Emergency Swarm:
A Digital Fabrication Collective for Post-disaster Scenarios

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Earthquakes in Turkey serve as unfortunate reminders etched in collective memory. Despite years of preparation by governmental and civil organizations for the devastating impacts of earthquakes, organizational challenges persist in the post-disaster. Disasters like the Kahramanmaraş and Hatay Earthquakes on February 6, for which we directed all available resources post-disaster, often exceed the capacity of existing preparations. To address such limitations in the future, the integration of digital fabrication tools and artificial intelligence supported organization of civil collectives emerges as a potential game-changer in disaster management. Additionally, the self-organization of disaster-affected individuals and volunteers has proven to be a critical component of effective disaster recovery planning. These technologies offer innovative solutions to enhance the organization of civil collectives and improve post-disaster response. Within this framework, the paper examines the possible contributions of digital fabrication tools and open-source architectural approaches in disaster recovery planning and explores their applications in emergency scenarios. The culmination of this research proposes the formation of a collective named *Emergency Swarm*, managed by artificial intelligence bots through the *Discord* network. The paper outlines how data would flow within this network and how stakeholders would interact. In conclusion, this research suggests that integrating digital fabrication tools, AI, and self-organization can revolutionize disaster response strategies and enhance community resilience. The potential of the Emergency Swarm network to transform disaster management practices is significant, offering a glimpse into the future of disaster response.

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Acil Durum Sürüsü: Afet Sonrası Senaryolar için bir Dijital Fabrikasyon Kolektifi

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Türkiye'de yaşanan depremler, toplumsal hafızaya kazınmış hazin birer hatıra niteliğindedir. Geçmiş depremlerin sıklığı ve tazeliği toplumsal olarak ciddi bir eforun ve kaynağın bu afetlere hazırlanmaya harcanmasını gerektiriyor. Yine de, resmi ve sivil kuruluşların bu felaketlere hazırlanmak için devam eden çabalarına rağmen, afet sonrasında önemli organizasyonel sıkıntılar devam etmektedir. En son 6 Şubat'ta meydana gelen Kahramanmaraş ve Hatay Depremleri, müdahale çabalarının mevcut hazırlıkların sınırlarını zorladığı örneklerin en yakın hatırlatıcısı olarak karşımıza çıkmaktadır. Gelecekte bu zorlukların üstesinden gelmek için, dijital üretim araçlarının ve yapay zeka destekli uygulamaların afet yönetimine entegrasyonu potansiyel bir oyun değiştirici olarak ortaya çıkmaktadır. Ayrıca bu teknolojiler, sivil kolektiflerin organizasyonunu geliştirmek ve afet sonrası müdahaleyi iyileştirmek için de yenilikçi çözümler sunmaktadır. Afet anında potansiyel faydaların aranması ve gerekli hızlı tepkinin oluşturulabilmesi bu entegrasyonu araştırmaya yönlendiriyor. Afetten etkilenen bireylerin ve gönüllülerin öz-örgütlenmelerinin afet kurtarma planlamasında önemli aktörler olarak etkin katkı sağladığı vakalar mevcuttur. Bu gibi vakalardan edinilen dersler organizasyonel zorlukları aşmak için daha iyi öz-örgütlenme yeteneğine sahip olmaya yönlendirmektedir. Bu çerçevede makale, dijital üretim araçlarının ve açık kaynaklı mimari yaklaşımların afet kurtarma planlamasına nasıl katkıda bulunabileceğini ve acil durum senaryolarında nasıl uygulanabileceğini araştırmaktadır. Bu araştırma sonucunda ise, Discord ağı üzerinden yapay zeka botları tarafından yönetilen *Acil Durum Sürüsü* adlı kolektifin oluşturulmasını önermektedir. Makale, verilerin bu ağ içinde nasıl akacağını ve paydaşların nasıl etkileşime gireceğini detaylı olarak açıklamaktadır. Etkin bir öz-örgütlenme ağında görev paylaşımı dört grup katılımcı üzerinden yapılabilir. *Üretici, Tedarikçi, Dağıtıcı, Montajcı* olarak isimlendirilen bu roller yapay zeka destekli botlar tarafından koordine edilerek görev paylaşımı ve iş birliği içerisinde çalışabilirler. Sistem ilk olarak görev paylaşımını başlattıktan sonra üretici, tedarikçi ve dağıtıcı arasında iş birliği imkanı sunar. Sonrasında bir montajcı grubu kurarak ilk üç rol ile iş birliği sağlanır. Ayrık üretim yöntemine göre paylaştırılan görevler üretim döngülerini kapatma amacıyla nihayete ulaştırılır. Sistem üretim gerçekleşirken aynı zamanda bu verileri değerlendirerek döngüleri daha iyi versiyonlarına ulaştırma çabası içindedir. Böylelikle süreç içerisinde kendini geliştiren ayrık üretim döngüleri oluşturulur. Sonuç olarak, bu araştırma dijital üretim araçları ve yapay zekanın ve öz-örgütlenmeyle entegrasyonunun afet müdahale stratejilerinde devrim yaratabileceği ve öngörülemeyen zorluklara karşı toplumsal dayanıklılığı artırabileceği üzerinde durmaktadır. *Acil Durum Sürüsü* ağının afet yönetimi uygulamalarını dönüştürme potansiyeli önemlidir ve afet müdahalesinin geleceğine bir bakış sunmaktadır.

