Empirical Study of a Multi-objective Medical Decision System for Aviation Disaster

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Abstract: - Aviation disasters cause huge loss of lives and properties. Any densely populated and economically viable country inevitably faces the challenge of efficiently and effectively responding to such disasters. This study supports in-time reaction to aviation disasters from the medical point of view: transferring patients to available hospitals to maximize their survival time. This study first assumes a large aircraft crash at the airport and many trauma patients generated in a metropolitan area. Second, we propose a multi-objective model of an emergent medical decision system, able to plan optimal patient transfer from one hospital to another according to various trauma situations to maximize survival time. Trauma patients are classified into three types: the emergent type (Red) to the normal type (Green). Each model objective maximizes survival time for each type of patient. Our model is established on the basis of the multi-objective location-allocation model in operational research; furthermore, the Visual Basic for Application (VBA), Lindo, and Geographic Information System (GIS) are successfully integrated to graphically show simulated results. Our multi-objective medical decision system is valuable as radio frequency identification (RFID) technology matures. Integrating our multi-objective GIS and RFID data from patients will optimally utilize medical resources.

Key-Words: Multi-objective, Aviation Disaster, Location-Allocation, Geographic Information System(GIS).

1. Introduction

Many aviation disasters continue to occur even though aviation history is more than 100 years old. The aviation accident database of the U.S. National Transportation Safety Broad easily validates this fact [17]. The database contains information, i.e., thousands of U.S. accident records and selected incidents from 1962 to the present, .while the International Civil Aviation Organization makes continuous efforts to increase aviation safety (ICAO) [10]. Aviation disasters often arise from two possible causes: human error: e.g., wrong operations, terrorisms, etc. or natural disasters: e.g., storms, typhoons, etc [11].

According to actual examples above, aviation disaster seems inevitable. Therefore, aviation disaster should be an international issue since it could happen anytime and anywhere. An air crash is similar to a natural disaster; we can’t know when it will happen, however full preparation and adequate prevention are necessary This study focuses on efficient transfer of trauma patients after an aviation disaster. This work proposes a multi-objective medical decision system to optimally allocate patients to available hospitals according to their various trauma characteristics. Patients are classified into three types, from emergent type (Red) to normal type (Green). The objective of each patient type is to maximize survival time. Such a multi-objective system can be simulated for various results on a geographic information system (GIS) with many scenarios, and the simulated results graphically present and identify existing medical network deficiencies.

This paper is organized as follows: Section 2 describes problem characteristics. The multi-objective location-allocation model is constructed for transferring patients after an aviation disaster in Section 3. Section 4 presents an actual example of Kaohsiung City in Taiwan to validate our formulation and resolution method by GIS. Finally, conclusions and recommendations are presented in Section 5.

2. Problem Description

This section briefly introduces aviation disaster rescue and the location-allocation model.

2.1 Aviation Disaster Rescue

This work divides time-varying aviation disaster outcomes into three periods [4]: the first period is the chaos period, when disaster and destruction occur unexpectedly. The rescue period follows the chaos period, with emergency rescue carried out according to the damage assessment report. The restoration period is the third period, beginning after rescue operations have adequately provided for lives and properties. A reconstruction plan in this period meets short-term, mid-term, and long-term needs. Here, our study establishes a model for the rescue period and assumes a correct damage assessment report for patients.

An aviation disaster generates various trauma patients [16]. A standardized injury categorization scheme helps transfer patients to available hospitals as soon as possible by classifying patients according to various trauma characteristics [4]. Aviation disaster injuries are very similar to those in an explosive bomb [1, 13] due to the easily flammable and explosive aircraft body with its huge fuel capacity. This study follows general medical guidelines to classify aviation disaster patients into three types [14]:

(a) Green – Injuries in this category recover fully in time without treatment. Generally these individuals are ambulatory and access needed care on their own. These injuries include minor to moderate lacerations, minor to moderate fractures, and small foreign bodies.

(b) Yellow – Secondary priority: This category is not a life threatening injury, but requires care. These patients need hospital transport, however a short hospital transport delay is not life threatening. These injuries include burns without airway complications, major or multiple bone or joint fractures, back problems (with or without spinal cord complications), and moderate hemorrhage (controllable).

(c) Red – First priority: This category represents serious, life threatening injuries that require immediate hospital transport. These injuries generally become life threatening within minutes and include those with airway, breathing, and shock problems, major burns, uncontrolled or severe bleeding, or decreased mental status.

