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CHALLENGES FOR THE SUSTAINABLE DEVELOPMENT OF ROAD SYSTEMS

Eng. Abdullah A. AL MOGBEL
Deputy Minister of Transport, Ministry of Transport, Kingdom of Saudi Arabia
almogbel@mot.gov.sa

Sustainable Road Transport Development in the Kingdom of Saudi Arabia

ABSTRACT

Saudi Arabia's highway system has evolved from less then 230 kilometers in 1953 to now over 46,000 kilometers of paved highways. After establishing principle connections between mayor cities, emphasis has been shifted towards the development of a whole road network that provides much needed access to all communities throughout the Kingdom. Road transport has emerged as the principle transportation mode and the level of motorization is following those of developed economies. In addition rail, air and maritime transport are playing an increasing role and the evolution of a comprehensive operations and maintenance capability for these transport modes, their inter-modal integration, and strengthening of regulatory systems are considered to be important tasks. Growing income levels have advanced Saudi Arabia to the group of high income countries. Thus, demands on the transportation sector are those of a maturing economy that is seeking a sustainable growth pattern and its competitive role in the increasingly globalizing world.

Against this backdrop a sustainable road transport development in Saudi Arabia can only happen on the basis of comprehensive planning, effective and efficient operation and maintenance, as well as giving focus on future development needs.

The Ministry of Transport is responsible for the regional land transport infrastructure, and the municipalities for urban transportation. The transport network as a whole is supporting the development corridors enshrined in the National Spatial Strategy for Saudi Arabia of the Ministry of Municipalities and Rural Affairs. In addition the Ministry of Economy and Planning prepares medium term National Development Plans, and periodically reviews the transport sector by undertaking the Saudi Arabia National Transportation Studies.

Further, the Ministry of Transport dedicates substantial resources for operation and maintenance of the national road network. Focus areas in this regard include the system of highway maintenance, traffic monitoring, road service centres, and supporting for the introduction of navigation services.

Future challenges of the Kingdom's transportation sector require a comprehensive and strategic approach to the development of policies, plans and programs in an integrated manner across all modes of transportation. Therefore, MOT is pursuing to improve its management and administrative tools as well as adopting new techniques that are needed to strengthen public administration of Saudi Arabia's transport sector. At present the most important focus areas of MOT include: the development of the National Transportation Strategy (NTS) for Saudi Arabia, establishing a Transport Geo Database, and developing an ITS Master Plan.

Sustainable Road Transport Development
in the Kingdom of Saudi Arabia

1. DEVELOPMENT OF THE TRANSPORT SECTOR IN SAUDI ARABIA

The Kingdoms highway system has evolved from less then 230 kilometers of paved roads in 1953 to over 146,000 kilometers of roads; of which over 46,000 kilometers are paved highways. After principle connections between mayor urban centres of the country were established mainly through expressways, emphasis shifted towards the development of feeder roads which provide much needed access to the smaller towns and villages.

Commercial trucking serves as a major national and international goods transport function, and buses, taxis and private cars deliver important and convenient passenger transport services between and within urban areas. The road vehicle fleet of Saudi Arabia consists of about 3 million passenger cars and 1.46 million goods vehicle (trucks) of which over 90% are privately owned. The vehicle fleet of Saudi Arabia (goods vehicle and passenger cars) has reached now 4.46 million units or 202 vehicles per 1000 persons. Analysis shows that the increasing number of vehicles in Saudi Arabia is closely related to income developments; hence, Saudi Arabia's level of motorization is following those of developed economies.

Similar accomplishments have been made in the construction of six commercial and twenty-two domestic regional airports. Saudi Arabia's main ports constitute the largest port network in the Middle East with increasing importance for the region. The present railway network of the Kingdom is being expended and with its future geographic coverage, railway's role is increasingly significant in providing freight and passenger transport services to the growing economic zones of Saudi Arabia and the entire GCC[1] region.

Saudi Arabia is aware of the importance and significance of the evolution of a comprehensive operations and maintenance capability for each of the transport modes, their inter-modal integration, and an adequate regulatory system requiring the active involvement of all concerned organizations and agencies.

The challenge today is to improve management of the whole transport sector so that it will meet the changing social and economic needs of the Kingdom in a safe, efficient and cost-effective manner for generations to come. The requirements and demands upon the transportation sector are significantly different from those faced in the past. While the need for network completion and expansion remains, particular focus is required on the operation and maintenance of a maturing system.