Anahtar Kelimeler: Afet, Deprem, Acil Durum Yönetimi, Afet Kurtarma Planlaması, Öz-örgütlenme, Dijital Fabrikasyon, Sürü Zekası, Türkiye

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1. INTRODUCTION

Turkey is located in a geographical landscape that faces high earthquake risk. The seismic events on February 6, 2023, centered in Kahramanmaraş and Hatay, stand out as a traumatic and recent reminder of this danger. Impacting a region inhabited by approximately 15 million people, these earthquakes have left enormous damage. Preliminary assessments indicate that over 500,000 homes were either completely destroyed or suffered severe damage, thrusting more than 2 million individuals into immediate housing challenges (Presidency of Strategy and Budget, 2023; Altunsu et al., 2024). Given the magnitude and intensity of these earthquakes, it is foreseeable that the existing construction sector may prove insufficient to manage the upcoming housing crisis. Immediate attention and strategic measures are necessary to counter and recover from the aftermath of such widespread and impactful earthquakes.

Based on data from the Turkish Statistical Institute (TUIK) in 2023, an average of 640,000 housing licenses were acquired over the past three years. In addition, the apparent surge in both nominal and real house prices in recent years has disrupted the economic equilibrium on the supply side of the housing market. To effectively address the housing problems in earthquake affected regions over the medium and long term, there is a necessity to shift the existing housing industry from other regions. Unfortunately, such a move could potentially disrupt the balance in the housing market.

Furthermore, the envisaged resource transfers, involving the transportation of substantial quantities of building materials, construction equipment, and labor, have the potential to create significant economic and logistical challenges. These challenges might persist for an extended period, causing enduring repercussions in both economic and operational costs. Careful planning and strategic measures are crucial to navigate this challenging scenario and minimize the negative impact on the housing market and the broader economy.

Addressing short, medium, and long-term shelter requirements after a disaster ranks among the most prominent issues (Zhao et al., 2017). Immediately after disasters, solutions like tents and containers, facilitating rapid settlement and installation, are often demanded

(Davis, 2011; Abulnour, 2014). While effective for short-term solutions, these options lack sufficiency over the medium and long term. Prefabricated buildings emerge as a viable alternative, capable of swiftly addressing shelter needs while offering sustainability in the medium and long term (Falza & Hariyadi, 2022). However, it is noteworthy that the current prefabricated building industry in Turkey may struggle to meet the surging demand (Amani & Niyazi, 2018).

In light of this challenge, digital fabrication presents a promising opportunity to balance the extraordinary growth in demand for prefabricated buildings (Gershenfeld, 2012). Embracing computer-aided manufacturing techniques, digital fabrication holds significant potential not only for the construction industry but also for sectors such as furniture, advertising, and vehicles. Notably, it has captured the interest of enthusiastic producers due to its simplified usage possibilities, offering a transformative solution to augment the existing prefabricated building industry's capacity to meet the increasing demand.

Furthermore, the Industry 4.0 concept presents strategies that can unleash the potential of small manufacturers by leveraging digital fabrication tools. A key concept is *Horizontal Networking*, encompassing the integration of manufacturing processes and establishing a robust communication and collaboration network among different stakeholders, businesses, and systems (Deloitte, 2015). This dynamic network facilitates seamless collaboration for small producers, enabling easier engagement with other businesses. Through direct communication and the exchange of data can establish more efficient and integrated supply chain management. Besides, it enables more adaptable production processes and customized products. In this network, when specific skills, production capacity, or resources are needed by other producers or customers, finding suitable resources becomes a streamlined process. Collaborating with other producers within such a network optimizes production in accordance with demand, leading to a more efficient utilization of resources. Therefore, it creates a dynamic environment for small manufacturers connected through digital fabrication tools, forming a production collective that amplifies collaboration, data sharing, demand and resource alignment, flexibility, and scalability – all crucial elements in post-disaster scenarios.

Collaboration among independent manufacturers, particularly those in industries like furniture, advertising, and transportation that have seamlessly incorporated digital fabrication tools into their production workflows, holds significant promise in addressing future post-disaster housing crises. The ability to make swift and independent decisions within a production network, activated during emergencies, provides a viable alternative to relying solely on authorized institutions and the conventional construction industry for meeting post-disaster needs. The utilization of digital fabrication tools in the production of modular houses offers a potential game-changer, especially in situations where the traditional construction sector struggles to meet the growing demand. These modular houses, crafted through advanced fabrication techniques, have the capacity to efficiently supplement the housing industry, offering a responsive and adaptable solution to the challenges posed by disasters. This collaborative approach, leveraging the agility of digital technologies, showcases a forward-thinking strategy to overcome housing crises and foster resilience in the face of unforeseen challenges.

Temel and Durst (2023) emphasized the importance of social media in the Kahramanmaraş and Hatay earthquakes, the significance of mobile communication and coordination applications in emergencies as an area that needs to be explored to minimize the impact of the earthquake and its active impact on disaster management. The lack of digital protocols in disaster management plans for post-disaster response and recovery in Turkey has been seen as a major problem after the recent earthquakes (Yılmaz, 2023). Digital fabrication experts can effectively contribute to disaster management if successfully integrated. Therefore, the paper initiated a preliminary investigation into modular designs achievable through digital fabrication capabilities. This exploration serves as an example of locally customized modular structures, designed in accordance with discrete manufacturing techniques and subsequently implemented by different manufacturers. Additionally, the paper delved into an inquiry concerning expert behaviors and collaborative initiatives in Turkey, particularly during significant events like the COVID-19 pandemic and the Hatay and Kahramanmaraş earthquakes on February 6. This research aims to examine the rapid decision-making process and the potential for post-disaster initiatives in Turkey.

