

Roh, Saeyeon; Lin, Hsuan Hung; Jang, Hyunmi

Article

Performance indicators for humanitarian relief logistics in Taiwan

Asian Journal of Shipping and Logistics (AJSL)

Provided in Cooperation with:

Korean Association of Shipping and Logistics, Seoul

Suggested Citation: Roh, Saeyeon; Lin, Hsuan Hung; Jang, Hyunmi (2022) : Performance indicators for humanitarian relief logistics in Taiwan, Asian Journal of Shipping and Logistics (AJSL), ISSN 2352-4871, Elsevier, Amsterdam, Vol. 38, Iss. 3, pp. 173-180, <https://doi.org/10.1016/j.ajsl.2022.06.002>

This Version is available at:

<https://hdl.handle.net/10419/329699>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by-nc-nd/4.0/>



Original article

Performance indicators for humanitarian relief logistics in Taiwan

Saeyeon Roh^a, Hsuan Hung Lin^a, Hyunmi Jang^{b,*}^a International Logistics, Plymouth University, Plymouth, Devon PL4 8AA, UK^b Graduate School of International Studies, Pusan National University, 2, Busandaehak-ro, 63beon-gil, Geumjeong-gu, Busan 46241, South Korea

ARTICLE INFO

Article history:

Received 2 March 2022

Received in revised form 3 April 2022

Accepted 7 June 2022

Keywords:

Humanitarian relief logistics

Performance evaluation

Analytic hierarchy process

Taiwan

NGO

ABSTRACT

The purpose of this work is to explore the international humanitarian relief organizations in Taiwan, and find the most crucial performance indicators of humanitarian logistics, according to the experience and opinion of those large NGOs in Taiwan. The research gathered detailed information on situations from literature and collected the data by questionnaire. Based on the information gathered from questionnaires, quantitative weight was calculated through the participation of experts by using AHP in this research. According to the humanitarian relief organizations' experiences and opinion in this research, the most critical performance indicators in humanitarian relief logistics is responsiveness, and the following is agility, reliability, cost, and dialog with authorities. Although the AHP method has been applied in many research of performance indicators chosen, there is no research using AHP to prioritize the performance indicators in the humanitarian logistics field, especially in Taiwan. Future research could include the smaller or reputable organizations in Taiwan to get more comprehensive opinions. Besides, the chosen indicators could be utilized in the actual case of humanitarian rescue action.

© 2022 The Authors. Production and hosting by Elsevier B.V. on behalf of The Korean Association of Shipping and Logistics, Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

CC_BY_NC_ND_4.0

1. Introduction

Over the past two decades, natural disasters, such as floods, tsunamis, and earthquakes, have significantly increased due to global warming and climate changes (Nguyen-Thi, 2014). Major catastrophic events, such as the Taiwan Chi-Chi earthquake in 1999, the South Asian tsunami in 2004, and the Tōhoku earthquake and tsunami in Japan in 2011, are some of the worst disasters in history. Natural disasters result in a significant loss of properties and life, breaking the local infrastructures, and threaten nearby daily operations and economies. Emergency management and relative non-governmental organizations (NGOs) have become an issue and have been highly valued by academia and governments internationally. In 1986, Taiwan's government announced the lifting of martial law (Chern, 2002). Following this, the number of civil societies started to grow and flourish, and the NGOs aiming to promote public welfare were established. The NGOs are usually non-profit organizations.

Therefore, with limited resources, organizational managers have focused on how to maximize effectiveness.

Taiwan is located on the first island chain in Asia. Taiwan's annual diplomatic activities were limited due to political pressure from the Chinese government (Lu, 2010), restricting Taiwan's access to crucial international organizations, such as the United Nations and World Health Organization (Public Diplomacy Coordination, 2002–2020). According to the report from Taiwan's Ministry of Foreign Affairs, the number of countries that have diplomatic relations with Taiwan has significantly decreased since 1970. Therefore, the NGOs in Taiwan—concerned with international humanitarian relief works—were seen as a hope to explore the diplomatic space internationally (Chang & Chang, 2011). Taiwan's humanitarian NGOs flourished during these years. Some of them, such as Tzu Chi International Humanitarian Aid Association (TCIHAA) and Fo Guang Shan Compassion Foundation, were already capable of carrying out humanitarian relief action independently (Chern, 2002). Research on the humanitarian relief chain in Taiwan usually focuses on the case studies of a single NGO or disaster. There has been no research on Taiwan's humanitarian logistics or how to measure the efficiency of humanitarian logistics. Therefore, this research can enhance the quality of humanitarian relief within Taiwan's NGOs.

* Corresponding author.

E-mail addresses: saeyeon.roh@plymouth.ac.uk (S. Roh),hsuan-huang.lin@postgrad.plymouth.ac.uk (H.H. Lin), jangh01@pusan.ac.kr (H. Jang).

Between 60% and 80% of expenditures on humanitarian operations are due to logistics activities (Lu, Goh, & De Souza, 2016). With an increase in the magnitude and frequency of disasters, lack of resources and funding, and need for accountability (Kaplan, 2001), humanitarian logistics were required to be transparent, efficient, and effective (Larrea, 2013). The average business usually prioritizes its profits. The value of the output can be directly calculated and measured by the quantitative standard of objective evaluation. The humanitarian supply chain usually lacks this type of concept, tools, and data. Therefore, it may result in wasted resources and failed missions long-term if the NGOs do not focus on performance measurement. One of the ways to evaluate an organization's performance is by performance measurement, common among businesses. Most humanitarian organizations lack a robust performance measurement system. Performance metrics help develop improvement practices and reduce factors that cause inefficiencies (Agarwal, Kant, & Shankar, 2019).

The resources and funds of Taiwanese NGOs usually came from social communities (Chang, 2015). With limited resources, it is crucial to inform NGOs and communities on how to use or manage resources effectively (Chern, 2002). Performance indicators are metrics used to evaluate whether an enterprise or a group has achieved its goal. This study will focus on finding the most crucial performance indicators of humanitarian logistics, according to the experience and opinion of the large NGOs in Taiwan. The results could be references for social enterprises, governments, and scholars for making the relevant policy. Therefore, the vital goal of this research is to explore the performance indicators and prioritize them based on Taiwan's humanitarian relief organizations (HROs). This study is significant as it can fill the lack of empirical studies in humanitarian relief logistics as compared to a multitude studies in other business logistics studies (e.g., Kim, Park, & Kim, 2021).

