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A Mobile Application Based Optimized Out-Patient Emergency Request Model

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ABSTRACT

This paper developed a mobile APP called Health Emergency Request APP (HER-APP). The App sends out-patients' emergency request to any closest health personnel within a particular location and matches a patient to a particular health personnel for immediate attention. We observed that the process of responding to out-of-hospital emergencies after a crisis have faced a lot of communication challenges between patients and the nearest healthcare personnel especially in Nigeria. There is also a problem of assigning a patient to the most qualified health personal for better care. This has resulted in increased mortality even when such emergency could better be handled. It becomes compelling to develop a mobile APP that allows a seamless communication between patient under emergency and the nearest medical expert with medical facility to save lives prior to the full engagement of the attention of a medical doctor or ambulance. This emergency request service-oriented mobile application helps patients contact any closest health personnel within a particular location using a location tracking service. The mobile application implements a matching algorithm between patients and responders, and assists people in emergency to get quick pre-clinical treatment. It uses an optimized service-oriented architecture which reduces the communication process between a patient in an emergency and the doctor or responder using a Google global positioning system as a location tracking service to helps track a patient requesting for assistance as well as all available responders. The APP uses location factor to determine a model to enhance the system on a large scale basis to provide a dispatch method to allocate patients to responders. This paper enhanced the Hungarian model and determines the best patient-responder match. The mobile APP is available at www.github.com/magnifikuc.

Key words: Health emergency, Hungarian algorithm, location tracking matching algorithm, mobile App

1. INTRODUCTION

The rising population of cities is putting tremendous pressure on the medical chain services such as the hospitals, healthcare centers, and ambulance services as well as health personnels. It becomes important to leverage on the available technology which has brought unprecedented opportunities in the healthcare sector as the demand for efficient and more reliable healthcare system is on the increase. The need to provide patients with improved quality healthcare, with low costs associated with healthcare services and, in the meantime, addressing the problem of lack of healthcare workers become very necessary even as mobile devices are gaining more relevance in healthcare service delivery [1], [2], [3]. In reality we utilize technological tools of all kinds on a regular basis for multiple purposes (e.g., regulating household appliances and tracking energy consumption), which has contributed to the creation and transmission of tremendous amounts of personal data in seconds. In [4-7] future studies to expand the scope, range and maneuverability of healthcare technologies are addressed by the use of wireless networking technology.

Additional studies demonstrating how practical, easy and effective it is to use portable devices to enhance the delivery of treatment in fields like medical data transmission [8], [11], electronic messaging systems [9], [10] made it a widespread news. There is a growing use for HealthCare mobile technologies such as the personal digital assistants, laptops and smartphones owing to their versatility and reliability than a range of virtual personal computers.

Human beings have been afflicted with crises for decades. In recent times these incidences has risen tremendously due to the rise in documentation of such occurrences. The dispatch of emergency services is of special importance e.g. in Russia-Ukraine [1] and Israel-Palestine [2] cases where war is ongoing and the corresponding surge in unexpected emergencies [12]. The fundamental principle, under usual situations, is emergency delivery: the availability of manpower to deliver emergency medical time as quickly as possible to the closest patients. Emergencies and disasters have large, complex, and dramatically damaging effects on human health. It involves unexpected domestic accidents, outbreaks of infection, lack of clean drinkable water supplies, and the impact of global wars on health. Throughout the preparedness and implementation of crises activities, public health authorities assume essential functions [13]. At federal level, these healthcare givers guarantee catastrophe prevention by the planning of the action strategy to maximize the future. They are creating emergency readiness at a community level by identifying local needs in case of accidents or outbreaks to ensure that the strategy is enforced immediately after the accident [14-17].With the occurrence of emergencies which cannot be eliminated in any society and with the advent and usage of latest mobile technologies, we therefore find solutions to the following existing gaps in the emergency units of our health systems. There is lack of adequate communication channel between patients in an emergency and healthcare persons. Previous developed systems operate a central system where users contact central operators and operators then contact field agents near the user to oversee emergencies. This results in undue delays in patients receiving medical attention from point of incident to the hospitals. Smarter, more personalized methods of receiving patient reviews will contribute to saving lives, time and costs [17]. This paper seeks to meet the following conditions: request an emergency by sending a summarized emergency information to an on-demand healthcare personnel, provide a real-time user's location information by immediately alerting closest available healthcare workers and provide the health professionals with precise position details for evacuation in real time. It integrates a location tracking service in order to locate patients at emergencies and efficiently implements a matching algorithm between patients and responders.