Consequently, the study aims to examine the management processes of a disaster recovery plan on a smaller scale. *Discord* (2015) platform was chosen as the platform for facilitating *Horizontal Networking* among producers, suppliers, distributors, and assemblers. Through this platform, the study provides the production and logistics chains of volunteers, ensuring accurate guidance of their potential during emergencies. Also, this platform, when activated for emergency shelter needs, will be able to execute processes and autonomous activities by assigning tasks to predefined roles. Besides, the study will explore the integration of bots and third-party tools to carry out autonomous processes. The study concludes with an examination of data flow in a practical case study conducted through a Discord channel, leading to the development of organizational support scenarios. These scenarios aim to support the existing industry resilience during emergency scenarios through the disaster management strategy gathered from the research.

2. SELF-ORGANIZATION AND DIGITAL FABRICATION

The influence of advancements in ICT on architectural practice is steadily on the rise. These ongoing developments, fostering a more participatory approach for all actors, hold immense potential. Architects can now freely share projects that adhere to universal design principles on the web, empowering users to customize and locally construct their spaces. The utilization of digital tools in designing modular buildings not only reduces architectural costs but also enhances accessibility.

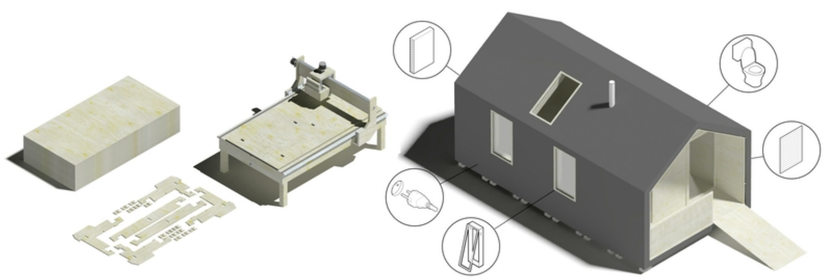
Furthermore, digital technologies can be leveraged for decentralization of disaster management in Turkey in terms of oversight systems, resource-allocation failure, and central-local collaboration (Hermansson, 2018). Jon and Purcell (2018) highlight the benefits of effective use of self-management in disaster recovery planning by examining cases in New Orleans, Indonesia, and Haiti. These cases demonstrate the power of social media and mobile technologies in emergencies. The transforming role of these technologies increases communication between actors and facilitates access to key resources such as materials, labor, and manufacturing opportunities.

Besides, mobile technologies can be deployed effectively to encourage self-organization in the first response to disasters (Nespeca et al., 2020). For example, the digital possibilities facilitating easy access to resources are reshaping the practice of architecture, making it more accessible, transparent, and participatory for a broader audience. The following analyzed cases delve into these potentials, particularly in the context of emergent scenarios.

2.1 Open-source Architecture: WikiHouse

Open-source refers to the intellectual property status of software where the source code is freely accessible, allowing users to view, modify, distribute, and share it according to specified license terms. In the 21st century, the concept of the free flow of information has also influenced the field of architecture. Developers can release architectural designs to users, enabling manufacturers and designers to access, modify, and distribute these designs. This promotes a collaborative, transparent, and participatory approach within the architectural ecosystem. Moreover, open-source projects, being freely available, reach a broad audience, allowing secondary developers to customize and enhance projects according to their specific needs, contributing to debugging and project improvement.

This notion advocates for increased accessibility in architecture, empowering individuals and communities to play an active role in designing and constructing their homes. It enables the democratization of architecture, emphasizing its affordability, sustainability, and adaptability compared to traditional approaches. In this context, *Open-source Architecture* emerges as an alternative to global housing challenges, capable of reaching base levels of society.



Şekil 1: WikiHouse Diagram (WikiHouse Diyagramı) (WikiHouse, 2011).

An exemplary illustration of open-source architecture is *WikiHouse* (2011), a building system empowering individuals to design and construct their homes using open-source projects and digital fabrication techniques like CNC cutting and 3D printing. Originating in 2011, WikiHouse aimed to provide an affordable, simple, and sustainable solution to the escalating global housing crisis. The WikiHouse initiative offers a platform featuring an online library of pre-designed building components, including walls, floors, and roofs. Users can easily customize and assemble these components to create a building design, complete with joint details (**Figure 1**). Technical details of the components are available for download, allowing for local production of materials and tools. This innovative approach to architecture shows the transformative potential of open-source principles in addressing housing challenges around the world.

2.2 An Emerging Organization in the Pandemic: 3-Dimentional Support

The 3-Dimensional Support (3-Boyutlu Destek) initiative is a collaborative network of volunteer makers spanning diverse locations, united to address specific needs within Turkey. Based on the strategy of the "maker" culture, this movement utilizes digital fabrication tools to address creative solutions for social challenges. Leveraging the power of collective production, a vast network of volunteer makers has been established to respond to needs across every province in Turkey. The initiative's open platform approach, avoiding a corporate identity, has facilitated the outreach to large masses.