The main focus of this study is how to efficiently transport patients to appropriate hospitals within an acceptable time period, especially "Red" patients. Available hospitals may not be equipped with devices for burn injuries; only specified hospitals (medical centers) are able to handle such special cases. Most responsible hospitals are only available for "Green" patients, some are available for "Yellow" patients, and only a few are available for "Red" patients. Patients should be optimally allocated to each hospital according to hospital availability. Obviously, if a hospital can handle "Red" patients, then it can care for "Yellow" and "Green" patients. Similarly, if a hospital can handle "Yellow" patients, then it can care for "Green" patients. Once patients are classified, then available hospitals can be identified according to how many patients of each type can be assigned to corresponding and appropriate hospitals. This aforementioned location-allocation problem is geographically related.

The Geographic Information System (GIS) is specially designed to find solutions to geographic problems by computer assistance (Carver, 1991; Chrisman, 1997), e.g., location problems, shortest route problems, distribution patterns of people, etc. In short, the GIS allows both practitioners and theoreticians the opportunity to grab large chunks of earth's surface and roll them around in their hands. Since the GIS effectively establishes actual road-network data, this work develops a customized application for an actual road-network with GIS assistance. As suggested by DeMers [7], the GIS encourages exploration of the world similar to that of geographers, naturalists, and explorers, but with a much more precise set of tools. This paper integrates the theoretical aspect (multi-objective location-allocation model), with the practical aspect (actual medical resources and locations of hospital on GIS), to plan a multi-objective medical decision system.

2.2 Location-allocation Model

This section proposes the location-allocation model for emergency rescue [2, 15, 16]: i.e., efficient patient transfer. The location-allocation model is popularly used in supply chain management for shipping products [5, 12]. A simple location-allocation model design seeks optimal location of facilities and optimal service assignment between the facility and the customer. The model is popularly used in supply chain design and is simply illustrated as follows [5],

$$\text{Min} \sum_{i=1}^{n} f_i y_i + \sum_{i=1}^{n}\sum_{j=1}^{m} D_j c_{ij} x_{ij} \qquad (1)$$

$$\text{st} \quad \sum_{i=1}^{n} x_{ij} = 1, \quad \text{for } j = 1, 2, \ldots, m;$$

$$\sum_{j=1}^{m} D_j x_{ij} \le K_i y_i, \quad \text{for } i = 1, 2, \ldots, n;$$

$$\sum_{i=1}^{n} y_i = L;$$

$$x_{ij}, y_i \in \{0,1\}$$

Where

x_{ij} : the decision variable, if customer j is served by facility i then it is 1; otherwise, it is 0;

y_i : the decision variable, if facility i is exactly set up then it is 1; otherwise, it is 0;

c_{ij} : the unit transportation cost from facility i to customer j;

f_i : the set-up cost of facility i;

D_j : the number of required products for customer j;

K_i : the product availability (capacity) for the facility j;

L : the number of facilities that must be set up; L=1,2,…,n.

The aforementioned model is only considered for the relationship between facilities and customers by minimizing their total fixed cost: $\sum_{i=1}^{n} f_i y_i$ and their total variable cost: $\sum_{i=1}^{n}\sum_{j=1}^{m} D_j c_{ij} x_{ij}$; thus, Equation (1) can be regarded as a two-level model in which products are produced in facilities and shipped to customers – assume L=3, m =6 and see Fig. 1.

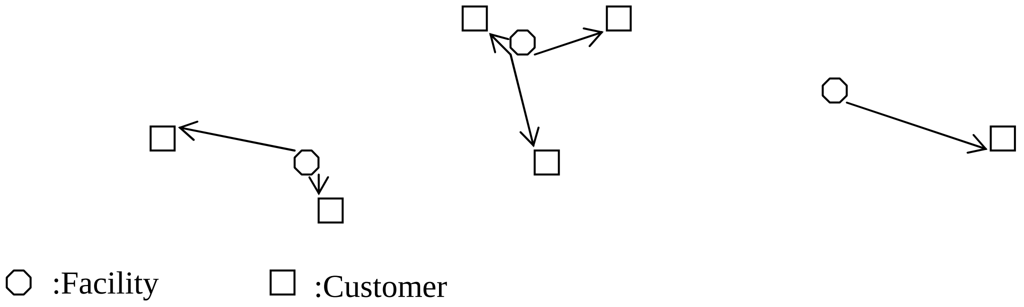

Fig. 1. Graphical Solution of Model (1) for L=3 and m=6

We extend the model (1) and consider a more complicated relationship of the three levels: Raw materials are first produced by the suppliers, then shipped to facilities for assembling, then the finished products are transported to warehouses for temporary storage. Finally the finished products are transferred to customers from warehouses. Therefore, we develop a more complicated model as follows [5]:

$$\text{Min} \begin{array}{l} \sum_{i=1}^{n} f_i y_i + \sum_{e=1}^{t} f_e y_e + \sum_{h=1}^{l}\sum_{i=1}^{n} c_{hi} x_{hi} + \\ \sum_{i=1}^{n}\sum_{e=1}^{t} c_{ie} x_{ie} + \sum_{e=1}^{t}\sum_{j=1}^{m} c_{ej} x_{ej} \end{array} \qquad (2)$$

$$\text{st} \quad \sum_{i=1}^{n} x_{hi} \le S_h, \quad \text{for } h = 1, 2, \ldots, l;$$

$$\sum_{h=1}^{l} x_{hi} - \sum_{e=1}^{t} x_{ie} \ge 0, \quad \text{for } i = 1, 2, \ldots, n;$$

$$\sum_{e=1}^{t} x_{ie} \le K_i y_i, \quad \text{for } i = 1, 2, \ldots, n;$$

$$\sum_{h=1}^{l} x_{ie} - \sum_{j=1}^{m} x_{ej} \ge 0, \quad \text{for } e = 1, 2, \ldots, t;$$

$$\sum_{j=1}^{m} x_{ej} \le W_e y_e, \quad \text{for } e = 1, 2, \ldots, t;$$

$$\sum_{e=1}^{t} x_{ej} \le D_j, \quad \text{for } j = 1, 2, \ldots, m;$$

$$\sum_{i=1}^{n} y_i = L_1;$$

$$\sum_{e=1}^{t} y_e = L_2;$$

x_{hi}, x_{ie} and x_{ej} are positive integers or zero; furthermore, $y_i, y_e \in \{0,1\}$.

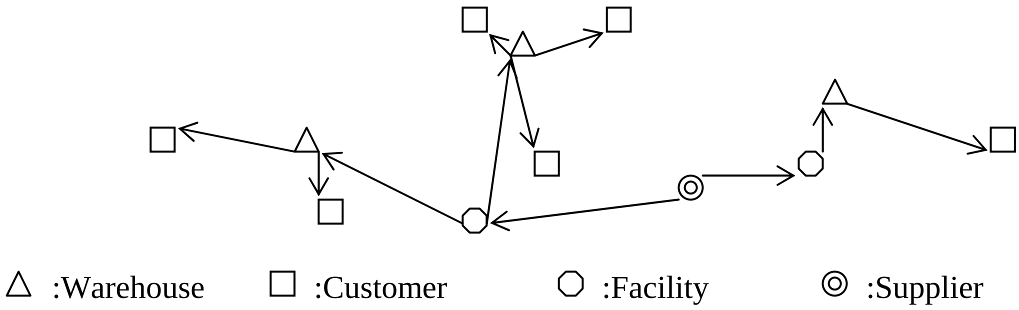

Fig. 2. Graphical Solution of Model (2) for L_1=2, $L_2 = 3$ and *m*=6

The planning result is similarly illustrated, where

x_{hi} :the decision variable denotes raw materials shipped from supplier *h* to facility *i*; if $x_{hi} > 0$, then this means some raw materials are shipped between supplier *h* and facility *i*; otherwise, it is 0;

x_{ie} :the decision variable denotes products shipped from facility *i* to warehouse *e*; if x_{ie} >0, then this means some products are shipped between facility *i* and warehouse *e*; otherwise, it is 0;

x_{ej} :the decision variable denotes products shipped from warehouse *e* to customer *j*; if x_{ej} >0, then this means some products are shipped between warehouse *e* and customer *j*; otherwise, it is 0;

y_i : the decision variable, if facility *i* is exactly set up then it is 1; otherwise, it is 0;

y_e : the decision variable, if warehouse *e* is exactly set up then it is 1; otherwise, it is 0;

c_{hi} : the unit transportation cost from supplier *h* to facility *i*;

c_{ie} : the unit transportation cost from facility *i* to warehouse *e*;

c_{ej} : the unit transportation cost from warehouse *e* to customer *j*;

f_i : the set up cost of facility *i*;

f_e : the set up cost of warehouse *e*;

D_j : the number of required products for customer *j*;

K_i : the product availability (capacity) for facility *j*;

W_e : the storage capacity for warehouse *e*;

L_1: the number of facilities that must be set up; L_1 =1,2,…,*n*;

L_2 : the number of warehouses that must be set up; L_2 =1,2,…,*t*.