The findings of this research would benefit patients who need emergency assistance from a trained healthcare person. It would also help to minimize the death rate by employing the services of emergency responders who respond to emergency requests through the system. Considering the need for an intelligent patient care system, patients residing in suburbs can easily be traced by anyone using a Google geo-location service to navigate.

2. RELATED WORKS

In previous years, the scheme of first-aid volunteer health care providers was extended to the emergency response services. The underlying principle of first respondents is indeed the inclusion of volunteers who come first at the location and provide first treatment quicker than that of the rescue worker [17]. Thus, it is possible to shorten preclinical 'no-therapy period,' established between the incident (accident, medical problems, etc.) and the intervention of skilled medical attention [18].

In recent years, emergencies have accumulated and contributed to greater rates of health challenges. Although the response services available seemed to be strong in metropolitan areas, the time needed was hard to reach. Due to the geographical isolation of the villages in rural areas, the situation became even more acute [18]. Therefore, it was important to extend the field of responsibility for full-time emergency services that can ensure that any position is covered in five minutes. The extension was impossible, and another method needed to be introduced due to insufficient financial capital. Therefore, as an alternative to emergency services, a first-aid voluntary scheme was developed for primary care patients [17].

2.1. Location Based Services in Health Emergencies

The use of GPS technology is vital to detect the individual's location in an emergency. An example of this is the monitoring of tasks by healthcare staff using GPS technologies or the patient position by the use of Google Maps on their cell phones throughout the implementation of a successful emergency services [19]. This has been remarkably successful.

The project Rapid SMS in Rwanda for example, has given healthcare providers in Africa the ability, according to [20], to monitor pregnant mothers, follow up on prenatal care, recognize women at risk and strengthen contact during emergencies with health care facilities. In their evaluation of mobile solutions in Bangladesh, [21] also found that the distribution of successful healthcare to pregnant mothers and neonates are feasible with reduced human resources by the introduction of a clever algorithm on mobile phones for health workers, as well as the usage of reduced human resources.

2.2. Matching Problem

Matching is an algorithmic topic that has been studied well. There are other variants within the problem of matching, such as matches in generic graphs, matches in bipartisan graphs and matches in weighted/unweighted charts. Maximal cardinal correspondence is sought in graphs without weights [22]. However, maximum matching with weight was therefore investigated in weighted diagrams [23]. Earlier literatures have also demonstrated that the matching or allocation problems has been listed as a combinatorial optimization method. While certain matching techniques exist, there are those which are improved with algorithms based on combining earlier techniques which serve as foundational algorithms. In this paper, we compare matching algorithms based on their similarities to the domain being discussed, they are the Blossom modelling technique considered to be the Edmond matching algorithms. [24] showed a graph that contains cyclic patterns which creates infinite alternating paths, it is basically a cyclic graph with 2k+1 edges in the worst-case example. The blossom algorithm as represented in *Algorithm 1* has a whole-time complexity of $O(|E||V|^2)$, for |E| complete edges and |V| whole

[1] https://www.google.com/amp/s/www.aljazeera.com/amp/news/2023/11/7/russia-ukraine-war-list-of-key-events-day-622.

[2] https://www.hrw.org/world-report/2023/country-chapters/israel-and-palestine.

vertices of the graph. The blossom-Edmond technique is represented as algorithm 1:

Algorithm 1: Blossom – Edmond Matching Algorithm

Input	:	Graph *G*, initial matching *M* on *G*	
Output	:	maximum matching *M** on *G*	
		FUNCTION	
	:		*find_maximum_matching*(*G*, *M*) : *M**
	:		*P* ← *find_augmenting_path*(*G*, *M*)
	:	**If**	*P* is non-empty **then**
	:	**Return**	*find_maximum_matching*(*G*, augment *M* along *P*)
	:	**Else**	
	:	**Return**	M*
	:	**End if**	
		END FUNCTION	

If *M* is a matching and *P* is an augmenting path, *G* is the graph, *U* is the first set of nodes, *V* is the second set of nodes and *E* is the Edges.

Secondly, the Hopcroft – Karp algorithm which implements enhanced strategies is close to the strategies of the Hungarian algorithm and the Edmonds algorithm. Researchers with experience have observed that Hopcroft-Karp is not as strong as the hypothesis implies [25], [26]. In the worst case example, the algorithm's time computational complexity is $O(|E|\sqrt{|V|})$, for $|E|$ complete edges and $|V|$ whole vertices contained in this graph.

