

UKRAINIAN CATHOLIC UNIVERSITY

BACHELOR THESIS

Data-driven supply planning for a humanitarian aid center during war

Author:
Solomiya SOROKOTYAHA

Supervisor:
Renata KONRAD

*A thesis submitted in fulfillment of the requirements
for the degree of Bachelor of Science*

in the

Department of Computer Sciences
Faculty of Applied Sciences



APPLIED
SCIENCES
FACULTY ●

Lviv 2022

Declaration of Authorship

I, Solomiya SOROKOTYAHA, declare that this thesis titled, “Data-driven supply planning for a humanitarian aid center during war” and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed:

Date:

“Nine times of ten an army has been destroyed because its supply lines have been severed.”

Douglas MacArthur

UKRAINIAN CATHOLIC UNIVERSITY

Faculty of Applied Sciences

Bachelor of Science

Data-driven supply planning for a humanitarian aid center during war

by Solomiya SOROKOTYAHA

Abstract

Consequences of natural disasters and military conflicts are becoming more devastating with the increase of population. Supply planning is widely studied and applied in commercial sectors, while not being fully benefited from by the humanitarian aid organizations. Volunteering movements fill gaps in which more formal, structured organizations are not able to respond. This project examined the operations of grassroots organizations during the Russian invasion of Ukraine in 2022.

A stakeholder analysis and a detailed research of fulfillment of the request process and inventory management of the grassroots volunteering center was conducted, based on centers request and supply real-time data, personal interviews of volunteers, life process observations.

As a result, this project offers recommendations how to start using data for decisions makers in volunteering centers, including supply planning, providing an example for other similar centers. The project offers a good starting point for future research.

Acknowledgements

I am sincerely grateful to my supervisor and friend, Dr. Renata Konrad, for her priceless support and interest in the subject, that inspired me to keep working, despite the air alarms and ongoing war in my country.

Thanks to Daniel Walker, whose motivation and strong personality were so powerful to reach me across half the globe.

Warmest thanks to Yana Kryshchuk, for a real friendship and company during sleepless nights working on our projects.

Big thanks to Ms. Yuliia Kleban, my program coordinator, who has put significant effort into my education throughout all four years.

Special gratitude to Ukrainian Catholic University for providing several educational opportunities and challenges, for investing in community and high values, for all great people I have met here.

Finally, I want to thank Kartel, my small university band, which became a family during these years . . .

Contents

Declaration of Authorship	i
Abstract	iii
Acknowledgements	iv
1 Introduction	1
1.1 Humanitarian Relief Efforts in Military Conflict and the role of Grass-root Organizations	1
1.2 UCU Volunteering Center	2
2 Problem Statement	3
3 Literature Review	4
3.1 Devastating consequences of military conflicts	4
3.2 Humanitarian impact of military conflict	4
3.3 Inventory planning	5
3.4 Inventory planning for Emergency Relief	6
3.5 Metrics to evaluate performance	6
4 UCU Volunteering Center (VC) Analysis	7
4.1 About the VC	7
4.2 Stakeholder analysis	7
4.3 Limitations and center security	7
4.4 Roles and responsibilities	8
4.5 Request System	10
5 Data analysis	12
5.1 Data flow for requests	12
5.2 Data Limitations	13
5.3 Data Overview	13
6 Center analysis using based on request and supply datasets	15
6.1 Initial Requests analysis	15
6.2 General Request Trends	17
6.3 General Supply trends	20
6.4 Cans	21
7 Basic inventory planning	26
8 Conclusions	28
8.1 Research summary	28
8.2 Next steps for research	28
8.3 Recommendations for UCU volunteering center	28

8.4 Expected benefit for UCU	29
Bibliography	32

List of Figures

1.1	Number of governing bodies of public organizations by region, Public organizations report by National Service of Statistics of Ukraine, 2018	1
4.1	Responsibilities, desires and needs per volunteer role in UCU VC as of April, 2022	9
4.2	State diagram of a request lifecycle at UCU VC as of April, 2022	10
5.1	Data flow diagram of fulfillment of request at UCU VC as of April, 2022	12
6.1	Number of declined requests comparing to total requests registered by day at UCU VC as of May, 2022	18
6.2	Number of days the request remained open since the day of register, by day at UCU VC as of May, 2022	19
6.3	Total number of supplies sent by day at UCU VC as of May, 2022	20
6.4	Total number of supplies registered by day at UCU VC as of May, 2022	20
6.5	Venn chart of requested items based on recipients categories at UCU VC as of April, 2022	21
6.6	Aggregated demand for cans by day at UCU VC as of May, 2022	22
6.7	Comparison of supply sent and supply received for cans, by day at UCU VC as of May, 2022	22
6.8	Number of cans, by day at UCU VC as of May, 2022	23
6.9	Number of days a cans request remained not closed, by day opened at UCU VC as of May, 2022	23
6.10	Aggregated requests for cans by recipient type at UCU VC as of May, 2022	24
6.11	Aggregated requests for cans by destination by day at UCU VC as of May, 2022	24
6.12	Aggregated requests for cans by destination at UCU VC as of May, 2022	25
1	Illustrative sample of VC supply item names and categories as of May	30
2	Aggregated requests for cans by destination by day at UCU VC as of May, 2022	31

List of Tables

6.1	Completeness check for requests dataset as of May 17, 2022	15
6.2	Value counts for priority of a request in VC requests dataset as of May 17,2022	16
6.3	Value counts for is_closed status of a request in VC requests dataset as of May 17,2022	16
6.4	Request treatment based on is_closed and date_sent values as of May, 2022	17

*Dedicated to unbreakable spirit of Free Ukraine, to fearless
Ukrainian Army and to kindest people around the world -
volunteers...*

Chapter 1

Introduction

1.1 Humanitarian Relief Efforts in Military Conflict and the role of Grassroot Organizations

Despite the technological advances at the dawn of the 21st century such as the digital art and renewable energy, humanity still faces the devastating consequences of natural disasters, such as floods, fires, tornados and manmade ones, such as air and water pollution, famines and military conflicts. Governments and nongovernmental organizations (NGOs) alone are not able to respond to these challenges. Volunteering movements fill gaps in which more formal, structured organizations are not able to respond. The volunteering movement is growing globally with many organizations focusing on gathering and distributing humanitarian aid in response to natural and manmade disasters.

Grassroot organizations are civilian movements in which individuals self organize and volunteer for a cause. Local grassroots efforts play a pivotal role in disaster response and recovery, particularly in logistical efforts related to humanitarian relief efforts. Diverse in scale, 'humanitarian logistics has been defined as 'the process of planning, implementing and controlling the flow and storage of goods and materials as well as related information, from point of origin to point of emergency, for the purpose of meeting the end beneficiary's requirements' (Laan et al., 2016)

The Revolution of Dignity in 2014, the annexation of Crimea and military conflict in the East of Ukraine pushed Ukrainians to cooperate, forming a new wave of volunteering movement. For instance, the number of public organizations is growing according to the National Service of Statistics of Ukraine, which states that the number of NGOs is increasing by about a thousand a year (4 percent) (Karmazina, 2018)

Number of governing bodies of public organizations by region

	2014	2015	2016	2017
Ukraine	21417	22185	23237	25988

FIGURE 1.1: Number of governing bodies of public organizations by region, Public organizations report by National Service of Statistics of Ukraine, 2018

The study (Zaychenko, 2022) shows that most of the samples are small local organizations, uniting people of the area under a common cause. While NGOs are

formal organizations, many of which rely on volunteers, many more informal grassroots organizations exist in which countless Ukrainians volunteer - statistics for this volume of effort do not exist.

Grassroot initiatives play a crucial role in the acute response phase until more established humanitarian aid organizations can enter. These initiatives establish the humanitarian aid demand rates and build initial communication networks. As well described by Elizabeth Dunn in (Dunn, 2022): *“I have seen this approach offer lots of flexibility: grassroots organizing can change quickly in response to changing conditions. Unlike what happens with traditional refugee aid groups, there’s no need to clear those changes with donors, develop new project proposals or deal with the paperwork and red tape. I have also observed that when local volunteers do the bulk of the work, aid can be distributed more efficiently. It passes directly to refugees themselves – who can also choose what help they accept”*

Being small, local and agile, grassroots organizations provide critical humanitarian relief in disasters. However, the operations research, logistics, network analysis, and supply chain management aspects of this critical response are understudied.

1.2 UCU Volunteering Center

This project is based on the case study of the one volunteering center (VC) in Lviv, Ukraine, that was established on February 24th, 2022 when Russia invaded Ukraine. UCU VC - is one of many grassroots organizations that emerged as a response to war, collecting humanitarian aid from donors from all across the globe, and sorting and distributing it in the country. Formed by the students of Ukrainian Catholic University (UCU), after 3 months of operations, the center has gone through several challenges that shaped its internal processes and division of responsibilities.

General panic is perhaps the greatest threat to the sustainability of its operations, execution of processes and overall organizational sustainability. Requesters often were experiencing panic attacks, which then translates to UCU volunteers, increasing their anxiety-causing improvisation in task completion. This sense of urgency reverberates back to suppliers, often from other countries, adding enormous pressure on logistics and sorting volunteers, increasing the risk of errors. After several weeks of operations, the center was able to mitigate the ‘panic effect’.

After the initial panicked response, the Center is able to consider planning and redesigning its processes for sustained operations. At the same time, several problems remain unsolved: inconsistent workload for volunteers due to variability in supply arrivals, random supplies, and quantities, and overwhelming and unpredictable demand. People - are the most valuable resource for grassroots organizations, as they are operating solely on volunteers’ desire to contribute their own time and energy towards a good cause. While the number of people helped is a key performance metric for such centers, it is critical to reducing volunteer burnout. Having established initial processes, UCU volunteering center (See Chapter 4) is now at the crossroads of being long-term oriented and implementing planning and schedules, or alternatively, dissolving.

Chapter 2

Problem Statement

Since the current Russian invasion of Ukraine on Feb 24, 2022 many people have united around newly created or existing volunteering organizations to provide humanitarian aid to the regions that suffer the most from military conflict. Volunteering centers play an important role in collecting humanitarian aid from local and foreign donations, sorting and distributing it to the ones in need. As much as big volunteering centers are fully operating in Ukraine, many recently created centers and grassroots organizations are filling gaps left by established organizations unable to respond due to a lack of local contacts, agility, or flexibility. Having sufficient flexibility and little to no bureaucracy, small volunteering centers have the advantage of a faster response compared to centralized humanitarian aid hubs, being able to fulfill smaller and more local requests.