The next section modifies the objective (2) as a multi-objective type [3, 6, 16]. Trauma patients are classified into three types: “Red”, “Yellow” and “Green”. All available hospitals are also classified into: (a) medical centers, able to handle “Red” patients (including “Yellow” and “Green” patients), (b) district hospitals, able to handle “Yellow” patients (including “Green” patients), and (c) local hospitals, only able to handle “Green” patients. The rescuing process reduces emergency patients to normal condition patients under serious supervision; thus, patient transfer between hospitals is only allowed from the top-level hospital to the lower level hospital: no other type of transfer is approved. This study follows the spirit of model (1) and (2) to develop a multi-objective medical decision model in the next section.

3. Model Construction and Resolution

The previous section considers three types of trauma patients, “Red”, “Yellow” and “Green” and three types of hospitals, medical center, district hospital, and local hospital for multi-objective modeling. This model also includes responsible hospitals, rescue units, e.g., 911 and patients. Among the three types of hospitals considered, specified patient transfer between hospitals is allowed (see Section 2.1). This work does not consider fixed (set up) costs of model (1) or (2) because the economics of rescue is insignificant compared to saving lives. This study replaces the variable costs in model (1) or (2) with transfer time of patients in the multi-objective model. The model is the extension and modification of location-allocation models in Section 2. The model achieves three objectives: maximizing survival time of “Red” patients, maximizing survival time of "Yellow" patients, and maximizing survival time of "Green" patients, respectively. The three objectives of different patients are necessary because this investigation assumes that these three types of patients compete with each other for limited medical resources, i.e., available beds/resources. This work tests if the "Red" patients should be emphasized or not.

The model is somewhat complicated, therefore the model parameters are first shown as follows,

H : the set of available hospitals in the study area;

A : the set of available ambulances;

p^i : the set of patients for three types, if i =1, then it is the set of "Red" patients; if i =2, then it is the set of "Yellow" patients; if i =3, then it is the set of "Green" patients;

S_{p^i} : the survival time of patients, belonging to set p^i, i=1,2,3;

S_h : the survival time of patients in hospital h;

T_h : the number of patients in hospital h;

M_h : the maximal capacity of hospital h;

N_a : the number of ambulances in rescue unit a;

W_a : the idle time in rescue unit a;

V_h : the idle time in hospital h;

R_a : the rescue coverage of rescue unit a;

γ_{ha} : if the hospital is covered by rescue unit a. then it is 1; otherwise, it is 0;

$\beta_{p^i a}$: if the patient set p^i is covered by rescue unit a. then it is 1; otherwise, it is 0;

$E_{hh'}$: the minimal travel time from hospital h to hospital h', directly measured on the GIS by the practical road-network;

$D_{p^i h}$: the minimal travel time from patient set p^i to hospital h, directly measured on the GIS by the practical road-network;

λ_{p^i} : the number of patients, belonging to p^i;

α_h : the ratio of patients in hospital h transferred to hospital h';

$z_{p^i h}$: the number of patients belonging to p^i transferred to hospital h;

f_a : the capacity of rescue unit a;

g_h : the number of patients transferred to hospital h;

$x_{p^i a}$: the decision variable, if patient set p^i is served by rescue unit a, then it is 1; otherwise, it is 0;

$y_{hh'}$: the decision variable, if the patient is transferred from hospital h to hospital h', then it is 1; otherwise, it is 0.

The three objectives used for the multi-objective model are all defined as survival time minus total transfer time:

(a) The objective function for the "Red" patients:

$$\text{Max} \quad S_{p^1} - \sum_{a\in A} x_{p^1 a} W_a - \sum_{h^M \in H} z_{p^1 h^M}(D_{p^1 h^M} + V_{h^M}) \tag{3}$$

(b) The objective function for the "Yellow" patients:

$$\text{Max} \quad \begin{aligned} & S_{p^2} - \sum_{a\in A} x_{p^2 a} W_a - \sum_{h^M \in H} z_{p^2 h^M}(D_{p^2 h^M} + V_{h^M}) \\ & - \sum_{h^D \in H} z_{p^2 h^D}(D_{p^2 h^D} + V_{h^D}) \end{aligned} \tag{4}$$

(c) The objective function for the "Green" patients:

$$\text{Max} \quad \begin{aligned} & S_{p^3} - \sum_{a\in A} x_{p^3 a} W_a - \sum_{h^D \in H} z_{p^3 h^D}(D_{p^3 h^D} + V_{h^D}) \\ & - \sum_{h^L \in H} z_{p^3 h^L}(D_{p^3 h^L} + V_{h^L}) \end{aligned} \tag{5}$$