2. Literature review

2.1. Relief chain performance measurement

Since 2000, disasters, such as the Indian Ocean tsunami in 2004 and the Tōhoku earthquake in 2011, have captured global attention. Donors and the media closely monitored how efficiently humanitarian organizations could respond to disasters (Sahebjamnia, Torabi, & Mansouri, 2017). Logistics and the supply chain are the foundation of processing the humanitarian crisis. Humanitarian organizations should provide aid at the appropriate time and place at a reasonable cost (Larrea, 2013). Humanitarian aid related to the accuracy of the items and quantities and responded to the speed and cost. To balance those works, it needs a method to measure the supply chain performance (Sahebjamnia et al., 2017). With an increase in the magnitude and frequency of the disaster, lack of resources and funding, and the need for accountability, humanitarian logistics were required to be transparent, efficient, and effective (Larrea, 2013). Therefore, performance measurement is currently critical in the humanitarian department. It could put pressure on HROs and have more effective actions (Wassenhove, 2006). The actual performance after disasters and the view delivered through media could be critical for humanitarian logistics. The achievements of organizational targets capture the attention of organizations and reflect the performance of organizations. The donors desire to know the actual performance of the organizations (Gustavsson, 2003).

Establishing a proper performance measurement could have many benefits by identifying the bottleneck in the logistics process, managing the donor's funds effectively, enhancing the emergency and preparedness of actions, and alleviating the suffering of victims during relief activities (Beamon & Balcik, 2008). The performance of the humanitarian organization after the disasters and perception of the organization's performance are the key factors of humanitarian

logistics. The ability to provide proper supplies to acceptors at the accurate time, number, and place is a core competency of an organization (Russell, 2005). Today, the conceptual framework of performance measurement—measuring the humanitarian supply chain—is still much less compared to the commercial supply chain (Tatham & Hughes, 2011). According to Micheli & Kennerley (2005), humanitarian supply chain management and performance measurement are still in the early stages. Researchers determined that the best several framework and indicators are still inconclusive. Compared to the commercial sector, the total number of papers in the specific area of performance measurement and management in the humanitarian supply chain is still very low (Micheli & Kennerley, 2005).

Humanitarian logistics leaders could be helped by performance measurement in their decision-making. Performance measurement could boost the effectiveness and efficiency of relief actions, display supply chain performance, and increase the accountability and transparency of operations (Beamon & Balcik, 2008). However, the relief chain's characteristics are unique. It is usually difficult to enhance the performance of an organization. Measurement systems and performance indicators in the supply chain do not generally develop and are systematically implemented. Therefore, data accuracy would be a problem (Beamon & Balcik, 2008). Abrahamsson, Hassel, & Tehler (2010) found four challenging aspects—value judgment, operating system complications within an emergency system, validating information, and operating systems during a specific situation—when analyzing and evaluating an emergency response system. Abidi et al. (2014) found that some difficulties of performance measurement within the humanitarian supply chain include the lack of empirical testing. First, only a few humanitarian organizations have contributed to the research conducted on the management of humanitarian supply chains. Second, the management of results-based is hard to reach. Humanitarian rescue aims to alleviate pain, and it is hard to identify and quantify the relationship between the goal of supply chain performance. The relationship between activities, inputs, short-term outputs, midterm outcomes, and long-term outcomes is complicated to determine. Third, humanitarian organizations need to ensure that they receive the appropriate information to meet the demand of donors. Therefore, it was believed that research measuring the performance of humanitarian supply chains still has a long way to go compared to the status of supply chains.

Due to the changeable environments and conditions of disasters, fulfilling the actions could be complicated. It would be difficult for humanitarian sectors to measure the performance because it lacks indicators (Larrea, 2013). Moreover, Lindgreen, Swaen, Maon, & Vanhamme (2009) believed that it should consider the culture and mention that the cultural differences between the relief organization and disaster area could be a challenge for performance measurement. According to Abidi, Leeuw, & Klumpp (2014), guidelines related to performance measurement were suggested. First, the measurement needs to consider the regional, national, and global levels for disaster management. Typically, each level might implement different activities. It has to be reflected in the humanitarian performance framework and the long-term and short-term management and measurements (Tatham & Hughes, 2011). Moreover, it should be related to the supply chain's strategic target of the humanitarian organizations, expressed and determined by strategic management. Therefore, Abidi et al. (2014) argued that performance measurements should be process-oriented, which means it should include: (1) input factors, including the financial aspect (in-kind donation or monetary), management, and technical resources, (communication equipment and warehouse) are required effective activities and processes, (2) humanitarian supply chain activities related to various missions, such as inventory management, procurement of relief items activities, warehouse management, relief

supplies distribution, fleet transportation, and management, (3) the output of measurable results by using relief supplies or services, (4) the outcomes—the anticipated result of planned output—showing the realization of the final target, and (5) the impact—the core of the humanitarian relief action. However, the advocacy, intervention, capacity building, and coordination of humanitarian relief actions are hard to measure.

2.2. Performance indicators of humanitarian logistics

Neely, Gregory, & Platts (1995) defined performance indicators as the efficiency and effectiveness of the process of quantifying operations. It requires a set of indicators to quantify the efficiency and effectiveness of operations—the two central goals in the organizations or companies (Neely, 2005). Performance measurement is essential to inform the team leader regarding tactical, strategic, and operational areas (Gunasekaran & Kobu, 2007). It could boost the correction and control effectively through comparing the level of current and anticipated performance, which means it is important for implementing and realizing strategic targets (Melnyk, Bititci, Platts, Tobias, & Andersen, 2014). In fact, measuring real performance in the supply chain is vital to identify whether the organization is hitting the target (Abidi et al., 2014). It is believed that the company which applies the performance measurement outperforms the company that does not (Neely, 2005). There are various performance indicators in the traditional commercial supply chain, yet it might be inappropriate or irrelevant for the unique characteristics of humanitarians to relieve the supply chain's environment (Beamon & Kotleba, 2006). Benefits do not refer to profit related to humanitarian logistics like in the commercial sector. Therefore, spending should focus on donations and providing aid in effective and efficient ways. Moreover, the management and control of the decision-maker could be improved by correctly choosing indicators (Beamon & Balcik, 2008). Five performance indicators chosen from the literature are as follows:

