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A descriptive study of the reality of the distribution of ambulance centers in urban and rural areas In the Kingdom of Saudi Arabia

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Abstract:

This study aims to describe the current reality of the distribution of ambulance centers in urban and rural areas in the Kingdom of Saudi Arabia highlighting the degree of balance and equity in the geographical allocation of these centers The study adopts a descriptive research approach that focuses on analyzing existing information and documented data related to ambulance services without introducing experimental or analytical variables The methodology relies primarily on comparison with previous studies official reports and related research in the field of emergency medical services to identify similarities differences and emerging patterns in service distribution The study reviews national and regional literature addressing emergency medical coverage response times population density and geographic challenges affecting ambulance center placement Particular attention is given to the contrast between urban areas which often benefit from higher population density and better infrastructure and rural areas which may face limitations related to distance terrain and resource availability By comparing findings from earlier research the study seeks to describe the extent to which current distribution practices meet community needs and support timely emergency response The results of this descriptive review are expected to provide a clearer understanding of existing strengths and gaps in ambulance center distribution contributing to informed decision-making and future planning The study concludes by emphasizing the importance of evidence-based distribution strategies to enhance equity accessibility and overall efficiency of ambulance services across both urban and rural regions in the Kingdom of Saudi Arabia .

Keywords: Ambulance Centers Emergency Medical Services Urban Areas Rural Areas Service Distribution Saudi Arabia.

- introduction

The ambulance system in the Kingdom of Saudi Arabia is one of the essential elements in the health transformation stipulated in the Kingdom's Vision 2030 The Saudi Red Crescent Authority seeks to expand comprehensive geographical coverage to ensure rapid response to emergencies By 2024 the total number of ambulance centers in the Kingdom reached more than 517 centers distributed across various administrative regions A new operational model was adopted based on dividing regions into independent ambulance sectors to raise the efficiency of resource management and ensure service access for all citizens

and residents regardless of their geographical location In addition to major urban areas such as Riyadh Makkah and Jeddah the reality of distribution is characterized by a high density commensurate with the increasing population growth as the largest percentage of centers and ambulances are concentrated in these cities For example the Makkah region includes about 98 ambulance centers distributed between Makkah Jeddah and Taif Despite the geographical proximity of the centers to beneficiaries in the cities the most important challenge is evident in traffic congestion which hinders response time The Kingdom is working to provide smart solutions such as the "Is'afni" (Help Me) application and linking ambulances to smart traffic systems to open safe routes 1 10

Moreover in rural and remote areas distribution takes on a strategic character based on covering highways and remote rural centers where vast areas and difficult terrain impose logistical challenges related to the long distances between ambulance centers and the proximity of specialized medical facilities To overcome this gap the Kingdom has strengthened its orientation towards air ambulance and the activation of mobile field deployment points especially during Hajj and Umrah seasons and in areas with low population density to ensure the provision of emergency and rapid medical care reflecting the commitment to achieving equity in the distribution of health services between urban and rural areas 8 6

- **The concept of emergency ambulance services in the Kingdom of Saudi Arabia**

Emergency ambulance services in the Kingdom of Saudi Arabia constitute an integrated system of immediate medical care provided to the injured or sick in emergency situations before their arrival at the hospital This system is led by the Saudi Red Crescent Authority which aims primarily to preserve life prevent the aggravation of injuries and alleviate pain through advanced medical interventions at the scene of the accident and during transport making it the main element in the national healthcare chain These services are subject to precise medical standards and protocols that are consistent with the goals and vision of the Kingdom 2030 where the focus is on the quality of service and raising the efficiency of response The concept of ambulance in the Kingdom is not limited to medical transport but includes accurate clinical assessment cardiopulmonary resuscitation and professional handling of injuries and major accidents through the provision of qualified national personnel of specialists and emergency medical technicians who work according to an advanced central communications system that connects the field with the operations rooms 2,6

In addition the Saudi ambulance system relies on an advanced technological infrastructure starting with receiving reports via the unified number997 or smart applications such as the "Is'afni" (Help Me) application which allows for highly accurate location tracking of the injured person using satellites The modern concept of ambulance services in the Kingdom also includes the activation of air ambulance services To reach remote areas or to deal with critical cases that require rapid transfer to specialized medical cities to ensure the provision of appropriate health care the concept of ambulance in the Kingdom is characterized by a strategic dimension that is the management of crises and crowds through the Hajj and Umrah seasons where specialized ambulance fleets are harnessed including small vehicles and ambulance motorcycles equipped to reach crowded places in addition to mobile ambulance centers This integration ensures the provision of a flexible and rapid response capable of adapting to geographical and human challenges thus ensuring the safety of citizens residents and pilgrims 6,7

