



WORLD'S FIRST ELECTRONIC ROAD PRICING

TRAFFIC GAME CHANGER

Gridlocks are a constant problem in major cities, from New York and Paris to Mumbai and Bangkok. Over the last few decades, city authorities had been implementing different forms of solutions but with little success. In 1998, when Singapore engineers introduced the Electronic Road Pricing, they looked east to the tiny island nation.

Singapore has had its fair share of traffic congestion since the 1960s, as the population of vehicles on the road grew unabated. In 1975, the Land Transport Authority introduced the Area Licensing Scheme to reduce congestion in the Central Business District. Motorists had to buy special paper licences to enter the CBD, whose boundaries were marked by manned gantries, during restricted, chargeable hours.

By 1989, the ALS had become too complicated because it had grown into several different types of licences that were priced differently at various points of entry. "Licence labels were in so many colours and shapes that it got unwieldy and inefficient," says Lew Yii Der, LTA's group director of corporate planning and development.

Guards at gantry points manually enforced the ALS, recording the vehicle plate numbers of offenders who did not display the proper labels on their windscreens. It was tedious and lacked precision. And it was not uncommon for offending motorists to get away scot-free. Yii Der, who was the senior engineer in charge of ERP trials between 1989 and 1995, says: "Daily and monthly passes also allowed drivers to enter for an unlimited number of times, resulting in a 'buffet effect'."

Shifting gears

In 1989, the government gave the go-ahead to search for an automated system that would charge vehicle toll fees based on the time of the day and the congestion levels at designated points on the roads. This was simply called the ERP System. Eight years later, after many trials and tenders were called and awarded, a yet-to-be-opened stretch of Seletar Expressway was converted into a 3km driving circuit to test the eventual ERP System.

"About 250 vehicles – taxis, lorries and buses – were put through their paces every day to pass through 11 ERP gantries," recalls Tan Hiok Seng, LTA director of investigations and customer services, who headed the ERP implementation project. "Engineers conducted the months-long trial to iron out kinks in the final system before a million in-vehicle units were produced for motorists. It was crucial that the system worked smoothly before the nod for mass production was given."

The ERP was designed as a multi-lane, free-flow system that could detect all types of vehicles running at high speed and charge them the exact toll fees. No other similar system existed elsewhere in the world at that time.

Yii Der says what made the ERP innovative was the integration of different technologies in the system. "It's about putting them together and making it work," he adds. "For example, the system uses microwave technology to help the sensors, cameras and antennae identify all vehicles through their IUs when they pass

left:

ERP gantry installed to ease traffic conditions during peak hours

bottom:

ERP evaluation test at a yet-to-be-opened stretch of Seletar Expressway





“There was none we could buy off the shelf. So, we had to invent our own system, conduct tests and pick the right partner to produce one that we needed.”

above:

L-R:
Leonard Tan Tee Siang,
Tan Hiok Seng,
Lew Yii Der,
Chin Kian Keong
and Grace Ong

under the gantry. There was none we could buy off the shelf, so we had to invent our own system, conduct tests and pick the right partner to produce one that we needed.”

And with the stored value card making its debut in the early 90s, LTA decided to adopt the cashless payment midway through the ERP trials. The specifications had to be changed quickly, says Yii Der, who worked with NETS, the operator of an electronic cashless payment network - and banks to implement the stored value card.

From April 1998, the ERP system was launched progressively, starting with the East Coast Parkway, followed by the Central Expressway, Pan-Island Expressway and Central Business District. A total of 33 gantries were installed.

System check

Developing the ERP came with its own set of challenges. Because the system is made up of several components, a lot of effort was invested to produce effective communication between vehicles and the gantry cameras and antennae. Detecting and identifying a vehicle at all points it passes had to be precise, deducting the correct amount from the stored value card in its IU.

To guarantee precision, every imaginable scenario was played out in the temporary road circuit to test the system - from speeding cars to motorcycles travelling between buses, to vehicles straddling two lanes in the day, night and during storms.

Hiok Seng recalls a test that left the engineers stumped: “The stored value card of a heavy goods vehicle could not be deducted, which meant that if we couldn’t find a remedy, the system was a no-go.”

Engineers who sat in the truck to pinpoint the source of the problem had noticed the system malfunctioned when the driver used the trunked radio system in his vehicle. “While he was using it, the ERP was not able to detect his IU,” says Hiok Seng. “We modified the in-vehicle unit’s circuit to correct the problem.”

The IU, which was also a new innovation, went through robust testing. Engineers designed its installation so that it would not turn into a dangerous projectile in an accident, explains Chin Kian Keong, LTA’s chief engineer, road and traffic. The then ERP manager for road pricing says radiation levels were also monitored and measured to ensure that they were lower than those of mobile phones.

“The trials at Seletar were a good system check as we were able to tick all the boxes of the ERP’s check-list for a trouble-free rollout,” he adds. “This included making sure the cameras performed at their optimum to detect the number plates of all vehicles, especially when there was insufficient funds in their stored value cards.”

The effects of the sun’s extreme heat on the IUs also came under scrutiny. After discovering that the stored value card warped in the IU under the hot sun, engineers worked with NETS to produce another card that could



above:

Before ERP was introduced, motorist had to purchase supplementary licence from Daily Area Licence sales booth

withstand temperatures of at least 100 deg C. It was tested to make sure it could stand the extreme heat, including boiling the prototype just to be sure.

The next stop: satellites

Today, there are 78 gantries in operation and the ERP technology has even expanded to include automated payment at car parks. The next generation of ERP system is scheduled to replace the existing one from 2020, and it will use satellite navigation technology instead of gantries.

A testament to Singapore’s land transport engineering prowess, traffic authorities from cities such as London, Stockholm, and Milan have studied and adapted the LTA’s pioneering ERP system.

As Yii Der looks back at the ERP journey, he says engineers need a multi-disciplinary approach to stay relevant by broadening their expertise. “Holding up the Intelligent Transport Systems as an example, it is a mix of different disciplines. Although traditionally civil engineers deal with traffic flow and concrete structures, they now need to understand something about electronics and the Internet of Things because we use these to monitor the condition of our roads and the health of our structures.

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Please advise