Implementation of a Nationwide Smart System for Roads in Egypt

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IDSC’s Commentary

President Abdel Fattah El-Sisi gave directives to launch the smart road system promptly according to the highest global standards. This shall announce the beginning of Egypt’s golden era of infrastructure and transport services. Through his directives, the President aimed at preserving Egyptians’ safety and security and establishing an efficient management for the roads and axes network. Thus, cities, logistic zones, and trade ports on the Mediterranean and Red Seas can be effectively linked, pushing the development wheel of Egypt’s process and meeting the requirements of sustainable development.

Within this context, the first phase of launching the smart road system aims at transforming 21 of Egypt’s most vital roads into integrated smart roads. In fact, transforming those 21 roads was supposed to be on 3 phases, but the Egyptian leadership accepted exerting tireless efforts to complete them in one phase.

Worthy to note, the smart road system offers several advantages, most importantly monitoring and managing traffic flow, fully securing Egypt’s roads network, automating payment of fees, and collecting fees of fuel and services presented to citizens on roads through advanced technologies by deducting from e-wallets.

The aforementioned advantages allow Egyptian authorities to manage traffic effectively, improve levels of performance and road services, provide instant information on roads status to citizens. Hence, bloodshed on roads can be halted, raising safety levels.

That being said, this issue of IDSC’s “Policy Perspective” highlights Egypt’s general progress in infrastructure. It also reviews Egypt’s vision on the smart road system, its aspects, objectives, and a general plan for it. In addition, efforts to guarantee Egypt’s smart transportation were tackled. The issue did not only discuss the paradigm shift in Egypt’s roads, but also Road projects set to promote Africa’s integration. A significant example of these projects is Cairo-Cape Town Road.
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Introduction

Smart roads have been an efficient solution to the challenges that the Egyptian road network is facing. These challenges include climate change, fatigue damage under the heavier loads, and demand of sustainable development. A road network is no longer a simple system to bear the traffic loads and ensure the basic transportation. Meanwhile, the development of sensor and wireless communication technologies continue apace. Our life and living environment are developing towards an intelligent direction, such as the Intelligent Transport System (ITS). They are becoming the direction of research and development, which means that the smart road is the future of our road network. Smart roads are road infrastructures capable of communicating with vehicles and self-monitoring fundamental perspectives concerning driverless vehicles and the roadway platform life cycle.

After the June 30 Revolution in 2013 and pushing through painful fiscal reforms, President Abdel Fattah El-Sisi is invested in the infrastructure drive’s success.

Egypt’s road network spans 188247 km, including paved and dusty roads during 2018. In a very clear sign of progress, Egypt’s ranking on the World Economic Forum’s (WEF) Global Competitive Report...
has improved in terms of the quality of road infrastructure. Over and above, the country’s ranking has jumped from 118th worldwide in 2014 to 28th in 2019. Thus, Egypt’s road quality now ranks second in Africa and 28th place globally, rising 90 ranks since previous years.

However, Egypt suffers a high rate of traffic accidents that kill thousands of people every year due to lack of highway monitoring systems, and negligence of traffic rules. Therefore, there is a dire need to introduce means of implementing a smart system for roads nationwide aimed at improving road safety in the country.

The Egyptian Government needs to establish a smart transportation system that meets the highest international standards, with the aim of managing Egypt’s road network, improving transportation among cities and commercial ports on the Mediterranean and Red seas, and increasing overall safety.
Egyptian Smart Roads Overview

The project aims to cut travel time, reduce road congestion, reduce accidents through technical solutions, follow-up on the movement of vehicles and their distribution, and provide statistics on the development of national projects. The minister of transport Kamel Al-Wazir clarified that the country’s road construction system was linked to smart solutions and modern technology in order to achieve safety and security and that the electronic gate system aimed to maintain security, automating toll payment and prevent traffic. Therefore, Egypt’s leadership had directed the localization of the IT industry in road construction to keep pace with global trends.

In addition, the Transport Regulatory Authority was working on issuing a unified transportation card.

On completion of the project, Egyptian commuters will be able to take different means of public transport within the country via the same smart card. The project aims to link the three metro lines with the electric train, private buses and some pub-
Public transport lines (1,600 buses set to enter the system). Besides, integrating railways and the monorail into the system shall be achieved, so that commuters can use all transport means with a unified ticket and the smart card. The project aims to contribute to easing citizens’ transport and reduce the need to queue outside ticket booths.

