Proposal for the location of facilities with a humanitarian approach

Rafael Granillo-Macías, Francisca Santana-Robles, Isidro J. González-Hernández, Quetzali Vicelis-Tellez, Atziri Wendy Sanchez-Oropeza
Universidad Autonoma del Estado de Hidalgo, Campus Sahagún, Tepeapulco, Hidalgo, México
rafaelgm@uaeh.edu.mx, profe_7739@uaeh.edu.mx, igonzalez@uaeh.edu.mx, vi333656@uaeh.edu.mx, sa408599@uaeh.edu.mx

Maria Paz Guadalupe Acosta-Quintana
Instituto Tecnologico de Sonora, Sonora, Mexico
mpacosta@itson.edu.mx

Abstract

The evaluation and measurement of the impact and efficiency of supply chains in the management of social problems have become one of the areas that currently demands immediate attention, and that includes the implementation of humanitarian logistics actions; all due to the role played by factors such as economic performance and social sustainability that allow work on the design of government strategies and policies to address the problems faced by those communities in vulnerable situations. In this article, through a case study, a proposal is presented based on the identification of the vulnerable population with high levels of marginalization, analyzing the routes and infrastructure available for distribution, and calculating the real distances of movement between locations, to finally describe some models for locating facilities based on qualitative techniques.

The objective of this work was to make a proposal for the design of a facility location model considering qualitative and quantitative variables as a basis for applying a facility location model in humanitarian logistics. The results of this proposal allow the identification and select common characteristics in the target population to design the distribution network, allowing to determine those strategies that should be implemented in humanitarian logistics.

Keywords
Supply chain, social sustainability, facility location problem, qualitative approach, quantitative approach.

1. Introduction
The constant development and growth of the population attend to a great variety of factors that converge around the events that guide said action; however, change is not always synonymous with well-being; considering that, just as advances arise, there are also lags that represent contradictory situations (Centro de Estudios, SF).

In the case of social problems, meticulous management is required based on a series of analyses that make it possible to visualize the origin points, track the effects and thus put the design of strategies into action. Economic performance, social sustainability, government policies, and other factors help reduce complexity in distribution and supply chain management. A specific case is humanitarian logistics, which aims to improve the conditions of those populations that are in vulnerable situations (The Logistics World, 2010)

The management of social problems in supply chains is an issue that is becoming increasingly important; together with economic performance, social sustainability is a factor that is considered within the design of government strategies and policies (Granillo-Macias, 2021).

Adequate planning in the design, analysis, and operation of logistics is a factor that impacts development in different areas such as economic, social, and territorial (Granillo-Macias, 2021). From a systemic approach, the projection and planning of logistics activities are part of an essential complement to understanding human activity comprehensively.

The topic of the management of social problems in supply chains has recently been addressed with greater force by professionals and researchers, given the question that they are related to social sustainability; In social approaches, it is essential to understand its complexity and everything that involves the design of strategies and general governmental policies in the supply chain, with the sole purpose of closing the existing gaps in the management of social problems through methods that imply accurate and concise actions (Granillo-Macias, 2021).

In particular, logistics deals with one of the most complicated factors that lies in distribution, and that precisely consists of determining optimal locations to locate facilities that will have the function of receiving the products, which implies a correct strategic analysis with an impact on the efficiency of the entire the supply chain (Dönmez et al., 2021).

Taking into account that, to select the most appropriate location, it is essential to consider factors such as the distance between the distribution center facilities and the points of consumption, as well as the generation of costs involved with the transfer time and the final disposal that incurred in the delivery of a product or service (González-Solano et al., 2017). The ultimate goal of logistics will then be to plausibly generate positive impacts in terms of network efficiency, ensuring the provision of resources optimally and safely. Additionally, for the administration of the supply chain, scenarios usually arise in which the logistics design is executed under an environment of uncertainty, explicitly encompassing various approaches, be it humanitarian or social sustainability, and therefore, only delivery is sought. of a product that covers basic needs for food or health care (Fritz Institute, 2004).

Humanitarian logistics is the process of efficiently planning, implementing, and controlling the flow and storage of materials, from the point of origin to the end of final consumption, to meet the needs of beneficiaries in vulnerable populations (Fritz Institute, 2004). In this way, humanitarian logistics is based on meeting the needs of people in vulnerable situations, whether due to natural disaster activity or socioeconomic factors, facilitating support, services, materials, and transportation to all those involved in the assistance of the affected population.

According to Zheng et al. (2015), the Meta-heuristics used in humanitarian aid in the following: Evolutionary Algorithms, Genetic Algorithms, Particle Swarm Optimization, Ant Colony Optimization, and Artificial Bee Colony. According to Hernández Vega (2019), one of the Artificial Intelligence techniques is solution-based models through Multi-Agent Systems in which the behavior of intelligent agents that solve problems cooperatively is studied. Another technique is evolutionary algorithms composed of population-based evolution models whose elements represent solutions to problems. They are helpful when dealing with complex or highly unsolvable problems, such as those characterized by high dimensionality, multimodality, strong nonlinearity, non differentiability, noise, and when dealing with time-dependent functions.