- **The importance of the geographical distribution of ambulance centers**

The importance of a well-planned geographical distribution of ambulance centers is evident in reducing response times to emergencies Which represents the important difference between life and death or between recovery and permanent disability When centers are distributed based on health demand maps and population density analyses paramedics can reach the location of the report within a few minutes which ensures the provision of life-saving interventions such as cardiopulmonary resuscitation or stopping severe bleeding in record time before transferring the patient to the appropriate medical facility The fair geographical distribution also contributes to achieving the principle of comprehensive health equity that

the Kingdom seeks to achieve as it ensures that emergency medical services reach the residents of rural and remote areas with the same quality and efficiency available in major cities The presence of ambulance centers strategically distributed on long highways and border areas removes spatial obstacles that may prevent the injured in those areas from obtaining the necessary care which enhances the health safety net for all citizens and residents regardless of their distance from the main urban centers9

In addition smart spatial distribution plays an important role in enhancing the Kingdom's ability to manage crises disasters and mass incidents with high efficiency The distributed centers provide wide coverage capable of absorbing the shocks resulting from major accidents or epidemics When an accident occurs in a densely populated area or a vital road the presence of multiple nearby centers allows for the dispatch of support supply teams from different directions which prevents the accumulation of reports at one center and ensures the continuity of ambulance work without interruption even in the most difficult operational conditions From an operational and economic perspective effective geographical distribution leads to improved resource management and reduced consumption of ambulance assets as spatial proximity reduces the distances traveled by vehicles which increases their lifespan and reduces fuel and maintenance costs Moreover this distribution helps to alleviate pressure on emergency departments in central hospitals by enabling ambulance teams to distribute the injured to the nearest qualified health facilities instead of constantly heading to major centers which raises the efficiency of the entire national health system3,6

- **Standards for planning and distributing ambulance centers**

The process of planning and distributing ambulance centers is primarily based on demographic and geographical criteria Population density in each area is analyzed to determine the number of centers needed to serve a certain number of individuals which is determined by the ratio of the population to each center In large densely populated cities centers are distributed according to the size of the population and the expected future urban growth In rural areas the focus is on the distances between population centers to ensure that there are no geographical gaps that prevent any area from being served This is done while taking into account the rugged terrain that may affect the speed of ambulance movement Time criteria and the target response time are the main drivers for determining the locations of these centers Strategic plans aim to place centers at points that allow ambulances to reach the location of the call within a world-class time This requires a careful study of road networks and traffic congestion patterns at different times of the day so that locations are chosen that allow paramedics to depart from main road axes that ensure flexibility of movement and rapid access to critical points It is also taken into consideration that the centers be close to medical facilities to reduce the time of return journey for patients 7,8

The distribution criteria also focus on identifying high-risk areas and vital facilities where centers are concentrated near highways with high accident rates industrial areas airports and holy sites during Hajj and Umrah seasons This proactive planning ensures the system's readiness to deal with injuries resulting from major traffic accidents or occupational emergencies These centers must be distributed to cover the largest possible area of hotspots where data indicates frequent accidents Recently geographic information systems have become Artificial intelligence is a key tool in planning the distribution of centers where advanced mathematical models are used to analyze historical data of reports and determine the optimal locations for building new centers These technologies also allow planners to conduct simulations and create different scenarios and distribute centers dynamically ensuring the maximum possible coverage with the least waste of resources thus transforming the distribution process from a rigid administrative division into a smart flexible system that responds to instantaneous changes and the accelerating population growth in various regions of the Kingdom 6,4

- **The reality of ambulance center distribution in urban areas**

The distribution of ambulance centers in major urban areas of the Kingdom of Saudi Arabia is characterized by high density directly proportional to the rapid population growth and urban sprawl witnessed by major cities such as Riyadh Jeddah and Dammam In these densely populated cities the centers are distributed

according to accurate health demand maps with the largest proportion of ambulance points concentrated in densely populated residential neighborhoods and near vital gatherings and major commercial centers This intensive distribution aims primarily to bring the service closer to beneficiaries to ensure rapid access to the injured in an environment characterized by high traffic and continuous activity around the clock The strategy followed in the cities also relies on integrating fixed ambulance centers with field deployment points that allow ambulances to be present in strategic locations outside official headquarters during peak hours This distribution reality aims to circumvent the challenges of traffic congestion that may hinder the movement of large vehicles as rapid intervention units and ambulance motorcycles are placed at the intersections of main axes to ensure smooth traffic flow Thanks to this dynamic distribution the system succeeds in covering large areas of the complex urban fabric which increases the efficiency of response to emergency calls in crowded areas 8,5