Civilian populations rarely prepare for war, particularly in regions that have experienced long periods of peace. The onset of war is never completely known, much less communicated to a civil population ahead of time. While some response organizations such as the Red Cross, and United Nations have processes and systems developed, conflict situations are dynamic and it may take several weeks or even months before even the best-prepared organization is able to respond. Therefore, most humanitarian response processes are built ad-hoc, including supply chains. Amongst several problems volunteering centers face are problems of unstable supply inflow, a surplus of several items, and scarcity of others. Oftentimes requests for needed supplies are outdated by the time they are fulfilled by a supply provider.

In response, this project evaluates the potential of using data for operational effectiveness of grassroots organizations during the war using the case study of UCU VC. In doing so, the project analyses demand-supply data, provides relevant metrics for measuring the center's performance, and offers recommendations for supply planning.

The **direct impact** of this project is that the UCU center will be able to assess their past performance and discover how inventory planning can help fulfill more requests while operating under uncertainty. A second goal for the project is to share the discoveries with other volunteering centers as an example of the implementation of data-driven supply planning as a step to ensuring sustainability. Finally, this project aims to bring attention to this field of study and involve more specialists to apply data analysis for supply planning similarly to the retail and business supply chains.

Chapter 3

Literature Review

3.1 Devastating consequences of military conflicts

Since the dawn of civilization, humans have suffered from war. Wars differ in terms of the scope of cruelty inflicted, organization, duration, and scale. Worldwide, an estimated 27 conflicts are ongoing. The Global Conflict Tracker categorizes these conflicts into three groups: “worsening,” “unchanging,” and “improving” - currently not a single conflict described as “improving.” Aside from the propaganda perspective of heroism and romantic view of people’s sacrifices, military conflicts always lead to devastating consequences for the majority of the local population. As estimated 2 billion people around the world are directly impacted by war. Last year, 84 million were forcibly displaced because of conflict, violence, and human rights violations. And this year, we estimate that at least 274 million will need humanitarian assistance. (Nations, 2022) In Ukraine 6,642,659 as of the moment of writing have left the country (UNHCR, 2022) and over 2 million have been internally displaced (Ukraine, 2022),(Semenova, 2022), and over 4 million people lack access to basic needs such as food, water, medicine. The actual number is higher and difficult to estimate, as 20 percent of the territories are occupied now and there is a shortage of almost everything while people are being forced to stay or leave to russia. (Ukraine, 2020), (UNICEF, 2022)

While supply chain operations and logistics are well-established in the commercial sectors, these methods are not applicable in military situations(Pedraza-Martinez and Van Wassenhove, 2016). Roads are disrupted, and communications channels are distributed. Rapid onset of demand for humanitarian relief is similar to that encountered in natural disasters. This section examines relevant literature from humanitarian logistics, and commercial applications

3.2 Humanitarian impact of military conflict

Governments and other humanitarian aid organizations are developing different strategies for providing fast response to massive disasters. A big part of the work is to determine the population groups exposed to risk and understand their needs, as different environments require different supplies and critical times of delivery. As an example, human life being the highest priority, it is vital to deliver fitting medical equipment on time and in the needed quantity. Therefore, estimating the kind and scale of needed help is a necessary step for developing a response plan. The Agency for Healthcare Research and Quality funded a research project titled the “Hospital Surge model” which estimates the number of casualties expected from an event, their arrival condition, and the resources that might be needed to treat them. Several models like the ones mentioned above and existing disease spread algorithms can

be used to assess the resource requirements and demand patterns for medical supplies. In (Zhou and Olsen, 2016) the authors bring attention to the increasing trend of consequences of emergencies and disasters becoming more devastating over time, having a growing number of injuries and casualties.

3.3 Inventory planning

Retail inventory planning has moved forward significantly over the last couple of decades. Many services can deliver ordered goods in a few days, having fast logistics and well-estimated stock. A great example of a leader in supply chain management, smart logistics, and bold technical decisions is Amazon, offering delivery on the same day as placing an order. Benefiting from big data and demand forecasting algorithms, the company has introduced the power of data for a fast response. What if there was an 'Amazon' for healthcare or humanitarian aid? Unfortunately, being not so profitable as retail, the rate of adoption of such technologies is low. At the same time, inventory management during emergencies is very different from that during normal operating conditions. As highlighted in the paper (Zhou and Olsen, 2016):

Demand is highly unpredictable

Even if an organization was planning and accumulating supplies for a disaster of a particular type, there can easily be a chain reaction and a new type of disaster caused. As an example, in April 2022, Russian rockets hit Kharkiv city and caused a massive fire on the enterprise producing automotive chemicals, which later was fully destroyed. As a result, the local population's need for humanitarian aid started to include not only food and first aid supplies that are usually sent to the cities suffering from missile attacks but also medical supplies for chemical poisoning (Ukrinform, 2022). The estimations of general quantities also rely on a population census, which is most often far from the real number.

Supply quantities are lead times are highly stochastic

Delivery logistics as the circulatory system of humanitarian aid organizations is highly vulnerable to environmental changes. Roads are often damaged or completely destroyed by aggression forcing organizations to find other routes for delivery, which takes time and significant effort. (Latschan, 2022)

Backorder penalties are high in terms of costs and life loss

When a disaster strikes, the countdown is for hours, if not minutes. Under normal operating conditions, backorder costs are expressed in dollars or other currency. In contrast for humanitarian aid organizations, the most significant costs are human lives. Thus, typical inventory planning models are not applicable in disaster situations. At the same time, alternative deprivation costs were introduced in (Pérez-Rodríguez and Holguín-Veras, 2015), used in inventory allocation and distribution models for post-disaster humanitarian logistics. As a result from one of the discussed models (IA-PTP) followed a suggestion to keep frequent smaller size deliveries to recipients from close areas, and less frequent but large size deliveries to distinct areas. At the same time, the model is not suitable for the project, as it is designed for post-disaster environment logistics, while this project examines the grassroots operations during an ongoing 'disaster' - military conflict with focus on practical recommendation for supply planning.

3.4 Inventory planning for Emergency Relief

The authors in (Zhou and Olsen, 2016) review several papers introducing models based on case studies of inventory planning for emergency relief operations in Sudan, the private healthcare sector in Malaysia and a single humanitarian agency operating a warehouse in Kenya, as well as more theoretical approaches. While these studies are all in the humanitarian relief context, the methods are not applicable to the UCU center, as they are concentrated on balancing between holding costs and time of a delivery. In contrast, grassroots organizations holding costs are largely overlooked by out-of-stock costs and are equal to the expiration costs.

Due to the rapid development and little to no data recorded, grassroots organizations during military conflict are rarely adopting any inventory planning methodologies, unlike their bigger brothers - large international funds or governmental programs. The estimation often relies on the domain knowledge of people involved in communication with the target population and suppliers. As well put by (Dunn, 2022) "Grassroots responses are by definition not standardized. Instead, they are the result of a million individual responses to a crisis: one room to share, one person driving a car, and so on." Therefore, models of most interest to grassroots are with the multiple suppliers, often non-stable ones, capturing the stochastic nature of supplies inflow and outflow, focusing on determining minimum stock level and size of order, and implementing rather a proactive strategy, than a reactive one.

3.5 Metrics to evaluate performance

Several metrics exist to measure the performance of organizations providing humanitarian aid. The target of humanitarian aid organizations during disasters is to minimize the number of deaths and alleviate human suffering. Taking into account that it is impossible to predict the exact location of the next disaster missile attack, so therefore to evacuate all people, the goal then is well described as: 'mitigating the '... urgent needs of a population with a sustainable reduction of their vulnerability in the shortest amount of time and with the least amount of resources'(Laan et al., 2016). Respectfully, the metrics for any systems must align with the goal and given the processes in grassroots:

- Time to fulfill request - response time (Zhou and Olsen, 2016);
- Number of people helped and percent coverage of the requests;
- Low request decline rate

Chapter 4

UCU Volunteering Center (VC) Analysis

4.1 About the VC

The UCU Volunteering Center arose from human kindness and unbreakable spirit. Starting from a single student's desire to help those most affected by the conflict by collecting and distributing humanitarian aid supplies, the organization soon grew to include several dozen individuals in self-formed departments or teams. Some of the departments later merged, some were divided into smaller units. For example, the volunteering center used to have a logistics department, consisting of 2 people who were responsible for finding a way to deliver supplies to the requester. They found cars, agreed on the dates of delivery, and kept the communication until confirmation of arrival. After the first few weeks of operation, as more routes were established, requesters began to pick up supplies directly from the center. Therefore, the logistics team switched to other operations. Small organizations are more impacted by the external instability. At the same time, the rule 'adapt or die' is very applicable. Iteration by iteration, challenge by challenge, the center is improving its operations and finding new opportunities for growth.

4.2 Stakeholder analysis

Within two weeks volunteers understood the need to share responsibilities and naturally formed the following center structure: Head Office and Inventory Management, also often called the Humanitarian Office. The Head Office consisted of 4 people: a 'CEO', a 'visioner', and a strategic partnerships manager. The fourth founder became a volunteer coordinator. These people joined the center in the first week and gathered others to create the current form of the center. Humanitarian Office currently consists of Administration, who members include: the Finance manager and Request manager; and Inventory Team, which includes the Data Managers, Volunteer Coordinators and workers. No individual has a formal title and all of the people mentioned above are volunteers; however, this terminology is used in the center. Furthermore, amongst the volunteers, it has been observed that an organizational hierarchy has been established, with the Administration team occupying the higher echelons of the organization.

4.3 Limitations and center security

From a personal safety and security perspective, it is important to note that the volunteers at the center are primarily current or former students of UCU. In only a few

cases was where someone from the broader university community was allowed to join volunteers with sorting the supplies. This limitation exists because the center is operating during war, and thus a potential target. In comparison to relief efforts for natural disasters such as hurricanes or floods, supply chains are not at risk of being destroyed as in a war in which missiles pose a threat to supply chains. Particularly with a drastic increase in the population in western Ukraine resulting from many people evacuating from the front lines, volunteering centers discovered a need for an extra layer of security. For instance, Lviv Plast keeps the location of their sorting and storage centers secret, known only by their internal community. Collection locations are made public to accept donations.

One of the key limitations of the volunteering center is human resources. Student volunteers have ongoing studies, some of the students were internally displaced from Eastern regions, many have part or full-time jobs. May and June are predictively seeing a decrease in volunteer resources due to the final exams. At the same time, everyone wants to contribute as much as possible, especially when air alarms interrupt their nights, reminding them that there are still many people who need help. Addressing the issue, volunteers decided to implement 4-hour shifts which for convenience, individuals can select their preferred time from 9 am to 9pm. Volunteers sign up via Google form and can submit new responses in case their availability changes. Initially, attempts were made to organize volunteers into groups was 6-hour shifts, but the idea did not live long due to the schedules of many students. Being fast to respond the center quickly accepted a more flexible approach. In fact, the center has gone through many operational challenges and every time found an improvement in terms of organization, responsibility distribution, workload and others that take significant amounts of time in large organizations to document, discuss and plan.