In particular, the location of facilities is positioned as a fundamental part of the structure of humanitarian logistics, which takes as its cause the inclusion and empowerment of national and local actors during humanitarian assistance; being that the location has a presence in the conformation of a radical reform together with strategic changes on the situation system, all under the framework of local responsibility as an active response to natural disasters (Frennesson et al., 2020). To carry out a structured analysis that allows making the right decisions regarding logistics design, it is necessary to consider both quantitative variables such as transportation costs and qualitative variables that indicate elements of interest for the study. , referring to data such as the geographical area in which the population in vulnerable situations is concentrated.

Based on the above background, through a case study in the state of Hidalgo in Mexico, a proposal is presented based on the identification of vulnerable populations with high levels of marginalization, analyzing the routes and infrastructure available for distribution, and calculating the actual travel distances between locations, to finally describe some models for locating facilities based on qualitative techniques.

This work aims to propose the design odesigninglocation model, taking into account qualitative and quantitative variables as a basis for applying humanitarian logistics to vulnerable populations.

2. Theoretical Framework

As a background in humanitarian logistics focused on vulnerable populations, authors such as Rueda-Velasco et al. (2020) present a case study on the supply chain of the government program called "Bienestarina," an assistance program carried out in Colombia. These authors mention that humanitarian social assistance programs take the efficiency orientation of traditional commercial logistics, adding in the objective function the "minimizing human suffering"; these authors present a comparison between the optimal structure and the current structure of a humanitarian assistance program (Rueda-Velasco et al., 2020). Finally, a mixed-integer linear programming (MILP) model is proposed to locate the warehouses and assign the load flows in the distribution system for the care program; this model seeks to ensure efficiency in deliveries through the minimization of the total distance and coverage of food aid considering minimizing the unsatisfied demand.

A deterministic location-allocation model applying MILP aims to increase utility and motivate blood donors in different hospitals in Teran, Iran. With a focus on health, the design of the blood supply chain is addressed, including blood donor areas, blood facilities, and hospital centers. The developed model incorporates uncertainty using a robust scenario-based optimization approach, also including social aspects of 1) the impact of blood donors on the design of the blood supply chain, 2) the formulation of supply uncertainty by a particular restriction, and 3) the distance, the cost of advertising and the experience factor is considered as social aspects in the decision of the donors (Ramezanian and Behboodi, 2017).

The design of a resilient and sustainable supply network is addressed in the work of Zare and Lotfi (2019) present a circular supply chain taking into account a focus on sustainability, resilience, solidity, and risk aversion; they also propose a MILP and a model is used robust counterparty to find uncertainties in demand. Asefi and Lim (2017) analyze the management of solid waste under sustainability requirements taking into account economic, environmental and social factors; they use the Technique for Order of Preferences by Similarity with the Ideal Solution (TOPSIS, for its acronym in English), the use of Geographic Information Systems (GIS, for its acronym in English) and the development of reliable suitability indicators to locate the components of a Waste Collection and Management System, in this proposal the objective function is to minimize the transportation cost and the fixed cost, maximizing the suitability of the entire system (Risanger et al., 2021).

In the proposal of Risanger et al. (2021), a model for optimizing locations and estimating the willingness to travel focused on the problem of COVID-19 is analyzed. The objective of the proposed model is to select the most extensive possible coverage of pharmacies for the application of rapid SAR Cov2 detection tests based on variables such as population density and the National Household Travel Survey in the United States.

The objective of the work is to survey the issues of location of facilities that are related to humanitarian logistics based both on the types of data models and on the types of problems, examining the situations before and after the disaster or emergency regarding the location of facilities, distribution centers, warehouses, shelters, and medical centers. Authors such as Boonmee et al. (2017) analyze the importance of the improvements and new contributions to the location problems of humanitarian logistics facilities. With another focus on the issue of humanitarian assistance, Cotes and Cantillo (2019) developed a facility location model to place supplies in preparation for disasters; in this contribution, the deprivation costs are considered within the objective function [16]. The model seeks to minimize global and private costs (transport, inventory, and fixed facility costs), focusing on social assistance interventions that must be carried out immediately (Cotes and Cantillo, 2019).

A comprehensive review of facility location issues under uncertainty in a humanitarian context is presented by Dönmez et al. (2021). The objective of the work of Dönmez et al. (2021). is to review and summarize the scientific literature from different perspectives, namely, in terms of the type of facilities involved, the decisions to be made, the criteria to optimize, the paradigm used to capture uncertainty and the method solution adopted.