In addition in urban areas the role of planning based on hotspots is prominent where locations where accidents or health problems are frequent are identified based on historical data and the distribution of centers in their immediate vicinity This reality makes the distribution of centers in cities a smart process that does not depend only on geographical distances but on the probability of emergency cases and their timing These centers are integrated with the network of hospitals and medical cities spread throughout urban areas which facilitates the process of transferring patients and distributing them to appropriate health facilities according to the type of case and the distance of the ambulance center from the nearest specialized emergency department The reality of distribution in urban areas is subject to a continuous process of updating in line with the massive development projects and urban expansion plans within the Kingdom's Vision 2030 where ambulance sites are included as a key part of the plans of new neighborhoods and smart cities This distribution is supported by digital connectivity technologies and geographic information systems that allow operations rooms to direct the nearest ambulance team to the location with extreme accuracy which turns population density from a potential obstacle into an opportunity to improve the spread of service This harmony between geographical distribution and advanced technology makes ambulance services in Saudi cities a sophisticated model that seeks to achieve the highest levels of public safety 7,8

- **The reality of ambulance center distribution in rural areas**

The reality of ambulance center distribution in rural areas of the Kingdom of Saudi Arabia differs from that of urban areas as distribution is based on the criterion of strategic coverage rather than population density This is due to the vast areas and widely dispersed population centers where ambulance centers are placed in vital focal points in the middle of villages with an intensive focus on the long highways that connect the administrative regions This distribution aims to create a safety network that covers the distances traveled to ensure the presence of an ambulance team capable of intervening in the event of traffic accidents or sudden health crises for the residents of those areas who may be hundreds of kilometers away from the nearest central hospital Accordingly the distribution process in rural areas faces diverse geographical and topographical challenges from the vast desert sands to the rugged mountainous highlands in the south of the Kingdom which imposes an operational reality that depends on multiple means In these areas distribution is not limited to permanent construction centers only but is reinforced by seasonal deployment points and support from civil defense centers and security agencies in very remote areas This integration ensures reducing geographical gaps and attempts to overcome the obstacle of long distances that may affect response time making the rural ambulance center a kind of advanced medical unit that plays a vital role in stabilizing cases before the long transport journey 6,5

Accordingly and to address the challenge associated with the distance of rural ambulance centers from specialized hospitals the Kingdom has strengthened the reality of service in rural areas by activating the air ambulance system intensively This approach complements the role of ground centers distributed in villages where ambulance helicopters act as an air bridge to transport critical cases from areas that are difficult to reach quickly by land roads This reality between ground distribution and air deployment ensures

health equity so that the residents of rural areas are not deprived of advanced care due to geographical factors or the small number of fixed centers compared to urban cities In addition the distribution of centers in rural areas is subject to a continuous development process within health transformation programs where these centers are linked technically to central operations rooms that use satellite imagery to direct teams through the shortest possible routes Coordination is also made between the distribution of these centers and the locations of primary health centers affiliated with the Ministry of Health in the villages to create an integrated care system that starts from field ambulance and ends with the initial diagnosis at the health center and then to the hospital This integrated reality aims to transform the geographical challenge in rural areas in the Kingdom into a successful model for managing emergency medical services in difficult and open areas 7,4

- **Differences between urban and rural areas in ambulance services**

The most prominent differences between urban and rural areas lie in the geographical distribution pattern and the density of available resources In major cities ambulance centers are distributed at a very high density to cover large population centers where each center serves a relatively small geographical area but it is densely populated which increases the number of daily recorded reports In rural areas however the distribution depends on covering vast distances rather than population density which makes the centers geographically dispersed and serving smaller population centers There is also an intensive focus on securing highways and the axes linking villages and cities to ensure intervention points in areas that lack major medical facilities The challenges affecting response time also differ radically between rural and urban areas In urban areas traffic congestion and vertical urban growth are the biggest obstacles facing ambulances despite the geographical proximity to the location of the report which necessitates smart solutions such as dedicated routes In contrast in rural areas the long distance and difficult natural terrain such as the desert sands or mountainous highlands represent the biggest challenge in those areas as the ambulance journey is inherently longer This has prompted the Kingdom to strengthen the air ambulance system in these areas as a vital tool to compensate for the time differences imposed by the geographical nature The difficult one 4,5