During the initial months of the pandemic, the team swiftly organized, collated online data on the requirements of healthcare workers, and harnessed 3D printers to manufacture various materials, including visors and protective equipment, in a remarkably short timeframe. This collective effort showcased the potential of mass production, as manufacturers collaborated to fulfill needs while volunteer couriers efficiently delivered the produced equipment. Scaling rapidly to encompass all 81 provinces of Turkey, the initiative garnered support from over 3000 individuals and institutions. Between March 23 and May 13, 2020, utilizing over 4500 3D printers and mobilizing more than 300 volunteer motorcycle couriers, the initiative produced and distributed over 135,000 mask visors. This exemplifies the impactful synergy achievable through the convergence of volunteerism, advanced technology, and collective effort in times of critical need (Kap, 2021).

2.3 An Emerging Network for Post-disaster: Earthquake Cooperation Group

The Earthquake Cooperation Group (Deprem Çalışma Grubu) emerged in response to the Kahramanmaraş and Hatay earthquakes, aiming to provide civil society support for earthquake preparedness and contribute to the country's recovery. In the post-disaster, the group directed its efforts towards the *National Housing Project (Ulusal Konut Projesi)*, a comprehensive initiative designed to address housing challenges in the aftermath of earthquakes. This visionary project proposes city-scale solutions to ensure housing for all citizens, envisioning 20 new cities with a focus on sustainability and local relevance at the urban scale. The initiative operates collaboratively with diverse stakeholders, including urban planners, economists, local communities, politicians, and municipalities, to bring the national housing project to life. Through this multi-faceted collaboration, the goal is to implement the project sustainably and in alignment with social needs.

Operating on the Discord (2015) platform, the earthquake working group serves as a dynamic hub for research, planning, and implementation processes integral to project development. It exemplifies the effective use of social media to address the urgent housing needs in the post-earthquake period and prepare for similar disasters in the future. Within the Discord platform, volunteers assume various roles, including architects, civil engineers, urban and regional planners, and academicians. Specialized channels and sub-working groups facilitate interdisciplinary interactions, allowing volunteers to exchange information and conduct research tailored to their areas of expertise. This collaborative and innovative approach highlights the transformative potential of digital platforms and collective expertise in addressing critical challenges in the aftermath of natural disasters (Elik, 2023).

3. EMERGENCY SWARM

The previous section demonstrates the impactful role of a manufacturing community seamlessly integrated with digital fabrication opportunities and social media platforms in fortifying measures against earthquake risks in Turkey. In this context, emergency shelter examples such as *WikiHouse*, where almost all parts can be produced with digital fabrication tools, can be included in disaster recovery planning. Modular designs, compatible with digital fabrication capabilities, present an appropriate manufacturing methodology convenient for discrete manufacturing. In the framework, all components required for a shelter unit can be organized as a task and assigned to different specialists. Each component can be fabricated in different manufacturing facilities, labeled appropriately, and transported disassembled to the construction site. In this scenario, a housing unit produced with digital fabrication tools can be transformed into an effective disaster recovery strategy through self-organization of specialists. Initiatives like the *3-Dimensional Support* team, which emerged during the global pandemic, and the *Earthquake Cooperation Group*, organized after the Kahramanmaraş and Hatay earthquakes, highlight the resilience of volunteer experts in Turkey to swiftly interact and collaborate.

In addressing the emergency shelter challenge, a unified platform encompassing manufacturing, procurement, distribution, and assembly, engaging volunteer manufacturers, logistics professionals, and a suitable workforce, can furnish rapid and organized solutions. Discord (2015) stands as a powerful network for collective organizations and provides a series of tools for collaboration, communication, and coordination with a substantial user base. Supporting both voice and text communication, it fulfills various needs like meetings, discussions, instant messaging, and information sharing. Its versatile features, including channels and roles, enable the creation of separate channels for different projects or tasks, with members assigned distinct roles. Integration with AI-supported bots and third-party tools further enriches its functionality. Customizable bots can execute tasks such as meeting reminders, voting systems, task tracking, and more.

Considering its extensive configuration options, Discord proves to be a platform that enhances organizational efficiency, promoting better organization and more effective task sharing in collective efforts. Bots and various integrations automate workflows, thereby augmenting efficiency. In light of the preliminary research, Discord emerges as a highly suitable platform for a production network activated during emergencies, offering a versatile and efficient environment for collaborative efforts.

3.1 Framework of Roles: Producer, Supplier, Distributer and Assembler

Free-to-join networks must establish mechanisms for distinguishing between organic users and bots, a crucial step for ensuring channel security and sustained functionality. Identifying organic users also serves as an early security measure to prevent potential abuse and malicious interference. To streamline interactions within the organization and ensure mismatches based on tasks and qualifications, volunteers can be categorized into sub-groups based on their skills and abilities.