With an average GDP per capita of about 13,400 US$ in 2005, Saudi Arabia has advanced to the group of high income countries. Thus, demands on the transportation sector are those of a maturing economy that is seeking a sustainable growth pattern and its competitive role in the increasingly globalizing world. These challenges require a comprehensive and strategic approach to the development of transport infrastructure and policies in an integrated manner across all modes of transportation. Further, this approach must be responsive to the changing global and local economic and technological environments and the evolving state of the Kingdoms resource base and economy.

[1] GCC - Gulf Cooperation Council

Against this backdrop a sustainable road transport development in Saudi Arabia can only happen on the basis of comprehensive planning, effective and efficient operation and maintenance, as well as giving focus on future development needs. This country report presents the various planning activities for developing the national road network, describes essential areas in support of road network operation and maintenance, and finally outlines specific development programmes to strengthen the future policy framework of the transportation sector and enhancing technology levels for road transportation.

Figure1 - Road Network of Saudi Arabia

2. PLANNING ACTIVITIES TO ENSURE SUSTAINABLE ROAD TRANSPORT

Transport infrastructure planning activities have come a long way in Saudi Arabia, whereby major physical challenges had to be resolved such as:

- The large land of the Kingdom
- The great distances separating the kingdom's cities and settlements
- Difficult geographical features, including vast areas of rocky plains and sand dunes, as well as mountainous regions adjacent to the red sea
- Extreme weather conditions, with long periods of high and low humidity in many regions

However, economic and social development needs have always guided the development of the Kingdom's transport infrastructure. Given the size of the country (2.1 million sq. km) and the fast growing population of nearly 24 million people in 2005, together with specific urbanization trends at mayor cities, transportation planning inherits great social and economic responsibilities for the Kingdom.

The tasks for developing the regional land transport infrastructure of the country rests on the Ministry of Transport, and for urban transportation needs on the municipalities. The transportation infrastructure as a whole and the road network in particular are recognized as an essential part of the development corridors enshrined in the National Spatial Strategy of Saudi Arabia. In addition the Ministry of Economy and Planning (MOEP) consolidates the medium term planning at national levels to National Development Plans, and with regard to transportation MOEP periodically reviews the transport sector by undertaking the Saudi Arabia National Transportation Studies (SANTRAPLAN).

While different government entities are involved in transportation planning at several levels and in various functions, this multi layer process offers the benefit that important social and economic development concerns are take into consideration while working towards the implementation of transport infrastructure projects and policies.

2.1. Saudi Arabian National Transportation Study (SANTRAPLAN)

In 2004 the SANTRAPLAN has been carried out for the third time since 1980, which reviewed the entire transportation sector. The study comprises a comprehensive sector analysis of road, rail, and air transport as well as sea trade and ports, private sector participation and environmental issues. It further surveys the transport demand in the country, and through transportation modelling it offers a detailed outlook on possible developments for different scenarios, particularly for road transportation.

2.2. National Development Plan

National Development Plans of Saudi Arabia provide the means for medium term planning of a coordinated development of Saudi Arabia across all sectors. The present 8th five year plan (2005 – 2009) sets out important objectives for the entire transport sector, and the policy for the road infrastructure focuses on "developing the road network with emphasis on feeder roads in the least developed regions".

2.3. National Spatial Strategy

The Ministry of Municipal and Rural Affairs (MOMRA) published in 2001 the "National Spatial Strategy". Although this strategy does not contain specific inputs for the formulation of transport related scenarios, it provides guidance for regional long-term development in which the transport sector plays and essential role. The overall objectives include achieving balanced inter- and intra-regional developments whereby integration of rural and urban areas is a particular focus. The Spatial Strategy set out specific measures such as:

- Promotion of a spatially balanced pattern of population distribution in the Kingdom
- Minimisation of the adverse consequences of the continuous increase in the population of large cities
- Ensuring the efficient utilisation of infrastructure and public services already in place

The Strategy establishes a direct link between spatial development and the transport sector by describing important development corridors for Saudi Arabia and calling for promoting growth centres within these corridors. These growth centres are functioning as transport areas that transmit development impulses of within larger areas.