4.4 Roles and responsibilities

As mentioned above, volunteer resources are driven by different types of motivation. One of the biggest values for volunteers the center provides is a feeling of security and support. Volunteers and coordinators are divided into 3 groups based on the item storage zones: medical supplies, food, hygiene and other. These teams are knowledge holders for the zones.

As part of this project, I interviewed and documented volunteering roles in the center. Based on the volunteers' feedback, the Figure 4.1 illustrates the snapshot of the system on April 31, as it has changed since February 24th and will continue changing as needs arise:

	Responsibilities	Desires	Needs
CEO	<ul style="list-style-type: none"> Conflict resolution Coordination between departments Reporting to the UCU administration Ensure wellbeing of all volunteers, Seek new opportunities 	<ul style="list-style-type: none"> Volunteers to be able to solve problems on their own See more requests being filled : vc supply to meet the demand Sustainability of the vc 	<ul style="list-style-type: none"> Good relations with all other volunteers Understand the source of the problem if one appears way to share a common vision for vc
Partnerships Manager	<ul style="list-style-type: none"> Find new partners and sponsors for vc, communication and negotiation, Finds potential suppliers in Ukraine from local businesses, support new initiatives 	<ul style="list-style-type: none"> Responsiveness of partners in helping vc More suppliers and good quality of supplies Interested in helping the military 	<ul style="list-style-type: none"> Know the demand, Advisory from SMEs, Credibility for vc, Reports from data people to increase trust
Request Manager	<ul style="list-style-type: none"> Receive and filter requests Communicate with recipients, Compose request lists and quantities for coordinator, ensure the request is collected by the time of pick up Collect feedback from recipients, Maintain the requests database 	<ul style="list-style-type: none"> Recipients clearly expressed their needs Recipients to be polite Relies on volunteers and coordinators accuracy Be able to accept majority of requests 	<ul style="list-style-type: none"> Stress resistance and communication skills Accurate data on available supply Coordinator fast response to new requests Mapping between recipient request and supply items naming and quantities
Finance Manager	<ul style="list-style-type: none"> Keep track of vc finance balance Plan future expenses Provide reports on spending Collect donations Cooperate with Partnership on work with sponsors 	<ul style="list-style-type: none"> Have enough funds to maintain operation in vc Clearness on expected expenses Proposed price compliance with the actual No problems with legacy and tax 	<ul style="list-style-type: none"> Template for documentation and reports Clear and verified information on payment details Separate bank account
Data Manager	<ul style="list-style-type: none"> Register the supply in the data base Update supply data regularly Collect data from volunteers - ensure it is correct Generate week reports of supply sent 	<ul style="list-style-type: none"> Shared understanding of units of measurements, categories of items among volunteers Unified format of data, no duplicates No data lost 	<ul style="list-style-type: none"> Easy access to data Precise numbers of supply counted from volunteers Convenient way of entering the data Laptop
Volunteers	<ul style="list-style-type: none"> Control the quality of volunteer work, solve local problems Ensure the volunteers know their responsibilities and are occupied Take pictures of a loaded vehicle (for report) Onboard and motivate volunteers 	<ul style="list-style-type: none"> Volunteers don't make mistakes Volunteer's respect Feel useful, fun and communication with other volunteers Space was clean and organized Know ahead of time the arrival of supplies 	<ul style="list-style-type: none"> Leadership and communication skills Feedback from recipients and administration Clear request lists Dedicated volunteers
Suppliers	<ul style="list-style-type: none"> Sort and count the supplies Pack the supplies for a request Load and unload vehicles with supply Arrive on time on shifts Report to coordinator\data people 	<ul style="list-style-type: none"> Snacks provision Clear tasks from coordinator Fun and communication with other volunteers Feel useful 	<ul style="list-style-type: none"> Information about vc schedules Responsible coordinator Space for rest Encouraging feedback from coordinator and recipients Convenient tool to register supplies
Recipients	<ul style="list-style-type: none"> Communicate with the vc date and details of delivery to the vc Collect the supplies from the request list* 	<ul style="list-style-type: none"> Support Ukrainians Transparency where the supply went Clear communication Unload the vehicle as fast as possible Want to send the items which are really needed 	<ul style="list-style-type: none"> Support on the delivery logistics Known schedules of vc Reports from the vc on distribution of supplies Request lists up to date
Finance Manager	<ul style="list-style-type: none"> Compose a list of needed items Communicate it clearly with the vc's Pick up collected items 	<ul style="list-style-type: none"> Request to be fulfilled as fast as possible (on the same day) 100% fulfillment of the request Supplies are of a good quality 	<ul style="list-style-type: none"> Fast way to communicate with vc regarding request and pick up Pick up place Help to load the vehicle with supplies (opt)

FIGURE 4.1: Responsibilities, desires and needs per volunteer role in UCU VC as of April, 2022

4.5 Request System

During crises like war or natural disaster, demand is highly unpredictable. It is also rarely captured accurately and more or less evaluated only after the crisis stabilizes or ends. Attempting to centralize different requests, many platforms offered their space as a dashboard to connect different suppliers with recipients (like Prozzoro). Yet, not many centers use it, as they see fewer benefits than efforts for maintaining. UCU had its own tables for storing and managing request data. Only the Request person, backup person and CEO have access to the table.

Currently, the center works with a 'request' system. Usually, requests originate from known people or reliable references. There is a base of military contacts, medics and partner volunteering organizations, which help with the distribution at the final location, who are communicating with the volunteering center and the end beneficiary. A request - is a text representation of a need documented by the Request person from a conversation with the recipient. Each request has details about the receiver, contact person, expected list of supplies, date opened and date closed, and also status. The supplies are accumulated at the center and then can be used to fulfill the request. Figure 4.2 demonstrates the lifecycle of a request on April 31, 2022.

Requests are collected directly by phone or messenger by the Requests division. The person receiving a request verifies if it is realistic to collect by verifying the availability of items requested on the inventory spreadsheet. The Request Manger uses subjective judgment to determine if a request can be realistically fulfilled. If deemed it can, - the request is opened. If not - then the person is advised to contact other organizations.

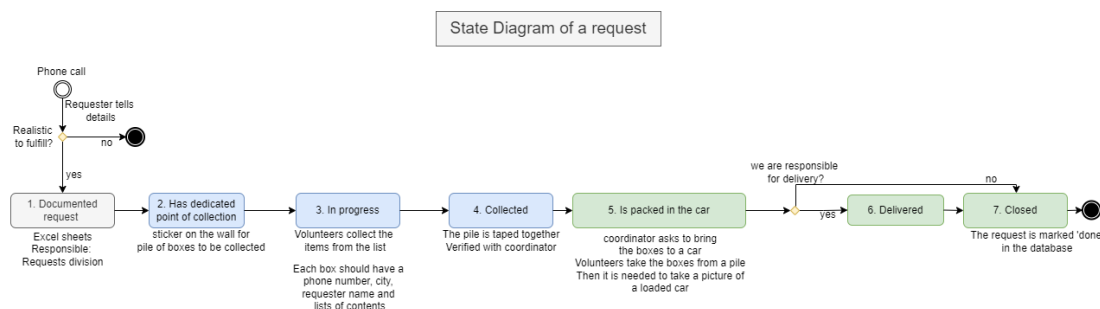


FIGURE 4.2: State diagram of a request lifecycle at UCU VC as of April, 2022

Respectively, each request moves through the states from 1 to 7:

(1) Opened. Then the request is entered in the Google spreadsheets including all needed details. More on request fields in the 'Data' section.

(2) In progress. The Request division forms a 'Request' form and prints it on the A4 paper. Request person adjusts the request list by the availability of supplies and other opened requests. It is then given to a Coordinator who finds a place for the future pile to be located. He physically sticks the paper to the wall, indicating a reserved place.

(3) In progress. Then Coordinator tells the volunteers to collect the needed items from the request list and place them at the dedicated spot. Volunteers navigate through the center by themselves and find the location of a needed item (usually fixed locations for several types of items). They pick up the needed or available quantity of items by themselves, packing and taking notes on quantities packed.

(4) Collected. When in 'collected' state - Coordinator verifies that the piled boxes match the request. Request waits to be picked up. When given to volunteers to collect, the requests are fulfilled within the day. If there is a lack of supplies for some requested items, they are not added on the next day - volunteers pack at most of what is available on the day of request.

(5) Sent. When the transport arrives, the Coordinator together with the volunteers loads it with a request items and takes a picture before departure. Picture is necessary for tracking the supplies: in case of any loss or damage - the center will know that it happened after they sent it.

If the requester can pick up from VC by himself - then the request goes to the 'Closed' state.

(6) Underway. If the VC is responsible for delivering the request - then the request remains open until it reaches the destination and there is a photo proof of the arrival.

(7) Closed. Request Manager marks the request 'Closed' in the database.

Understanding the process of collecting data is an essential step in center analysis and argumentation for decision making.

Chapter 5

Data analysis

5.1 Data flow for requests

While businesses benefit from advanced Enterprise Resource Planning (ERP) systems, most grassroots organizations don't have a structured way of collecting data. There were several approaches to documenting the requests and supplies: UCU center used Google sheets, Elohim center in Kyiv used Atlassian Jira, many others used simple notebooks and paper stickers. Yet the majority of information remains in messengers, while very convenient and familiar to volunteers, this data is difficult to aggregate and analyze. Figure 5.1 illustrates the UCU VC data flow as of April 31.