Algorithm 2 represents a sample of the Hopcroft-Karp Algorithm with input as a Bipartite graph and output as Matched nodes. The process of discovering the shortest path is looped until a path is matched and displayed.

Algorithm 2: Hopcroft – Karp Algorithm

Input	:	Bipartite graph G(U ∪ V, E)	
Output	:	Matching (M ϵ E), M ← E	
		BEGIN	
	:		M ← ∅
	:	**REPEAT**	l ← Length of the shortest
	:		augmenting path
	:		P ← {P1,...,Pk} inclusion-maximal
	:		set of vertex-disjoint
	:		augmenting paths of length l
	:		M ← M ⊕ (P1 ∪ P2 ∪ ... ∪ Pk)
	:	**UNTIL**	P = ∅
	:	**RETURN**	M
	:	**END**	

The Kuhn Munkre's (K-M) Modelling technique which is an optimized Hungarian Maximal matching algorithm is a popular two-part graph algorithm that identifies the most matching results while discovering augmented paths. This is shown in *Algorithm 3*. It begins with a randomized match, along with a null match. Thereafter, it creates a breadth first search tree, towards identifying an increasing route [26]. This algorithm eventually was modified with improved data structures to $O(|V|^3)$ time.

Algorithm 3: Hungarian Maximum Matching Algorithm

Input	:	Matrix *M*, initial n X n matrix on *G*	
Output	:	maximum matching *M* of *G=(U,V)*	
		BEGIN	
	:		initialize labels
	:	**WHILE**	matching is not complete **DO**
	:		find a root of an alternating path
	:	**WHILE**	alternating path not found **DO**
	:	**Try**	to find alternating path in equality graph
	:	**IF**	alt. path not found
	:	**THEN**	update labels
		END	
			increase matching
		END	
		END	

The results from these algorithms determine areas where it can be used. There are other algorithms which also are used to solve bipartite graphs, but they are relevant in other areas of complexity optimization problems.

2.3. Concept and Methodology Adopted by Other Researchers

This section aims at investigating the concepts and methodology adopted by other researchers which tries to validate the processes involved in mobile health applications, its functionalities, usage, e.t.c by both responders and hospitals.

In [27], M. Khafajiy et al. proposed system called Smart Hospital Emergency System (SHES) with an aim of saving human lives by improving Patient and emergency communication services. After studying the challenges of emergency services, the research showed that there was a bottleneck with communication going through a longer route from the point of emergency-to-emergency services. This was achieved by usage of health information contained on the mobile smartphone and internal data monitoring service (GPU, Gyroscope, e.t.c.), live video feed through an enterprise resource software to enhance initial interactions of emergency personnel with patients with applications and technologies in order to maximize the performance of emergency communication whilst minimizing problems and concerns with emergency alert mechanisms.

Metelmann, C., et al in [28] presented an idea of a new smart phone application designed to optimize the connection between first aid contact or responders and the control rooms. Although, the first responder information and communication software, "FRICS", which was designed for the Austrian first responder community was targeted to be an introduction into how the operations of the medical first responder's systems works. It was discussed that the system increased first responder's time and location determination after a survey and implementation of the survey's output was actualized.

After observing a common trend in the communication of emergencies which circulated through a central system, J. Lohokare et al [29] proposed a way to ensure minimal latency duration for those in need of these facilities. The research suggested that a focus should be on recording of the emergency services live location. This helps the user to easily communicate with the closest accessible officials. It was also suggested that an Internet and a global positioning system (GPS) is activated for each emergency response official. The application must begin to transmit data to servers on live position. The primary benefit of the research was in its provision of a modular approach that can be generalized across the entire city where millions of people utilize this device.

S. Chiou et al in [30] proposed a real-time emergency medical service network with emphasis on patient's privacy protection aimed at alerting nearby rescuers to the point of emergency. The study proposed a solution to allow emergency professionals to arrive at an incident scene faster, with mobile devices, patients and workers instantly transmit their current positions by supplying their data to a central server. In reaction to a warning of an injury, the system alerts emergency personnel to the event as quickly as possible, providing the workers specific instructions to locate the individual in need so that the response time is minimized. The outcome of the designed framework runs on Android devices while preserving privacy and patient details, including data security, confidentiality, authorization, secrecy of coordinates, enforceability of coordinates and resistance to persistent threats and monitoring threats.