Development Corridors of Saudi Arabia

Emerging corridors: • Within the Central Region a corridor covering an area extending from Al Kharj to Qassim with the city of Riyadh as its major urban centre; • In the Eastern Province a development corridor covering an area extending from Hofuf in the Al Ahsa area via Dammam to the industrial city of Jubail; • Within the Western Region an emerging corridor extending from Taif to the cities of Jeddah, Madinah and the industrial city of Yanbu.
Corridor development in the medium term: • Extension of the central corridor beyond Qassim to Hail, Tayma- Tabuk and further north to Haql • Taif to Baha and Abha • Jeddah to Jizan
Corridor development in the long term: • Riyadh – Dammam/Hofuf • Riyadh – Najran • Riyadh – Makkah • Hail – Jordanian border

2.4. Implementation of the Road Master Plan

While policy aspects for the road network development are among others determined by the spatial strategy and the development plan, MOT's responsibility is to elaborate, coordinate and update the Road Master Plan for Saudi Arabia within this policy framework. It includes all existing and future planned road links, which are classified as main roads, secondary roads, and feeder roads. The current Road Master Plan has bee established through continuous comprehensive planning activities at MOT for main roads and secondary roads, while also taking requirements of other government entities into consideration. The feeder road network is mainly planned according to the needs and demands of local communities and the local government in each of the regions.

Since March 2002 the Kingdom of Saudi Arabia has become party to the United Nations Agreement on International Roads in the Arab Mashreq, which sets out a network of highways as well as minimum technical standards for its construction for the entire Middle

East region. This treaty poses a number of requirements in regard to international connectivity of the MOT road network. Moreover, countries, which have become party to this treaty, are required to accord priority in the establishment of national plans for the construction, maintenance and development of the national road networks related to the regional road network. While the agreement has entered into force, the MOT is implementing the provisions, which include updating of the Road Master Plan, according priority to related road projects, and placement of new road signs that indicate the route numbers along the allocated roads.

The road links of this master plan are listed for each of the 30 regions and the priority of these road projects is being annually reviewed at MOT by considering aspects such as traffic volume and accident rates. In a subsequent step the local governments review the recommendations of MOT and may suggest changes. After having reached agreement with local governments on project priorities, MOT extracts a shortlist of road projects from the master plan and proposes these projects to the Ministry of Finance (MOF) for budget allocation. The final decision on the projects to be financed under the annual budget is then been taken by the MOF together with MOT and MOEP. At present MOT's annual budget for road construction is in the range of 8 billion Saudi Riyals.

2.5. Technical Planning Aspects

Sound technical standards for road design, construction, and maintenance are essential for building a sustainable road network. Therefore MOT has established a comprehensive set of technical manuals such as:

- Highway Design Manual
- Highway Construction Manual
- Highway Maintenance Manual
- Manual of Uniform Traffic Control Devices
- Survey and Mapping Manual

These manuals have been prepared on the basis of recommended AASHTO[2] standards and taking best practices of road construction, operation, and administration into account. These manuals establish important procedures and practices for MOT while building highways and administering related contracts. The objective of these technical standards and procedures is to provide uniformity in the various classes of roads in the Kingdom, giving the road user a consistent expectancy in operation. Adherence to these standards along with sound engineering judgement shall provide a safe, fast, and economical facility compatible with its environment.

[2] AASHTO – American Association of State Highway and Transport Officials

3. ROAD OPERATION AND MAINTENANCE IN SAUDI ARABIA

MOT dedicates substantial resources to the operation and maintenance of its country wide road network. For the purpose of this country report a few activity areas have been selected which may provide some insight on the Kingdom's approaches to offer sustainable road transportation services to its users. This paragraph outlines the system of highway maintenance, traffic monitoring, road service centres, and MOT's support for the introduction of navigation services.

3.1. Highway Maintenance

The management of road maintenance (organisation, supervision and planning of maintenance) is well established at MOT. In international comparison, MOT is applying advanced measuring and documentation methods. Road conditions are monitored by special measuring vehicles; monitored criteria are "rutting", "visual cracks", "cracking", "ravelling", and "roughness". The information is then visualized by a Geographical Information System (GIS database), thus providing the best possible assistance for decision making.