1) Reliability

Reliability is a basic required ability of a humanitarian organization. The reliability shows that the organization could deliver the right supplies in the right quantities and qualities at the right time. In the humanitarian relief action, the goods given from donors to victims usually pass multiple hands in logistics. It could be postponed or prone to errors for various reasons. It reflects how reliable the whole humanitarian supply chain is (Lu et al., 2016). Some uncertainties result in humanitarian logistics network damage and cause paralysis and local failure, such as diffusivity, randomness, or consequence of disasters. It brings serious after-effects for the whole economic system. Therefore, the reliability already gains the attention of humanitarian logistics personnel. Once the humanitarian logistics network is suddenly attacked, the most crucial mission is to swiftly restore it to a normal operating mode. Reliability is the key to this mission (Wang, Huang, & Liang, 2018).

2) Responsiveness

Responsiveness is an indicator related to the response time of humanitarian supply chain management. It is based on order fulfillment cycle time, which includes sourcing, assembling, and delivery fulfillment time. It shows the overall responsiveness in the humanitarian supply chain. Moreover, the external event response and inventory percentage would also be considered. Given that humanitarian relief organizations usually face various risk events, they must quickly respond to any unexpected incident (Lu et al., 2016). It was believed that in the humanitarian relief chain, responsiveness is one of the most important performance indicators (Sahebjamnia et al., 2017). Responsiveness will be affected for many reasons. The humanitarian relief chain's

entities, such as lead-time or transportation facilities, the demand of supplies goods, and destruction level of infrastructures, affect response time. To reduce the response time, they argued that the aim should shorten the lead-time in the supply chain, including the relief item's waiting, loading, and unloading times. Beamon and Balcik (2008) also viewed response time as an important indicator. In the humanitarian supply chain, many factors, including procurement, delivery strategy, transportation choice, infrastructure, suppliers' location, transportation choice, and politics, could affect response time.

3) Cost

This indicator is a chief measure of logistics financial performance. Humanitarian costs come from supply chain management, sourcing, inventory management, delivery, and risk mitigation (Lu et al., 2016). Sahebjamnia et al. (2017) determined that the cost of the humanitarian relief chain includes facilities setting and distribution costs. Compared to the commercial supply chain, demand uncertainty makes transportation planning in the humanitarian supply chain more complex and expensive. The cost is a vital resource indicator in the traditional commercial supply chain. The cost could include overhead, contribution, and inventory costs. However, there are three main costs in humanitarian logistics: inventory holding, supplies, and distribution costs. Some large companies have inventory costs to operate and maintain their warehouses. It includes inventory obsolescence, inventory investment, order/setup costs, and holding costs. Due to the lead time, the huge differences in demand make inventory management challenging in humanitarian logistics. Moreover, the inventory cost depends on the type of goods being held (Beamon & Balcik, 2008).

It is hard to evaluate the supply procurement options before a disaster occurs. Compared to the traditional commercial supply chain, the unpredictable demand increases the complexity between suppliers and relief organizations. Therefore, it might be difficult or impossible to control the cost of supplies. However, the mode of humanitarianism is changing as more humanitarian organizations sign long-term contracts with suppliers. This kind of contract can control the cost of emergency supplies and ensure certain quantities of items when a disaster occurs. Furthermore, humanitarian relief organizations need to transport a huge number of supplies in a short time. The varied disaster location, remote location of the disaster, local tariffs and tax, and unpredictable demand in the supply chain will increase distribution costs in the humanitarian chain. By measuring different components of distribution costs, relief organizations could make sure to decrease potential costs in some areas (Beamon & Balcik, 2008).

4) Agility

In some business environments, various forms of agilities are seen as growth strategies and modes of survival, such as the fashion supply chain. Agility is also viewed as an increasing power within a changing and unpredictable environment (Oloruntoba & Kovács, 2015). In fact, humanitarian relief organizations would face various uncertainties and should rapidly adjust to the needs on the ground. It includes the flexibility of the upstream supply chain, upside delivery, and upside source, which means the number of days required when the organization requires an unplanned order. It also measures the current on-hand inventory and purchases order cycle time, which shows the ability to immediately provide goods (Lu et al., 2016). Considering that the flexibility could provide stakes of reliable supply (human health and human life) and uncertain demand (volumes, location, and type), flexibility is crucial for the humanitarian supply chain. Flexibility is the ability to handle different levels of disasters. It could measure the range and response time in a disaster. Moreover, there is a large number of different types of items sent to

affected areas, including ready-to-eat meals, high-energy biscuits, jerry cans, kitchen sets, hygiene kits, tarps, blankets, tents, clothing, and medicines. Flexibility in the humanitarian supply chain could measure the chain, which provides various items in a period of time (Beamon & Balcik, 2008). Emergency disaster relief does require agility and depends on supply chains to provide immediate survival support. The principle of agility is already linked to emergency disaster relief delivery (Oloruntoba & Kovács, 2015).

5) Dialog with authorities

Good conversation with the authorities is essential to maintain contact with their jurisdictions, manage their resources well, and protect individuals from the misconduct of armed forces, prison or camp authorities, and all types of special forces (Russbach & Fink, 1994). The huge amount of relief organizations and serious disasters, such as the South Asian tsunami in 2004, make specialists realize the importance of leverage resources and the dialog and coordination between governments, private sectors, and humanitarian organizations to more effective economic contributions. The challenge comes from providing aids and distributes resources to different organizations, which blurs the boundaries of their roles and achieves a smooth, coordinated, and fast response (Fritz Institute, 2005). For example, there were more than 800 international and local NGOs operating humanitarian, development, and reconstruction plans in Afghanistan, providing aid in this country after decades of war (Olson, 2006). Olson (2006) noticed that continuous conversations and advocacy between NGOs and the local military have made some positive changes. In this case, even though regular meetings and conversations between NGOs and the military were a great change, the huge cultural differences indicate that the dialog was not always easy or effective. According to the NGOs' observations and reports, the ongoing communication seems to be yielding results. They welcomed more space for humanitarian and constructive change through advocacy and dialog with the military.

