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Research Article

Optimizing Football World Cup Logistics and Operations with Information Systems

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Logistics and operations for such a big event like the Football World Cup need to be well-established and efficient. This article provides an account of the application of advanced information systems in managing and enhancing the flow of logistics and other operations during such events in general and logistics in particular. This paper, therefore, discusses how integrated solutions can be adopted by analysing a case of practice of these systems in Saudi Arabia. The modern applications of the tracking systems in real-time are based on two major technologies namely Geographic Information Systems (GIS) and the Internet of Things (IoT) to monitor and control the flow of vehicles and to decrease traffic jams when managing vehicle fleets. This is also useful for the current study is the application of predictive analytics in demand forecasting, resource availability, and transportation scheduling. Further, automation of business processes helps in stock control and timely delivery of products and services without stagnation. Blockchain technology is examined for the purpose of increasing information transparency in the supply chain, data accuracy and effective interaction between the participants. The case also shows the use of cloud-based solutions to support communication and collaboration between logistics teams to increase the flexibility of processes. This article compares how the increasing digital landscape of Saudi Arabia can act as a standard in terms of logistics for huge sporting events around the world, with an emphasis on the function of activities like logistics and operations management for the success of an occasion.

Keywords: Football, world cup, operations, information's, logistics, technology, and logistic routes.

INTRODUCTION

The processes involved in logistics and operations of a global event such as Football World Cup is a meticulous planning, flawless performance, and robust infrastructure, to make it successful and efficient. The use of advanced information systems to manage the flow of logistics, streamline operations and retain control over a vast network of interdependent activities [1]. The application of cutting-edge technologies in optimizing logistics and operations management is explored in this paper, with Saudi Arabia being the case study. This article examines the deployment of Geographic Information Systems (GIS), the Internet of Things (IoT), predictive analytics and other innovative solutions to address logistics challenges of such large scale sporting events.

Real time tracking, predictive analytics and automation are all elements of modern logistics management that require advanced technologies to help goods, services and people move smoothly [2]. Monitoring and controlling vehicle fleets, decreasing traffic congestion and optimising transportation routes all depend on GIS and IoT. These technologies give logistics managers real time, precise insights into the location, movement and status of vehicles. Such systems offer to apply in Saudi Arabia and to use transportation networks attuned to the requirements of the World Cup, whilst keeping disruptions and inefficiencies to a minimum.

Forecasting demand, managing resources and scheduling transportation are all areas in which predictive analytics are used [3]. Through analyzing historical and real time data, logistics teams can predict what challenges may arise and what proactive steps need to be taken to avoid them. In the context of the Football World Cup, where attendance is fluctuating, weather conditions can be interfering and supply chain dynamics are changing, this capability is particularly relevant. By incorporating the predictive analytics into existing infrastructure, decision making at different levels in the Saudi Logistics environment can be improved as well as operational efficiency in general [4].

Another important element of contemporary logistics management is automation that contributes to the effective control of inventories, goods, and service stocks, as well as delivery. Automations decrease the possibility of mistakes by people, increase efficiency and guarantees that logistic processes are fulfilled without problems. For instance, the automated warehousing solutions can control the inventory, manage the shipment and even coordinate the delivery process to a large extent [5]. Such level of automation is necessary to coordinate the great network of logistics that is necessary to organize the World Cup.

A very important advantage that can be provided by means of block chain is the abilities of the supply chain that can be made transparent, accurate, and trustworthy [6]. Through the creation of an unchangeable ledger, blockchain technology helps logistics teams to view the flow of products from one point to the next while ensuring the authenticity of records. This technology promotes stakeholder cooperation, decreases fraud possibilities, and increases accountability. As for Saudi Arabia, the use of the blockchain is going to enable the participants of the logistics chain to gain a clear understanding of the situation and have access to accurate information in real time [7].

Logistics processes are also made more flexible and effective by cloud based solutions in communication between teams and persons. Such platforms enable the stakeholders to exchange information, synchronize his/her activities and adapt to changes in the environment. In World Cup, logistics teams are expected to coordinate different activities and interact with multiple stakeholders, cloud solutions offer a single source of truth that enables stakeholders to be on the same page [9-14]. This is particularly important for Saudi Arabian operations due to the nation's high level of digital readiness and readiness for the implementation of such solutions for logistics teams.

The growing IT environment in Saudi Arabia presents a timely chance to establish a global benchmark for logistics in mega-sporting events. As the country is committed to smart city construction, transportation infrastructure construction, and technological innovation, it has ample capital to reveal the value of the integrated logistics system. Using GIS, IoT, predictive analytics, automation, blockchain and cloud based platforms, Saudi Arabia can demonstrate it's readiness and capability to host such a prestigious event like the FIFA world cup [15].