Here, h^M, h^D and h^L represent the medical center, district hospital, and local hospital, respectively. Each is a subset of H. Objective (3) means that survival time of "Red" patients is the average survival time minus transfer time to, and idle time in, medical centers. Objective (4) means that survival time of "Yellow" patients is the average survival time minus transfer time to, and idle time in, medical centers, minus the similar term of district hospitals. Objective (5) means that survival time of "Green" patients is the average survival time minus transfer time to, and idle time in, district hospitals, minus the similar term of local hospitals. The aforementioned objective design is to supervise trauma patient transfer to a higher standard to avoid unexpected outcomes. The constraints are shown as follows:

$$T_h + \sum_{p^i \in P} \lambda_{p^i} z_{p^i h} - \sum_{h' \in H - \{h\}} \alpha_{h'} y_{hh'} + \sum_{h' \in H - \{h\}} \alpha_h y_{h'h} \le g_h \quad ; \quad \forall h \in H \tag{6}$$

$$z_{p^i h} \le \gamma_{ha} x_{p^i a} \qquad \forall p^i \in P, a \in A, h \in H, i = 1,2,3; \tag{7}$$

$$\sum_{p^i \in P} \lambda_{p^i} x_{p^i a} \le f_a \qquad \forall a \in A, i = 1,2,3 \tag{8}$$

$$\sum_{h\in H} z_{p^i h} = 1 \qquad \forall p^i \in P, i = 1,2,3; \tag{9}$$

$$x_{p^i a} < \beta_{p^i a} \qquad \forall p^i \in P, a \in A, i = 1,2,3; \tag{10}$$

$$\sum_{h' \in H} y_{hh'} \le 1 \qquad \forall h \in H; \tag{11}$$

$$\sum_{a\in A} x_{p^i a} = 1 \qquad \forall p^i \in P, i = 1,2,3; \tag{12}$$

$$z_{p^i h} \in \{0,1\} \qquad \forall h \in H, \forall p^i \in P; \tag{13}$$

$$y_{hh'} \in \{0,1\} \qquad \forall h, h' \in H; \tag{14}$$

$$x_{p^i a} \in \{0,1\} \qquad \forall p^i \in P, a \in A. \tag{15}$$

These constraints are explained as follows:
Equation(6): is used to limit the number of patients, served in hospital *h* (including those transferred in or out), to not exceed the maximal capacity of hospital *h*;
Equation (7): is used to test if patient set p^i is served by rescue unit *a* or not;
Equation (8): is used to limit the number of patients served by rescue unit *a*, to not exceed the maximal capacity of rescue unit *a*;
Equation (9): is used to express that patients must be transferred (assigned) to only one hospital;
Equation (10): is used to express that if $\beta_{p^i a} = 0$, then $x_{p^i a} = 0$;
Equation (11): is used to control whether patients in hospital *h* should be transferred to hospital h' or not;
Equation(12): is used to express that patients must be served by only one rescue unit;
Equation (13): is used to denote that $z_{p^i h}$ is a binary decision variable;
Equation (14): is used to denote that $y_{hh'}$ is a binary decision variable;
Equation (15): is used to denote that $x_{p^i a}$ is a binary decision variable.
This study uses the multi-objective model to make emergency medical decisions, showing how various patients are transferred among available hospitals and what their survival time is. Choosing different model parameters for Equations (3)-(15), makes it easy to check if survival time is acceptable or not by various scenarios.
This work uses the weighting method for integrating Equations (3)-(5) [9]. Two weighting mechanisms, AHP weighting [9] and subjective weighting are used to compare performance (average survival time of each patient). Furthermore, the model (3)-(15) is directly encoded into the GIS for resolution and presentation.

4. Empirical study of Kaohsiung City in Taiwan

The following case is supported by the Department of Health, Taiwan. Kaohsiung City is located in the southern part of Taiwan, the second largest city next to Taipei. The Kaohsiung international airport is very close to the city metropolis, thus aviation safety and a reaction plan are necessarily well prepared. Since no aviation accidents have occurred in Kaohsiung, this research assumes a large aviation disaster near the Kaohsiung airport, generating 100 “Red” patients , thirty “Yellow” patients, and twenty “Green” patients for the following simulation.