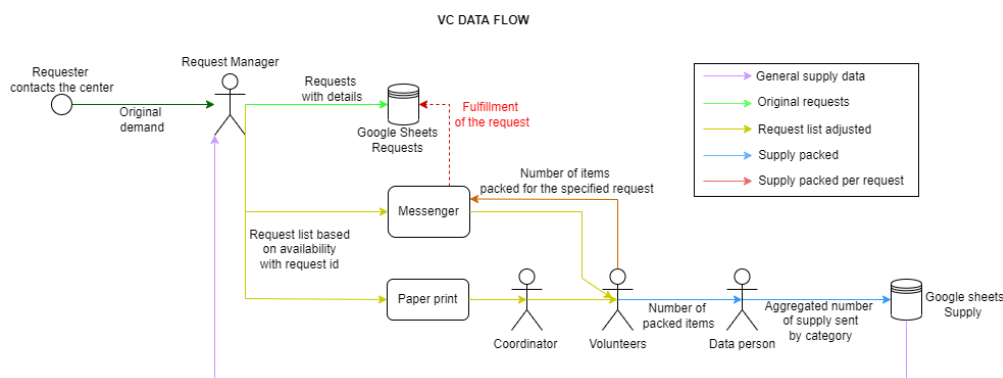


FIGURE 5.1: Data flow diagram of fulfillment of request at UCU VC as of April, 2022

The Request Manager plays a very important role in the center: evaluating center capacity to accept the request, documenting the original request, determining the list of items to collect, deciding on the distribution of scarce supplies between the requests - intuitive prioritization. Each of these steps is not shown in the datasets - the actual list of supplies planned to send per a specific request potentially are communicated through the messenger chats (as indicated by the yellow arcs in Figure 4.2). The biggest problem with the current approach is that after the volunteers pack requested supplies, they report about quantities in messenger as well - therefore, there is no feedback to the database on what portion of request was actually fulfilled (as indicated by the dashed red arcs in Figure 4.2). As will be shown later, we can evaluate the total number of supplies of a particular category sent on that day and compare with the opened requests. However, it is still not possible to determine how much of the total supplies sent was related to the specific request. Another inefficiency is that each volunteer delivers information to the data person in the form most convenient to them: some send a text message, others send a screenshot of notes, while others verbally report the number packed sorted, or provide a hand

written report to the Data person. The data team needs then to aggregate all data records into a precise number sent received and enter the item data into the correct category. For example, one volunteer indicated that 20 meat cans and 20 fish cans were packed; however, there is no specific item inventory category for canned meat. As a result, the data person needs to map the numbers to existing category: packed 40 'Cans salty'. If the Data Manager can't find a suitable map, they add a new category. After a few weeks of operations, the volunteers already know available categories and therefore provide numbers within categories. At the same time, it is a big learning curve for newcomers, as generally, there are 7 different supply categories, consisting of a total of 419 different item types (See Appendix A (8.4 for more details). Supply data is stored in a separate database, as it represents the state of storage at the given time, regardless of the origin of supplies or their destination. It is used by the Request Manager to evaluate what supplies are currently available for usage. The data is updated at least once a day as a rule, but usually the data people enter aggregated numbers to the database several times per day.

5.2 Data Limitations

Data is necessary for ensuring transparency within the UCU center and building trustworthy relationships with suppliers and partners. At the same time, collecting and storing request data is a security concern for the center during war. Such data lists the personal information of volunteers, drivers' contacts, requests' destination and other details. Accordingly this data is very sensitive, as it can be used by the enemy's army, as well as tracking records of supplies coming in and out the storage, as it can change a perception of a volunteer from a regular civilian to be views as a threat and therefore - to be eliminated. Volunteers are often targets for russian soldiers (Shutka, 2022). As an example, in March when there was active military aggression in the Kyiv region, a grassroots organization located just an hour away in Kyiv kept all their records in paper format and at the end of the day would burn all records to mitigate the personal risk of volunteers and their families.

In contrast to humanitarian organizations operating responding to natural disasters, obtaining access to humanitarian aid organizations' data during war, especially during the acute phase of an unstable conflict, can be a challenge to external advisors and analysts and requires patience and negotiation skills.

The data used for this analysis was collected after the center established core roles around mid-March. It is important to note that initial attempts to record data in the center was a single table with very inconsistent, free text data. Such efforts are another example of how centers evolve by iterations, not aiming to do everything perfectly the first try.

5.3 Data Overview

There are two datasets available: request and supply. As both are continuously updated, for the project, observations between 2022-03-04; 2022-05-20 were used for analyses. Contact information for volunteers and recipients was removed for security purposes. The request dataset consists of:

Date opened (type: date dd-mm-yy). Date when the Request person received and documented the request. There were no cases when a request was received on one day and documented on another.

Destination (type: string). Freetext string representing the destination where the request would go. Data entry was inconsistent - the field could contain detailed address information; only the name of the city; name of organization; name of military unit or name of the hospital to receive help, or simply words 'to the front lines'. Because of the inconsistency and context specification, manual data cleaning was required. This column is important for understanding the center's role and if it is close to achieving its set goals.

Request list (type: string). This field is intended to capture the list of requested items. This field is important, yet consists of the most unreadable part of the data set, typically consisting of a free text list of items, often without indication of quantities needed.

Number of people (type: string). This column captures the number of people to receive help from the request. Due to the freetext data entry, the values are often not numeric, which made it difficult to parse. Often, the requester did not know the needed number of items, so they indicated the number of people to serve. Based on this column and on the 'destination' the Request Manager made assumptions regarding a reasonable amount of supplies to hand out.

Priority (type: integer). This field is intended to represent the importance and urgency of the request. It is filled subjectively by the Request Manger, who is communicating with the requester and therefore can intuitively assess their situation and intonation. 1- highest priority, 3 - lowest priority.

Comment (type: string). This column captures important notes about the request. Sometimes fulfillment data is indicated there typically as a result of mistype. Usually it points to messengers for additional information. This column can be useful for understanding the context of the request.

Supply sent per request (type: string). This column meant to indicate how much supply was actually sent to the recipient and therefore allow mapping 'requested-supplied'. Initially there was some effort to track it in the requests dataset, but as more operations moved to the messenger, actual fulfillment data is not available for the analysis.

Is Closed (type: binary). Field to indicate whether the request is closed. When the UCU center was providing delivery support for the requests, the request would only be marked as closed after the confirmation of arrival to the recipient, regardless of date closed.

Date sent (type: date dd-mm-yy). Date when the supplies left the UCU center. As more recipients started to pick up from the center by themselves, the values often coincide with the date of closing the request, which is not represented in the dataset.

Examining the column names it may appear that the center did a thorough job with data collection. While data collection was significantly advanced compared to other grassroots organizations interviewed, simple completeness checks reveal the shortcomings in VC data collection.

Chapter 6

Center analysis using based on request and supply datasets

6.1 Initial Requests analysis

Table 6.1 contains how much data was captured during March 3, 2022 to May 17, 2022 in the Request Dataset.

Column name	Count
date_opened	575
destination	551
request_lst	569
num_people	255
priority	576
comment	9
fulfilled	27
is_closed	526
date_sent	409

TABLE 6.1: Completeness check for requests dataset as of May 17, 2022

Total number of requests captured is 576. There was only one request did not have a date_opened, and there were 7 that did not have the request_lst. Important to note, that there can be multiple requests per day, and some days have none. The center has accumulated date for 68 unique dates, having an average of 8.5 requests per day.

Due to the free text manner of data entry, the number of repetitive destinations is higher than expressed in the data (128 identical values for destination). The more detailed the destination description is, the more difficult it is to parse the destination and type of the recipient : military, volunteers or civilians. Most of the duplicate data points in 'destination' column consist of one word - name of the city. At the same time, there are few entries indicating the repetitiveness of the request. Due to the emptiness of the 'fulfillment' column - it is not known if those requests repeat because they were not supplied or because the demand increased.

Priority: value	Count
1	555
2	18
3	2
'Text message important'	1

TABLE 6.2: Value counts for priority of a request in VC requests dataset as of May 17,2022

Despite the fact that all requests have a priority recorded, 96 percent of requests were marked as 'top priority', which essentially states that all requests have the same priority.

Table 6.3 provides the unique value counts for the field Is_closed counts:

is_closed	Count
yes	437
no	89

TABLE 6.3: Value counts for is_closed status of a request in VC requests dataset as of May 17,2022

Almost one fifths of the all requests is marked as 'not_closed'. Important to know, that sometimes the requests are marked as closed when the supplies were sent to the recipient, even without 100 percent of the requested items and quantities. At the same time, there were cases when the supplies were sent, but the request was marked as not closed due to partial fulfillment. Requests that are marked as closed have a date_sent value as a rule, except for the requests made on March 7-13. These requests don't have the date sent, but are considered closed and colored 'green' to make it more visually distinguishable for the Request Manager. Taking into account that the beginning of March is really the beginning of the center's operations, we can assume that this means they were sent on the same day.

It is necessary to understand the usage of those two columns, as they serve a base for the further analysis. Although, the data is highly inconsistent as the center has been changing its operations, which therefore changed the way the data was treated. Based on observations of the process of documenting the requests and interviewing volunteers of different roles, we can proceed with the following definition in Table 6.4:

	Is_closed is True	Is_closed is False	Is_closed is blank
Date_sent is recorded	Most common case; indicates the request was satisfied. Does not imply absolute fulfillment. <i>Assumption: treat as done</i>	Supplies were sent, but fulfilled only partially the request <i>Assumption: treat as done</i>	Supplies were sent, but most probably didn't fulfill the request completely. <i>Assumption: treat as done</i>
Date_sent is blank	Supplies were sent on the same day as request was opened <i>Assumption: treat as done</i>	Request was denied and none of the supplies were sent for the request <i>Assumption: treat as not done</i>	Needs more context. 1.Request was opened long time ago and was declined 2.The requests are still open <i>Assumption: treat as not done</i>

TABLE 6.4: Request treatment based on is_closed and date_sent values as of May, 2022

Respectfully to the introduced definitions, there are 449 closed requests and 118 requests will be treated as declined.

6.2 General Request Trends

One of the weaknesses of many grassroots like UCU, who manage to have at least some data, is that they do not intend to analyze it - their goal is to just capture it. Which might work in a short term, especially when there are most of the processes changing every week. Due to that, it is very difficult to establish the volume of a request as it requires manual mapping of the items requested to the existing supply taxonomy in the center, and a manual search for quantities which can be expressed as word or as a number are not always mentioned at all. Because of too many conditions, typos, different formats of request and even different language, script parsing of the request list is not practically implementable and had to be manually parsed.

