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A Novel Approach to Organize Blood Donation Camp and Blood Unit Wastage Management

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ABSTRACT

In the countries or areas where the supply-demand ratio of blood is not maintained, the medication process is being deteriorated, and this may be as fatal as death of the patients. It is being observed in different areas in different seasons or may be at the time of festival scarcity of blood may happen. On the other hand, if the blood donation camp is organized frequently, there may be a surplus of blood as it has expiry dates. Along with these issues, due to the transportation or mismanagement, blood units are wasted. These problems are addressed in this research work, and methodologies are proposed to determine the most suitable blood bank with respect to the blood donation camp. Further, a demand forecasting algorithm is used both for predicting the blood unit demand of every blood bank and for transferring excess blood units to the blood bank where it is needed the most, and also, for the efficient transportation of the blood units, taxicab geometry-based paths are employed.

KEYWORDS

Blood, Blood Donation, Blood Wastage, Forecasting, Lexicographic Optimization, LSTM, Multi-Objective Optimization, Taxicab Path

INTRODUCTION

Blood is essential for human life. As blood circulates throughout the body it delivers oxygen and nutrients to body cells. If this function stops or does not function properly a lot of problems will occur in the human body, which may even lead to death. Not only about the blood related diseases (hematologic disease) for other issues such as accidents, but operations blood is also required be given

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externally. Although modern medical science has improved dramatically, the production of blood is still not possible. Blood can be given externally by taking the blood from another human body only in the form of a blood donation. To meet this emergency requirement and demand of blood, blood donation camps (Chaudhari et al., 2018; AlZu'bi et al., 2022) play a pivotal role. Recognizing this, countries that prioritize the well-being of their citizens understand the positive impact of organizing well-planned and scientifically driven blood donation camps (Dutta et al., 2018; Luo et al., 2021; Sadri et al., 2021) within their healthcare systems. Numerous studies (Devi et al., 2012; Alexander & Adler, 2020) indicate that in countries such as India, Pakistan, and Bangladesh, only one-third (Devi et al., 2012) of the required blood units are obtained through various blood donation camps. Hence, promoting awareness (Dutta et al., 2018) about blood donation is crucial for every compassionate nation. At the same time, blood donation camps are often organized in a haphazard manner (Sadri et al., 2021), lacking any prior planning regarding the optimal location for the camp or which blood bank to coordinate with for collecting blood units (Sadri et al., 2021). In certain instances, these camps may even be influenced by the vested interests of a few political leaders (Dutta et al., 2018), rendering any form of pre-computation or data analysis (Ghosh, Sadhu, & Sen, 2021) irrelevant. As a result, a significant number of blood units end up being wasted (Alexander & Adler, 2020) over time.

Another reason for wasting blood units is mismanagement (Sadri et al., 2021) in distributing blood units. Consequently, blood banks in need of blood units are facing shortages, while those with lower demand have an excess of blood units, resulting in a waste of human blood. In developing countries with limited medical infrastructure, these challenges have a more pronounced impact (Devi et al., 2012). The lack of sufficient healthcare resources and facilities exacerbates the effects of these issues on the population. Therefore, it is vital to emphasize the importance of raising awareness about blood donation while simultaneously highlighting the critical significance of effectively managing blood unit distribution and preservation. Both aspects are essential to meet healthcare demands and ensure a steady and safe blood supply for those in need. In the subsequent paragraphs, different mathematical concepts are presented that relate to distance calculation as blood needs to be moved between blood donation camp, blood banks, hospitals, etc.

The most common form of distance calculation is Euclidean geometry, and the formula is shown in Equation 1:

$$distance\left(A,B\right)=\sqrt{\left[\left(X_A-X_B\right)^2+\left(Y_A-Y_B\right)^2\right]} \tag{1}$$

Equation 1 functions accurately in the areas that have no obstacles, however in reality that is not possible due to the physical obstacles in the form of buildings, other constructions, water bodies and other constraints, such as one-way roads, private roads, etc. These barriers can hinder the direct route, making it challenging to determine an efficient and straightforward distance measurement between the two locations as shown in Figure 1.

Therefore, considering all different constraints in this domain, the lexicographic optimization (Arora, 2017; Zykina, 2004) technique is used to optimize dimensions one after another, starting from the most important dimension. Applying lexicographic optimization in this case mainly requires optimization of three dimensions:

1. Minimum distance traversal from blood donation camp to the blood bank.
2. Minimum distance transfer of the excess blood units from one blood bank to the other that need them the most.
3. And supplying new blood units to the blood banks having minimum available blood units with respect to the demand (Sadri et al., 2021).