Table 1. Data of Available Hospitals

Hospital	Available Beds	Maximal Ability
A	146	Green
B	125	Green
C	61	Green
D	523	Red
E	417	Red
F	556	Red
G	645	Red
H	549	Red
I	328	Red
J	556	Red
K	95	Red
L	168	Red
M	120	Yellow
N	279	Yellow
O	95	Yellow
P	393	Red

4.1 Planning Results and Sensitivity Analysis

Available resources are summarized in Table 1. This work first practically surveys available hospital beds in Kaohsiung City, and records these data by GIS. Hospital ability, available beds, and the location of each hospital are summarized in Fig. 3 and Table 1. Rescue units (911) from R1 to R11 are illustrated in Fig. 4. The rescue process is defined as: Patients are first rescued by rescue units in Fig. 4, then transferred to responsible hospitals according to their trauma characteristics to maximize their survival time.

This study uses two weighting mechanisms to integrate objectives (3)-(5) and compare their performances with the average survival time of each type of patient. The AHP is the first weighing mechanism [9]. We choose five experts to assess the relative importance among Equations (3), (4), and (5), and all regard the "Red" patients as the first priority. Thus, we obtain the weight of 0.36 for the first objective, 0.33 for the second objective, and 0.31 for the third objective. Planning results are in Table 2. Furthermore, we use the equal weight of each objective as the second weighting mechanism. This means that each objective weight is exactly 0.33, and these planning results are included in Table 3. The planned results of Table 2 are also graphically illustrated in Fig. 5. We apply the VBA in GIS to control the Lindo; thus, the multi-objective model (3)-(15) can be directly resolved and graphically presented on GIS (see Fig. 5). Here, the green line presents the transfer of "Green" patients, the blue line presents the transfer of "Yellow" patients, and the red line presents the transfer of "Red" patients.