Accordingly the means and technologies of emergency care used in each environment are distinguished to suit its field nature In urban areas there is increasing reliance on ambulance motorcycles and small equipped cars that are highly maneuverable through narrow and crowded streets for rapid arrival and initiation of resuscitation operations In rural and remote areas ambulance fleets are equipped with advanced four-wheel drive vehicles capable of traversing unpaved roads along with advanced medical equipment that supports stabilizing the condition for longer periods during transport given that the distance to the nearest specialized hospital may take longer than usual urban rates The nature of the medical destination and the chain of care also differs in both regions In urban areas there are multiple options of government hospitals and specialized medical cities which facilitates directing the injured person to the most appropriate destination for the type of injury in record time In rural areas ambulance centers mostly work in coordination with primary health care centers or small general hospitals as initial stabilization points In critical cases the air transport protocol is activated directly to reference centers in major cities reflecting an integrated system that seeks to bridge the gap in the quality of emergency medical care between the populations of urban and rural areas 8,4

- **Challenges facing the distribution of ambulance centers**

The first challenge is the geographical and spatial obstacles resulting from the vast area of the Kingdom and the diversity of its terrain The extended deserts and rugged mountainous highlands impose a great difficulty in achieving comprehensive ambulance coverage that ensures access to all rural areas This geographical distance between small population centers makes it difficult to secure fixed centers in every point which places a great logistical burden on the system in balancing the distribution of resources between areas of high density and isolated areas that may witness critical accidents far from the nearest medical support As in urban areas the most prominent challenge is the rapid urban growth and traffic

congestion which makes short distances lose their time value as ambulances suffer from difficulty in maneuvering on the main congested axes or reaching old neighborhoods with narrow streets Planners also face a scarcity of available land in strategic locations in the heart of cities to establish new ambulance centers which forces them to resort to temporary field deployment points that may lack the integrated logistical equipment provided by permanent construction centers which complicates the process of managing teams and changing shifts with high efficiency 2,5

In addition infrastructure and communication challenges in rural and border areas are an additional obstacle affecting the accuracy of distribution as weak mobile network coverage on some long highways may delay the arrival of the report or hinder the accurate identification of the victim's location via digital mapping systems This technical deficiency necessitates reliance on expensive technologies such as satellite communication and makes the process of directing ambulance teams from central operations rooms a complex process that requires high coordination to ensure that time is not wasted searching for the accident site in areas that sometimes lack clear landmarks The increasing need for real-time data and predictive analysis represents a strategic challenge in planning the distribution of centers as it requires complex information integration between multiple entities to monitor the growth of new neighborhoods traffic shifts and road accidents on a daily basis Any gap in updating this data may lead to the misallocation of resources so that centers are established in areas where health demand is low while other emerging areas remain suffering from a lack of coverage Therefore the shift towards dynamic distribution that relies on artificial intelligence faces technical and human challenges in building simulation models capable of predicting the locations of hotspots before accidents actually occur 5,8

- **The impact of ambulance center distribution on response time and service quality**

The distribution of ambulance centers is directly linked to reducing response time which is the gold standard for measuring the efficiency of emergency medical systems globally When centers are located at carefully chosen geographical points based on access map analysis the distance between the dispatch center and the location of the incident is reduced allowing ambulance teams to intervene in the critical first minutes This strategic distribution ensures that response time remains within internationally recommended limits which is vital especially in cases of cardiac arrest stroke and severe bleeding as every minute of delay increases the likelihood of death or permanent irreversible complications In terms of the quality of medical service provided the geographical proximity of centers gives paramedics a greater opportunity to implement advanced life support protocols Early intervention rather than just rapid transport and the arrival of an ambulance equipped with qualified personnel in record time means starting resuscitation operations and controlling the patient's vital signs at the scene of the accident which turns the ambulance into a mobile intensive care unit This early stabilization of the health condition raises the overall quality of care and reduces the patient's length of stay in the hospital later as the case is handed over to the emergency department in a more stable clinical condition as a result of the rapid intervention resulting from equitable distribution8