The Kingdom has been divided into 72 maintenance zones, for which contractors are awarded 3-year contracts based on competitive bidding for road maintenance. Implementation of the maintenance contracts is monitored and administered by MOT's district offices in the field and coordinated by the central MOT Road Maintenance Department.

3.2. Monitoring of Traffic

For ten years MOT is monitoring traffic developments through measuring traffic volumes (AADT[3]) axle and vehicle weight. Therefore MOT operates more than 50 permanent traffic counting sites and 38 permanent weighing stations for trucks, as well a number of mobile counting and weighing stations. The main purpose of this traffic monitoring has been to measure developments of traffic volumes for reviewing the Road Master Plan, as well as obtaining AADT and axle weight data for road design and pavement management. A further achievement of the weighing stations has been to curb overloading of trucks and better enforcement of goods transport regulations since MOT also inspects goods transport licenses of trucks at the weighing stations and traffic police is following up traffic violations.

The traffic data system is centrally organized within the environment of the MOT Road Data Base. Present development activities are related to improve data communication and upgrading measurement technology, visualizing traffic data through GIS applications of the MOT Transport-Geo-Database, as well as merging traffic count data and weighing station data for the purpose of better analysis.

Tasks of MOT have changed toward planning, building and maintaining the Kingdom's regional road transport network. Hence, there is a need to advance the traffic monitoring system in such a way that it delivers data and estimates for entire MOT road network. Therefore MOT is continuously upgrading its traffic monitoring system, is aiming at a concept of that comprises a combined system of permanent and temporary traffic counts;

[3] AADT - Annual Average Daily Traffic

together with established statistical methods that allows solid traffic data estimations for each road section of an entire road network for any day of a year.

3.3. Road Service Facilities

To manage and maintain the country wide road network MOT has established over 500 road side service centres to cater the needs for the work in the field. Depending on its location these service centres offer a range of facilities such, mosque, rest rooms, telephone, and accommodation facilities. Further some centres include additional facilities such as a police station, ambulance service, weighing station for trucks, and workshops.

3.4. Navigation

GPS navigations systems for cars have become a very popular tool for road users. With the growing number of cars and the expanding road network of cities and the country as a whole navigation system providers are showing increasing interest to offer such services for Saudi Arabia. MOT is interested in establishing high quality navigation facilities for the Kingdom and is lending its support to these providers, since navigation tools are offering great assistance to road users. At present MOT cooperation includes sharing of GIS data with the systems providers in order to maintain and update road network information for the benefit of the users.

4. ACTIVITIES FOR FUTURE DEVELOPMENTS

Future challenges of the Kingdom's transportation sector require a comprehensive and strategic approach to the development of policies, plans and programs in an integrated manner across all modes of transportation. Therefore MOT is pursuing to improve its management and administrative tools as well as adopting new techniques that are needed to strengthen public administration of Saudi Arabia's transport sector. Moreover, an enhanced dialogue with all related transport sector agencies is important to better align and formulate transportation sector policies and programmes. At present the most important focus areas of MOT include: the development of the National Transportation Strategy (NTS) for Saudi Arabia, establishing a Transport Geo Database, and developing an ITS Master Plan. The following provides an overview of these programmes which are being implemented by MOT.

4.1. Developing the National Transportation Strategy (NTS)

Since 1999 the Ministry of Transport is pursuing the development of Saudi Arabia's National Transportation Strategy (NTS). The aim of NTS is to establish an overall comprehensive framework for achieving the national development goals by efficiently managing the transport sector in times of growing intermodal and international competition, and increased globalization and complexity of the transport market.

NTS shall provide guidance to the allocation of the technical and administrative resources and utilization of emerging new technologies to better meet challenges and take advantage of opportunities in the transportation sector and to contribute to the national development goals and objectives, and offer dynamic mechanisms for the translation of the national goals into specific action plans, programs and policies related directly to the transportation sector.

Until now the MOT has reviewed the existing situation and developed jointly with all concerned transport sector agencies a principle strategic framework for the NTS. It comprises the NTS Vision, a set of six Strategic Goals, as well as working steps for the formulation of NTS.

NTS - VISION

"To develop and maintain a multimodal transportation system, serving the needs of society by ensuring a safe, efficient and technologically advanced transport system that promotes social and economic development and international competitiveness, and ensures a healthy and secure environment for its citizens."