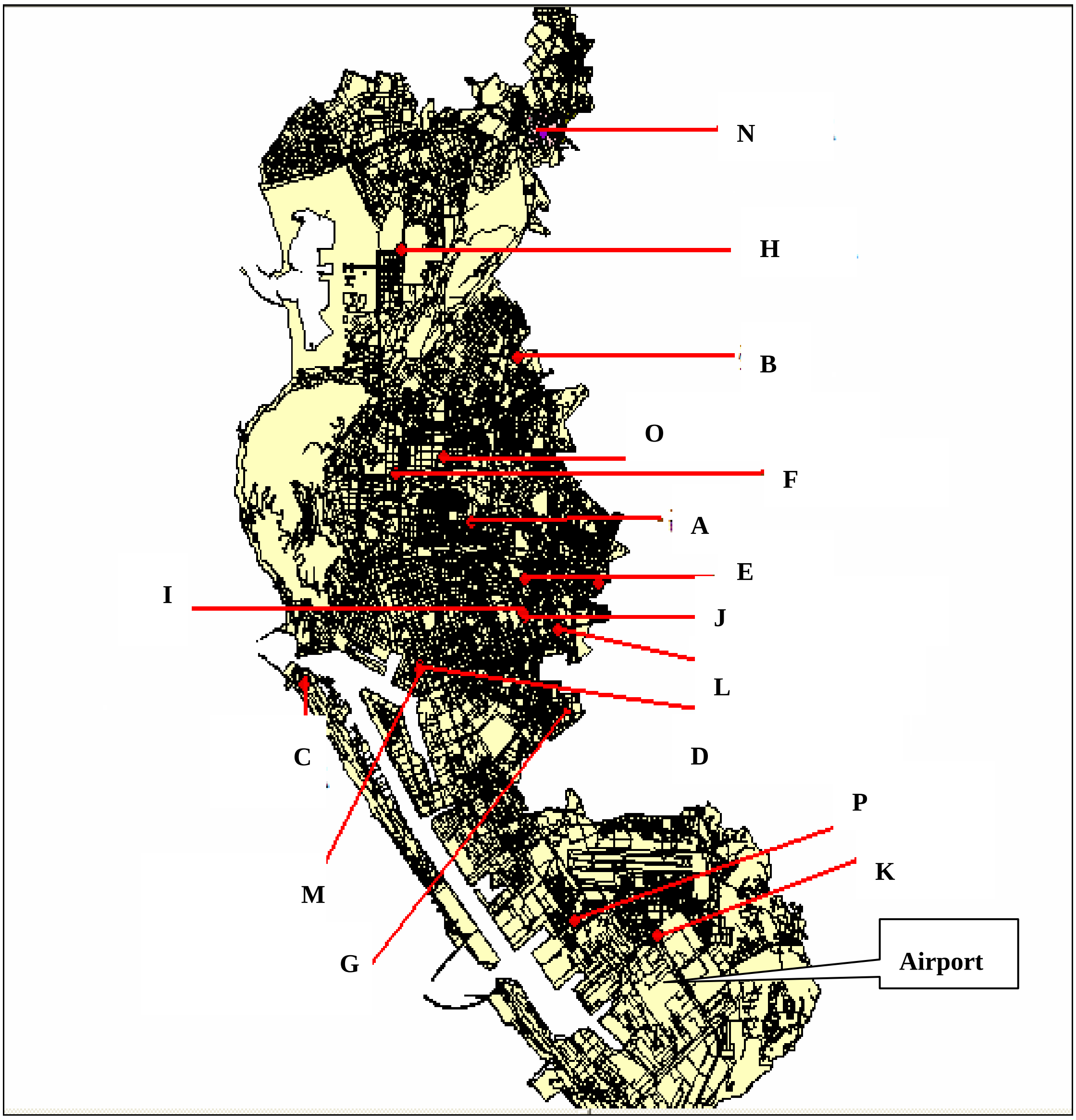

Fig.3 Location of Available Hospitals for Kaohsiung International Airport

When we set each objective with equal weights, the "Red" patient has a higher survival time, 6.66 min, compared to the AHP weight. Thus, if the "Red" patient is emphasized, the equal weight model seems better than the AHP weight model. The second weighting mechanism (equal weight) favors the "Red" patients, and "Red" patients are important in this study. We set equal weights for each objective to propose sensitivity analysis, including two conditions: the first condition assumes that available beds for each hospital are duplicated. The second condition assumes that transferred patients are duplicated.

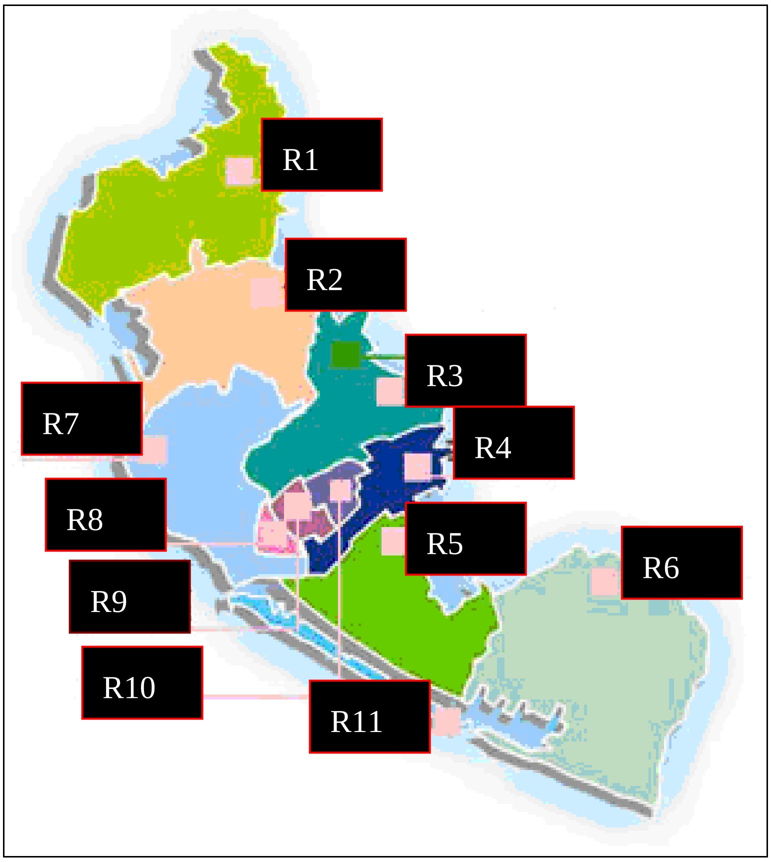

Fig.4 Rescuing Units in Kaohsiung City

Table 2 Planning Results of Multi-objective Model

Type of patient	Number of patient	Used rescuing unit	Hospital that patients are transferred to
Red	100[6.16]	R6	D(7),E(5),F(4),G(17),H(5),I(19),J(3),K(12),L(3),P(25)
Yellow	30[31.33]	R7	M(7), N(10), O(13)
Green	20[48.19]	R5	A(5), B(7), C(8)

[]:denotes the average survival time of each patient (min)
():denotes the number of transferred patients

4.2 Discussions

This work integrates the VBA, Lindo, and GIS to resolve the multi-objective model (3)-(15). Some interesting observations are summarized as follows:

(a) Whether from the AHP weight model or from the equal weight model, hospital K and P in Fig. 3 are both regarded as appropriate locations for "Red" patient care. These hospitals are very close to Kaohsiung International Airport. Thus, authorities should prepare full medical resources in these two locations for "Red" patients. These are the important hospitals and should be seriously monitored for service level.