Fathalikhani, Hafezalkotob, and Soltani (2020) mentioned that humanitarian organizations should focus more on their relationships with governments. During disasters, local governments recognized comprehensive and adequate coverage of disasters within the border. However, humanitarian relief actions require professional knowledge and skill. Governments usually fail in humanitarian relief actions due to a lack of proper capabilities or budget, and it does not absolve the governments' obligations. Therefore, it is more desirable that governments work with international and local NGOs in humanitarian relief actions. Properly planned good relationships between NGOs and governments lead to better management in humanitarian relief actions.

3. Methodology

3.1. Data collection

To achieve the objective of this study, the Analytical Hierarchy Process (AHP) was chosen as the main method, which was used in various studies including Ly, Roh, and Jang (2021), Park (2015) and Choi and Yang (2004). Given that the AHP method relies on experts' judgment to appropriately provide feedback for the entire process (Khalil, Kamaruzzaman, & Baharum, 2016), the participants were the specialists from Taiwan's large NGOs, which focused on humanitarian relief. Participants are those specialists who have working experience in disaster rescue and humanitarian relief areas in the NGOs. This research considers the literature's classification regarding the selection of large NGOs in Taiwan. According to the Asian Development Bank's report (1991), it divided NGOs based on the level of operation into community-based organizations, citywide organizations, national organizations, and international

organizations. Based on the different types of initiators of NGOs, NGOs are divided into three types: governmental-organized NGOs, individual-organized NGOs, and volunteer organizations (Knup, 1997).

In addition, Lin (2004) classified NGOs into two types. One is based on the scope of activities, such as local NGOs, national NGOs, and international NGOs. The other one is based on the objectives of the activities, such as human rights NGOs, environmental NGOs, women's NGOs, and humanitarian NGOs. It was believed that international NGOs should have branches stationed abroad. The branches' resources mainly come from Taiwan and provide long-term and regular services locally. To focus on the critical goals of overseas rescue and development activities, Lin (2004) excluded the following four organizations: organizations that purely donate money or materials, organizations related to government, organizations only engaged in relief actions in Taiwan, and branches from foreign aid organizations in Taiwan (Lin, 2004). Based on the literature mentioned above, the NGOs which are selected in this research will follow the rules listed below:

- 1) The international humanitarian NGOs will execute domestic and international humanitarian relief missions every year.
- 2) The organization should be headquartered in Taiwan and have branches abroad.

3.2. AHP method

The research uses the AHP as a primary tool, which adopts the quantitative method, in the questionnaire. The AHP, proposed by Saaty & Vargas (1980), is one of the most popular multi-criteria decision-making (MCDM) tools for making and analyzing decisions (Saaty & Vargas, 1980). It helps decision-makers to prioritize and make the best decisions (Nam, Nguyen, & Oh, 2019). The AHP is a theory that measures by pairwise comparison and relies on experts' judgment to obtain priority scales (Khalil et al., 2016).

The AHP could be used in solving and analyzing problems. According to Saaty & Vargas (1991), this method is used in several areas, including measuring performance to estimate the weight of its performance indicators in a specific field. Tzeng (2005) used the AHP to explore the key factors considered in the performance measurement of engineering and technical personnel in the paper industry. Podgorski (2015) applied the AHP method to demonstrate the prioritization of leading indicators of occupational safety and health management systems (OSH MS) performance. Besides, a performance measurement of sanitary sewer systems was developed in Nam et al. (2019). However, there is no research using the AHP to prioritize the performance indicators in the humanitarian logistics field. Hence, this research uses the AHP as the main tool which adopts the quantitative method in the questionnaire.

The AHP is a method that collects opinions from a group of specialists or the decision-maker. It converts complex system problems into a concise hierarchy system. It uses the scale to make elements at each level and become a pairwise comparison. After quantization, a Pairwise Comparison Matrix is established for each element. Calculating the Eigenvector from the Pairwise Comparison Matrix will represent the priority order among the elements and provide decision-makers with a reference. This research is based on the paper that relates to the research on performance measurement in humanitarian logistics. The research chooses several performance indicators to build the hierarchy.

The research will design the questionnaire according to the structure. The elements of each level are matched with the application of the 1–9 rating scale for pairwise comparison. The basic division of the evaluation scale for pairwise comparison includes five degrees, including equal importance, weak importance, essential importance, very strong importance, and absolute importance. The

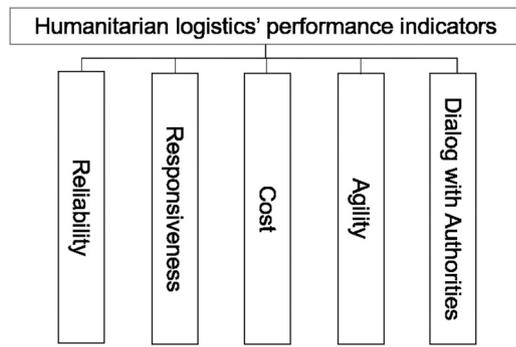


Fig. 1. AHP structure of this research.

nominal scales are assigned 1, 3, 5, 7, and 9. Other four scales are between the five basic scales, 2, 4, 6, and 8. Due to the complexity of the AHP questionnaire, the questionnaire should clearly describe each paired comparison question and provide detailed instructions.

3.3. AHP structure

The performance indicators of humanitarian logistics were collected from the literature review, as shown in Fig. 1. The five performance indicators include Reliability, Responsiveness, Cost, Agility, and Dialog with authorities. The definition of humanitarian logistics' performance indicators is shown in Table 1.

According to Saaty's recommendation, if Consistency Ratio (CR) ≤ 0.1, it could be viewed as consistent in the research.

4. Analysis finding and discussion

4.1. Data collection

Thirty-nine questionnaires were sent out to the humanitarian relief organizations in Taiwan, selected based on rules. Due to the complexity of the AHP, the researcher called the organization and explained the detailed questionnaire before sending it. After collecting the results, a preliminary consistency check was calculated. The researcher found that several numbers of consistency are high and used the telephone or email to recheck the opinions until the consistency was acceptable. In the end, this research included 25 questionnaires, and the overall recovery ratio of the questionnaires was about 64%.