NTS STRATEGIC GOALS

Efficiency

Ensure the sector's technical, economic and financial sustainability by improving overall performance of public and private transport service providers, by reducing governmental involvement in tasks which can be more efficiently executed by the private sector, and by rationalizing existing pricing and cost recovery schemes.

Socio-Economic Development

Support the Kingdoms economic growth and competitiveness, domestically and internationally, and provide good access to all services and mobility for all people.

Safety

Develop and implement a coordinated and comprehensive set of safety improvement measures addressing all aspects of the transportation system to reduce the number of transportation related deaths, to reduce the number and severity of transportation related injuries, and to reduce the economic and productivity losses caused by accidents.

Environment

Minimize the sectors negative impact on the environment through mitigation and avoidance and create environmental awareness in society.

National Security

Provide a transportation system that capably meets the mobility needs of national defense and security, and natural and man made disasters.

Hajj Transport

Provide a coordinated, multi-modal transport system that meets the unique and special travel needs of Hajj, in a safe and efficient manner.

A comprehensive development of the NTS requires a high-level involvement and contribution of all concerned government agencies in Saudi Arabia, therefore a programme has been agreed to perform the necessary tasks and facilitate the interagency dialogue. This programme includes the evaluation of activities and plans of all concerned agencies with regard to the NTS vision and goals. A subsequent step includes a comparative analysis that maps out all activities, programmes and responsibilities of the individual agencies across the transportation sector to identify important NTS issues and challenges.

The next step includes the formulation of NTS policies and programmes that provide practical guidance and orientation to contribute towards the Strategic Goals. It is most important for Saudi Arabia that these NTS policies and programmes are practical and offer best possible mechanism while actively involving all stakeholders. Although a 20 year period has been envisaged for particular programmes, the strategic instruments need to determine a dynamic strategy for future transport sector development beyond.

MOT is currently preparing a "White Paper"[4] on NTS in cooperation with all participating agencies. The "White Paper" will include the overall framework of NTS, and outline important policies, programmes, and action plans for a period of up to 20 years until 2025. A National Workshop will be thoroughly discuss and evaluate the "White Paper" in order to reach agreement on important policies and programmes at national levels, thus paving the way for the Government of Saudi Arabia to adopt NTS and implement the programmes and policies.

4.2. Establishing a Transport Geo Database

MOT has always developed and used advanced data applications to support its operational and planning activities. Until recent the road database was based on an Oracle system which has served MOT for a many years. However, the old system does no longer meet the needs of the Ministry because of its limited compatibility with modern advanced Geographic Information Systems (GIS). MOT has decided to resolve this issue by transforming the road data base into a GIS compatible Transport-Geo-Database, which can serve many different users and applications. This new platform offers a whole new range of opportunities for improving the data quality.

The foundation of the new Transport-Geo-Database was laid in 2004 by deciding for a new GIS platform and a dedicated server setup. Since then a new Transport Data Model has been developed, new data maintenance routines have been initialized and the final implementation has started. Other related achievements includes the development of MOT web map applications for Intranet and Internet, the migration to a new generation of GIS software, inventory and documentation of existing GIS data and the creation of a SPOT[5] and Landsat[6] satellite image archive.

Road data and maps are already accessible through intranet applications at MOT, but this can be taken further by connecting it to the Transport-Geo-Database and adding more functionalities. The most valuable asset of GIS is not the system itself but the data. Many new applications can be introduced to the system but if available data are not accurate and complete, high quality results can not be achieved. With this in mind, the up coming challenge is to improve the quality of the road data. New opportunities will arise once the road database is finally transformed into a modern, centralized, reliable, Transport-Geo-Database.

GIS offers the unique opportunity to become a natural tool to search, analyse and edit transport data at MOT, and can be used in all stages of the road administration. The Transport-Geo-Database shall serve as the central hub for all surrounding users and applications using road data. This GIS platform, in combination with efforts for improving the road data quality, is an essential prerequisite for further development. Satellite images, topographical data, urban road networks, and other background data could improve quality control of road geometry, enable navigable road data, 3D-visualisations and facilitate planning and road design. The Transport-Geo-Database is intended to be a unifying system where information is shared between all departments, districts, and possibly other interested users.