**Government Efforts**

The Government has made additional investments in land transport segment following the creation of the National Roads Project, and in early 2020, the Ministry of Transport announced a budget of $9.8bn for road development. In FY 2018/19 over 2000 km road projects were carried out, and another 2000 km were completed in FY 2019/20. While focus is on key projects in Cairo and Alexandria, a number of other regions in the country will also see substantial road building, maintenance and upgrades.

According to the Ministry of Planning, the Government allocated around EGP 16.9 billion Egyptian for the national road network “Investment plan 2020/2021”.

Egypt’s Armed Forces Engineering Authority has become a major player in large-scale construction projects in recent times. The authority oversees 2,300 projects and approximately 5 million civil employees across a number of sectors including agriculture, mining, seafood and infrastructure.

Despite lockdown measures implemented during the Covid-19 pandemic, construction activity continued on Cairo’s new road projects. The projects are part of an $895m government plan to reduce road congestion and build 40 new bridges. While the majority of the work is concentrated in East Cairo, construction is also being carried out elsewhere, including Ahmed Hamdy Tunnel 2.
link, which will run under the Suez Canal and is expected for completion in
mid-2021. An additional $142 million was spent building road infrastructure in
New Alamein City, an urban development to the west of Alexandria on Egypt’s
north coast.

Egyptian President Abdel Fattah El-Sisi urged officials to adopt modern technology
to monitor roads, including the use of monitoring cameras to curb violations, ensure
smooth traffic and improve road safety. He said a new system for recording driving
violations would be adopted, whereby short messages would be instantly sent to
drivers on their mobile phones to notify them about their violations.

Egypt has allocated billions of pounds to developing and expanding road networks
in recent years after a national project for road development was launched by
El-Sisi in 2014, with the goal of building and upgrading 7,000 km of highways
costing EGP 175 billion ($10.9 billion). Almost 4,500 km are now complete,
according to figures provided by the Transport Ministry.

Deadly road crashes take place near daily in Egypt, but efforts to upgrade roads
have been ongoing in recent years. However, the number of road accidents fell by
around 30 percent in 2019 to 9,992, down from 14,403, according to data from the
country’s official statistics agency CAPMAS.

According to the World Bank, the Greater Cairo Metropolitan Area is home to around one-fifth
of Egypt’s population - approximately 19 million people - a figure that is expected to rise to 24m
by 2027. This sharp increase will likely create additional pressure on road infrastructure
in the capital. An additional $142m was spent building road infrastructure in New Alamein
City, an urban development to the west of Alexandria on Egypt’s north coast.

One significant road project is the recently completed overhead bridge that crosses the Nile

River at Warraq Island to the north of Cairo and forms part of a link stretching from the Red Sea to the northwest extremity of Egypt’s Mediterranean coast. It was inaugurated by President Abdel Fattah El-Sisi in May 2019 and is the widest bridge in the world.

**Trans-African-Highways**

Given Egypt’s strategic geographic importance at the crossroads of Africa, Europe and the Middle East, its infrastructure programs also have regional economic implications. The Cairo to Cape Town road project, which was first discussed in the 1890s, has slowly re-entered the economic spotlight. Construction of Egypt’s section of the motorway began in mid-2015 and was completed in February 2019. The road begins in Alexandria and passes through Cairo and Aswan, south to the border with Sudan.

The Egyptian territory includes another of the continent’s important Trans-African-Highways, which spans from Cairo to Dakar, passing from the Egyptian capital to Alexandria and west along the North African coast to the Senegalese capital. With the arrival of the African Continental Free Trade Agreement, alternatives to maritime and air transport via trunk roads will further facilitate intra-African trade. In early 2020, this mode became increasingly important due to the disruption of global maritime and air supply chains because of the Covid-19 pandemic, especially in regard to air freight.
Applying ITS will support the strategic aim of Egypt to be a regional logistics hub for the African countries.

**The Cairo to Cape Town road project**

![Cairo to Cape Town road project map](source: MOT (2021))

**Egyptian Smart Roads Road-Map**

Part of the Government’s road network expansion and improvement initiative is another first-of-its-kind project, which will see the implementation of a nationwide smart system for roads. Initial construction was to begin on 21 roads, seven of which are selected for urgent stage execution, with a total length of 1,070 km.
• The cost of the first phase of the smart transportation system is estimated at LE two billion.