Other authors, such as Ahmadi et al. (2015), propose a multiple depot location routing model that considers network failures, multiple vehicles uses, and standard relief time. The model determines local depot locations and the route for last-mile distribution after an earthquake. The model is programmed as a two-stage stochastic with random travel time to determine the areas of the distribution centers. A variable neighborhood search algorithm is designed to solve the deterministic model; through small instances solved in GAMS, unsatisfied demands can be significantly reduced at the cost of momore significantl depots and vehicles.

Authors such as Zhong et al. (2020) developed a Bi-Objective model for the location routing problem (LRP) of disaster relief with stochastic demand, in which the decisions to be made are the following: 1) given the established DCs, what center(s) must be open after a disaster (because not all DCs are necessarily open considering opening costs and demands); 2) given a set of vehicles, how these vehicles should be assigned to each open DC; 3) how these vehicles should be assigned from the DCs to the demand points in the most efficient way possible; and 4) what quantity of goods must be delivered at each demand point on the condition that the relief allocation plan is made before the actual demand is revealed. Additionally, Bozorgi-Amiri and Khorsi (2016) propose a multi-objective dynamic stochastic programming model for a humanitarian aid logistics problem where decisions are made before and after the disaster. The model has three objectives: to minimize the maximum amount of shortage between the affected areas in all periods, the total travel time, and the sum of the costs before and after the disaster. The first goal pursues equity—doing best to ensure delivery of relief commodities to all points of demand—while the other two goals pursue efficiency. The proposed model is solved as a single objective mixed integer programming model by applying the ε constraint method, which is used as a case study for disaster planning of earthquake scenarios in the megacity of Tehran. The findings demonstrate that the model can benefit decision-making on facility location, resource allocation, and routing decisions in cases of disaster relief efforts.

In a unique way, López-Vargas et al. (2018) they provide a guided approach towards the preparation operations of action and coordination response to natural disasters; Taking into account the human and material losses that they bring with them, a pattern of frequency and intensity of events that acquire greater power, one after another, has been detected and with this, the urgent need has arisen to pay total attention to those activities destined to mitigate the effects caused by natural disasters; focusing mainly on those factors that facilitate and hinder the coordination of said activities under a humanitarian logistics framework that aims to outline supply actions during the stages of provisioning, storing, transporting, distributing and coordinating both goods and people in the event of a disaster, however , the importance of these actions stands out in avoiding, as far as possible, the death and suffering of human lives; Considering that the coordination of response activities depends on the environment in which the disaster originates, it is imperative that the entities that have the organizational capacity to act have a solid and structured plan that allows them to prepare, work and recover the elements priority in the best possible way in the face of such events (López-Vargas et al., 2018)

From the perspective of López-Vargas et al. (2018) , the issue of food production is strongly linked to the process to be distributed, considering the substantial expansion of global capacities and with it, the growing development of the population, has given rise to an accelerated increase in products necessary to survive; it is easy to encounter problematic situations that hinder the adequate process to distribute food to the assigned destinations in a timely manner when required; adding to this the fact that food chains become more vulnerable in terms of the impact they represent for environmental pollution; The proposed method suggests establishing measures that allow not only to visualize, but also to guarantee a vast and sufficient access to food at the exact moment in which it is requested, assuming that the actions carried out have not presented favorable results based on ambitions to combat two of the world's biggest problems; hunger and poverty, closely linked and that despite all medium or arduous efforts, have not diminished and continue to be an incandescent focus of unfavorable situations due to investments and misguided efforts that are increasing every day (Salazar et al., 2014).

In another work, Ceballos-Parra (2018) performs through a bibliometric analysis identifies quantitative trends through specific indicators, applying statistical methods to be submitted under study in order to be executed with established data in terms of humanitarian logistics; the degree of importance given as a strong point and of consultation for the structure of government strategies with impacts on the social sector and the private sector is highlighted; given the circumstances in which both natural and man-made disasters require immediate attention in terms of prevention, action and mitigation of damages and losses; however, there are still several points that weaken the processes and with this, the activities are carried out excessively and it is not always possible to meet the objectives set, adding that the logistics structure is still provided with very important weak points starting from from the agencies or organizations intended to provide support and humanitarian attention that are designed to prevent disasters and address the damage caused; coupled with addressing the importance and increase in closer human relations between organizations with the sole purpose of increasing information with applied research and thus, once the field of knowledge has been expanded, have more excellent tools to coordinate preparedness, response and recovery actions duriype of event that involves the feats of humanitarian logistics (Ceballos-Parra, 2018).