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[4] White Paper - A paper published by a government on a topic
[5] SPOT - *Satellite Pour l'Observation de la Terre,* French commercial earth observation satellites
[6] Landsat - earth resource observation satellites in operation by US agencies

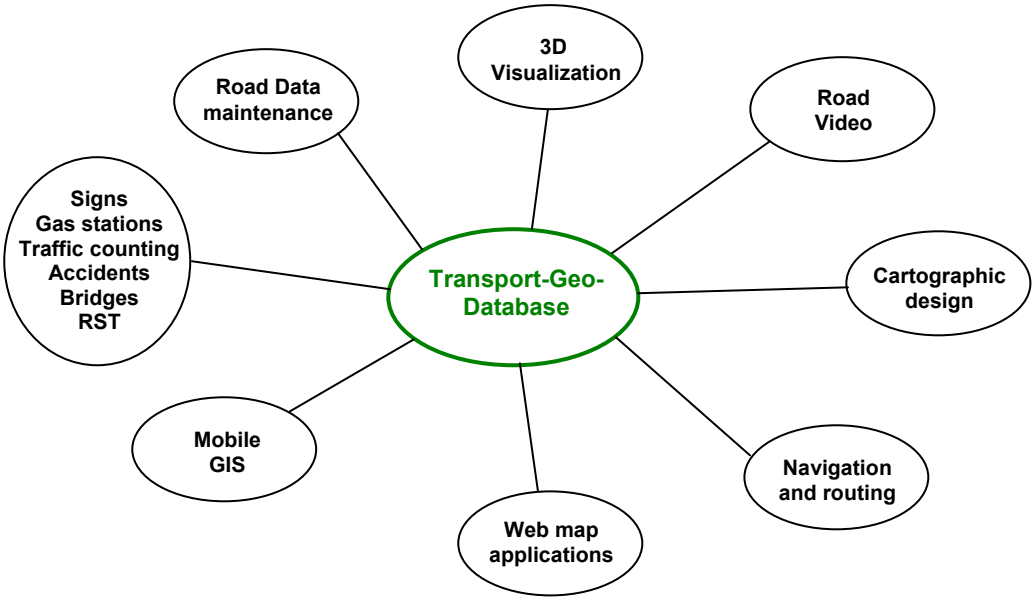

Figure2 - MOT Transport – GEO - Database

This Transport-Geo database follows entirely the standards of UNETRANS[7] and of EuroRoadS[8] where applicable. UNETRANS has been developed in consultation with a consortium of highway agencies, transit and rail organizations, city streets departments and airport authorities and planning consultants in North America, Europe and Asia. EuroRoadS is supported by ERTICO[9] and other European transport agencies. Yet under development, this standard aims at making national road data available in a harmonised and interoperable way. The EuroRoadS application schema is based on the ISO 19100 suite of international standards for geographical information.

The introduction of the Transport-Geo-Database brings a number of advantages to the MOT such as:

- Centralized database, available to many users
- Distributed layer update responsibilities, differentiated access levels
- Handles positioning with both GPS[10] coordinates and “distance from reference point”
- Navigational functionalities in desktop GIS (best route etc.)
- No data redundancy
- GIS tools available for road data management
- Updates are shown instantly in maps and documents
- Quality control and minimizing of input errors risk

As the Transport-Geo-Database is established, more applications and functionalities may be utilised, however, it also creates a demand for better quality of data. A main goal of

[7] UNETRANS - Unified Network for Transportation data model
[8] EuroRoadS - European Road Data Solution for road data bases
[9] ERTICO - Europe’s private-public partnership for advocacy and advisory on ITS in Europe
[10] GPS – Global Positioning System

MOT is to involve as much departments as possible in using the Transport-Geo Database. This also includes the district offices, which are gradually connected to the computer network of MOT. The new tools certainly require training for the users.

4.3. Intelligent Transport Systems (ITS) for Saudi Arabia

The Kingdom of Saudi Arabia faces huge challenges such as high levels of fatal road accidents and increased needs for mobility. Hence, a unified ITS strategy shall address urgent national needs regarding improvement of traffic safety and mobility enhancement throughout the Kingdom. Therefore, MOT is presently developing an ITS Master Plan for the Kingdom of Saudi Arabia that formulates a nationwide strategy for utilizing ITS technology country wide.