• Included in phase one are the Cairo-Alexandria Desert Road (220 km), Cairo-Ismailia-Port Said Road (195 km), Cairo-Suez Road (134 km), Cairo-Ain Sokhna Road (110 km), the regional ring road (338 km), and Shubra-Benha Freeway (40 km).

• In addition. There are 32 toll gates serving these routes, the first application of the Smart Transport System was executed on Shubra-Benha Freeway, which has the following components:

• The system includes state-of-the-art technologies, such as video surveillance cameras, Accident management and detection system, Traffic count equipment and Traffic and speed control and automatic accident detection.

• The Intelligent Transport System essentially contains traffic management and road operation centers. The entire application relies on data collection and transmission to the main data center for immediate analysis and immediate decision-making, which will achieve the efficiency necessary for traffic management and road operation.

• The Intelligent Transport System will encourage increased investment within the Egyptian transport sector and pave the way for the establishment of upgraded logistics areas at the entrances to roads, reflecting the enhancement of State revenues to support national output.

• The system will also support the existing road network infrastructure, as well as the positive impact on the environment in terms of improved security, enhanced trade, reduced fuel consumption, reduced mobility time, improved crime prevention, and reduced accidents and traffic bottlenecks. This will lead to safer roads and better living standards in Egypt.

• Roads are equipped with gates, control points, management and installation of networks, metal bridges, equipment and sensors, as well as the establishment of main centers, equipment and software for the operation of the system, electronic wallet, payment and collection system.
• Provision of a link between the main center and the road control points. Studies also covered all operational and maintenance matters for a period of 10 years.

• Intelligent Transport Systems (SMS) is the technology for using computers, electronics, communications and control to meet many of the challenges we face in road transport, such as improving safety, productivity and general traffic. Smart transport systems employ computer-managed communications and machine technologies to obtain information on the performance of transport facilities, the demand for transport and intercommunication among vehicles themselves, and sometimes on weather and environmental conditions, as well as on the provision of imminent accidents, in addition to providing these data and making them available for publishing.

• This smart system aims to provide greater capacity and higher efficiency without relying entirely on the establishment of new transport facilities.
Technologies of “Information Interaction”

In the field of science and technology, the word “smart” refers to “capable of making adjustments that resemble those resulting from human decisions, chiefly by means of electronic sensors and computer technology” (American Heritage® Dictionary of the English Language).

In the smart road system, when the self-aware devices are working, many data are produced, the data needs to be obtained, saved, delivered, and analyzed. In the function area of information interaction, 3 objects are involved- road infrastructures, road users and information center (or management institute).

In order to connect road infrastructures, vehicles and management institutes, the information-exchanging center needs to be equipped in smart roads. The interactions between these implements include condition data uploading, condition data feedback, vehicle data feedback and automatic warning (see Fig.1).

![Data interactions between implements](source: Zhao & Wu (2015))

Data uploading includes condition data uploading and vehicle data uploading. Condition data is obtained by “self-aware” sensor network of smart road, traffic data and vehicle information are uploaded by the vehicle-road interaction system. Information-exchanging center screens the uploaded data and does the analysis. After the data analysis and screening, the screened data would be sent to the “self-adapt”
devices and vehicles and reduce the data redundancy, the analyzed data would be uploaded to the management institutes. Wireless communication technologies can be utilized in the sensor network, such as near filed communication technologies and 3G communication technology. Sensor data would be summarized and packed, and transferred at last.

Interaction between vehicles and road aims to guarantee the traffic safety and efficiency. 2 ways can be used in guiding and automatically warning:

- Vision-based interaction (electronic boards, line markings)
- Wireless communication interaction

Fig. 2 shows the structure of information interaction in smart road.

Fig. 2. Schematic diagram of information interaction

“All roads joining the smart system will be monitored by a network of cameras that monitors traffic 24/7... and registers any violations,”. 

Source: Zhao & Wu (2015)
Applying RFID system as a smart solution

Ten Million Egyptian Cars to be Tracked via RFID

Using an RFID solution, with hardware and software provided by Kathrein Solutions in cooperation with Wireless Dynamics, Egypt’s Ministry of Interior (MOI) plans to identify millions of vehicles while traveling on the country’s roads. The system, which will be implemented on approximately 10 million of the country’s vehicles during the next five years, consists of passive UHF RFID stickers attached to each car’s windshield, as well as tags on headlamps that respond to interrogation from readers installed above roadways, even at high speeds.