3. Methods

A study region was selected as a first step for developing this proposal. The state of Hidalgo was set since it has an area of 20,813 square kilometers (Km2), its location coordinates are longitude 99°51'34.20" W 97°59'05.64" W, latitude 19°35'52.08" N 21 °23'54.60" N, has a total population of 3,082,841 people, occupies the thirteenth position at the level of the Mexican Republic with a high level of marginalization, with 73.95 points, its percentage of poverty is 1.9 percentage points higher than the national percentage (41.9%). In that same year, the portion of the vulnerable population due to social deprivation in Hidalgo was 38.9%, that is, approximately 1,162,100 people presented at least one poverty (INEGI, 2020).

The region of Hidalgo, Mexico, is particularly vulnerable to reporting major natural disasters due to the area near Veracruz and the Gulf of Mexico. The population of Hidalgo is exposed to many risks derived from natural phenomena, such as hurricanes, landslides, and floods. It is worth mentioning that it is a state that is below the national average in terms of insured goods and people.

Based on these antecedents, it was later using information from databases of the National Institute of Statistics, Geography and Informatics (INEGI), the National Institute for Federalism and Municipal Development (INAFED), and the Secretariat of Social Development (SEDESOL), the communities for the case study of the state of Hidalgo. Using the Google Maps application, the central communities with high and medium rates of marginalization were geographically located (Figure 1), selecting a specific region of the Hidalgo highlands.

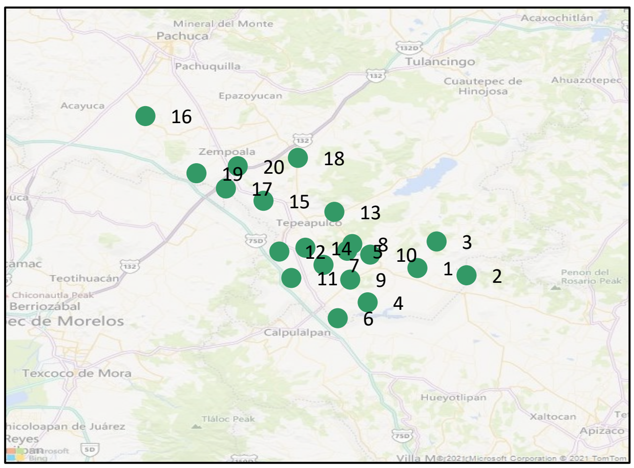

Figure 1. Geographic locations

The communities selected as an example for this study were a total of 20, which were: 1) Almoloya, 2) Santiago Tetlapayac, 3) Tepepatlaxco, 4) Lazaro Cárdenas, 5) La Laguna, 6) Zotoluca, 7) Acopinalco, 8) Lomas del Pedregal, 9) Colonia Los Voladores, 10) San José Jiquilpan, 11) San José, 12) Irolo, 13) Los Cides, 14) San Bartolo, 15) Chinconcuac, 16) Jaguey de Téllez, 17) Santiago Tepeyahualco, 18) Santo Tomas, 19) San Agustín Zapotlan and 20) Acelotla de Ocampo. These communities were located within the hidalgo highlands region. Subsequently, with the geographic coordinates obtained with Google Maps, a census was carried out on the available infrastructure in each selected community.

It was determined if there was basic infrastructure in the community to carry out distribution logistics; in this case, the availability of health centers, auditoriums, or churches was considered possible points for distribution. This analysis was carried out in the 20 communities to identify the characteristics that could be considered when choosing the distribution point and those known based on marginalization and vulnerability conditions.

Subsequently, using the method of weighted weights consists of meeting with the team of people that represents the "Client," with its objectives and functions defined to have the best location and restrictions. Each participant assigns a factor to each objective function and constraint, in this case using factors such as: 1) available infastructure, 2) poverty levels, 3) transportation, and 4) the number of habitats. In the end, all the scores are added, and the elements of each list of objectives, functions, and restrictions are ordered by their final value or "weight".”In this way, we will be able to compare all the needs itoestablish which is more important and which is less (Design Thinking, 2022). According to Carro and Gonzalez (2012), the factor weighting method allows defining the main determining factors in a location to assign weighted values of relative weight according to their importance. The relative weight is based on a sum equal to one; It strongly depends on the criteria and experience of the evaluator.

For this case, the facility location method with weighted weights was used. As a start, five qualitative factors relevant to the location were identified by consensus: F1= percentage of literacy, F2= level of marginalization, F3= transportation time, F4= number of inhabitants, and F5= number of buildings (available infrastructure); with this information, a model was generated in Microsoft Excel to evaluate the different locations. As an example, Table 1 shows the weighting table, and Figure 2 shows the description and results obtained through this method.