At first it is important to understand how many requests are being received by the center. As the Request person filters out the initial demand, available data includes only the requests which UCU center attempted to fulfill, not the number of requests denied. There were few records with empty request list cells - most probably meaning this data again remained in messengers 5.1, leaving in total 569 available requests. Based on Table 6.4, the 20% of the total number of requests recorded are declined. At the same time, there is a clear downward trend in the frequency of requests and number of requests per day, as illustrated by Figure 6.1

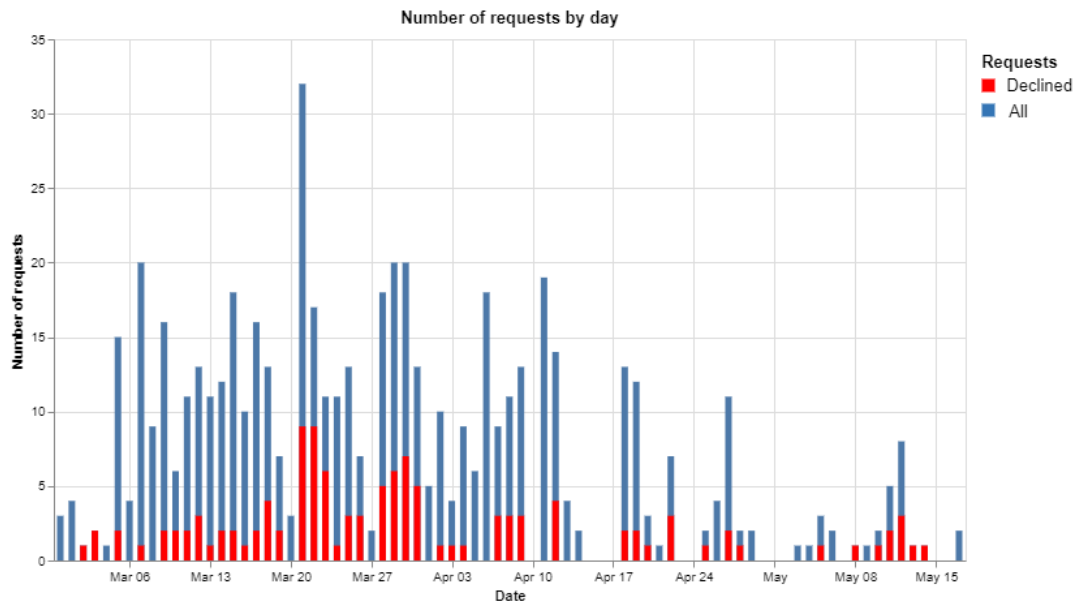


FIGURE 6.1: Number of declined requests comparing to total requests registered by day at UCU VC as of May, 2022

These observations can be explained as follows :

- In the beginning of March - a week after the war started, most people were experiencing a 'panic' effect. To increase the chance of receiving help, often a requesting organization reached out to several relief organizations with the same request. Once receiving needed supplies from one center, all other requests at other organizations were canceled. Based on the available data it is hard to tell what was the reason for a request decline.
- As time passed, more connections between requesting organizations and the humanitarian organizations were established. Recipients selected a preferred centers as their source of aid. Additionally, more grassroots organizations were created, further spreading out the supply.
- Request data does not account for the items' durability and quantity. Depending on the item's expected shelf-life. For example, some items such as food, continuously need to be replenished as the item is consumed. Other items, such as sleeping bags can be used over and over. As a result, demand data may appear to diminish, but in reality demand for multiple-use supplies might have been covered. For example, having ordered 'sleeping bags' in one week, it is unlikely that the same recipient would have a need for 'sleeping bags' the next week exploitation time, quantity.

Center ability to fulfill a request in a shortest possible time is another important factor for evaluating performance of a humanitarian aid centers. Large organizations spend significant effort on potential risk screening and developing emergency response preparedness programs, such as described in (UNHCR, 2015), aiming to decrease the response time. While grassroots appear as a response to a disaster themselves, without any prior planning, providing critical assistance to the affected population is a necessity for organizing centers' operations. Figure 6.2 is an approximate demonstration of UCU VC velocity, based on the difference between date_opened and date_closed values for a request.

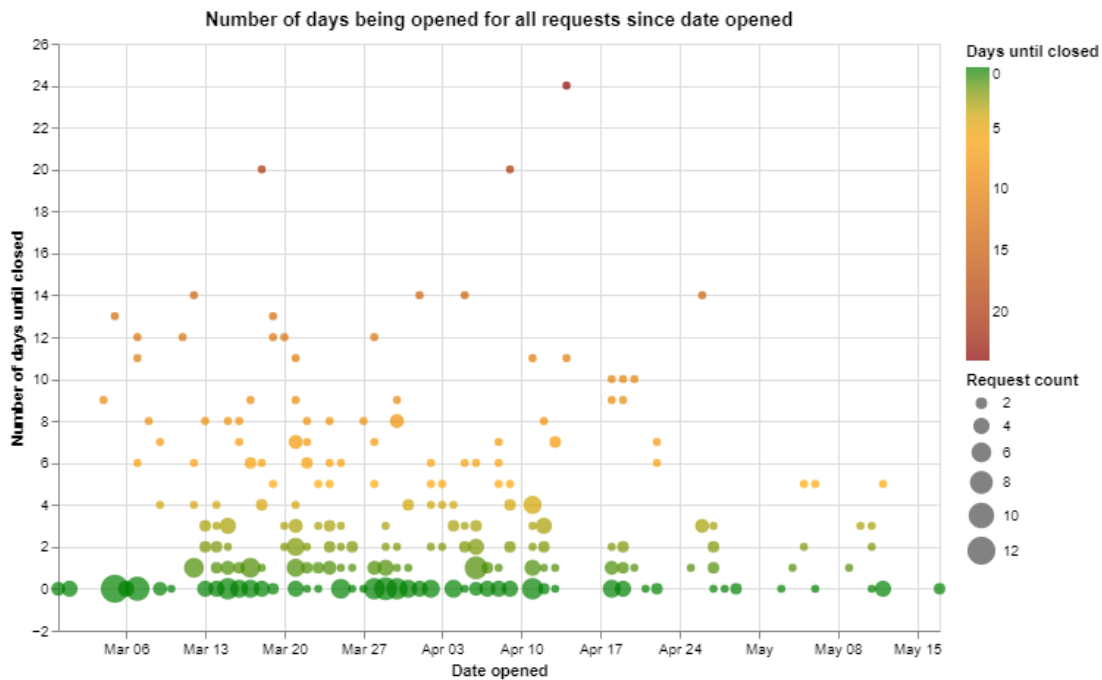


FIGURE 6.2: Number of days the request remained open since the day of register, by day at UCU VC as of May, 2022

Negative scale was added to the chart for a better readability, as there were several requests with 0 days of waiting. Only closed requests were plotted with a recorded date_sent. It is seen that the majority of requests the VC was able to send within first three days. However, there was still significant number of requests that remained in the center for longer than a week. As the number of requests decrease, the waiting time decreases as well. The waiting time decreases as well as the recipients started to pick up supplies from the center by themselves.

Important to know, that the center collects supplies for a request on the same date of receiving the request, even if there were not enough of supplies on stock - the volunteers pack whatever is available. The request is not upfilled on the next day if the needed supply arrived. This approach meant to decrease the response time when the center was receiving dozens of request every day, however at the cost of fulfillment rate.

6.3 General Supply trends

While request data in its current version of May, 2022 does not capture full demand, the supplies dataset is in a way more convenient format. With respect to taxonomy (8.4), the food category had the most data entries available for analysis. There are over 74 types of food items, however it is important to see the general trend for supplies arrivals and consumption:

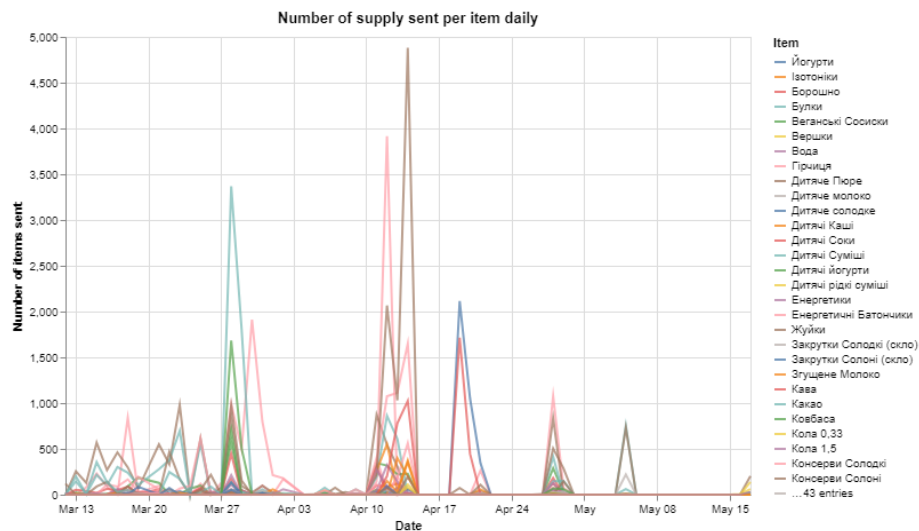


FIGURE 6.3: Total number of supplies sent by day at UCU VC as of May, 2022

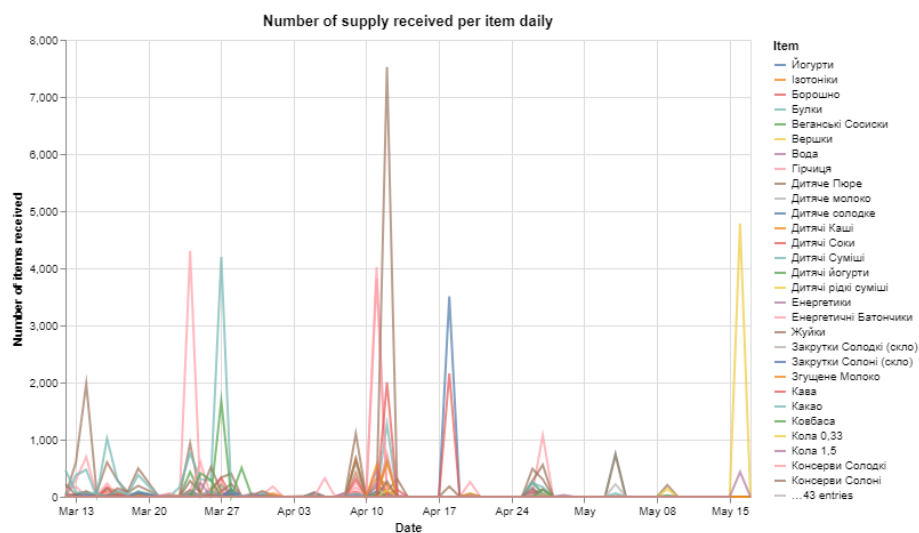


FIGURE 6.4: Total number of supplies registered by day at UCU VC as of May, 2022

Comparing the charts 6.3 and 6.4, a downward trend is noticeable in both supplies sent and supplies received: the volume of registered supplies is decreasing as well as frequency of arrivals. Most of supplies arrivals happen at least once a week, and the send out soon follows them. Large values in supply received followed by the smaller are usually describing one arrival of supplies, as the same volunteers are unloading the vehicle and then sorting and counting supplies received. The process

requires time and effort, therefore the next day after an arrival of a great volume of supplies, a decline in numbers is observed due to reduced human resources. At the same time, there can be small donation during the week, which would be also represented in the chart. The arrivals of supplies are rarely if ever scheduled. Since the mid-April, the deficit is also noticeable - requests were mainly sent out only when supplies arrived. The individual plots for each food item can be found in the Appendix. While some items have high rates in consumption, the majority of item types is below 100/week. Consumption analysis provides opportunity for prioritizing the items to be supported, diminishing the unnecessary items. The most popular product of consumption is salty canned food (8.4).