Egypt faces an increasing challenge regarding traffic and the management of all vehicles operating on its roadways. For instance, some vehicles may have been cited for traffic violations and should not be on the roads at all. The MOI sought a way to control the traffic violations on its roadways, especially around Cairo and detect vehicles that should not operate on roads.

The main challenge was to implement a cutting-edge RFID technology that has never been deployed in the region and to maintain the highest level of security and data integrity without reducing the [RFID read] performance.

As part of a pilot, Kathrein provided 5,000 transponders that were attached to select vehicles in order to help the MOI identify them on the nation’s highways.

The pilot involved four readers and 16 antennas installed on overhead gantries on multiple-lane highways, which read tags as vehicles travelled by highway speeds. Early in 2018, Kathrein began working with Go+ and Wireless Dynamics to provide the full solution that is now being expanded to all vehicles.
The solution consists of multi-lane highways on which vehicles freely flow at high speeds, as well as areas in which cars may slow or stop. “It will be quite a mixture,” Schnebinger states. Kathrein ARU 3500 readers with integrated antenna are installed with automated number plate recognition (ANPR) cameras, as well as Go+’s solution with solar-power panels to energize the readers and cameras. Typically, two antennas are deployed with each reader.

The vehicle tags come with NXP UCDE DNA chips that support up to two 128-bit AES authentication keys. Cryptographic keys can be used for tag authentication, as well as for privacy protection. “The Government chose the highest possible security level, based on NXP’s UCODE DNA IC,” Schnebinger states. Although the use of a secure transmission takes longer than a standard EPC RFID tag read, “With our setup, we ensured a constantly reliable reading performance.”

The tags can accomplish reads at highway speeds. During the company’s internal tests at Sachensing Race Circuit, they have achieved reliable readings at a maximum speed of 220 kilometers per hour for a 4-wheeler, and approximately 240 kilometers per hour for motorcycles,” while using the full 128-bit AES encryption, TAM2 (see RFID Breaks Speed Records for Tolling Solution). “The reading distance of the tags is 15 to 20 meters depending on the surrounding conditions,” he adds.

The installation is going through multiple phases, with the first phase aimed at tagging 10 million of the nation’s vehicles. To date, around five million tags have been deployed and are being tracked on Egypt’s roadways. The tags are attached to each vehicle and are commissioned as an operator brings it in for vehicle registration or renewal. During the electronic vehicle registration process, Go+’s staff or agency officials check the tag’s location for each vehicle and then apply the transponder accordingly. There are three areas on the windshield at which tags can be applied, depending on whether the cars have metalized windows or heating systems. The tag’s unique ID number is entered into the Go+ software and is linked to the vehicle’s information. The system then forwards that data to the MOI database. Next, the driver proceeds to operate the vehicle on public streets. Each time that vehicle passes a reader, the device captures its tag ID. Go+ software structures the data, encrypts it and transports it to the dedicated, cloud-based central data center, El Sayed explains. Go+ used Kathrein’s JAVA-based software developers kit (SDK)
to create its roadside software to capture and manage the RFID data. The system can identify not only the vehicle and the speed at which it is travelling, but also the lane it is in. Kathrein’s RRU 4500 reader, together with its wide-range 30-degree antenna, ensures lane-selective identification of each vehicle. In addition, the camera mounted with each reader provides vehicle license plate images that are transmitted to the back end via an interface, together with the RFID data. The information is being used for two purposes: to track the flow of traffic and to identify vehicles for law enforcement. For traffic flow, El Sayed says, the data can help the MOI to plan its roadwork projects.

“The system provides the agency with accurate, digital and live data in order to control traffic flow and minimize illegal activities,” El Sayed states. A third goal is to track vehicles’ speed. With the data, law enforcement could potentially identify which vehicles are travelling at excessive speeds. The tags are designed to be tamperproof, in order to prevent individuals from removing them from vehicles or replacing them. If anyone tries to peel a tag off a windshield, it will no longer operate properly. Go+ is also in discussion with four other countries about the possibility of implementing this solution once the Egyptian system is fully deployed.
Benefits of Implementing Smart System on Roads Nationwide

The new system will help regulate drivers’ behavior, improve road safety, reduce traffic accidents, and increase control on roads.