Table 1. Weighting method. Factors and assigned weights

Community ID	F1	F2	F3	F4	F5
1	5	10	5	10	10
2	10	10	5	2	6
3	0	0	5	2	4
4	5	10	5	10	2
5	5	10	10	6	4
6	5	10	5	4	4
7	5	10	10	2	8
8	5	0	10	2	6
9	5	10	10	2	2
10	0	10	5	2	6
11	10	10	5	6	8
12	10	10	5	6	4
13	5	0	10	4	4
14	5	10	5	4	6
15	10	10	5	2	8
16	10	10	0	10	10
17	5	10	5	10	4
18	5	10	5	8	6
19	5	0	5	4	4
20	5	0	5	4	4

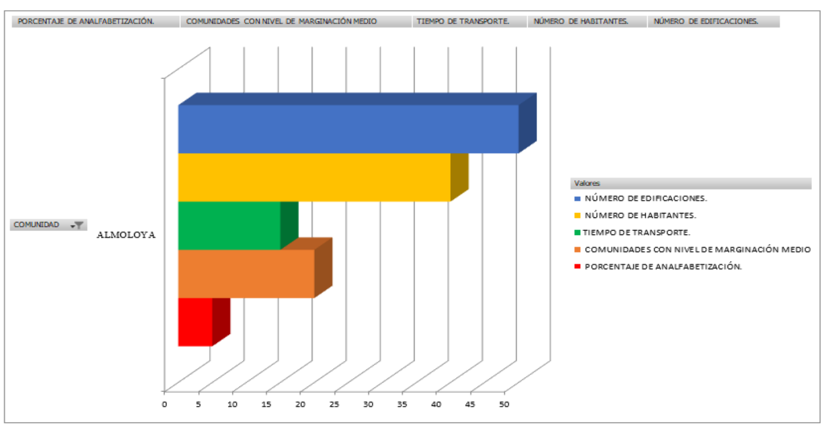

Figure 2. Result of scores obtained

With this first proposal, the community of Almoloya was obtained as the optimal location (Figure 3).

Subsequently, using a ponderation method is a crucial piece of support in the construction of techniques that need to be subjected to mathematical or statistical analysis to evaluate the data produced by first-source information obtained from resources such as consensus, which derive from the careful compilation of information to process it to be correctly interpreted; Within this, there is the evaluation of characteristics that later become classified, and for this, the data can be modified so that all the information is adapted to a field of data that share similarities and grant greater vmore excellentd impact to the study. This being the case, once the information has been adapted, a more mathematically precise method is used, using the data count based on the variables provided after classifying the information provided by the consensus. In other words, once the classifications have been assigned, it is possible to continue counting numerical data that quantify and point out parameters in quantities on the study being carried out (Garcia et al., 2005).

Subsequently, considering that the location was the community of Almoloya, the information provided by the database of the National Institute of Statistics, Geography, and Informatics (INEGI) was used to identify data to structure the framework of qualitative variables.

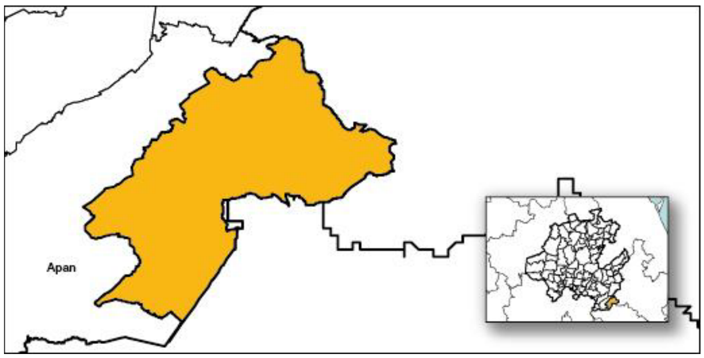

Figure 3. Municipality of Almoloya, Hidalgo

As a subsequent stage, the infrastructure available in the community was an; ased, as an example of this analysis is shown in Table 2.

Table 2. Infrastructure analysis

	Location	Type	Latitude / Longitude
1	Centro de Salud	Health center	19.70307 / -98.40308
2	Secundaria General "Ramón López Velarde"	School	19.69838 / -98.4158
3	Colegio de Bachilleres del Estado de Hidalgo Plantel Almoloya	School	19.69801 / -98.41411
4	Primaria Gonzalo G Agiz.	School	19.70209 / -98.40541
5	Gran Auditorio Municipal	School	19.69801 / -98.41411
6	Auditorio de "El Barrio del Techin"	Auditorium	19.70209 / -98.40541
7	Parroquia de la Purísima Concepción	Church	19.70377 / -98.40354
8	Centro Médico y Holístico Los Ángeles	Health center	19.70496 / -98.4088
9	Casa Ejidal	Auditorium	19.70386 / -98.40565
10	Parque Ecológico El Ayacahuite	Park	19.7034 / -98.40205

The existing infrastructure in the region was qualitatively analyzed to determine if it has the necessary means to carry out distribution logistics, identifying potential locations such as health centers, auditoriums, churches, and schools, among others.