6.4 Cans

The center was created to support Ukrainians during the war. As illustrated in Figure 6.5 the center is sending supplies to recipients, which can be categorized into 3 groups: directly to military, directly to civilians, and other organizations such as hospitals or similar humanitarian aid centers, that also distribute supplies to the places of highest need. Respectively, each group of recipients has their specific needs as well as shares of common requests.



FIGURE 6.5: Venn chart of requested items based on recipients categories at UCU VC as of April, 2022

Other organizations reach out to the UCU center most often to help fulfill the requests for military or civilians, therefore, their request list to the center mostly consists of requested items common to the mentioned groups combined. For example, 'diapers' may appear in requests of groups 2 and 3, but not in 1, while thermal clothes are to be seen in 1 and 2, not in 3. Specific requests for only group 2 might be wheelchairs, printers, or office equipment needed by volunteers to operate. The biggest volume of requests was in the intersection - mainly first aid medication kits and food.

Therefore, for the purpose of deeper analysis, it was decided to pick an item of the most common use - cans of food. Coincidentally, this item had the most data entered in the supply database. It took 3 hours to find and clean all requests mentioning cans and derive the requested quantities, categorize the requests' destination and type of recipient.

Due to the freehand format of the data, quantities were manually parsed from the request list description and when missing, interpolated by the following method: 1 can per person, if the number of people indicated; 1 can per 200 grams, if the weight is indicated; 8 cans per pack, if the number of packs indicated; 20 cans per box, if

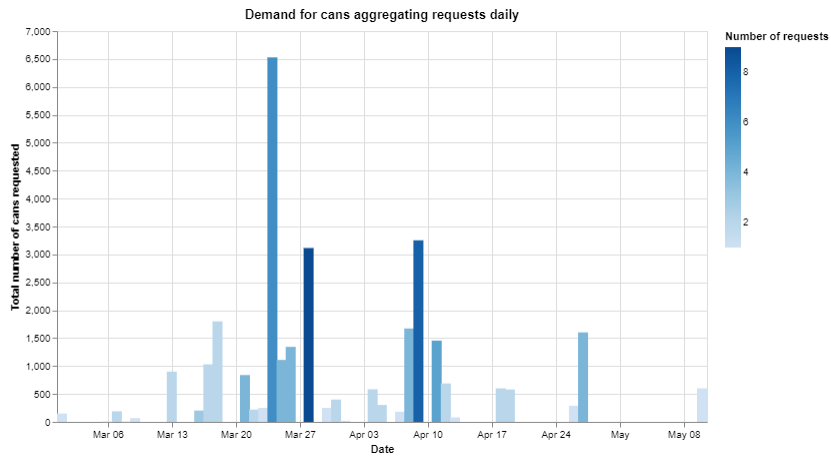


FIGURE 6.6: Aggregated demand for cans by day at UCU VC as of May, 2022

number of boxes indicated, average of the past 7 days, including day of the request opened, when there were no other detailed mentioned. These approximations were taken directly from the data, where both number of people and number of cans were indicated, similarly for packs and boxes. Figure 6.6 illustrates the aggregated daily demand for cans with the respect to number of requests. March 13 - April 17 is a period of the highest activity in the center.

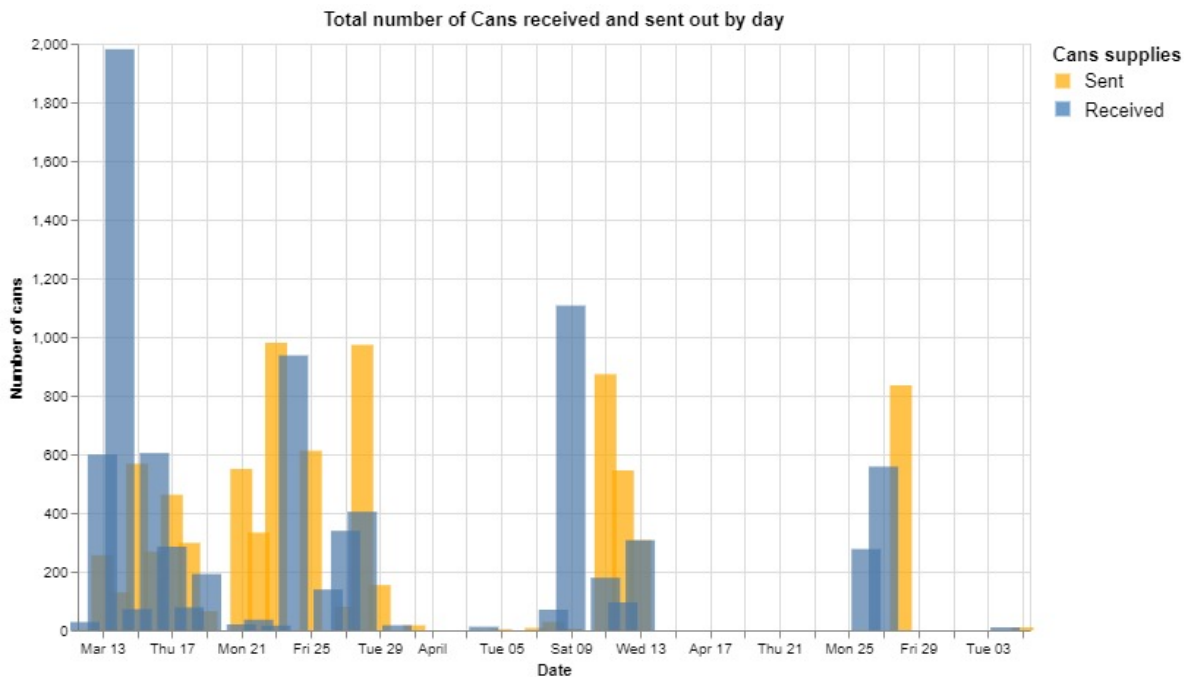


FIGURE 6.7: Comparison of supply sent and supply received for cans, by day at UCU VC as of May, 2022

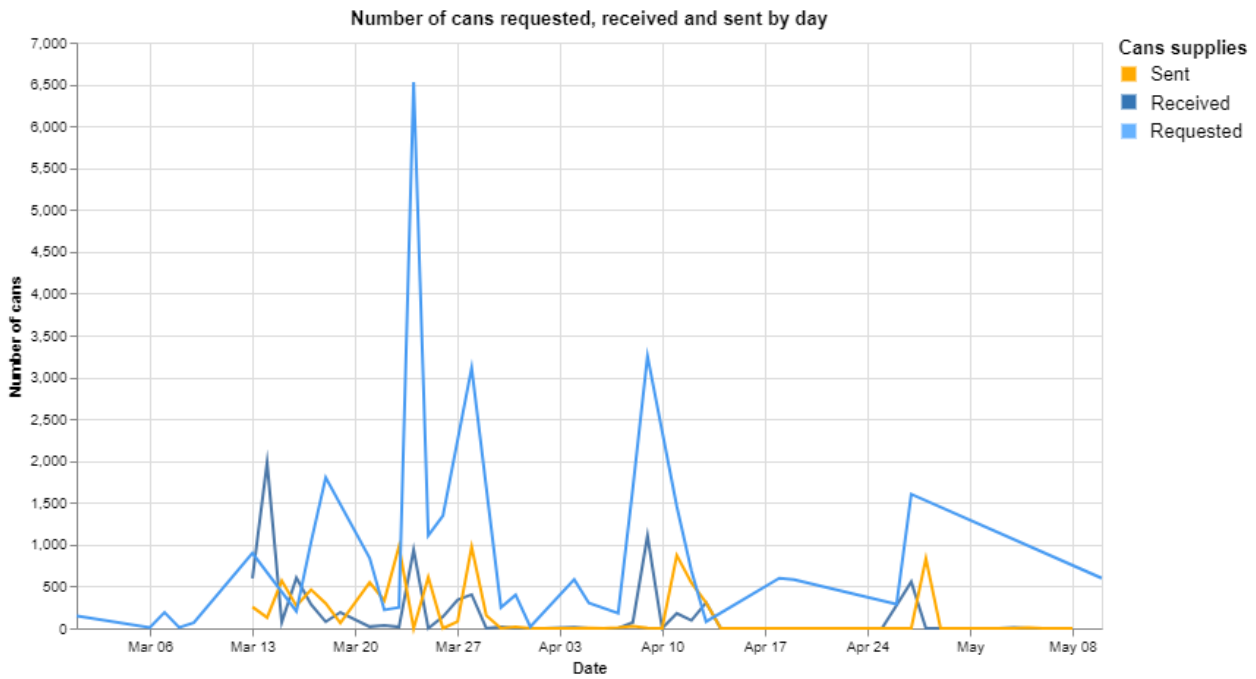


FIGURE 6.8: Number of cans, by day at UCU VC as of May, 2022

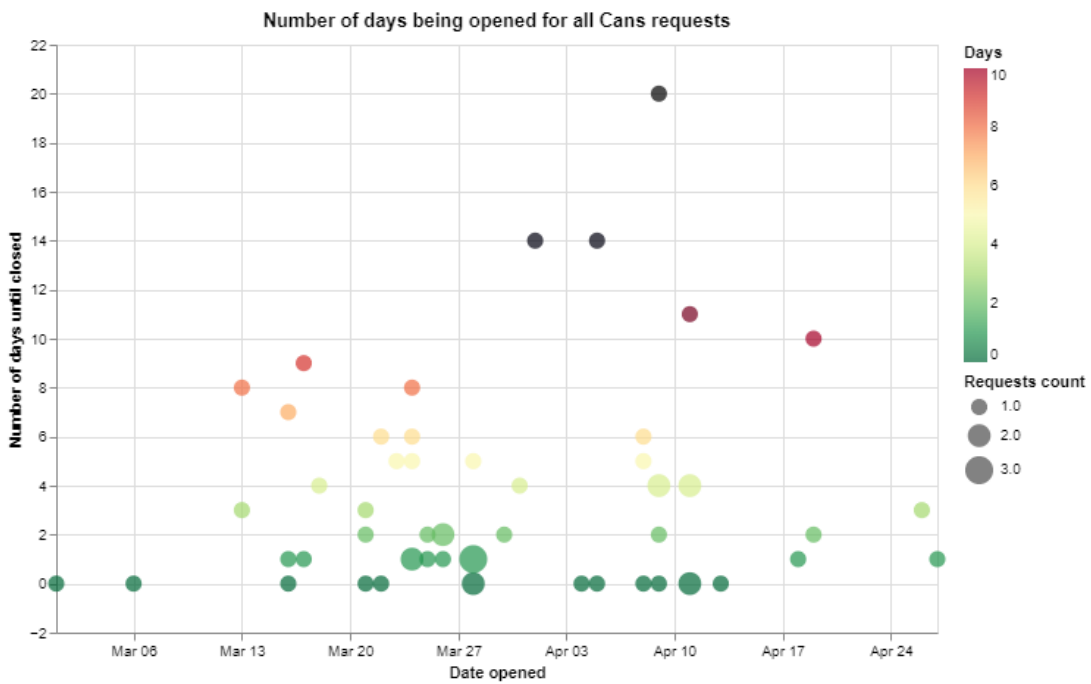


FIGURE 6.9: Number of days a cans request remained not closed, by day opened at UCU VC as of May, 2022