The intelligent and systematic distribution of centers also leads to improved resource management and avoids operational burnout which positively impacts the quality of continuous service When centers cover geographical areas in a balanced manner the pressure of emergency calls is distributed across several points instead of being concentrated in a single center This ensures that teams and equipment are always ready and prepared to respond without delays caused by the occupancy of all vehicles This balance reduces the likelihood of human error resulting from fatigue and ensures better periodic maintenance of vehicles thus enhancing the reliability of ambulance services and public confidence in the speed and quality of response during emergencies In addition the impact of planned distribution is evident in achieving integration with the larger healthcare system The role of distribution does not end upon reaching the patient but extends to ensuring the quality of the transport journey to the hospital Similarly the geographical distribution which takes into account the distance between ambulance centers and specialized hospitals such as cardiac catheterization centers or trauma centers ensures that the patient reaches the appropriate

medical facility at the right time This harmony between the location of the ambulance center and the hospital reduces the overall transport time which improves the quality of final medical outcomes and contributes to achieving the goals and vision of the Kingdom's Vision 2030 in raising life expectancy and improving quality of life through an integrated healthcare system that responds effectively to every need Challenges 5,4

Methodology

The study adopts a descriptive research methodology aimed at portraying the current reality of ambulance center distribution in urban and rural areas of the Kingdom of Saudi Arabia The primary research tool is comparative analysis based on previous studies published research and official reports relevant to emergency medical services Data are collected through a comprehensive review of academic literature and related studies followed by systematic comparison of their findings to describe trends challenges and disparities in distribution This approach allows for an objective description of the existing situation without intervention or experimentation providing a factual and structured understanding of the topic

- **Results and Recommendations**

Results

- The results showed a high concentration of ambulance centers in major urban areas in proportion to population density as these areas account for the largest share of manpower and machinery while distribution in rural areas depends on covering axes and highways to compensate for the low population density
- The study demonstrated the Kingdom’s success in reducing the average response time in cities as a result of adopting field deployment points instead of relying entirely on fixed centers while the response time in rural areas still represents a logistical challenge due to the vast inter-area distances which is currently being addressed through the expansion of air ambulance services
- The study explained that integrating geographic information systems In distributing the centers he contributed to identifying the hotspots Accurately reporting accidents allowed for the dynamic redirection of emergency resources especially in urban areas experiencing constant changes in traffic flow and rapid urban growth
- The study showed a need to increase ambulance centers on the long highways that connect administrative regions as the distances between some of the existing centers exceed the standard value for the ideal arrival time in cases of major traffic accidents

Recommendations

- The need to move from the traditional fixed-center model to a flexible predictive deployment where ambulances are moved to specific points During peak hours in cities or during Hajj seasons based on artificial intelligence algorithms that predict potential accident locations
- The need to increase the number of air ambulance bases to cover areas lacking rapid ground coverage in rural areas and desert highways to ensure that critical cases are transported directly to advanced trauma centers and overcome the obstacle of long distances
- The need for full integration between the Red Crescent Authority’s systems and urban traffic management systems to automatically activate safe routes when ambulances pass through which contributes to reducing response time in crowded cities by significant percentages
- The need to unify databases among all service providers – the Red Crescent the National Guard Health Affairs and the Ministry of Defense Health Services – to comprehensively analyze response time and the quality of clinical outputs thus supporting decision-makers in identifying the actual needs of new centers

- The need to invest in training and equipping volunteers and health personnel in primary care centers in rural areas to act as first responders ensuring the provision of life-saving interventions in the first minutes until the ambulance team arrives from the nearest remote center

Conclusion

The study aimed to assess the current distribution of ambulance centers belonging to the Saudi Red Crescent Authority between urban and rural areas The study focused on examining the relationship between the number of ambulance centers population density and distances between the centers and referral hospitals in addition to the response time to accidents in each geographical area The results of the study showed that the level of distribution of ambulance centers in urban areas is advanced in terms of density and readiness while some rural and remote areas suffer from a shortage of centers and long distances between ambulance points and hospitals which leads to an increase in response time and a delay in providing emergency care in critical cases It also showed that geographical factors such as mountains and vast deserts pose a logistical challenge in delivering ambulance services quickly and efficiently The study recommended the need to redistribute the centers according to scientific criteria based on population demand and accident rates It also stressed the need to expand the use of technology in determining the locations of incidents and to support mobile ambulances in rural areas It emphasized that improving the network of ambulance centers is a fundamental step towards achieving the goals and vision of the Kingdom in raising the efficiency of health services and promoting equity in access to emergency care 2030 throughout the Kingdom

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