(b) When available hospital beds are duplicated, patient survival time does not significantly increase when comparing Table 2 and 3; however, as transferred patients are duplicated, patient survival time dramatically reduces. This observation hints that numerous patients will be the key challenge to the rescue unit (911), rather than inadequate beds. In other words, transfer efficiency will be hampered if numerous patients are actually generated. This deficiency does not result from insufficient hospital beds because increasing beds does not significantly affect outcomes. Actually, this bottleneck problem arises from low rescue unit capacity; patients are transferred to each hospital by each rescue unit. Therefore, the most responsible rescue units, e.g., R5, R6 and R7 in Fig. 4 should be equipped with more ambulances or large capacity carriers for efficient patient transfer. We also suggest that authorities borrow medical resources from other rescue units R5, R6, and R7, if these units are over equipped.

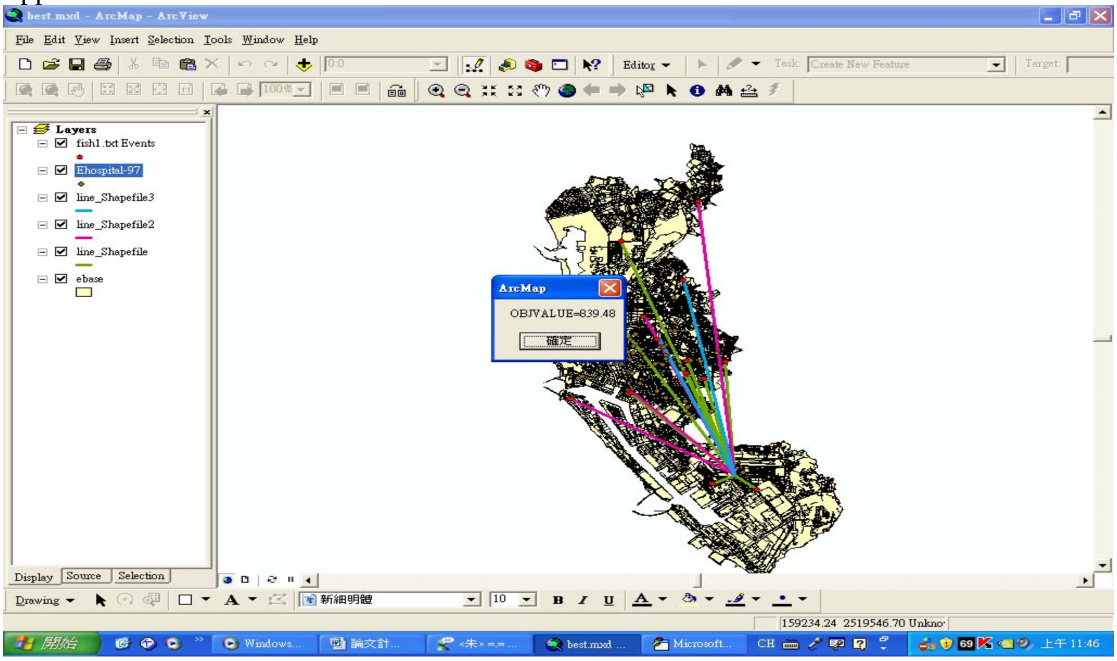

Fig.5 Graphical Solution of Planning Results in Table 2

5. Conclusions and Recommendations

Traditional patient transfer following an aviation disaster is very difficult to measure or to formulate effective rescue. However, this study successfully combines the multi-objective model and the GIS to simulate rescue effectiveness of an aviation disaster. Linking VBA, Lindo, and GIS is quite simple in the ESRI ArcView 9.x [8] for various customized developments. The problem introduced in this study may be emergent and should gain more attention if aviation risk increases.

The main benefit of simulating an efficient rescue plan for aviation disaster includes: (a) a good rescue plan guides rescue units and hospitals to prevent wasting medical resources, and (b) an efficient rescue plan promotes government reaction and reputation. Therefore, this study should be continuously explored, developed, and modified to accommodate a larger scale situation.

More factors should be considered to reflect greater realities, e.g., the number of doctors in each hospital, the type of blood in each hospital, the routing problem between the international airport and the hospital (rescue unit). In other words, necessary parameters should be collected to more completely and realistically modify the model. Applying radio frequency identification (RFID)[18] to trauma patients could make classification more rapid and efficient, thus RFID signals should also be integrated into our multi-objective GIS later. Since the ArcView GIS 9.X and RFID integrate by a VB framework, as RFID technology matures, integration of our multi-objective GIS and RFID data from patients will significantly benefit trauma patients.

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