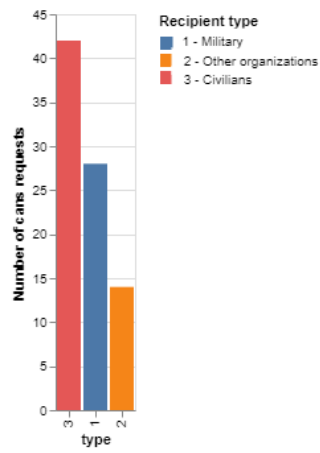


FIGURE 6.10: Aggregated requests for cans by recipient type at UCU VC as of May, 2022

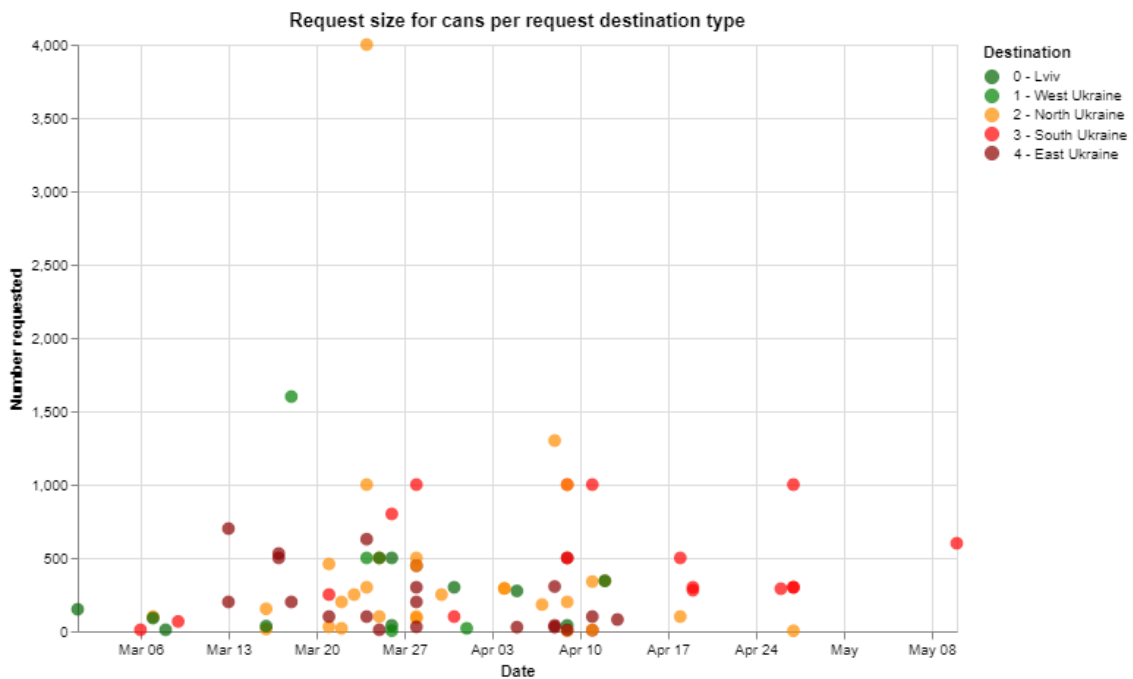


FIGURE 6.11: Aggregated requests for cans by destination by day at UCU VC as of May, 2022

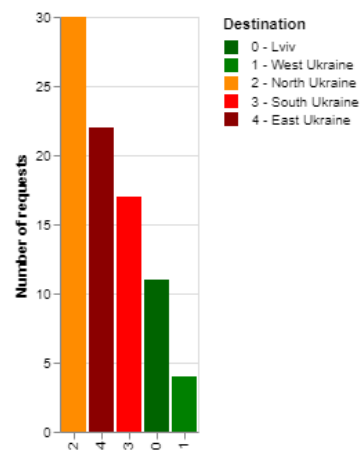


FIGURE 6.12: Aggregated requests for cans by destination at UCU VC as of May, 2022

Chapter 7

Basic inventory planning

When it comes to inventory planning it is important to understand the planning horizon. In the case of the UCU center the planning horizon is highly dependent on the length of suppliers' interarrival times, taking into account that the center has not yet established long term supply agreements with other centers in Europe and most of the supplies arrivals were not scheduled ahead. In interviewing the Administration team, it was clear that the center did not have the time and resources to work on building those relationships as the number of suppliers was large. As such, there was no immediate need to schedule supply orders. The center was overwhelmed with all sorts of donated items and therefore decided to focus on covering the gaps in their the sorting-distributing operations. With time, as some of the suppliers stopped sending humanitarian aid, the center started to notice deficits in some categories of the items. There were days when there was barely any inventory left. As part of addressing the issue, the Partnership manager worked towards supporting local manufacturers of goods such as thermal accumulators, tactical clothes, and first-aid medical bags, rather than wait for delivery from abroad. While purchasing items from local businesses supports the Ukrainian economy, it bears large costs for the Center and does not fulfill the demand.

A good starting point for UCU for implementing inventory planning would be to find a supplier for at least one category and agree on scheduled supplies. Having looked at the supply inflow charts, we can assume that a substantial amount of supplies are delivered at least once in a week. This gives a base for the following setup:

Assumption for inventory planning: Time of delivery of supplies once an order is placed is 1 week. UCU orders supply at the end of week. The quantity ordered = quantity delivered. Order arrives on time. Order covers the demand for the following week. No other supplies are arriving, except the ordered ones.

Thus, the following variables can be introduced for one item: $Inventory_n$ - the number of a particular item left at the end of week n ; $Order_n$ - the number of particular items ordered from suppliers at the end of week n , which will arrive at the end of week $n+1$; $supply_out_n$ - total number of items sent at the end of week n .

Therefore, the inventory level can be expressed as:

$$inventory_n = order_{n-2} - supply_out_n$$

To express the size of an order made at week n , we need to estimate the number of supplies to be sent for week $n+1$ and $n+2$. In fact, the ordered supplies will not arrive until the end of week $n+1$, which means the order size should be in respect to the estimated demand of the week $n+2$:

$$order_n = estimated_supply_out_{n+2}$$

This logic would work in the ideal world of 100% accurate estimations and very punctual suppliers. To make the management of inventory more realistic, the following adjustments can be made:

Assumption: Time of delivery of supplies once order is placed is 1 week UCU orders supply at the end of week The quantity ordered = quantity delivered No delays with delivery

In this setup, the number ordered for the week is not necessarily equal to the demand, for example when the actual demand is lower than expected or there were unplanned supplies arrivals from other donations. To account for for inventory remaining from the previous week:

$$\text{inventory}_n = \text{order}_{n-2} - \text{supply_out}_n + \text{inventory}_{n-1}$$

$$\text{order}_n = - \text{inventory}_n - \text{order}_{n-1} + \text{estimated_supply_out}_{n+1} + \text{estimated_supply_out}_{n+2}$$

Clearly there is a large dependency on estimation accuracy of the demand for the next $n \times 2$, where n - delivery cycle. Using the cleaned cans request data, estimated demand was generated using a Poisson distribution with lambda being equal to the cans quantity requested mode, median and mean. As seen in the table (), due to the small sample size of 70 days, the distribution did not fit the data, however, the results from table1 show that the scheduled supplies lead to the greater fulfillment rate.

Chapter 8

Conclusions

8.1 Research summary

This project examined the operations of grassroots organizations during the war, focusing on in depth analysis of UCU VC. A detailed research of fulfillment of the request process and inventory management of the center was conducted. A stakeholder analysis was performed, including volunteer roles - responsibility distribution and needs. Investigated the data flow in the center uncovering the bottlenecks, data processing issues and provided recommendations how to solve them (treat). Data used for the project includes : centers datasets on request and supply register, personal interviews of volunteers, life process observations. Due to the data format and inconsistency, the detailed analysis of demand and supply was conducted on the item of most frequent use - canned food, introducing the example of implementation of scheduled supply. The model was tested using tree Poisson estimates for demand using mean, mode and median of actual demand as a parameter. The obtained results confirm that the fulfillment rate is higher ordering supplies ahead. As part of the sharing the the discoveries with other volunteering centers, a one page visual guide was developed providing advice for data collection and supply order. Finally, this project provided recommendations for further research and application of data analysis for supply planning for small volunteering organizations operation during war or natural disasters, such as including the probability of order delay, supplier capacity limitations, multifactor demand estimation using external data. The combination of these approaches could help to reach better results

8.2 Next steps for research

Determine minimal level of inventory for a sample of selected items Make a table with different scenarios for order delay, delivery length and supplier variables Make a shareable dashboard where one can plug-in data and see the visualization recommendations Predict demand using external data Assign cost for not fulfilling the request, for fulfilling with the delay.

8.3 Recommendations for UCU volunteering center

Based on the stufy of UCU operational processes and data analysis, the following enhancements are suggested:

- Structurize the data entry

- Collecting the request lists in a single agreed manner, indicating the quantities requested, using separate columns for geographical destination and recipient type,

use existing naming for the products. For the automation, may consider using ERPs, such as ODDO.

Keep track of what was sent per request

Almost no additional effort is needed to implement this enhancement, as the data is being collected by the volunteers in the Messenger, which is difficult to analyze and search. Keeping those records in the request table allows mapping the supply sent to a particular request and therefore providing a better representation of percent fulfilled at any point in time.

Establish long-term relationships with suppliers

Contact existing suppliers, categorize them depending on their interest in cooperation and capacity. An example of groups is: long-term, reserve, one-time. Imply a communication strategy based on the suppliers category.