Coordination and supply chain management are vital components for such events, which involve the transportation of products, services and workforce in the right place at the right time [16]. One can imagine how complicated and challenging logistics is, from transportation to storing, from crowd control to security issues. In Saudi Arabia, the use of advanced information systems can help solve most of the hurdles that come with the World Cup such as high traffic density, variability, and supply chain issues. If the country incorporates these technologies into its logistic structure, it can set up a model that can be used to manage many events effectively and sustainably [17].

The Football World Cup is one of the biggest challenges for the organization and management of logistics and operation systems. This paper covers the topic of the use of information systems in supply chain management with reference to Saudi Arabia's potential to implement advanced technologies to achieve optimal results. Through the implementation of integrated solution like GIS, IoT, predictive analytics, automation, blockchain and cloud based platform, Saudi Arabia can show the world how digital innovation can be used to bring positive change in the management of logistics for large scale sporting events.

FOOTBALL WORLD CUP

In world class tournament like FIFA World Cup, teams are evaluated based on their capability of winning a match. For being a winner, a team must look for effective ways to have ball possession by making successful attacks for scoring chances and to accomplish them by producing goals by high efficiency. So, Football game mirrors the potential and performance quality of a team. The technical as well as the tactical along with the physiological and the psychological associations decide team performance. A match analysis is often practiced in many sports. It is taken as an important process that makes coaches to gather objective and necessary information which may be utilized to make feedback on performance. Essentially match analysis is taken to be an important as well as primary source of information for the staffs who are engaged in a team for training the players about the strength and weakness of own as well as opponent teams.

History was made when Uruguay hosted the first World Cup tournament under the supreme guidance of FIFA in 1930.The first World Cup championship matches took place during the period of from the 13th July to the 30th July1930 for men's National Association Football teams. All the matches of the World Cup (1930) were played in Montevideo, the Uruguayan capital. Most of the matches were held at the Estadio Centenario built specially for this tournament. The first FIFA World Cup 1930 is exception in one case. It was the only FIFA World Cup which allowed every member country of the FIFA to take part in the tournament. American countries showed their huge interest to participate in this world cup. Thirteen teams participated in the tournament. Seven teams from South America, four teams from Europe and two teams from North America listed their names as the first participants in the tournament. The participated teams were classified into four groups. From each group one top team based on the performance in the groups progressed to the semifinals. Four teams, Argentina, France, Chile, and Mexico were categorized in the 1st group. Argentina topped the group. In group stage Argentina won all three matches. Chile and France registered 2nd and 3rd places accordingly. Yugoslavia came out as topper in the 2nd group. The host nation Uruguay won the group three with two victories and in the final group the United States found the top position. Argentina, Uruguay, the United States and Yugoslavia each made entry for the semi-finals. The host team, Uruguay won the title against Argentina with a score line (4-2) in their favour.

Since 1930, the FIFA World Cup Tournaments were held regularly with a gap of four years involving the men's National teams from the member countries of FIFA. The FIFA World Cup 2018 which was the 21st one in the history of World Cup Football was taken place in Russia from the 14th June to the 15th July 2018. It was the first ever FIFA World Cup held in Eastern Europe. This World Cup will remain memorable for using video assistant referee system for the first time. The official mascot was Zabivaka, an anthropomorphic wolf which was made colourful, like the Russian national team. The official match ball was "Telstar-18"and the official song of the tournament was "Live It Up". It was performed by Will Smith, Nicky Jam and Era Istrefi. Belgium, Croatia, England, and France were the most successful teams as they entered in the semi-finals for this tournament. Finally, France has been the winner of the title for the second time [18].

USE CASE ON LOGISTICS AND OPERATIONS WITH INFORMATION SYSTEMS

YOLO V8, the new version of the YOLO object detection model, provides strong features that can improve logistics and operations for large-scale events such as the Football World Cup when combined with sophisticated informational technologies. Information systems could also be developed to form the basis of addressing the data produced by the YOLO V8 in a way that supports real-time decision making for logistics and operations. Due to the object detection feature, YOLO V8 can monitor the crowd movement as well as the logistics operation by processing the video stream in real-time. In the context of logistics, YOLO V8 can detect vehicles including buses, trucks, and vehicles for delivery and offer the best route to avoid traffic congestion and time wastage. It can interface with cameras located at transit centres, parking facilities and points of entrance to recognize automobiles, allocate parking spaces and control traffic patterns. The information can be inputted into large databases which would supply the logistics teams with real-time information on vehicle positions to enhance resource application and enhance transportation.