Jing et al in [31] studied the existing problems being experienced in some china hospitals. They observed the difficulties of patients seeing doctors as well as the contradictions which suffice between doctors and patients. Using a Multi-patient Treatment Mode (MTM) problem as categorized, they derived an approach called Doctor Patient Combined Matching (DPCM) which is based on an improved ant colony optimization approach.

X. Zhe et al [32] attempted to model an aspect of dispatch algorithm in the transportation domain without laying emphasis on integrating location factor in his analysis. They observed a problem as previous literatures considered as traditional way of dealing with an order dispatch which was focused mainly on just customer satisfaction. In order to solve the problem, they developed an approach consisting of planning and learning approach order dispatch phases. They made use of the Hungarian Technique which was able to identify drivers and match them with passenger's orders.

Further research also showed evolutions of technologies used on mobile device operating systems to enhance the optimization of the objectives of mobile health systems. As technologies evolved from java based operating systems and applications to android based operating systems and applications, there has been a tremendous improvement in mobile health applications and an improved response to emergencies. In recent times, there has been developments of assistant autonomous mobile robots [33] which are used in cases of emergency for the elderly or for the visually impaired or handicapped individuals [34 - 36].

A review on related literatures shows that there are still gaps which exist in this domain of study. Publications in this domain proposed different technologies and frameworks in mobile devices which were deployed to assist patients in emergencies, but these technologies and frameworks have been overtaken by advancement in health research as well as a more refined methodology which are employed in today's software application design.

This paper, therefore, proposes an improved design architecture which is an upgraded architectural design compared to the reviewed articles but also employs most of the logical ideas being presented by these publications. The service-oriented architecture has been the underlying architecture for building most of the health emergency applications being used today. This paper also seeks to propose an enhanced allocation framework which aims to manage a community of responders to an increasing demand of emergency request, reduce responder's time by being informed on which patient to handle at a particular time.

3. METHODOLOGY

HER-APP is developed on an integrated clinical information system model with a software that is dependent on pattern programming strategies. The researchers proposed an allocation model that dispatches respondents to patients. It efficiently allocates emergency resource to patients to further reduce delay in emergency response. In the event of a crisis at a particular geographic location, emergency resources allocation and delivery would be needed to rescue lives. Also, within an event of saving more than one life, resources do need to be evaluated and distributed to still have a sustainable system [37].

3.1. Modelling Technique

The challenges of matching graphs are usually related to edges that do not have similar vertices, such as placing students in a school according to their credential. To maximize system benefits, we approached the assignment problem by modelling it using a traditional maximum-weight bipartite matching algorithm using heuristic method as a criterion. Based on X. Zhe et al [31], the main objective of the online order dispatch technique was to identify the best match between drivers and orders. Within the problem description, the main objective was viewed as the optimal answer to maximize a coordinated global advantage for each driver route Path. Previously, the dispatch algorithm of the unified order objective has been maintained as:

$$\text{argmax}_{a_{ij}} = \sum_{i=0^*}^{m} \sum_{j=0}^{n} Q\pi(i,j) a_{ij} \tag{1}$$

$$\sum_{i=0}^{m} a_{ij} = 1,\ j = 1,2,3, \dots\dots, n \tag{2}$$

$$\sum_{j=0}^{n} a_{ij} = 1,\ i = 1,2,3, \dots\dots, m \tag{3}$$

Where:

$Q\pi$ is the weight of the graph G, between node i and node j which are the two vertices of the graph. The equation above outputs a maximum weighted matrix match between drivers and passenger's orders.

3.2. Proposed Method

The methodology adopted in this paper is to retrieve the location of the patient which is the longitude and latitude coordinates, then we assign weights values to the type of emergencies which are captured in the system. Subsequently, by using the output values of the above computations, we assign patients orders to available responders by using a matching technique. A notification containing the information of the matched pair is then sent to the patient.

3.3. Deriving the Location Distance

With the assistance of the global positioning system (GPS) technology, locations of any point are captured in longitudes and latitudes coordinates. These coordinates are used in measuring distances from point A to point B. Given that distances are captured, and an average speed calculated using the embedded device mapping service, we determined the shortest path from point A to Point B as well as the expected time of arrival between these two points. Therefore, in order to calculate the optimum match, one of the required parameters is the distance in kilometers or miles. Therefore, we defined distance, *D* to obtain the distance of both points and by using the Google spherical API function:
"google.maps.geometry.spherical.computeDistanceBetween(latLngA,latLngB)",
we calculated the distance of point A to point B in this expression by parsing the latitude and longitude parameters into the function. The result of D is in meters or can be converted to kilometers, miles, etc.