Narrow the list of supplies to support

Select a few categories of products to deliver and communicate it with stakeholders, preventing them from sending unneeded supply in favor of real necessary items. Align the choice of categories to the general vision of the center.

Start ordering supplies for the required quantities

Select a couple of items as a starting point - then add planning for more items as the supplier relations improve.

Define metrics for centers operation performance

Analogically, a success measure of a doctor is a low number of same reason visits per patient : the service provided covered the patient's need sufficiently. Therefore, the center can use the number of repetitive requests from the same recipient as an indicator of bad performance. Another important metric to collect is fulfillment rate as well as the number and reason of requests declined.

8.4 Expected benefit for UCU

Having implemented the suggestions of section 8.3, the expected benefits are:

Stabilized workload for volunteers, as the most valuable resource. Knowing what to expect from the truck arrivals and the approximate dates allows planning and scheduling of volunteer efforts, which decreases the pressure on the volunteers.

Less garbage on the storage. By having established a communication channel with suppliers, they will eventually stop sending not needed items, which decreases the size of unnecessary work.

Increased transparency. Enhancements in data collections will allow generation custom reports per supplier, which can be used for building trustworthy relationships. At the same side, for the center itself will be much easier to parse and analyse the data, trace the supply movement and evaluate the performance.

Stronger and more argumentative negotiating position with partners and suppliers. Bringing relationship with the suppliers to a new level of cooperation: instead of one random truck, a systematic delivery of highly needed stuff.

Decrease of the effect of Donor fatigue, as the suppliers are not wasting their resources on unnecessary supply.

Appendix A

Sample table of items names per category for supply management

Tactical Gear	Devices	Clothing	Products	Hygiene	Dishes	Other
helmet	radio transmitter	thermosuits	sublimated food	pads	Waterbottles	Paper A4.
tactical shoes	powerbanks	thermoshirt	macaroni	cotton pads	Metal bowls	empty bags
sleeping mat	flashlights	thermoleggins	cigarettes	wet wipes	Metal cups	warm blankets
sleeping bags	telephones	Balakhava	cans salty	Dry wipes	plastic utensils	scissors
tactical mittens	Night vision devices	sweaters men	Protein drinks	cotton	cardboard utensils	matches
kneapads	Binoculars	T-shirts men	Groats	cotton buds	Fork / Spoons Metal	towel
elbowpads	monocular	sweatpants men	sweets	toothbrush	camping pot	blanket
Inflatable mattresses	drones	footwear (sneakers) men	dry food/ sublimats	toothpaste	Bottles for children	Pillows
tourniquets	Tablets	footwear men	Snacks	Shower Gel	thermos	bags for towels
tourniquet	ports\sockets	fleece jacket	coffee	liquid soap	children plates	Crutches
tactical first aid kits	laptops	baffe	tea	toilet paper	Bibs	garbage bags
enabling\inflatable pillows	Batteries in packs	panties men	sugar	solid soap	Disposable plates	warm sitting matts
mats for sitting	Type C Cables	panties women	Energy drinks	razer	Paper cups	sheets
mattress	micro usb.	socks	juice	cream	food containers	Lighters
backpacks	iPhone Cables	Insoles for shoes	Children's puree	mouthwash	Multiple-usage glasses	Gas balloons
glasses	Blocks to charges	Caps	Children's dry mixes	shaving foam	Breast pump	Inflatable mattresses
tactical glasses	car charging	children's clothing	Children's porridge	deodorant	pot	Armed tape
tents	solar battery	Military trousers	oil	Pads for breastfeeding moms	frying pan	mittens for washing
casque	chainsaw	Jackets	milky drinks	micellar water	scoop	crutches
ballistic goggles	headphone	underwear	water	paper towels	Scissors for children	wheelchair
Respirators	tees	vest	cream	Men's pads	Children's spoons	cane
Emergency sleeping bag	car battery	sweater	salt	Oil for children	nipples for the bottles	Aprons

FIGURE 1: Illustrative sample of VC supply item names and categories as of May

Appendix B

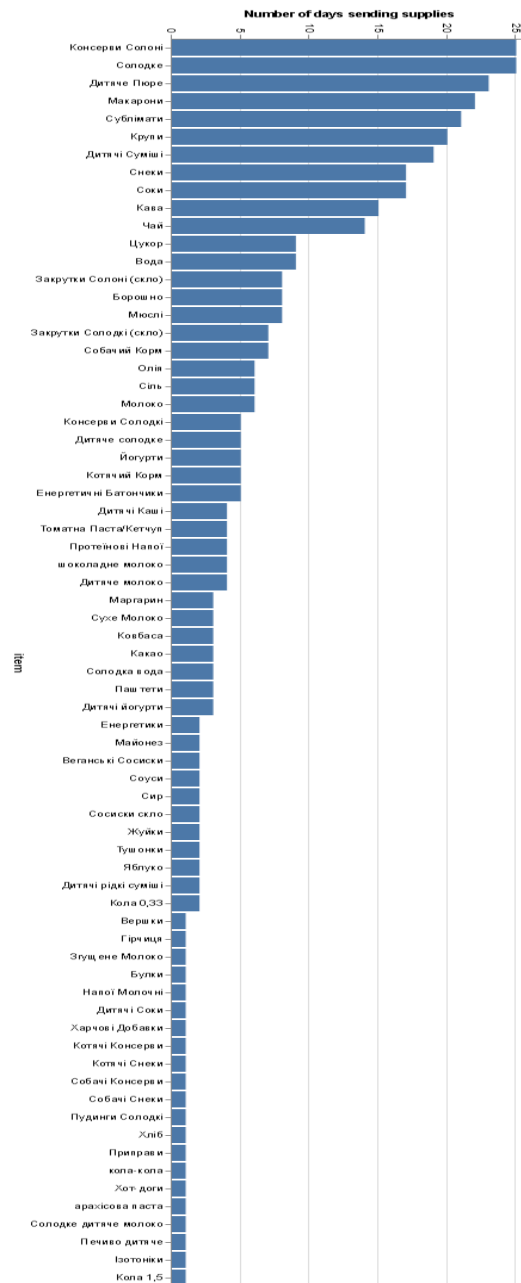


FIGURE 2: Aggregated requests for cans by destination by day at UCU VC as of May, 2022

Bibliography

- Dunn, Elizabeth Cullen (2022). "A wave of grassroots humanitarianism is supporting millions of Ukrainian refugees". In: *The Conversation*. URL: <https://doi.org/10.2307/2946696>.
- Karmazina, O. (2018). *Activities of public organizations in Ukraine in 2017*. Tech. rep. State Statistics Service of Ukraine. URL: http://www.ukrstat.gov.ua/druk/publicat/Arhiv_u/15/Arch_go_bl.html.
- Laan, Erwin van der et al. (2016). "Demand forecasting and order planning for humanitarian logistics: An empirical assessment". In: *Journal of Operations Management*. DOI: [10.1016/j.jom.2016.05.004](https://doi.org/10.1016/j.jom.2016.05.004).
- Latschan, Thomas (2022). "Ukraine: Will the railroad be what decides the war?" In: *Deutsche Welle*. URL: <https://www.dw.com/en/ukraine-will-the-railroad-be-what-decides-the-war/a-61714831>.
- Nations, United (2022). "'War's Greatest Cost Is Its Human Toll', Secretary-General Reminds Peacebuilding Commission, Warning of 'Perilous Impunity' Taking Hold". In: *United Nations Secretary-General*. URL: <https://www.un.org/press/en/2022/sgsm21216.doc.htm>.
- Pedraza-Martinez, AJ and LN Van Wassenhove (2016). "Empirically grounded research in humanitarian operations management: The way forward". In: *Journal of Operations Management*.
- Pérez-Rodríguez, Noel and José Holguín-Veras (Mar. 2015). "Inventory-Allocation Distribution Models for Postdisaster Humanitarian Logistics with Explicit Consideration of Deprivation Costs". In: *Transportation Science* 50, p. 150313072241006. DOI: [10.1287/trsc.2014.0565](https://doi.org/10.1287/trsc.2014.0565).
- Semenova, Maryna (2022). "Status of internally displaced persons in Ukraine". In: *Liga Zakon*. URL: https://jurliga.ligazakon.net/news/211039_status-vnutrshno-peremshcheno-osobi-v-ukran.
- Shutka, Natalia (2022). "The Russians shot a car with volunteers in Bucha". In: *Zaxid.net*. URL: https://zaxid.net/rosiyani_rozstrilyali_avtomobil_iz_volonterami_v_buchi_n1537675.
- Ukraine, Ministry of Social Policy of (2022). "More than 2 million people have registered as internally displaced persons since the imposition of martial law". In: *United Nations Operation Data Portal*. URL: <https://www.kmu.gov.ua/news/ponad-2-miljoniv-lyudej-zareyestruvalis-yak-vnutrishno-peremishcheni-osobi-pislya-vprovadzhennya-voyennogo-stanu>.
- Ukraine, OCHA (2020). "10 things you need to know about the humanitarian crisis in Ukraine". In: *United Nations Ukraine*. URL: <https://ukraine.un.org/uk/88874-10-rechey-yaki-potribno-znati-pro-gumanitarnu-krizu-v-ukraini>.
- Ukrinform (2022). *Civil society of Ukraine: figures and facts*. URL: <https://www.ukrinform.ua/rubric-ato/3471766-u-harkovi-rosijski-raketi-znisili-himicne-pidpriemstvo.html> (visited on 06/01/2022).
- UNHCR (2015). *Emergency Response Preparedness (ERP) approach (IASC, IDP situations, natural disasters)*. URL: <https://emergency.unhcr.org/entry/54228/>

- emergency - response - preparedness - erp - approach - iasc - idp - situations - natural-disasters.
- UNHCR (2022). "Ukraine Refugee Situation". In: *United Nations Operation Data Portal*. URL: <https://data.unhcr.org/en/situations/ukraine>.
- UNICEF (2022). "1.4 million people without running water across war-affected eastern Ukraine". In: *UNICEF*. URL: <https://www.unicef.org/press-releases/14-million-people-without-running-water-across-war-affected-eastern-ukraine>.
- Zaychenko, Serhiy (2022). "Civil society of Ukraine: figures and facts". In: *Hromadskyi Prostir*. URL: <https://www.prostir.ua/?news=hromadyanske-suspilstvo-ukrajiny-tsyfry-i-fakty>.
- Zhou, Spring and Tava Olsen (Aug. 2016). "Inventory Rotation of Medical Supplies for Emergency Response". In: *European Journal of Operational Research* 257. DOI: 10.1016/j.ejor.2016.08.010.