YOLO V8 can also locate and recognize goods and equipment in storage and transport facilities where, once tagged, the products can be tracked with precision in a database for inventory purposes. This data can then be fed into information systems that can track inventory in real time meaning that the supply chain processes can run smoothly. In crowd management, YOLO V8 is useful in determining the number of people within a particular area and feeding this information to an information system for crowd redirection or extra capacity.

Incorporation of YOLO V8 in drones and its connectivity with an information system helps in having a wide range of view of the area and helps in management of crowd and logistics. In security operations, when YOLO V8 is detecting suspicious objects, they can activate an alarm within the information system to call the attention of the security team. Therefore, when integrated with information systems, YOLO V8 improves the capacity to optimise logistics, security and crowd control during the Football World Cup to ensure that the event is seamless and secure.

The convolutional layers are of YOLOv8-MM, which uses cross-stage partial connections for enhanced information transfer between layers. This design uses VGG-16 but split into the head and the backbone. The head of YOLOv8 algorithm consists of several convolutional layers and several wholly connected layers. These layers predict bounding bounds, scores and class probabilities of objects that are likely to be found in a picture.

Another interesting detail is that in the network's brain, it is possible to use a self-attention mechanism. This method enables the model to weigh different image parts in relation to the job to be done in a way that is most appropriate. The final important feature of YOLOv8 is the ability to perform object detection across multiple scales. The model scans an image for objects of different dimensions and sizes with the help of a feature pyramid network. Such a feature-based network has many layers, where the model learns to recognize items in an image in different size as small or big items. Classification is performed at the top of the YOLOv8-based VGG-16, and simple image preprocessing is done in the backbone part.

VGG-16

The VGG-16 network is utilized in the context of World Cup logistics through automated classification for dataset analysis. Trained with the Instancesnet database, which includes 1000 classes, the VGG-16 network achieves high performance even with limited data. The architecture consists of five convolutional layers with 3×3 filters, a 2×2 max pooling layer after each convolutional layer, and three fully connected layers. The final layer employs a softmax classifier, while ReLU activation is used for all hidden layers.

During the pre-processing stage, data is mixed to prevent overfitting, ensuring the network adapts to specific classes or subsets of data. Labels are randomly shuffled with their associated samples to minimize over-training and improve classification accuracy. The normalization step uses the min-max approach, scaling data between 0 and 1 to optimize processing and reduce computational costs. This method enhances the overall classification performance by effectively managing data variability and ensuring efficient learning. The VGG-16 model can be applied to logistical tasks in World Cup operations, such as crowd management, event tracking, and resource optimization.

$$N_{nrml} = (N_s - N_{s_{min}}) \times (N_{s_{max}} - N_{s_{min}})^{-1} \text{---------}(1)$$

Equation values lies among the scale of 0 and 1 where the minimum ($N_{s_{min}}$) and maximum ($N_{s_{max}}$) with normalized form is indicated as N_{nrml}. Additionally, expression level at current position of a element is indicated as N_s.

Feature Selection

The Artificial Bee Colony (ABC) optimization algorithm is a metaheuristic based on the foraging behaviour of bee colonies in the search space. It is used for optimisation procedures as a model of bees looking for, and harvesting food resources. It also provides high efficiency in the search procedure by achieving a good measure of exploration and exploitation in the search space.

Start point of the ABC algorithm is the generation of a population of food sources (potential solutions) randomly at the search space. The population is initialized in a given domain, which is given in equation 2, it defines the range of the initial values of the solution variables. These first foods are potential solutions for the optimization problem.

The algorithm works in three main phases: the employed bee phase, the onlooker bee phase and the scout bee phase. In these phases, the algorithm looks for the global optimum by continuously optimizing food sources in the search space. This makes ABC appropriate for solving challenging optimizations including logistics, resources, and scheduling problems in large scales such as the World Cup logistics.

$$a_{mi} = l_i + rand(0,1) * (u_i - l_i) \text{---------}(2)$$

where the food sources are indicated by a_{mi}, the upper and lower bound is indicated as u_i *and* l_i, respectively. The phases of ABC optimization algorithm are,

Employee bee phase: In the Artificial Bee Colony (ABC) optimization algorithm, employed bees have a very important function in the search. These bees randomly search the space of possibilities by seeking out this or that type of food: the food corresponds to a potential solution to the optimal problem. Once orphaned bees locate food they share about this through the waggle dance that informs other bees in the hive on the location of food. This dance is basically used by the bees to communicate to other bees in the hive information about the location and quality of the discovered food source.