3.4. Weight Score Assignment

Our system is designed to capture the type of emergency which the patient is experiencing. Although, behind the scenes, we implemented a weighted score starting from 1 to n, n being the highest number of emergencies registered on the system, and mapped each emergency sequentially to each number. For example, if the patient selected epilepsy, and epilepsy is the 5th item in the database, we assigned the number five (5) as the weight score.
Therefore, to calculate the weight score in our proposed system, we use:

$$\text{Average score, } S_a = \frac{E_m}{T_{EM}} \quad (4)$$

Where: E_m = Type of Emergency
T_{EM} = Total amount of listed emergencies

3.5 Weighted Value Between Patient Request and Responder

In order to get the weighted value, we define the weight, W between the patient request node P_i and the responder node R_j as W_{ij}, given as:

$$W_{ij} = \textit{Distance} + \text{Average score } (S_a)$$

Or

$$W_{ij} = D + \frac{E_m}{T_{EM}} \quad (5)$$

3.6. Matrix Derivation

Assuming p ∈ P and r ∈ R be patient and responder respectively so we have m kinds of patients who should be serviced by n kinds of responders. The following $P_i \in [1..., m]$ equates to a request by the patient at this timestamp, whilst $R_j \in [1, ..., n]$ applies to all available serving responders. We noted that i = 0 and j = 0 is the special default operation which in this timestamp does not satisfy any demands from the patient.

$$m_{ij} = \sum_{i=0}^{m} * \sum_{j=0}^{n} W(i,j) \quad (6)$$

$$\sum_{i=0}^{m} m_{ij} = 1, \ j = 1,2,3, \ldots\ldots, n \quad (7)$$

$$\sum_{j=0}^{n} m_{ij} = 1, \ i = 1,2,3, \ldots\ldots, m \quad (8)$$

Where

$$W_i = \begin{cases} 1 \text{ if } P_i \text{ is assigned to } R\ j. \\ 0 \text{ if } P_i \text{ is not assigned to } R\ j \end{cases}$$

This makes the problem the optimum distribution of the given two-part graph G. The problem is transformed into a matrix, M*ij* in equation (9). An example of the matrix as described in *Table 1*, increases as more conditions are considered and added.

$$m_{ij} = \begin{vmatrix} (P_1 R_1) & (P_2 R_1) & \ldots & (P_m R_1) \\ (P_1 R_2) & (P_2 R_2) & \ldots & (P_m R_2) \\ \vdots & \vdots & & \vdots \\ (P_1 R_n) & (P_1 R_n) & & (P_m R_n) \end{vmatrix} \quad (9)$$

Table 1: An example for the list of edges in a matrix [38]

	R_1	R_2	R_3
P_1	1.1	0.8	1.3
P_2	0.3	1.2	0.6
P_3	2.2	0.2	1.6

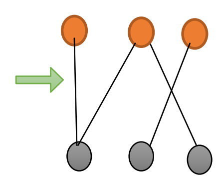

Figure 1: Kuhn Munkre Match Pattern [39]

The Hungarian theory hypothesizes that vertices and edges graph exist, G = {P, R, E} as illustrated in *Figure 1*, where P and R are node sets in each graph partition, and E is the set of weights. The Hungarian algorithm [39] is used to transform Kuhn Munkres (6) to a problem of assignment in figure 1, its ultimate solution is optimum allocation, and the solution is more sensitive to practical requirements.

3.7. Dispatch Algorithm

Definitions: Patient, *Pt*; Responders, *Rp*; current GPS location, *Gl*; Look Up Table, *LUT*; Emergency, *Er*; Type of Emergency, *Em*; Database, *Db*; Distance, *D;* Total Emergencies, T_{EM}

Algorithm 4: Enhanced Dispatch Algorithm

Input :	***Gl***; ***Er***;	
Output :	***Pt* ← *Rp***	
:	**If**	***Er*** = True, **do**:
:		Update ***Db*** with ***Er;***
:	**While**	(***Gl*** is on) **do**:
:		Try ***Gl*** = request getLocation(longitude and latitude);
:	**If**	(***Gl*** ≠ ø) then:
:	**for**	every timestamp of *Rp* **do**:
:		**update** online ***Rp*** into ***LUT*** based on their ***Gl****;*
	for	each ***Er,*** calculate ***distance*** between ***Pt*** and ***Rp***;
:		calculate **Distance** using D + $\frac{E_m}{T_{EM}}$;
:		Using **M**, match ***Pt*** to ***Rp*** using *Algorithm 3* above.
:		eliminate the ***Rp*** from the system;
:	**end for**	
:		Return (***Pt***) ← (***Rp***) pair
:	**end for**	
:		Forward a push notification to ***Pt*;**
	Else:	
:		get ***Gl*** access from ***Pt;***
:	**Update**	the ***Db;***