As a reference to the information obtained from the National Institute of Statistics, Geography, and Informatics (INEGI) database, it is possible to visualize the locations selected to carry out the case study in the municipality of Almoloya.

With the information collected in the previous steps, an analysis was carried out initially, considering the model for locating facilities based on Euclidean distances.

For the calculation of distances between locations, Google Maps and Microsoft Bing tools were used to calculate the Euclidean distances of travel between locations. With the results of the distances, a matrix of 10 origins and ten destinations was generated, each of these distances calculated in kilometers (Figure 4).

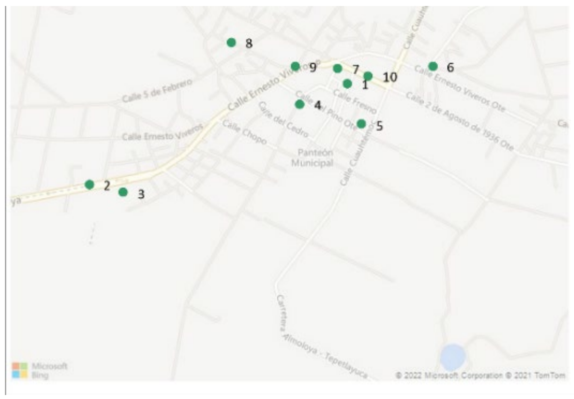

Figure 4. Origin and destination

The matrix of origins and destinations for the selected locations is shown in Table 3

Table 3. Origin and destination matrix

Location ID	Name	Address	Latitude (y)	Longitude (x)	Demand	May be a facility?	Capacity	Setup cost
1	Centro de Salud		19.70307	-98.40308	1	May be a facility	10	0
2	Secundaria General "Ramon Lopez Velarde"		19.69838	-98.4158	1	May be a facility	10	0
3	Colegio de Bachilleres del Estado de Hidalgo Plantel Almoloya		19.69801	-98.41411	1	May be a facility	10	0
4	Primaria Gonzalo G Agiz.		19.70209	-98.40541	1	May be a facility	10	0
5	Gran Auditorio Municipal		19.70117	-98.40237	1	May be a facility	10	0
6	Auditorio de "El Barrio del Techin"		19.70387	-98.39888	1	May be a facility	10	0
7	Parroquia de la Purisima Concepcion		19.70377	-98.40354	1	May be a facility	10	0
8	Centro Médico y Holístico Los Ángeles		19.70496	-98.4088	1	May be a facility	10	0
9	Casa Ejidal		19.70386	-98.40565	1	May be a facility	10	0
10	Parque Ecologico El Ayacahuite		19.7034	-98.40205	1	May be a facility	10	0

The proposed facility location model was based on Eq. (1)

$$d_2^2(x, a^i) = (x_1 - a_1^i)^2 + (x_2 - a_2^i)^2 \text{ Eq. } (1)$$

For all $x = (x_1, x_2) \in R^2$ and all $a^i := (a_1^i, a_2^i)$, $i = 1, \dots, m$, so the location problem is given by Eq. (2)

$$\sum_{i=1}^{m} d_2^2(x, a^i) = \sum_{i=1}^{m} \left(\left(x_1 - a_1^i\right)^2 + \left(x_2 - a_2^i\right)^2 \right) \rightarrow min_{x \in R^2} \text{ Eq. } (2)$$

Where x is the points of the locations of the communities and the optimal location, for the solution of this model, the proposal of Erdogan (2017) using FLP Spreadsheet Solver was used.

In this way, the FLP Spreadsheet Solver was used to calculate the distances between the selected locations and thus define the transfer between one point to another. With this, it was established that the optimal site is in the Ejidal House (Figure 5). With this location, and incurred cost (distance traveled) of 3.70 km is obtained.

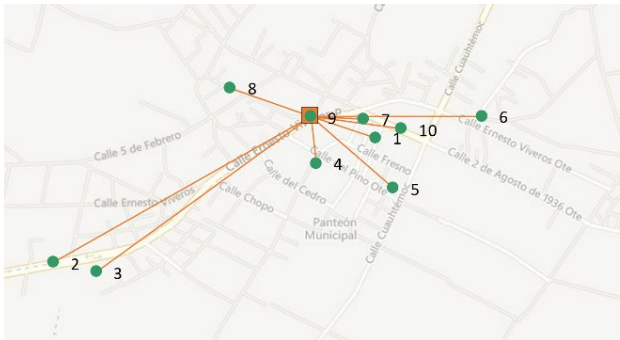

Figure 5. Optimal location

Seeking to analyze other scenarios if the chosen location is unavailable due to various situations and risks, a second location was determined following the same procedure. In this case, this second location is considered a strategic point to meet the objective of the network; this location is a location "4," called "Primaria Gonzalo G Agiz" (Figure 6). The optimal site's second alternative was obtained, obtaining a total distance traveled of 3.90 km.