Of the collected questionnaires, the participants include 16 males and nine females. The participants' ages range from 30 to 50. More than 80% of participants have a bachelor's degree. The three primary

Table 1
The definition of humanitarian logistics' performance indicators.

Performance indicators	Description	Literature support
Reliability	Reliability means that humanitarian relief organizations can deliver materials at the right time in the right quantity and quality.	Lu et al. (2016)
Responsiveness	Responsiveness is an indicator related to the rapid response time of humanitarian supply chain management. It is based on material fulfillment time, including procurement, integration, and delivery time, and therefore shows the overall responsiveness in the humanitarian supply chain.	Lu et al. (2016) Beamon & Balcik (2008)
Cost	In addition, the impact and percentage of external events will also be considered. Considering that humanitarian relief organizations face various risk events, they must respond quickly to any emergencies. This indicator is the main indicator for measuring the financial performance of humanitarian logistics. The cost of humane logistics comes from supply chain management, material procurement, warehouse management, material delivery, and risk management.	Lu et al. (2016) Beamon & Balcik (2008)
Agility	Humanitarian relief organizations face various uncertainties and need to quickly adjust their actions according to local needs. It includes the delivery time and flexibility of the upstream supply chain as well as the number of warehouses in the humanitarian relief organization to cope with the sudden disaster.	Lu et al. (2016) Oloruntoba & Gray (2009) Beamon & Balcik (2008)
Dialog with authorities	Good dialog and coordination with the authorities will establish a relationship, which helps to allocate and manage supplies and protect individuals from the unstable local environment in the disaster area.	Russbach & Fink (1994) Fathalikhani et al. (2020)

Table 2
Demographic information.

Age	Percentage
20≥30	8 %
30≥40	32 %
40≥50	36 %
50≥60	24 %
Gender	
Male	64 %
Female	36 %
Education	
Undergraduate	84 %
Postgraduate	16 %
Title/Position	
Assistant Manager	32 %
Manager	28 %
Supervisor	40 %
Job Tenure	
under 2 years	8 %
greater than or equal to 2 - less than 4 years	12 %
greater than or equal to 4 - less than 6 years	32 %
greater than or equal to 6 - less than 8 years	32 %
greater than or equal to 8 years	16 %

positions of the participants are supervisor, assistant manager, and manager. About 80% of participants engaged in this industry for more than four years. Based on the education, position, and time in this industry in Table 2, the participants seem to have enough experience to answer the question about humanitarian relief logistics.

The criteria in the structure include reliability, responsiveness, cost, agility, and dialog with authorities. Based on the results of the questionnaire, opinions of specialists in humanitarian relief organizations on the relative importance of each criterion in the structure were obtained, which formed a paired comparison matrix and the weights and rankings of each criterion as shown in Table 3.

Lamda max is determined by an average of the values calculated as: each value in a specific column of the pairwise comparison matrix is multiplied by the corresponding priority of that criteria; the values across the rows are added to obtain the weighted sum; then the values in the weighted sum are divided by the corresponding priority of each criterion. Subsequently, the consistency index (CI), $CI = (\lambda_{max} - n) / (n - 1)$ is computed and then used to calculate $CR = CI / RI$, Random Index (RI) is the consistency index of a randomly generated pairwise comparison matrix and this index depends on the number of items being computed. The case study presented in this paper there are $n = 5$ criteria, therefore $RI = 1.12$ according to the random consistency indices table. Table 3 indicates that the consistency ratio, 0.0058, is much lower than 0.1, which means that the overall level of consistency is high. Therefore, the weight of each criterion obtained has high credibility and is

Table 3
Pair-wise comparison matrix.

	Reliability	Responsiveness	Cost	Agility	Dialog with authorities	Weight	Ranking
Reliability	1.000	0.465	1.081	0.578	1.795	0.163	3
Responsiveness	2.149	1.000	2.119	1.725	2.744	0.342	1
Cost	0.925	0.472	1.000	0.763	1.398	0.158	4
Agility	1.730	0.580	1.311	1.000	2.157	0.228	2
Dialog with authorities	0.557	0.364	0.715	0.464	1.000	0.108	5

Lambda max = 5.0261, Consistency Index = 0.0065, Consistency Ratio = 0.0058

representative. The highest weight is responsiveness, at 0.342—three times higher than dialog with authorities. Agility stands in second place, at 0.228. The third and fourth are reliability and cost, similar at 0.163 and 0.158. The least popular criterion is a dialog with authorities, which is only 0.108.

4.2. Discussion

4.2.1. Responsiveness

In the emergency rescue and short-term resettlement services, the first step is to enter the disaster site (Lin, 2011). The disaster relief participants should arrive at the disaster site as soon as possible. If the traffic is interrupted and unable to reach the disaster area, it will be difficult to find a place for victims' evacuation. Further, the NGOs could cooperate with local authorities, such as the fire brigade, by using helicopters to transport emergency materials to remote areas. As a result of this study, responsiveness was selected as the most critical factor. This result can be confirmed through the previous cases of aid agencies trying to respond quickly to various disasters. In the typhoon Morakot case in August 2009, Tzu Chi urgently mobilized about 148,000 volunteers from all over Taiwan to carry out rescue work in various disaster-stricken areas, providing food, blankets, and other livelihood supplies for the victims. One principle in Tzu Chi's humanitarian relief action is timeliness and sending aid supplies and goods to the victims as soon as possible (Tzu Chi Foundation, 2009). Another example can be taken from during the Sichuan, China earthquake in October 2008 which affected more than 4000 million people. Taiwan Red Cross Organization transported supplies such as disaster relief materials, medicines, and sanitary materials totaling 150 metric tons to Chengdu, by all-cargo planes, distributed to the people in need by the Sichuan Red Cross. Dharma Drum Mountain and Fo Guang Shan also supported in transporting relief items such as tents, blankets, sleeping bags, drinking water, etc. and rescue personnel as a rapid response to Sichuan disaster (Chen, 2009).