The other food sources near the hive which the other bees search based on waggle dance are computed using an equation that shows how the near sources are affected by the information given by the employed bees. This is captured in three mathematically in equation 3 where distances between the current food source and the next food source and the quality of the current food source is used to determine the proximity of the next food source. In ABC, the distance of the food sources is related to help the onlooker bees to estimate and choose the food sources that may offer higher nectar, i.e., better solution to the optimization problem.

Information sharing and search of food sources is very important in the alternation of exploitation and exploration in the ABC algorithm, and puts the algorithm close to the greatest or close to greatest solution.

$b_{mi} = a_{mi} + \emptyset_{mi}(a_{mi} - a_{ki})$ ---------(3)

where randomly opted source of food is indicated as a_{ki}, index is indicated as i, and the range of random number $\emptyset_{mi}$ is [-a,a]. A new source of food b_{mi} and its fitness is estimated whereby selection of greedy technique is employed among b_{mi} and a_{mi}.

Onlooker bee phase: In the Artificial Bee Colony (ABC) optimization algorithm, onlooker bees have the major role of choosing the most preferable food sources out of the information that the employed bees provide through the waggle dance. The watching bees take note of the dance, and while the speed and energy of the move communicate the nature of the source (fitness of the solution), the simplicity of the move communicates its quality. The quicker and more spirited the dance, the greater the number of flowers visited, which means a superior solution.

Worker bees assess the possibility of choosing the food source of a certain employed bee depending on the quality of nectar. The probability value which indicates the extent of chance that an onlooker bee goes for any food source depends with the nectar amount of the food source in question. This value is mathematically defined in equation 4 which shows that the probability is directly proportional to the nectar amount of each food source to the total nectar of food sources.

$p_m = \frac{fit_m(\overrightarrow{a_m})}{\sum_{m=1}^{SN} fit_m(\overrightarrow{a_m})}$---------(4)

Scout bee phase: The ABC optimization algorithm has a part named scout bee which is charged with a duty of searching a new area of the space of solution in an effort of identifying other areas with better sources of food. The scout bees work differently from the employed bees and the onlooker bees. : They do not use waggle dance information but rather make random foraging for new food sources, if the existing sources (solutions) are no longer growing or improving. This enables the algorithm to sustain heterogeneity and forbids it from fixing at undesirable solutions too quickly.

Scout bees initiate the search process randomly at the beginning to discover new search areas for food sources. When a scout bee locates a good source of food then it becomes the starting point on the search. This direction is then relayed, and employed bees start to follow this direction, and they fine-tune the search around the new source of food found. The process assists to steer the swarm towards global search by presenting new solutions, especially when local search gets stuck in suboptimal areas.

This way, the mechanism guarantees that the ABC algorithm can move in the search space and avoid the problem of getting stuck in local optima, yet keeping exploitation and exploration in control. In this way, ABC can incorporate the scout bees' exploration in order to modify its search space in order to maximize its probability of finding the global optimum.

The Artificial Bee Colony (ABC) algorithm is particularly good at exploration because of the scout bee phase which allows the algorithm to search randomly across the problems solution space. This capability is especially helpful when searching for global optima in a dynamic and highly nonlinear environment, for example, the optimal multicast tree under QoS constrain. However, the algorithm lacks exploitation capability and consequently low convergence rates and poor fine-tuning of the solutions once the search space has been adequately characterized.

As a result, the basic ABC algorithm is complemented with randomization strategies that increase its exploitation abilities and, at the same time, retains its high exploration potential. These improvements assist in achieving an adequate balance between exploration and exploitation which is crucial for the optimisation of solutions where time is a constraint in large dynamic systems.

When used in conjunction with the multicast routing problem, the ABC algorithm was shown to be capable of defining the possible paths in the network and arriving at the tree that yields the minimal value for the objective function which may include cost, latency and bandwidth usage. The strength of the ABC algorithm is its capability to search the whole search space, and at the same time guarantee that the best feasible solutions have been arrived at within the prescribed time. In general, the proposed ABC algorithm can be regarded as a universal and easily adjustable optimization technique that can be applied across a wide range of problems and can provide solutions to these problems with the help of global optimization under constraints.