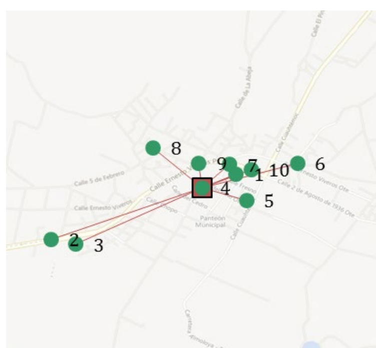

Figure 6. Optimal location

Table 4 shows the locations for the second proposal, indicating the latitude and longitude of the possible points for distribution in the selected community.

Table 4. Origin destination matrix, a second proposal

1	Location ID	Name	Address	Latitude (y)	Longitude (x)	Demand	May be a facility?	Capacity	Setup cost
2	1	Centro de Salud	C. Hidalgo 5, Centro, 43940 Almoloya, Hgo.	19.70307	-98.40308	1	May be a facility	10	0
3	2	Secundaria General "Ramon Lopez Velarde"	Camino Vecinal, Francisco González Bocanegra 38, Almoloya, Hgo.	19.69838	-98.4158	1	May be a facility	10	0
4	3	Colegio de Bachilleres del Estado de Hidalgo Plantel Almoloya	Chabacano SN, 43940 Almoloya, Hgo.	19.69801	-98.41411	1	May be a facility	10	0
5	4	Primaria Gonzalo G Agiz.	C. Álvaro Obregón Sur 11, Centro, 43940 Ejido del Centro, Hgo.	19.70209	-98.40541	1	May be a facility	10	0
6	5	Gran Auditorio Municipal	Centro, 43940 Almoloya, Hgo.	19.70117	-98.40237	1	May be a facility	10	0
7	6	Auditorio de "El Barrio del Techin"	Barrio del Techin, 43943 Almoloya, Hgo.	19.70387	-98.39888	1	May be a facility	10	0
8	7	Parroquia de la Purisima Concepcion	C. 2 de Agosto de 1936 Ote. 1, Centro, 43940 Almoloya, Hgo.	19.70377	-98.40354	1	May be a facility	10	0
9	8	Centro Médico y Holístico Los Ángeles	C. 5 de Febrero 8, Centro, 43944 Almoloya, Hgo.	19.70496	-98.4088	1	May be a facility	10	0
10	9	Casa Ejidal	Centro, 43944 Almoloya, Hgo.	19.70386	-98.40565	1	May be a facility	10	0
11	10	Parque Ecologico El Ayacahuite	C. 2 de Agosto de 1936 Ote. 25, Centro, 43943 Ejido del Centro, Hgo.	19.7034	-98.40205	1	May be a facility	10	0
12									

4. Results and Discussion

Properly, humanitarian logistics still lacks structural schemes that facilitate carrying out the objective activities starting from any crisis that may arise; prevent a natural disaster by following the precautions and recommendations put to use of reason for the entire population in general or those caused by man that are visibly more controllable and that, under the monitoring of an adequate culture, can be eradicated unlike the natural ones that cannot be stopped; act immediately, given that the scenarios in which the crisis unfolds can manifest itself in one way or another, the teams must be prepared to work in the face of any variable that arises during the situation; and subsequently, recover as much as possible using the most significant possible efforts since the main objective lies in saving the most important number of lives and avoiding the number of losses and human suffering.

5. Conclusion

Considering that each time, the theme of distribution and supply becomes more and more remarkable in tasks designed to safeguard human life and the conservation of the environment; At the same time, attending to emergencies that derive from global problems such as poverty, hunger and the most recent, of course, the COVID-19 virus pandemic. Identifying common characteristics in the target population when designing the distribution network will allow determining those strategies that should be implemented in humanitarian logistics, given the broad field of opportunity that opens up before an in-depth study on the subject. For example, suppose a high degree of insecurity is detected in a community food. In that case, the strategy should include mitigating this social problem through different types of breakfasts with nutritional values necessary for this population. In future stages of this project, the integration of this proposal with a Vehicle Routing with Time Windows (VRPTW) model is sought, ensuring that deliveries are made promptly at the established times, which leads to an improvement in the level of service to the community.

Jointly, humanitarian logistics has, for its sound, to provide the necessary means to act in any situation that represents a risk to life, health, or the environment, coordinating efforts and drawing up action plans that avoid an increase in human and material losses.

Acknowledgments

The authors wish to express their gratitude to Universidad Autonoma de Hidalgo – Escuela Superior de Ciudad for supporting this research.

References

Fritz Institute. Humanitarian Logistics Conference 2004 (online). (Ginebra, Suiza). Available in: http://www.fritzinstitute.org/prgSCHLCaf2004-proceedings.htm, accessed on September 2021.