4.2.2. Agility

There are three types of methods to collect emergency materials in Taiwan to enhance the flexibility of humanitarian logistics (Hsieh, 2013). They are: (1) General mode: through the news media, TV, podcast, the required materials are collected from the public, (2) Focus mode: the type and quantity of the bulk materials required are determined and specific objects are individually raised from the organizations, such as public welfare organizations, charitable organizations, manufacturers suppliers, (3) Contract mode: open contracts with supermarkets or other manufacturers and contacted and delivered according to the number of materials required. Furthermore, two categories of relief supplies at different times are prepared by humanitarian relief organizations. The first is food and medical supplies which mostly accompanies an emergency rescue team. The other which depends on the demand from the disaster area, will include various non-food-items in quantity (Chen, 2009). In cooperation with the different delivery approach during a different period after the disaster occurrence, the agility of material supplies could be higher. Tzu Chi Foundation developed a disaster prevention coordination system in 2010 after the lesson learnt from

Morakot typhoon disaster in 2009. Through the system, the disaster rescue center would know the status of the establishment of relief supplies after the disaster occurs. It grasps the needs assessment for assistance in the recovery and procurement of materials in various Tzu Chi's branch in the region. The materials include standard equipment, consumable equipment, charity distribution equipment, and large-package solid food. Moreover, Tzu Chi's volunteers can use disaster prevention coordination systems to report inventory quantity, applications, or write-offs and help inventory management thrive in Tzu Chi's international warehouse (Liang, 2013). With reliable and rapid information, the humanitarian relief logistics could have more agility to handle emergency issues happened. Agility could provide stakes of reliable supply (human health and life) and uncertainty demand (volumes, location, and type) which crucial for the humanitarian supply chain (Beamon & Balcik, 2008).

4.2.3. Reliability

The monitoring and management of disaster prevention and relief resources could ensure a reliable humanitarian logistics by building a credible and real-time information exchange system (Hsieh, 2013). The integration of various information from the government and private organizations and establishment of a credible, transparent, and accurate disaster information exchange system is an important aspect in disaster relief. A large number of relief resources enter the disaster area during the relief support, and organizations need to respond to various needs for people-in-need. If the resources are not adequately managed and allocated, it might cause imbalance in supply and demand and ineffective resource usage. To increase the reliability of humanitarian relief action, Tzu Chi developed a software that provides the latest disaster information and pictures equipped with a user-friendly interface for volunteers' accessibility. This new technology makes the operations in each district more consistent allows disaster relief supplies to be quickly coordinated, operated, and reliably controlled (Liang, 2013). To have a stable supplier and logistics system, Fo Guang Shan purchase the daily emergency necessities near the disaster area to enhance the reliability in humanitarian logistics (Chen, 2009). Reliability is more crucial for humanitarian logistics in a human-made disaster because the humanitarian logistics network could be attacked in the human-made disaster area (Wang et al., 2018). However, most of Taiwan's humanitarian organization usually focuses on large scale natural disasters, and only a few organizations have the human-made disaster rescue experience. It might be the reason why the participants did not see it as the most crucial indicator in the performance measurement of humanitarian logistics.

4.2.4. Cost

Many researchers claim that cost is crucial in the performance indicators in humanitarian relief logistics (Beamon & Balcik, 2008). However, the large humanitarian relief organization in Taiwan, especially Buddhist organizations, do not see cost as the most critical performance indicator when it comes to performance measurement. Generally, there are no detailed rules for the income and expenditures of humanitarian "organizations" donations. The report on donations is incomplete, or the inquiry interface is not friendly (Chang, 2015). Even during an economic downturn, Tai (2007) found

that Buddhist organizations received donations from public to express kindness and donate for particular purposes. According to the Association of Philanthropic Accountability (APA), the donation per person in Taiwan is relatively high and accounts for 0.45% of the gross domestic product (GDP) compared to the many social welfare countries, such as Sweden (0.16%), the Netherlands (0.13%), Norway (0.11%), and Switzerland (0.09%).

4.2.5. Dialog with authorities

Limits and challenges exist in the cooperation between government and NGOs during relief operation (Hsieh, 2013). The difference of the public affairs perception between the government and NGOs would create obstacles to their interactions. In general, the public sectors mainly prioritize the interests of the people or the country mainly considers the large-scale humanitarian relief operations. However, NGOs pursue the interests of people-in-need emphasizing micro public welfare. Furthermore, government and NGOs have to overcome the institutional differences. Government agencies are usually bureaucratic as the wide range of public affairs and complex departments make authority and responsibility vague and uncertain. Many NGO funds come from governments, create unequal power relations, which also exist in most cooperative relations. Over-reliance on the government's financial resources will lose their autonomy in operation. The last but not the least, insufficient information is the main factor that hinders the cooperation between government and NGOs. Many NGOs informed that a lack of relevant information and communication channels create more disputes when cooperating with the government. During the typhoon Morakot, it was found that there was a communication gap between the people-in-need, TCIHAA, and Kaohsiung city government regarding how and where to relocate the permanent facilities (Yang, 2019; Zhong, 2010). To emphasize "efficiency," the decision to relocate villages did not gain consensus and triggered fierce resistance and backlash (Yang, 2019). Humanitarian organizations should take responsibility for communications as they have more professional knowledge of relief actions (Yang, 2019).

5. Conclusion

The large NGOs in Taiwan have grown over the years, especially Buddhist organizations. The humanitarian relief action in those organizations already strives for international space for Taiwan. Organizations, such as the Tzu Chi Foundation, Fo Guang Shan, Dharma Drum Mountain, are experiencing global success through international humanitarian assistance and charity activities. The soft power among the organizations also promotes and shapes Taiwan's international image (Chen, 2009). Taiwan's government hopes to break the suppression through the non-profit, non-political, and across the national frontier of organizations and increase the opportunities to participate in international cooperation. Hence, the NGO groups in Taiwan, which focus on international humanitarian relief work, are crucial for the government. Without involvement in political or other sensitive issues, the NGOs can transcend ethnic, political, religious, and regional restrictions and enter different international societies in a short period of time.

With the increase of the magnitude and frequency of the disaster, lack of resources and funding, and the need for accountability, humanitarian logistics were required to be transparent, efficient, and effective (Larrea, 2013). Therefore, performance measurement is currently critical in the humanitarian department (Wassenhove, 2006). The performance indicators of humanitarian logistics are collected from the literature review. The five performance indicators include reliability, responsiveness, cost, agility, and dialog with authorities. After collecting the questionnaire about the performance indicators in humanitarian relief logistics form in large Taiwan's NGOs and calculating and ranking through the AHP, the most

important performance indicator is responsiveness followed by agility, reliability, cost, and dialog with authorities. The results of this study can be utilized to improve the present performance of humanitarian relief aid by academics and executors.