Classification using Convolutional Neural Network

Convolution Layer: In the convolutional layer of a neural network for feature extraction, filters (also called kernels) move across the input data and where each element of the filter is multiplied by the corresponding element of the input data, the results are summed up. Each filter produces an output value associated with the receptive field which is a portion of the input data on which the filter acts. The summation of input elements is then forwarded as an input element to the next level and this the network can learn features at higher levels. The ability of sliding the focus area (or receptive field) over the entire input pattern provides multiple output values (feature maps) for capturing spatial relations.

In convolution operations, the filter parameters include, zero padding, stride and filter size in defining the manner in which the filter scans the input data. Padding of zero means that the spatial dimension of the output is preserved at least or controlled and stride specifies the movement of the filter across the input. The filter size means the size of the filter, from which the receptive field and depth of feature extraction depend.

For the enhancement of the training of the neural network and fast convergence in the network the activation function Rectified Linear Unit (ReLU) is chosen. ReLU is simple to implement and operates as a thresholding function: if the input value is less than zero it returns zero, if the input value is greater than zero, it returns the value of input. Mathematically, ReLU can be expressed as:

$AF = \max(0, t)$---------(5)

When the AF value hits 0, the gradient technique stops learning, and the leaky ReLU is then triggered. The following is a list of its functions:

$AF_l = \begin{cases} t & t > 0 \\ o \times t & t \leq 0 \end{cases}, o$---------(6)

where the predefined parameter is indicated as o and assigned with the value 0.01.

Pooling Layer: The pooling layer is a constituent in CNNs since it computes a scalar measure of the features maps generated by the convolution layer and condenses spatial information. The pooling layer is basically aimed at shrinking the feature map because this improve the efficiency of the model and the level of over-fitting by minimizing the parameters as well as the computational cost. Pooling is normally performed by using some processes such as max pooling or average pooling. Max pooling only picks the maximum value from any given region (window) in the feature map, while average pooling calculates the average of the region.

Fully Connected Layer: The fully connected (FC) layer is one of the most important layers of the neural network that accepts the convolutional and pooling layers output which extracts many hierarchical features and uses them to make the final decision. This is based on high level and non-linear features that are learned during the previous stages of the design. The FC layer links each neuron with a neuron from the other layer which results in dense layer that enable the model to interpret the interrelation of features.

Softmax Layer: The softmax layer is the last layer used in classification exercises; in fact, it is most commonly used in multi-class classification. Usually it takes the raw outputs scores (logits) that are obtained from the fully connected layer and generates a probability distribution. The softmax function translates these scores to a range of 0 – 1 meaning a probability of that class.

$Op_x \frac{e^{z_x}}{\sum_{x=1}^{M} e^{z_x}}$---------(7)

When output of the softmax is shown as op_x for output count x, output x prior to the softmax is shown as z_x, and total output node count is shown as M. In this layer, the class labels are classified.

Table 1. Details of layers in the VGG16

Layers	Layer Details	Size of the Output
Convolution Layer	7 x7 Convolution and stride of size two	112x112
Classification Layer	7 x 7 Global Average Pool 1000D Full connected and softmax	1x1
Pooling Layer	3 x 3 Maximum Pooling Layer and Stride of size two	56x56
Dense Block	$1 \times 1conv$ $3 \times 3conv$ x6	56x56
Dense Block	$1 \times 1conv$ $3 \times 3conv$ x32	7x7
Transition Block	1 x 1 Convolution	56x56
	2 x 2 Average Pooling , Stride of size 2	28x28
Transition Block	1 x 1 Convolution	14x14
	2 x 2 Average Pooling, Stride of size 2	7x7
Dense Block	$1 \times 1conv$ $3 \times 3conv$ x12	28x28
Transition Block	1 x 1 Convolution	28x28
	2 x 2 Average Pooling, Stride of Size of two	14x14
Dense Block	$1 \times 1conv$ $3 \times 3conv$ x32	14x14

Optimisers are very important in deep learning models because they are the one that updated the trainable parameters such as weight and bias in order to make the model perform better relating to the loss function. In selecting an optimizer, which is the fifth major component, there is a drastic difference in the training process and the model that it produces. There are several optimizers that available for optimization, RMSProp (Root Mean Square Propagation) is one of them, which has faster convergence than the traditional optimization algorithms such gradient descent and it can be tuned less when it is used in transfer learning.

Optimized learning rate of RMSProp optimization algorithm is calculated by using the average of recent gradients for each parameter needed to make important steps in overcoming the problems such as vanishing and exploding gradients. This contributes to the problem convergence faster and more effectively when the data involves high variance or has sparse gradients.