• Response time to accidents will be reduced, which is forecast to provide an economic return of EGP 900 million annually.

• Toll fees will be collected electronically without the need to stop.

• A decrease in the number of accidents from between 22 and 48 percent is expected, with the critical accident rate shrinking from 22 to nine percent.

• Traffic violations are expected to drop by 45 percent due to the system’s capacity to send warnings to drivers.

• Operating speeds on the road network are estimated to increase by 35 percent at peak times.

• Total fuel consumption is projected to decrease by up to 13 percent annually upon the implementation of the smart system.

The smart system will be circulated on all highways, “No road in Egypt will not have the smart system.”

• The system aims to support decision makers in traffic management and to increase the efficiency of road performance.

• It will improve road performance and services through the transmission and dissemination of real-time information on status of the road.

• It will send weather messages and warnings, traffic, traffic, accident locations and alerts via mobile phones.
• It will increase the capacity of the road network without building more roads or even increasing their width.

• It will reduce congestion by improving the transport system and creating savings for the local economy by saving energy and time.

• It will provide real-time traffic information to users in an interactive manner.

• It will help to increase the control of violations, not putting them off to surprise the owners when the licenses are renewed, but they will be collected electronically on an instant basis.

• Electronic wallets can be used to pay in fuel stations, cafeteria, etc.

• The new application will send messages to the driver to reduce speed in the event of an accident or thick fog.

• Smart roads will make it easier to survey cars that pass on roads, their cargo and areas of congestion, and this will be useful when developing and renovating roads.
• A smart application with multiple features will be launched.

• The application of smart roads, which will be with a monthly subscription, will ensure the arrival of messages showing the state of the road and traffic densities, temperatures and traffic, and a map of the services on the road.

• The new application will allow for advertisements, which will not hinder the driver from performing his or her task.

• It will allow priority to be given to designated road users, such as high-duty vehicles, passenger buses, trucks and transit vehicles.

How New Road Systems Support Egypt’s Economy?

Egypt’s growing population and dynamic economy have resulted in a need for greater infrastructure development over recent years. Given that cars remain Egypt’s most popular mode of personal transportation – as do trucks for carrying cargo –, this need is seen most notably in its roads; Cairo and many other cities in the country suffer from chronic traffic congestion. As such, the Egyptian government has spearheaded significant investment in the road system to ensure that it will have the capacity to cope with long-term increases in freight and car journeys.

At the of end of 2019, Egypt’s National Roads Project – implemented in 2014 – has developed 4500 km of a pledged 7000 km of new roads in the country. An improved road network will support economic development, reduce traffic congestion and improve overall safety.

The highways and bridges the Government establishes are the most visible part of a big infrastructure push meant to galvanize Egypt’s economy after decades of rapid population growth and unplanned building.
Conclusion

• The new system aims at facilitating movement of citizens and goods through the application of modern technology in order to provide passengers with updated information on road conditions and traffic and in order to help reduce congestion and save time, effort and energy.

• All roads joining the smart system will be under 24/7 surveillance and monitoring via a network of cameras. This will enable traffic controllers to understand traffic flow, as well as register any traffic violations including speeding.

• The visibility of such systems will include lights and flashes, with the countermeasures against violations helping to improve driver behavior. This will ensure that drivers know that their actions will have consequences, which will in part help citizens abide by laws and regulations as accidents have for long been a major issue causing thousands of deaths and daily damage on Egyptian roads.

• Another major advantage of such digitalization is the ability to streamline the process of traffic tickets with instant notifications via SMS to violators. Drivers will also be able to appeal and pay such violations electronically.
• Another major benefit of such systems is the use of data analytics to deepen the understanding of the infrastructure and how it is being used. This includes monitoring where traffic bottlenecks occur, safety issues in areas of recurring accidents, and seasonality and trends.

• In recent years, there has been a drop in technology prices such as smart cameras, along with the drastic development of the Internet of Things (IoT) and Artificial Intelligence (AI) technologies. These have opened the doors for the large scale implementation of such systems, and Egypt is at the forefront of such an exciting journey.

• Undoubtedly, this technology needs to be parallel with raising public awareness of speeding and seat-belt wearing, as well as improving the enforcement of speed restrictions. At the same time, there should also be tougher penalties for non-compliance and requirements for issuing new licenses, as well as engaging civil society in road safety.

References