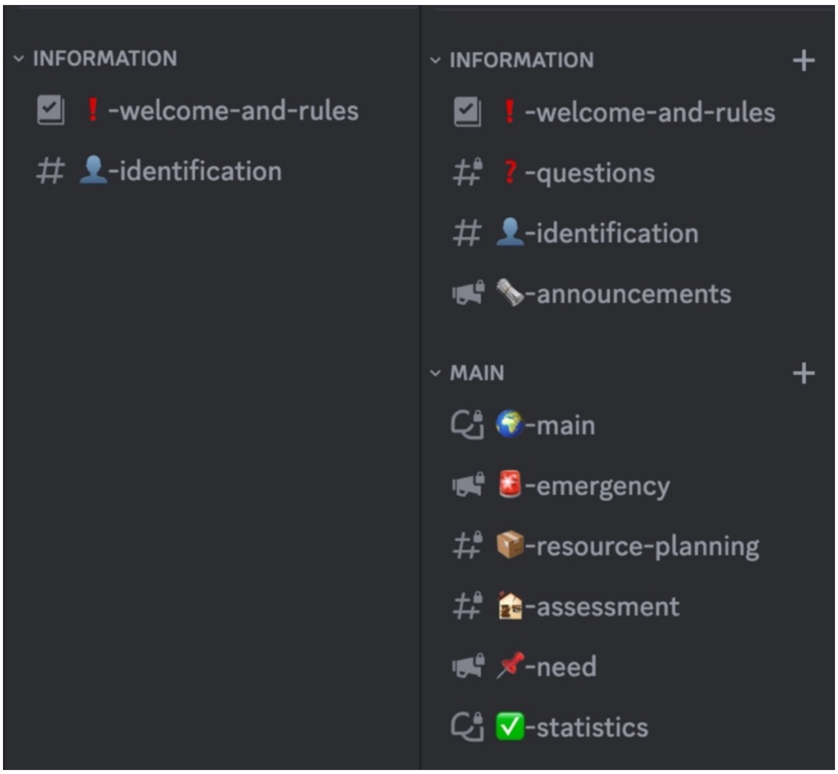


Figure 2: Forum, announcement, and text channels activated after volunteer roles are assigned (Gönüllü rolleri atandıktan sonra aktive olan forum, duyuru ve metin kanalları) (Discord, Emergency Swarm Community).

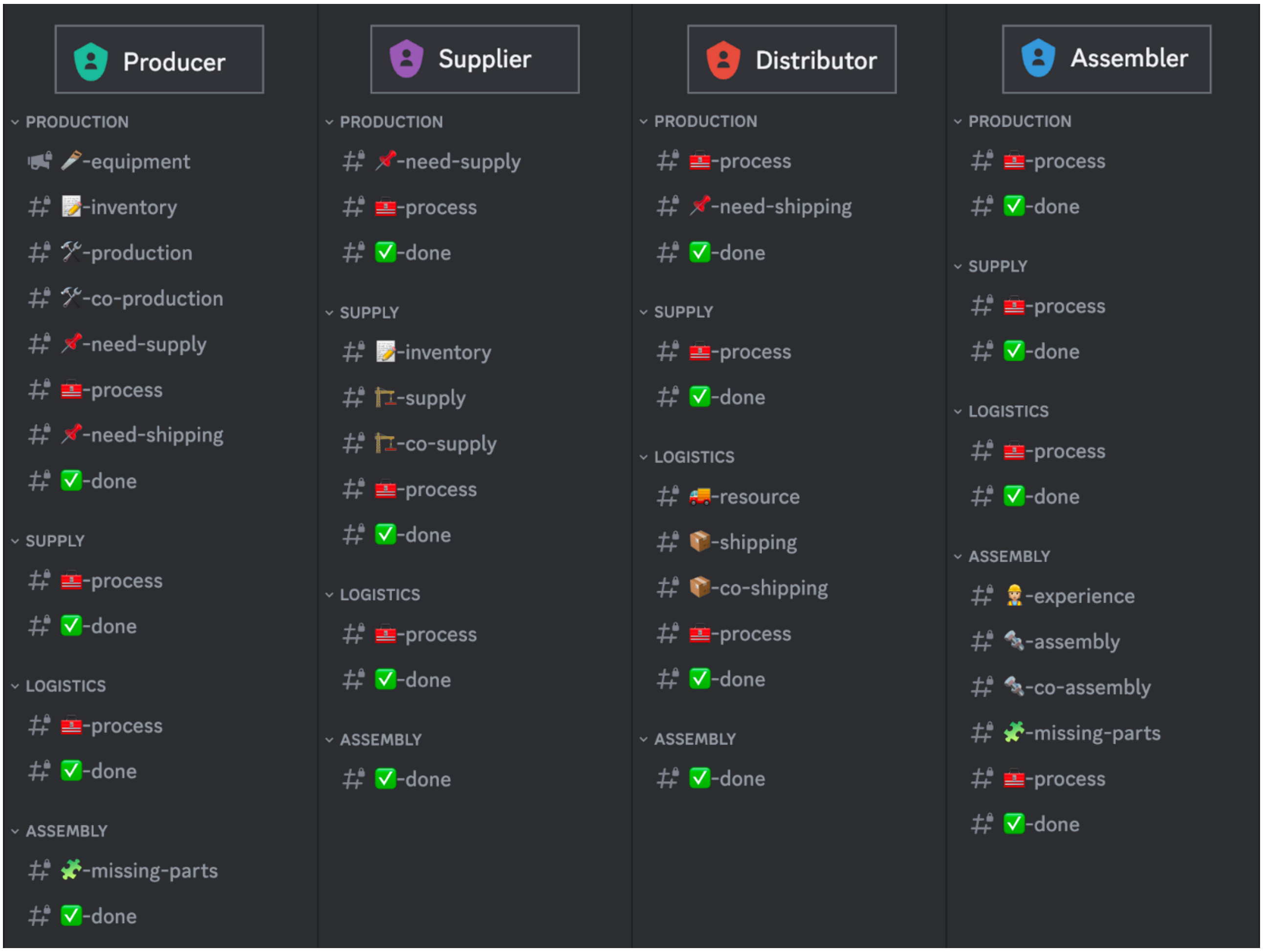


Figure 3: Sub-organizational channels involved according to volunteer roles (Gönüllü rolleri ne göre dahil olunan alt organizasyon kanalları) (Discord, Emergency Swarm Community).