$w_{t+1} = w_t - \left(\frac{\alpha_t}{(w_t+\varepsilon)^{-0.5}}\right) +* [\delta L/\delta w_t]$ ---------(8)

$v_t = \beta v_{t+1} + (1-\beta)[\delta L/\delta w_t]$ ---------(9)

where v_t is summation of square of previous gradient and positive constant is indicated by ε with the value 10^{-8}.

The learning objective is to calculate the settings to reduce the unfortunate work. The probability of class ei given information X is referred to as softmax work given in Equation 10 where yi is the score of the ith class out of absolute e classes. The softmax misfortune E in Equation 11, where N is the length of the class vector is given as the negative log probability of the softmax work.

$P(c_i X) = \frac{e^{zi}}{\sum_{j=1}^{C} e^{zi}}$------(10)

$E = \left(\frac{-1}{N}\right) \sum \log \left(P\left(\frac{c_n}{X}\right)\right)$------(11)

Stochastic Gradient Descent with Momentum is the method used to advance the misfortune minimization. Equation 12 describes the updating process for the t^{th} cycle.

$\varphi_t = v\varphi_{t-1} - \eta \nabla G(w_{t-1})$ ------(12)

$w_t = w_{t-1} + \varphi_t$------(13)

The weight update process involves the current weight (ϕt) being updated based on the previous weight (ϕt−1), with ww representing weights, GG being the average loss over the dataset, and ∇G(w) denoting the negative gradient. The learning rate (η) and momentum (v) are key parameters for accelerating convergence and reducing oscillations. In the training setup, η is initially set to 0.001 and reduced by a factor of 0.11 after every 20,000 iterations, while v is fixed at 0.91. Training is conducted for approximately 8 epochs per stage, based on observed training curves.

The model uses binary cross entropy as its loss function rather than weighted binary cross entropy used in the actual model. Binary cross entropy is applied for binary classification problems and calculates distances between forecasted probabilities and real binary labels: 0 or 1. This penalizes incorrect predictions more than the sigmoid; it produces the negative log of the probabilities that it expects. This loss function is appropriate when the number of positive and negative instances is approximately equal, although may perform worse in a case of class imbalance than weighted binary cross-entropy which assigns different weights to positive and negative classes.

$$Loss\ function = -\frac{1}{N}\sum_{i=1}^{N} y_i \cdot \log\big(p(y_i)\big) + (1 - y_i).\log\,(1 - p(y_i)) \text{ ------(14)}$$

When it comes to classification with the help of feature VGG16, the term y means an actual variable that defines the class of the input data analyzed within the framework of the algorithm; in this case, the value of y = 1 indicates that the case under consideration is positive, i.e., the input data contains a certain feature or belongs to a specific class, while the value of y = 0 points to a negative case, which means The symbol p(y) refers to the chances of classification of the given study (or sample) as negative or positive on the basis of the result of the model.

SIMULATION ANALYSIS

This section presents the findings of the shortest path identification system with emphasis on traffic flow in Saudi Arabia. The system uses actual traffic picture with images of the traffic density and vehicle numbers, which are necessary for determination of the shortest paths in the congested urban setting like Riyadh or Jeddah. Traffic information is created by using generated nodes based on a table of traffic information. Python 3.8 and Spyder Integrated Development Environment is used to analyse and to process this data as per the proposed system. The study uses a coordinate matrix in which different places in Riyadh are depicted as coordinates as depicted in table 2 below which indicates the coordinates of Riyadh's urban development.

Table 2. City Coordinate Matrix (Riyadh)

City Locations	City-Coordinate Matrix	
	X value	Y value
King Fahd Road	-300	0
Al Malaz	-225	250
Olaya	-150	150
Al-Qassim	0	75
King Abdulaziz	300	250
Al-Tawun	300	0
Airport	0	-75
Diplomatic Area	300	-250
Northern Riyadh	-150	-150
Southern Riyadh	-225	-250

The distance between every individual location and their starting as well as ending point is indicated in Table 3.

Table 3. Start and End Point with Distance

Start	End	Distance (kms)
0	1	10
1	4	5
4	5	6
5	7	4

The shortest route from location 1 to location 7, in this case, is 1 → 4 → 5 → 7. From the data in Table 2 and Table 3, the shortest possible route from Al-Qassim to Northern Riyadh is depicted in Figure 3, with a total distance of 8.5 km.

