. Based on these results, it is evident that the proposed approach provides significantly better solutions, with nearly a 20% improvement in the ETSC values. This improvement is primarily due to the consideration of supply chain viability in the second stage of the model, after uncertainty is realized. By incorporating the viability and resilient aspects within the context of HSC design, the number of warehouses and collection centers is determined concurrently, leading to a significant reduction in total shortage levels.

**Table** 1 Comparison of results obtained by GACRFNI and without proposed approach (WPA)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **|C|** | **|W|** | **|P|** | **FF** | **TSOC (%)** | **ETWOC (%)** | **ETDC (%)** | **ETSC (%)** | **TNOS** | **ENTOW** | **CPU** |
| **GACRFNI** | 10 | 8 | 20 | 9463170 | 0.21 | 0.28 | 0.20 | 0.31 | 4 | 6.26 | 388.45 |
| **WPA** | 10 | 8 | 20 | 10972180 | 0.15 | 0.33 | 0.12 | 0.40 | 3 | 8.00 | 238.44 |
| **diff.** | - | - | - | -1509010 | 0.06 | -0.05 | 0.08 | -0.09 | 1 | -1.75 | 0 |

By applying the proposed GACRFNI approach to a real case study from the literature, it has been demonstrated that the method is effective for addressing large-scale, real-world problems. Moreover, incorporating the viability aspect into HSC design has significantly reduced both shortage levels and overall costs. However, it is important to note that in reality, needs may change over time after a disruption occurs. The proposed framework does not account for these evolving needs, which represents a limitation. This limitation could be addressed by adopting a multi-stage approach, which would better capture the dynamic nature of demand over time.