After an external volunteer joins the channel, a questionnaire is administered to measure quantitative and qualitative characteristics. The questionnaire results determine the volunteer's role — *Manufacturer, Supplier, Distributor, or Assembler*. This role assignment allows for the creation of categories defining sub-organizations, ensuring that individuals can only access fulfillment channels corresponding to their voluntary roles.

The *INFORMATION* category (Figure 2) encompasses announcement channels, including welcome-and-rules, questions and answers, identification and participation surveys, and announcements. Besides, the *MAIN* category (Figure 2) includes forums, announcements, and text channels for introductions, general conversations, emergency messages, resource-planning, post-disaster needs assessment, shelter needs data, and completion statistics. Both categories are open to volunteers of all roles and can be accessed at any time. The public channel serves as a forum, while the other channels in the category activate during emergencies, remaining open to receive messages. This structured approach ensures efficient communication, task alignment, and streamlined collaboration within the network.

A participant with the role of **Producer** engages with the announcement and text channels illustrated in **Figure 3**. *Equipment* and *Inventory* serve as announcement channels, displaying real-time data on equipment, labor, resources, and raw materials after *Resource-planning*. These channels, summarizing the overall status of the production sub-organization, aim to monitor capacity throughout the process and ensure the proper allocation of resources. The *Production* channel is designed to assign a single producer and facilitate the transfer of necessary documentation for production to volunteers. Processing equipment, inventory, and location information, offers are dispatched, starting with the most suitable candidates. In cases where a single producer cannot handle the task, it is subdivided and shared among multiple producers through the *Co-production* channel. Material support can be integrated into the process through the joint inventory *Need-supply* channel between the producer and supplier roles. The *Process* channel serves as an announcement channel where incomplete production statistics can be tracked by all volunteer roles. This enables individuals within the organization to access completion percentages of tasks, allowing them to schedule their tasks effectively based on the flowchart. When the anticipated completion time for the production process is determined, the appropriate distributor is matched with the product based on location and capacity using the shared *Need-Shipping* channel, common for both the producer and distributor volunteer roles. Following the delivery by the producer, they can receive new orders, and the data in the *Done* and *Statistics* channel is updated and accessible to all volunteers. This structured approach ensures transparency, efficiency, and seamless collaboration within the production network.

A participant taking the role of **Supplier** actively engages with the announcement and text channels outlined in **Figure 3**. After *Resource-planning*, the *Inventory* channel functions as an announcement platform, providing real-time data on current warehouse capacity and raw material availability. This channel enables suppliers to access occupancy rates in their warehouse network, facilitating informed resource routing. After identifying the needed materials in the *Need-supply* channel, offers are extended to suitable individual suppliers, considering factors such as inventory levels, transportation, and location data. In cases where a single supplier cannot handle the task, it is segmented into sub-parts and shared among multiple suppliers through the *Co-supply* channel. The *Process* channel serves as an announcement platform where incomplete procurement statistics are visible to all volunteer roles. Once the supplier fulfills the order, they can receive a new request, and the data in the *Done* and *Statistics* channel is updated and accessible to all volunteers. This streamlined approach ensures transparency, efficiency, and collaborative success within the supply network.

A participant undertaking the volunteer role of **Distributor** engages with the announcement and text channels shown in **Figure 3**. After *Resource-planning*, the *Resource* channel operates as an announcement platform, providing real-time data on vehicle availability, driver information, and fleet status. Distributors utilize this channel to assess the current capacity of their logistics network, enabling strategic planning for resource transfer collaborations like shared distribution and driver-vehicle pairings. After identifying the need for shipping in the *Need-Shipping* channel, an offer is dispatched to the suitable individual distributors in the *Shipping* channel, considering resource and location data. Should a single distributor prove insufficient for the task, the responsibility is intelligently subdivided and shared among multiple distributors through the *Co-Shipping* channel. The *Process* channel serves as an announcement platform where incomplete supply statistics are accessible to all volunteer roles. Following the successful delivery by the distributor, they seamlessly receive a new order, and the data in the *Done* and *Statistics* channel is promptly updated and available for viewing by all volunteers. This systematic approach ensures transparency, operational efficiency, and collaborative success within the distribution network.