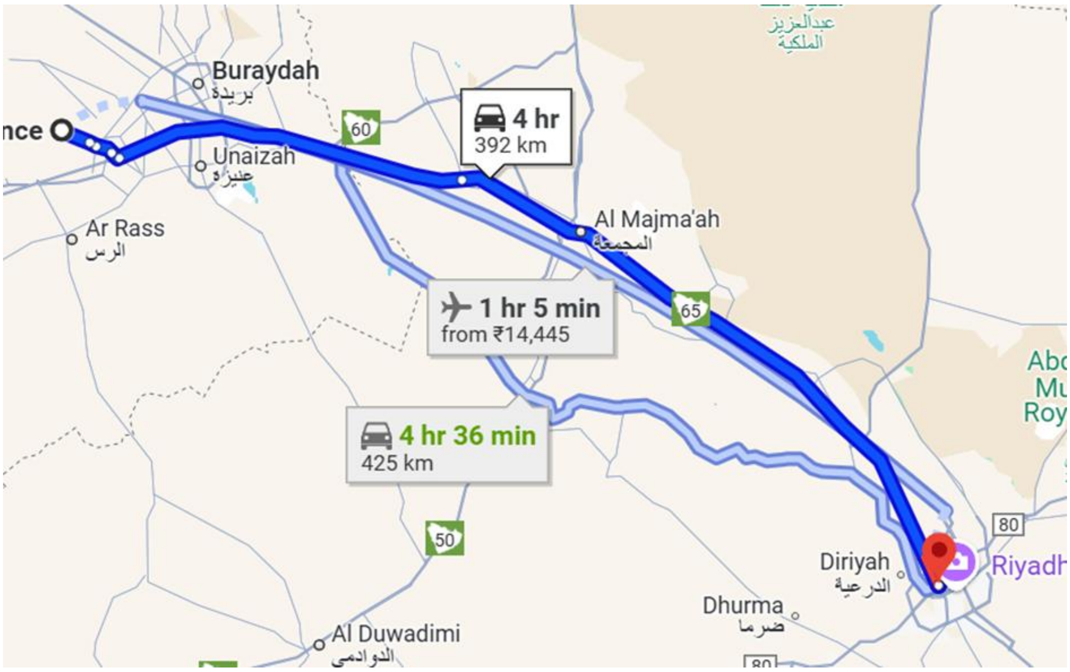

Figure 3: Shortest Possible Route from Al-Qassim to Northern Riyadh

Accuracy: Accuracy describes how closely a specific value matches cases that have been categorised. Accuracy is the representation of systematic mistakes and statistical bias. Additionally, it is the identification of (both TP and TN values) among the count of the assessed classes, as well as how closely an estimation resembles the genuine value. Achieved accuracy of existing and proposed technique is given and illustrated in Table 3 and Figure 4, respectively. It's calculated by the following equation,