Although this research already prioritized the crucial performance indicators in Taiwan's humanitarian relief logistics based on the specialist opinion, due to the limitation of the research, recommendations for further research could be derived. First, the research only focuses on international rescue organizations' opinions according to the selected rules. The international organizations are the large humanitarian relief organizations, which means the analyzed results are based on those large organizations. Future research could include the smaller reputable organizations in Taiwan to obtain more comprehensive opinions. Second, the chosen indicators could be utilized in real cases of humanitarian rescue actions to verify the practicality. Furthermore, future research could measure the performance based on a relief action and improve it.

To achieve the objectives of this study and address the research gaps, it is essential to collect relevant data from the case study. This makes humanitarian relief strategic decision-makers at Taiwan NGO the target respondents for empirical data collection. The collected data from the respondents where relevant specialist is identified to describe and explain the key constructs observed. Nonetheless, some supplements of this study are needed due to the generalizability issue in arising from the data collected from limited sample. AHP has drawbacks, such as vagueness, uncertainty, and bias, in particular, limitation of practical application arising from the difficulty of attaining consistency from subjective judgments in making a decision. Further research can be incorporated into this study with different hierarchical and detailed objectives with sub-factors, considering using a different combination of methods of data collection and analysis.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- Abidi, H., De Leeuw, S., & Klumpp, M. (2014). Humanitarian supply chain performance management: a systematic literature review. *Supply Chain Management: An International Journal*, 19(5/6), 592–608. <https://doi.org/10.1108/SCM-09-2013-0349>
- Abrahamsson, M., Hassel, H., & Tehler, H. (2010). Towards a system-oriented framework for analysing and evaluating emergency response. *Journal of Contingencies and Crisis Management*, 18(1), 14–25. <https://doi.org/10.1111/j.1468-5973.2009.00601.x>
- Agarwal, S., Kant, R., & Shankar, R. (2019). Humanitarian supply chain management frameworks: a critical literature review and framework for future development. *Benchmarking: An International Journal*, 26(6), 1749–1780. <https://doi.org/10.1108/BIJ-08-2018-0245>
- Asian Development Bank and Economic Development Institute, (1991). *The Urban Poor and Basic Infrastructure Services in Asia and the Pacific: Country papers*, Asian Development Bank, Mandaluyong, Philippines.
- Beamon, B. M., & Kotleba, S. A. (2006). Inventory management support systems for emergency humanitarian relief operations in South Sudan. *The International Journal of Logistics Management*, 17(2), 187–212. <https://doi.org/10.1108/09574090610689952>
- Beamon, B. M., & Balcik, B. (2008). Performance measurement in humanitarian relief chains. *International Journal of Public Sector Management*, 21(1), 4–25. <https://doi.org/10.1108/09513550810846087>
- Chaing, Y. W., & Chang, K. Y. (2011). The international participation of Taiwanese NGO's and its struggle - international voluntary service as examples. *Journal of Cheng Shiu University*, 145–162.
- Chang, J. H. (2015). Where did your donations go?, *The Journalist*.
- Chen, Z. L. (2009). A Study of humanitarian assistance in Sichuan earthquake by NGOs—a case study of Dharma Drum Mountain Social Welfare and Charity Foundation and Tzu Chi Foundation, Nanhua University, Taiwan.
- Chern, J.-H. (2002). An empirical study on the performance evaluation of indicators for the Nonprofit organizations—an example of 300 major foundations in Taiwan, Nation Defense University, Taiwan.