MOT is aware of the need to coordinate and guide the implementation of ITS in order to ensure interoperability and compatibility of all ITS components. Therefore an open architecture would provide a seamless functionality between all regions of the Kingdom. Moreover MOT gives also emphasis on internationally accepted standards which need to be followed in design and implementation of ITS technologies. This will ensure the use of proven technology and at the same time offers the opportunity to expand the system as ITS technology advances.

The ITS Master Plan will establish a high-level strategic plan for Saudi Arabia's ITS architecture. Further, problem areas and specific needs of the Kingdom will be identified in order to select service bundles and user services for inclusion in the architecture. For a successful ITS installation it is critical to involve all concerned agencies, and ensure the integration of operations and data flow. To arrive at practical solutions, the Master Plan will also take into account lessons learnt and best practices, which have been demonstrated in other countries. It has been noted that during the planning of a system, issues such as maintenance and operations, as well as allocation of funds and resources are often not given appropriate attention. Such issues, as well as marketing, public relations and implementation strategies will also be thoroughly addressed by the Master Plan.

The aim of the Ministry of Transport is to deploy a reliable, interoperable Intelligent Transport System in the Kingdom of Saudi Arabia, which offers dependable service to the wider public and transport users, and can be utilized with confidence by concerned agencies.

Once the ITS Master Plan is being implemented, the people of the Kingdom may begin to reap the benefits of improved mobility and increased transport productivity and safety. The transportation systems will become more reliable and predictable, better integrated and more environmentally friendly. This smart and innovative system will enhance national competitiveness and prosperity, and improve the quality of life for all road users. In the end, the comprehensive interaction of all measures will determine the true success of this plan.

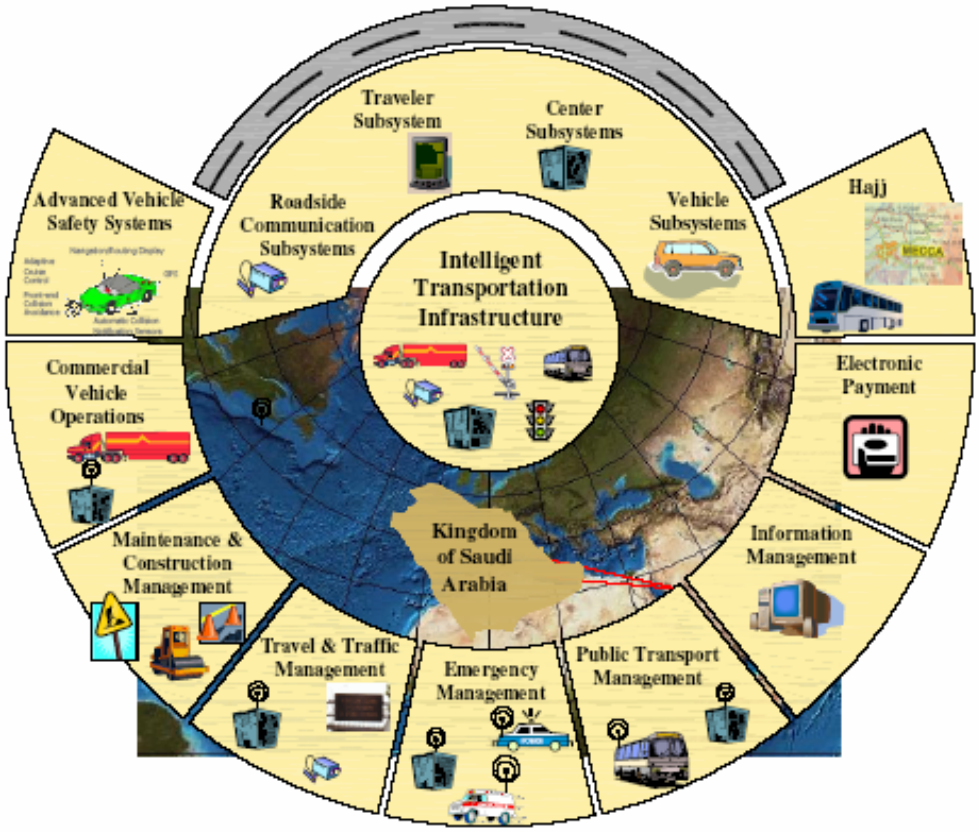

Figure3 - ITS Concept for Saudi Arabia