García, María Dolly , & Salcedo, Gladys Elena , & Hurtado, L., Un Modelo De Ponderación Para La Autoevaluación De Un Programa Academico. *Scientia Et Technica*, XI(29),69-73, ISSN: 0122-1701. Available in: https://www.redalyc.org/articulo.oa?id=84911948029, 2005.

González-Solano, F., Escorcia-Caballero, J., & Patiño-Toledo, L. Localización óptima y confiable de instalaciones en una cadena de suministro. Ingeniare. *Revista Chilena de Ingeniería*, 25(4), 693–706, 2017.

Granillo-Macías, R., Logistics optimization through a social approach for food distribution. Socio-Economic Planning Sciences, 76, 100972, 2021.

Hernández Vega, José Isidro., Modelo basado en sistema multi-agente para distribución de ayuda en especie en logística humanitaria. Doctorado thesis, Universidad Autónoma de Nuevo León, 2019

INEGI. Mexico en cifras 2021, información del Instituto Nacional de Estadistica Geografia e Información de INEGI Sitio web: https://www.inegi.org.mx/app/areasgeograficas/?ag=13#collapse-Resumen, available in september 10, 2020.

Ramezanian, R., & Behboodi, Z., Blood supply chain network design under uncertainties in supply and demand considering social aspects. *Transportation Research Part E: Logistics and Transportation Review,* 104, 69–82, 2017.

Risanger, S., Singh, B., Morton, D., & Meyers, L. A., Selecting pharmacies for COVID-19 testing to ensure access. Health Care Management Science, 24(2), 330–338, 2021.

Rueda-Velasco, F. J., Adarme-Jaimes, W., Garzón-Luna, A., Marroquín-Ávila, J., & Parada-Caro, G, Evaluation of a facility location for a food assistance supply chain. The case of Bienestarina in Colombia*. Ingeniería e Investigación*, 39(3), 50–61, 2020.

Salazar, Fernando, Cavazos, Judith, & Vargas, G., Logística Humanitaria: Un enfoque del Suministro desde las Cadenas Agroalimentarias. *Información tecnológica,* 25(4), 43-50, 2014.

López-Vargas, Juan Camilo, & Cárdenas-Aguirre, Diana María., Factores de influencia en la coordinación logística para la preparación y atención de desastres - Una revisión de literatura. *Revista EIA*, 15(30), 41-56, 2018.

The Logistics World., Logística humanitaria: planeación y control del producto.| Conéctate e inspírate. https://thelogisticsworld.com/historico/logistica-humanitaria-planeacion-y-control-del-producto/, 2010.

Zare Mehrjerdi, Y., Lotfi, R., Development of a Mathematical Model for Sustainable Closed-loop Supply Chain with Efficiency and Resilience Systematic Framework. *International Journal of Supply and Operations Management*, 6(4), 360-388, 2019.

Zheng, Y.-J., S.-Y. Chen y H.-F. Ling, Evolutionary optimization for disaster relief operations: A survey , Applied Soft Computing, 27, 553– 566, 2015.

Zhong, S., Cheng, R., Jiang, Y., Wang, Z., Larsen, A., & Nielsen, O. A., Risk-averse optimization of disaster relief facility location and vehicle routing under stochastic demand. *Transportation Research Part E: Logistics and Transportation Review*, 141, 102015, 2020.

Biographies

Rafael Granillo-Macias graduated with a BSc. in Industrial Enginnering, MSc. degree in Industrial Enginnering; PhD in Logistics and Supply Chain Management. ORCID: 0000-0002-1015-667X. His research interests include logistics, supply chain, optimization and simulation.

Francisca Santana-Robles is graduated the BSc. in Industrial Enginnering, MSc. degree in Industrial Enginnering. PhD degree in Industrial Enginnering. ORCID: 0000-0002-3301-9790. His research interests include logistics, supply chain, optimization and simulation.

Isidro J. Gonzalez-Hernandez is graduated the BSc. in Industrial Enginnering, MSc. degree in Industrial Enginnering. PhD degree in Strategic Planning and Technology Management. ORCID: 0000-0003-2805-6674. His research interests include logistics, supply chain, optimization and simulation,

Quetzali Vicelis-Tellez, is a student in industrial engineering at the Superior School of Ciudad Sahagún, UAEH.

Atziri Wendy Sanchez-Oropeza, is a student in industrial engineering at the Superior School of Ciudad Sahagún, UAEH.

Maria Paz Guadalupe Acosta-Quintana is graduated the BSc. in Industrial Enginnering, MSc. degree in Industrial Enginnering; PhD degree in Logistics and Supply Chain Management. ORCID: 0000-0001-7115-9076. His research interests include logistics, supply chain, optimization and simulation.