- Choi, J. H., & Yang, H. K. (2004). Promotion strategy of interactive image contents industry using AHP data analysis technique. *Journal of the Korean Data Analysis Society*, 6(4), 1097–1108.
- Fathalikhani, S., Hafezalkotob, A., & Soltani, R. (2020). Government intervention on cooperation, competition, and cooptation of humanitarian supply chains. *Socio-Economic Planning Sciences*, 69, Article 100715. <https://doi.org/10.1016/j.seps.2019.05.006>
- Fritz Institute. (2005). Logistics and the effective delivery of humanitarian relief, Fritz Institute, San Francisco, CA.
- Gunasekaran, A., & Kobu, B. (2007). Performance measures and metrics in logistics and supply chain management: a review of recent literature (1995–2004) for research and applications. *International Journal of Production Research*, 45(12), 2819–2840. <https://doi.org/10.1080/00207540600806513>
- Gustavsson, L. (2003). Humanitarian logistics: context and challenges. *Forced Migration Review*, 18, 6–8.
- Hsieh, M. C. (2013). Research on Tzu Chi's disaster relief operations in Morakot, National Dong Hwa University, Taiwan.
- Kaplan, R. (2001). Strategic performance measurement and management in non-profit organization. *Nonprofit Management and Leadership*, 11(3), 353–370. <https://doi.org/10.1002/nml.11308>
- Khalil, N., Kamaruzzaman, S. N., & Baharum, M. R. (2016). Ranking the indicators of building performance and the users' risk via analytical hierarchy process (AHP): case of Malaysia. *Ecological Indicators*, 71, 567–576. <https://doi.org/10.1016/j.ecolind.2016.07.032>
- Kim, S. Y., Park, H., & Kim, T. (2021). A study on the development and utilization of overseas port selection information system for logistics network. *Journal of the Korean Data Analysis Society*, 23(5), 2077–2093. <https://doi.org/10.37727/jkdas.2021.23.5.2077>
- Knup, E. (1997). Environmental NGOs in China: an overview. *China Environment Series*, 1, 9–15.
- Larrea, O. (2013). Key performance indicators in humanitarian logistics in Colombia, IFAC Proceedings Volumes, 46(24), 211–216.
- Liang, L.M.Z.Y.Z. (2013). Real-time transmission of disaster relief information combined with App [Online]. Available: <http://www.tzuchi.org.tw/%E5%85%A8%E7%90%83%E5%BF%97%E6%A5%AD/%E8%87%BA%E7%81%A3/item/10113-%E7%B5%90%E5%90%88App-%E6%95%91%E7%81%BD%E8%A8%8A%E6%81%AF%E5%8D%B3%E6%99%82%E5%82%B3>
- Lin, W. Y. (2011). Handbook of disaster management and social work practice, Chuliu.
- Lin, Y. (2004). The analysis of Taiwan's foreign aid with non-governmental organizations(NGOs) towards Southeast Asia, Master, National Cheng Kung University.
- Lindgreen, A., Swaen, V., Maon, F., & Vanhamme, J. (2009). Developing supply chains in disaster relief operations through cross-sector socially oriented collaborations: A theoretical model. *Supply Chain Management*, 14(2), 149–164. <https://doi.org/10.1108/13598540910942019>
- Lu, Q., Goh, M., & De Souza, R. (2016). A SCOR framework to measure logistics performance of humanitarian organizations. *Journal of Humanitarian Logistics and Supply Chain Management*, 6(2), 222–239. <https://doi.org/10.1108/JHLSCM-09-2015-0038>
- Lu, C. A. (2010). The strategic significance of PRC submarines breaking through the 1st island chain, Tamkang University, Taiwan.
- Ly, T. H., Roh, S., & Jang, H. (2021). Selection of functional logistics service providers: AHP and DEMATEL application. *Journal of the Korean Data Analysis Society*, 23(4), 1517–1534. <https://doi.org/10.37727/jkdas.2021.23.4.1517>
- Melnyk, S. A., Bititci, U., Platts, K., Tobias, J., & Andersen, B. (2014). Is performance measurement and management fit for the future? *Management Accounting Research*, 25(2), 173–186. <https://doi.org/10.1016/j.mar.2013.07.007>
- Micheli, P., & Kennerley, M. (2005). Performance measurement frameworks in public and non-profit sectors. *Production Planning & Control*, 16(2), 125–134. <https://doi.org/10.1080/09537280512331333039>
- Nam, S.-N., Nguyen, T. T., & Oh, J. (2019). Performance indicators framework for assessment of a sanitary sewer system using the analytic hierarchy process (AHP). *Sustainability*, 11(10), 2746. <https://doi.org/10.3390/su11102746>
- Neely, A. (2005). The evolution of performance measurement research. *International Journal of Operations & Production Management*, 25(12), 1264–1277. <https://doi.org/10.1108/014435705106336648>
- Neely, A. D., Gregory, M., & Platts, K. (1995). Performance measurement system design: A literature review and research agenda. *International Journal of Operations & Production Management*, 15(4), 80–116. <https://doi.org/10.1108/01443579510083622>
- Nguyen-Thi, T. (2014). An Investigation of critical factor for risk mitigation in humanitarian logistics, National Kaohsiung University of Applied Sciences, Taiwan.
- Oloruntoba, R., & Gray, R. (2009). Customer service in emergency relief chains. *International Journal of Physical Distribution & Logistics Management*, 39(6), 486–505. <https://doi.org/10.1108/09600030910985839>
- Oloruntoba, R., & Kovács, G. (2015). A commentary on agility in humanitarian aid supply chains. *Supply Chain Management*, 20(6), 708–716. <https://doi.org/10.1108/SCM-06-2015-0244>
- Olson, L. (2006). Fighting for humanitarian space: NGOs in Afghanistan. *Journal of Military and Strategic Studies*, 9(1).
- Park, J.-H. (2015). Weight development of checklist for the evaluation of international technology transfer using AHP: with an emphasis on the joint ventures. *Journal of the Korean Data Analysis Society*, 17(1), 267–277.
- Podgorski, D. (2015). Measuring operational performance of OSH management system – A demonstration of AHP-based selection of leading key performance indicators. *Safety Science*, 73, 146–166. <https://doi.org/10.1016/j.ssci.2014.11.018>
- Public Diplomacy Coordination. (2002–2020). The Cases of China Obstructs Taiwan's Diplomatic Activity, Ministry of Foreign Affairs, Republic of China (Taiwan).
- Russbach, R., & Fink, D. (1994). Humanitarian action in current armed conflicts: opportunities and obstacles. *Medicine and Global Survival*, 1(4), 188–199.
- Russell, T. E. (2005). The humanitarian relief supply chain: analysis of the 2004 South East Asia earthquake and Tsunami, Massachusetts Institute of Technology, Cambridge.
- Saaty, T. L., & Vargas, L. G. (1980). Hierarchical analysis of behavior in competition: prediction in chess. *Behavioral Science*, 25, 180–191.
- Saaty, T.L. & Vargas, L.G. (1991). Prediction, projection, and forecasting: applications of the analytic hierarchy process in economics, finance, politics, games, and sports, Kluwer Academic Pub.
- Sahebjamnia, N, Torabi, S. A., & Mansouri, S. A. (2017). A hybrid decision support system for managing humanitarian relief chain. *Decision Support Systems*, 95, 12–26.
- Tai, M.H. (2007). The study of international strategy in non profit organization-take Tzu Chi and Fo Guang Shan for example. Master, Yu Da University of Science and Technology.
- Tatham, P., & Hughes, K. (2011). Humanitarian logistics metrics: where we are and how we might improve. *Humanitarian logistics: Meeting the challenge of preparing for and responding to disasters. Kogan*, 65–84.
- Tzeng, J.-T. (2005). A study on applying analytic hierarchy process to technician performance evaluation for the paper industry. Master, Sun Yat-sen University.
- Tzu Chi Foundation. (2009). Statistics of Tzu Chi's disaster relief [Online]. Available: https://tw.tzuchi.org/projects/88flood/index.php?option=com_content&view=article&id=369:tzuchi-2009-08-31-07-23-15&catid=25:2012-08-06-08-37-23&Itemid=226
- Wang, W., Huang, L., & LIANG, X (2018). On the simulation-based reliability of complex emergency logistics networks in post-accident rescues. *International Journal of Environmental Research and Public Health*, 15, 79.
- Wassenhove, L. V. (2006). Humanitarian aid logistics: Supply chain management in high gear. *Journal of The Operational Research Society. J OPER RES SOC*, 57, 475–489.
- Yang, H.J. (2019). Tracking the typhoon in August 8th for 10 years: The regret of patriarchal village relocation. The Reporter.
- Zhong, S.X. (2010). Disputes between refugees, government and NGOs [Online]. 88news. Available: <https://www.88news.org/posts/5115>.