In Algorithm 4, an emergency request is sent by a patient via the device and any respondent at the same position is automatically evaluated for this patient. The patient is matched to the response person having a full efficiency feature if such respondents are tested for the patient. The patient is then withdrawn, and the resulting reaction is the reintegration of the respondent into the system. The procedures will arise until the next emergency happens.

4. RESULT AND DISCUSSION

To provide a more detailed view of the feasibility of this proposed technique we tested the approach using wolfram cloud, an online dispatcher environment that implements the model based on certain constraints. Provided a two-part map (one in which any edge runs between both parted parts), a maximal fit (set of disconnected vertices) is found in the Hungarian algorithm. The algorithm begins from any of the corresponding M and creates a tree through a first breadth search to find an alternative path. See *Figure 2*.

4.1 Experimentation

The proposed matching algorithm as described earlier in this study was experimented using the Wolfram Cloud Simulator [40]. This is an online mathematical simulating environment for testing mathematical algorithms using the wolfram language. *Figure 2* shows a representation of the mathematical graph of the dispatch algorithm where patients are matched with responders.

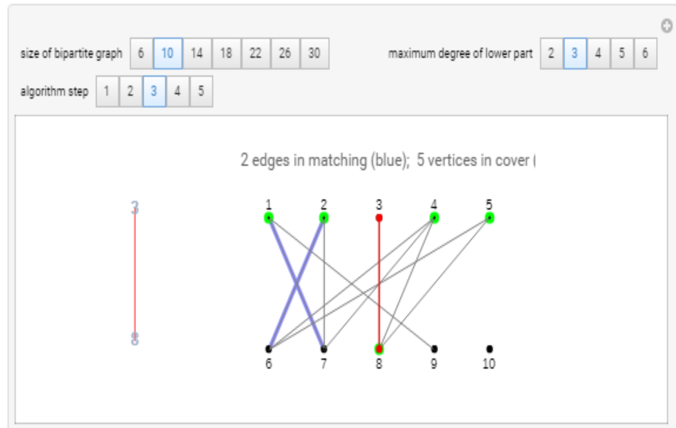

Figure 2: Kuhn Munkres Maximal Matching Graph

Figure 2 shows a bipartite graph with an optimal solution of vertex (3-8). The upper part (12345) are the number of patients and the lower part (6789) are the responders. The non-colored paths are the alternatives if the matched patient is not attended to by the responder. Based on the constraints above, we arrived at a successful matching result.

4.2. Performance Metrics

Table 2 shows a comparison of a model attribute features of the base model and its enhanced version. From the table, there were similarities to the base model, however, the different application of this base model with new parameters causes an improvement to the system. Therefore, the improvements identified in our study are the matching algorithm, the integration of geolocation tracking service, the technology deployed on the mobile application design.

The efficient dispatching of health resources carried out by registered healthcare professionals is strictly followed as a matter of urgency and this promotes an organized system. The availability of proximity data also assist in locating patients for responders who are new to an environment. The deployed technology allows for multiple platforms such as the iOS and the Android operating systems allowing for more users of the HER system.

Table 2: Performance Metrics of the Proposed System

S/n	Model/Attribute	Hungarian	HER System
1.	Graph Patterns	Vertices / Edge	Vertices / Edge
2.	Time Complexity	O(|V|^3)	O(|V|^3)
3.	Type of Edge Value	Random	Location and type of emergency.
4	Uses	Assignment	Medical Dispatch

5. CONCLUSION

Throughout this study, we found an increased responder response rate and substantially shortened response times for responders relative to emergency responses due to the use of mobile GPS monitoring to notify and deliver qualified responders during urgency requests. A responder appeared at the emergency site prior to Emergency Ambulance services in more than four out of five situations. The solution proposed in this paper has been implemented and all processes and functionality checked. This platform would allow the city's knowledgeable people to communicate easily with a certified responder who is trained to handle emergencies. It would save patients from future problems created by delays in contacting hospital authorities and also matches a patient in emergency to the most qualified healthcare personnel. This approach guarantees the security of the individuals by exploiting online connectivity in smart cities.

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