A participant assuming the **Assembler** role engages with the announcement and text channels outlined in **Figure 3**. Given that the Assembler role operates in the final stage of the entire process, participants with this role have access to all process channels, distinguishing them from other volunteers. The *Experience* channel functions as an announcement platform, presenting current experience, equipment, and labor data post-resource planning. Within this channel, experienced and inexperienced teams can strategize collaborations and coordinate resource transfers. Assignments in the assembly and production channels are inherently interconnected. Essentially, the process commences after the manufacturer and assembler are matched. The channel processes information on experience, equipment, workforce, and location, sending offers starting with the most suitable candidates. In instances where a single assembly team cannot be assigned, teams of experienced and inexperienced volunteers are formed in the *Co-Production* channel, and the task is intelligently divided into sub-parts among multiple assemblers. If defective or missing parts are detected during the process, a new rapid procurement cycle is initiated in the *Missing-Parts* channel, involving both manufacturer and assembler roles. The *Process* channel, specific to the assembler role, can only be viewed by participants in this role. Given that the volunteer team at the end of the cycle is involved in this process, the channel is exclusive to the assembler role. Upon the assembly team's on-site delivery completion, they can undertake a new task, and the data in the *Done* and *Statistics* channel is promptly updated, accessible to all volunteers. This intricate yet systematic approach ensures transparency, operational efficiency, and collaborative success within the assembly process.

Additionally, volunteers within the network have the flexibility to assume multiple roles. For instance, individuals acting as both material suppliers and producers with extensive inventories may not require additional materials. In such cases, the system seamlessly integrates these cycles internally. Similarly, producers equipped with an assembly team have the capability to conduct the entire process in-house, leveraging the organizational chart and contributing solely to the statistical data. Within this network, volunteers can establish an initiative with the capacity to execute assigned tasks quickly and appropriately, enabling quick and effective decision-making. As a result, an emergency shelter designed in Plywood or OSB material can be manufactured through the collaboration of these four groups of volunteer, divided into sub-tasks. In this pre-planned process, seamless collaboration is more important than manufacturing techniques or architectural design. The division of the current task into as many sub-groups as possible emphasizes opportunities such as rapid response.

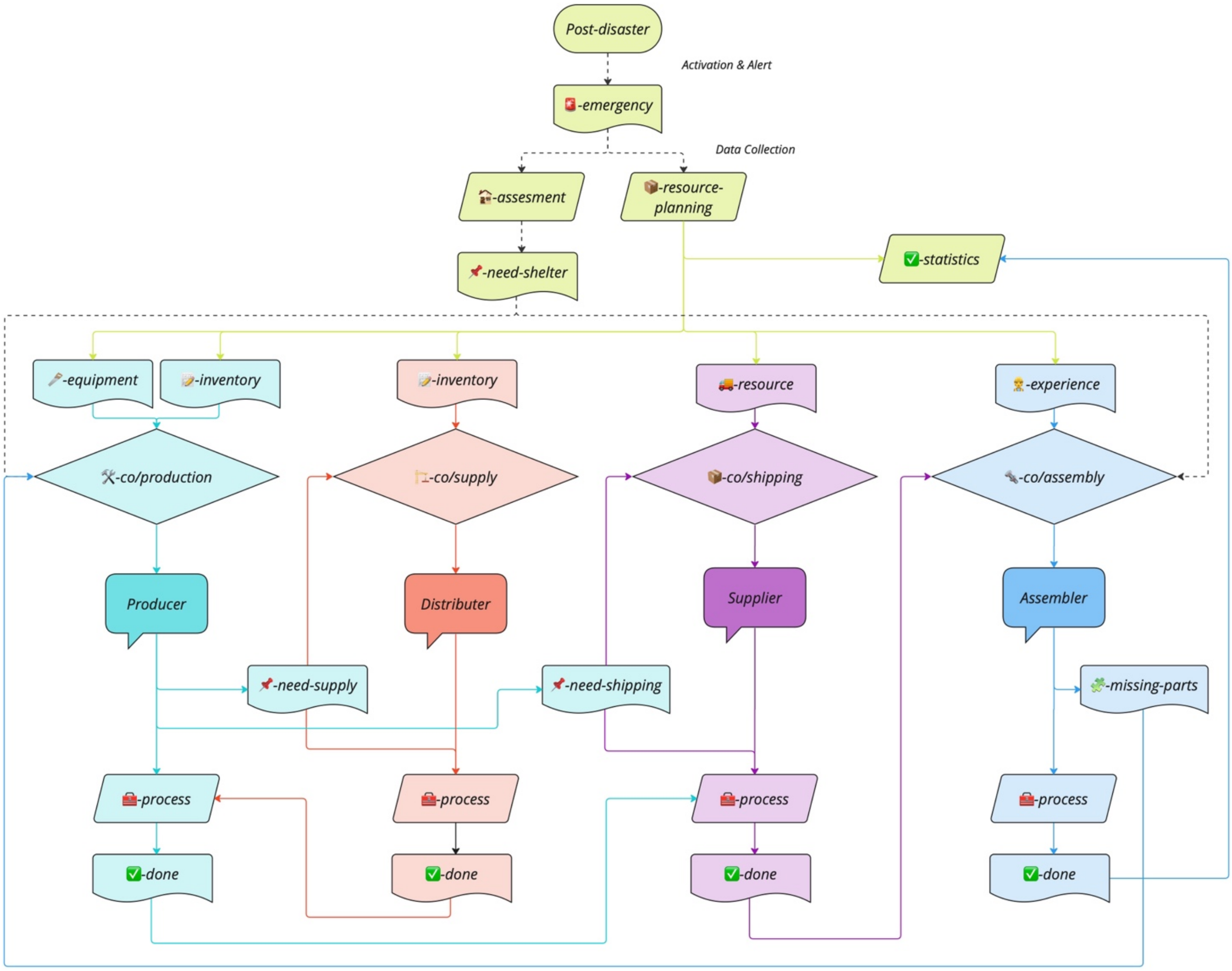


Figure 4: Data Flowchart (Veri Akış Şeması).