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

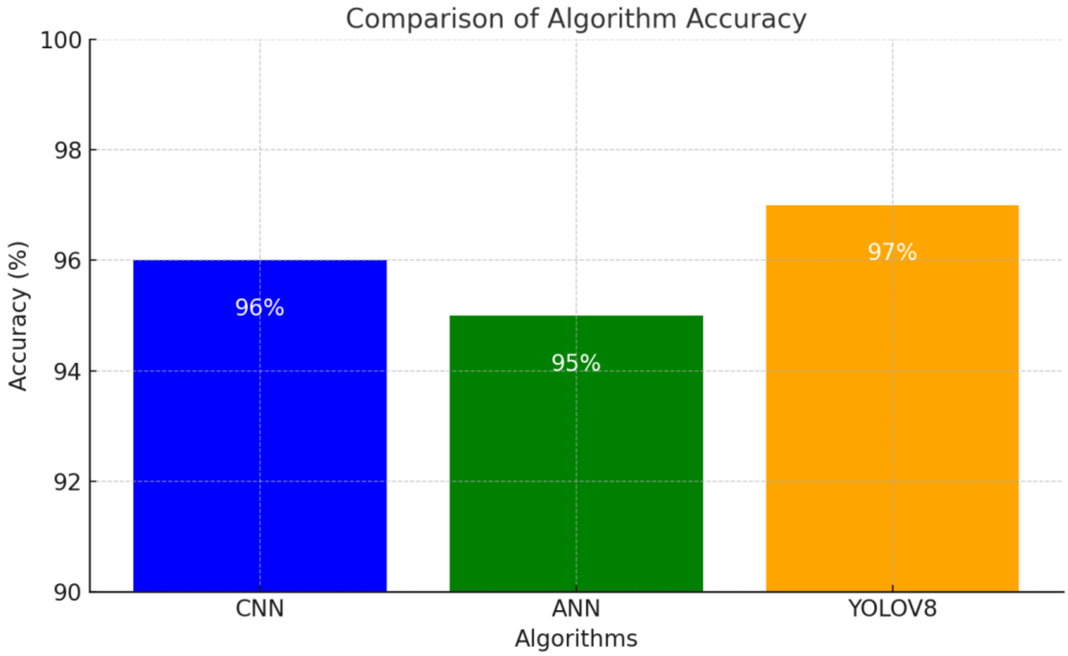

Figure 4. Comparison of Accuracy

From the Figure 4, it is identified that the accuracy of YOLOV8 is effective than the ANN and CNN technique. The proposed hybridized approach is 2% higher than ANN and 1% higher than CNN. The traffic detection accuracy level indicates the significance of proposed approach and it can enhance the traffic detection as well as optimal path identification.

Table 4. Performance of Transport System

Location	X-Axis	Y-Axis	Total Rounds	Signals	Routing Nature
King Fahd Road	-300	0	12	8	Fast
Al Malaz	-225	250			
Olaya	-150	150			
Al-Qassim	0	75			
King Abdulaziz	300	250			
Al-Tawun	300	0			
Airport	0	-75			
Diplomatic Area	300	-250			
Northern Riyadh	-150	-150			
Southern Riyadh	-225	-250			

Figure 5. Indication of Traveling from King Fahd Road to Southern Riyadh

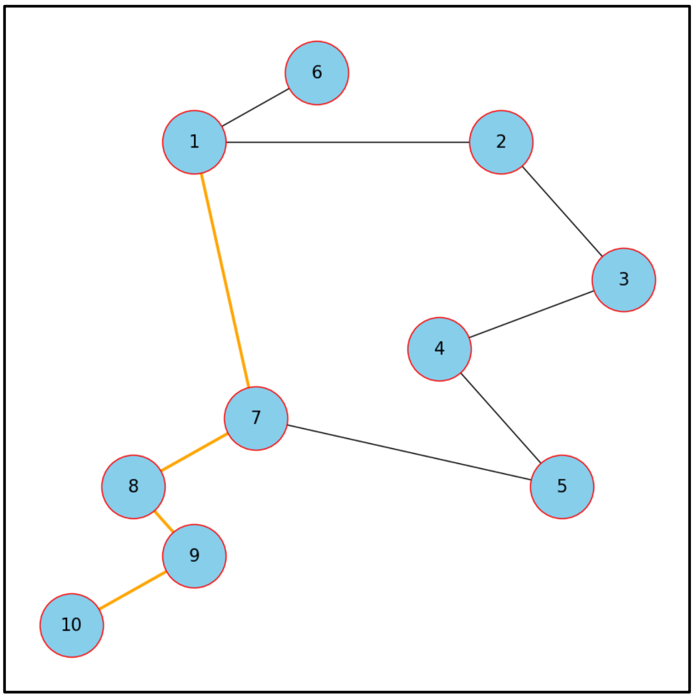

Figure 6. Node Representation of Traveling Across Various Signals

The optimal traffic route found using the proposed system with traffic density incorporated into the decision-making process is illustrated in Fig 6. The system effectively determines the best route regarding traffic jams, and is thus a valuable tool to improve traffic and transportation in Saudi Arabia's developing urban setting.

CONCLUSION

Organizing such a large event as the Football World Cup entails efficient logistics and operations management and backed by efficient information systems. This study explains how Saudi Arabia can apply technologies such as Geographic Information Systems (GIS), the Internet of Things (IoT), predictive analytics, automation, blockchain and cloud-based platforms to overcome logistically related issues and achieve operational effectiveness. There is need for real time traffic management, demand forecasting and real time supply chain management to meet the dynamic demand of such a large event. Blockchain helps to build trust and transparency within the chain of supply, and cloud supports cooperation and effective communication of logistics' teams. Here, Saudi Arabia spending in digital infrastructure as well as smart technologies has put it in a vantage place as a model for efficient logistics management in international sporting events. With the help of these modern systems, the country can reduce the problem of traffic congestions, improve efficiency of the usage of resources as well as guarantee the proper delivery of goods and services. The approach used in the execution of this event also guarantees the success of the event while setting a standard for other large-scale events that may be organised in the world in the future to showcase the effectiveness of technology in logistics and operation management.

Other possible future developments include the use of artificial intelligence for predictive purposes, as well as the use of self-driving cars for transportation purposes, and the use of blockchain technology for complete supply chain visibility. Further, using digital twins, it is possible to visualise and enhance logistic processes in real-time for better productivity.

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