3.2 Data Flowchart: Production, Supply, Distribution and Assembly Network

Simplifying administrative systems necessitates exposing individuals to an optimal amount of data. Uncontrolled data flow can complicate tracking and reduce task adoption rates. Hence, it is crucial to tailor the data visibility for each user and distribute tasks with precision. This calls for a diligently planned data flow and task hierarchy, illustrated in **Figure 4** by the closed loop of channels triggering one another, as detailed in the preceding section.

The system is set in motion post-disaster through the activation of AI bots, which initiate an emergency state for users. Initially, these AI bots conduct an *Assessment* and *Resource-planning* to evaluate the current situation. Subsequently, the average *Need-shelter* is determined, facilitating the matchmaking between the *Producer* and *Assembler* teams. Throughout the process, AI bots continuously gather equipment, inventory, resources, and experience data, leveraging statistical evaluation to make new matches within the loop. These efficiency-maximizing assessments are then shared with users via the *Done* and *Statistics* channel. This organized approach ensures a controlled and efficient flow of information, promoting better tracking and user engagement.

3.3 Self-organization with AI Bots

AI bots offer an avenue for self-organization, proving particularly invaluable in fostering collaboration during emergencies. Discord supports various types of AI bots designed for distinct purposes, including moderation, engagement, information, and emergency response bots. These bots, when employed collaboratively with humans, can elevate situational awareness, streamline data collection, enhance analysis and visualization, and facilitate communication in emergency scenarios. In Discord channels, these emergency response bots can contribute to triage and coordination, data collection and analysis, situational awareness, disaster response robots, as well as communication and information sharing. By managing and automating various tasks, AI bots empower users to concentrate on collaborative efforts and support emergencies (Midha, 2023; TopAI.tools, 2024).

While AI bots offer valuable contributions to emergency response, potential challenges must be acknowledged. One concern is the potential for AI systems to inherit biases from training data, potentially leading to inaccurate predictions. AI bots, in particular, may struggle to comprehend certain human responses, especially in crises, and may not fully replace human interaction. Another consideration is the risk that vulnerable users may overestimate the benefits of AI bots and encounter unforeseen risks, particularly during a crisis. Additionally, the inherent susceptibility of AI systems to errors raises concerns about potential liability issues. To address these challenges, it is crucial to implement rigorous safety measures, establish robust regulations, and promote collaborative standards to ensure the responsible and ethical use of AI technologies (Banafa, 2023).

4. DISCUSSION

One primary concern with this system revolves around its activation during a disaster and its ability to accurately detect the situation. This research did not have the opportunity to experiment with the *Emergency Swarm* platform with real actors. Nor has this paper been able to answer questions about its activation in the case of a real disaster. However, it presents an innovative scenario as an introductory phase of a large-scale research that could be examined as a scientific research project. Only a study of this scope can address the questions about this platform and answer whether collaboration with all experts can be established, whether AI bots can foster self-organization, and whether the architectural aspects of the product will be satisfactory.

Besides, questions regarding the activation and proper guidance of AI bots in the activation of this scenario also need to be investigated. While tracking Twitter data is one potential approach, historical instances, such as Microsoft's Tay chatbot in 2016, being miseducated as a Nazi supporter and racist, underscore the vulnerability of bots to deliberate manipulation (Schwartz, 2024). Despite advancements in AI technology since 2016, the risk of active data tracking being misdirected by harmful actors with artificial data remains, necessitating thorough testing and long-term development for bots serving as managers. Besides, there is a risk that these bots might unintentionally push volunteers beyond their capacity. Relying solely on completion data tracking might lead to the exhaustion of highly dedicated volunteers. To reduce this, precautionary mechanisms should be implemented, such as assigning easier tasks when a certain capacity threshold is exceeded.

In addition to equitable task distribution within the platform, measuring system sustainability requires the involvement of real actors. Implementing a rank system based on task completion and system finalization can offer statistical records and measure efficiency on a volunteer basis. Pairing more experienced individuals with less experienced ones can facilitate knowledge transfer within the system. Assigning relatively easier tasks to inexperienced volunteers serves both as an incentive and a training opportunity. Additionally, the system can be enriched with information on volunteers' production methods, capacities, supply chains, and transportation networks.

Furthermore, evolutionary approaches, such as observing volunteer behavior and training agents in experiments without using real actors, can further enhance the training of AI bots. Swarm intelligence, leveraging a reward and punishment mechanism, allows bots to strive for successful task completion despite incomplete knowledge. The methods applied by ant swarms to construct structures could be a subject of this research for AI bots to direct the experts. Also, optimization bots using genetic algorithms, for instance, can make precise matches between logistics and fabrication.

Looking ahead, a future projection involves developing a nationwide earthquake organization application, integrating a BIM system, and functioning as a comprehensive work management network. The inclusion of digital fabrication experts in disaster recovery planning is the unique value of this research. An effective future scenario needs to include this potential and explore the possibilities. Recent collective assistance events following the Kahramanmaraş and Hatay earthquakes demonstrate Turkey's suitability for implementing such a system. Meeting the urgent housing needs post-disaster requires transcending existing boundaries and dedicating efforts beyond current capacities.

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