Assisting California to lower transportation-related costs

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Research conducted in the University of Pretoria's Department of Civil Engineering is assisting California to lower transportation-related costs. A pilot study used vehicle-pavement interaction (V-PI) principles and other tools to measure the peak loads and vertical acceleration of trucks and freight on different pavement surface profiles. This study was limited to the State Highway System (SHS) and a district of the California Department of Transportation (Caltrans).

The purpose of the study was to gather information from simulations and measurements, track truck logistics (and costs, if available), and provide input for an economic evaluation based on V-PI principles and a freight logistics investigation. The findings of the research will be used to improve Caltrans's decision-making and help manage the pavement network more effectively. The decisions taken (in other words, whether to resurface and improve riding quality or delays) will have an economic effect.

The researchers also examined links to available information, pavement construction specifications and roadway maintenance, in order to make an economic evaluation of the effects of delayed road maintenance, which could lead to deteriorated riding quality and subsequent increases in vehicle operating costs, as well as vehicle and freight damage. The information provided would support Caltrans's freight programme and legislation.

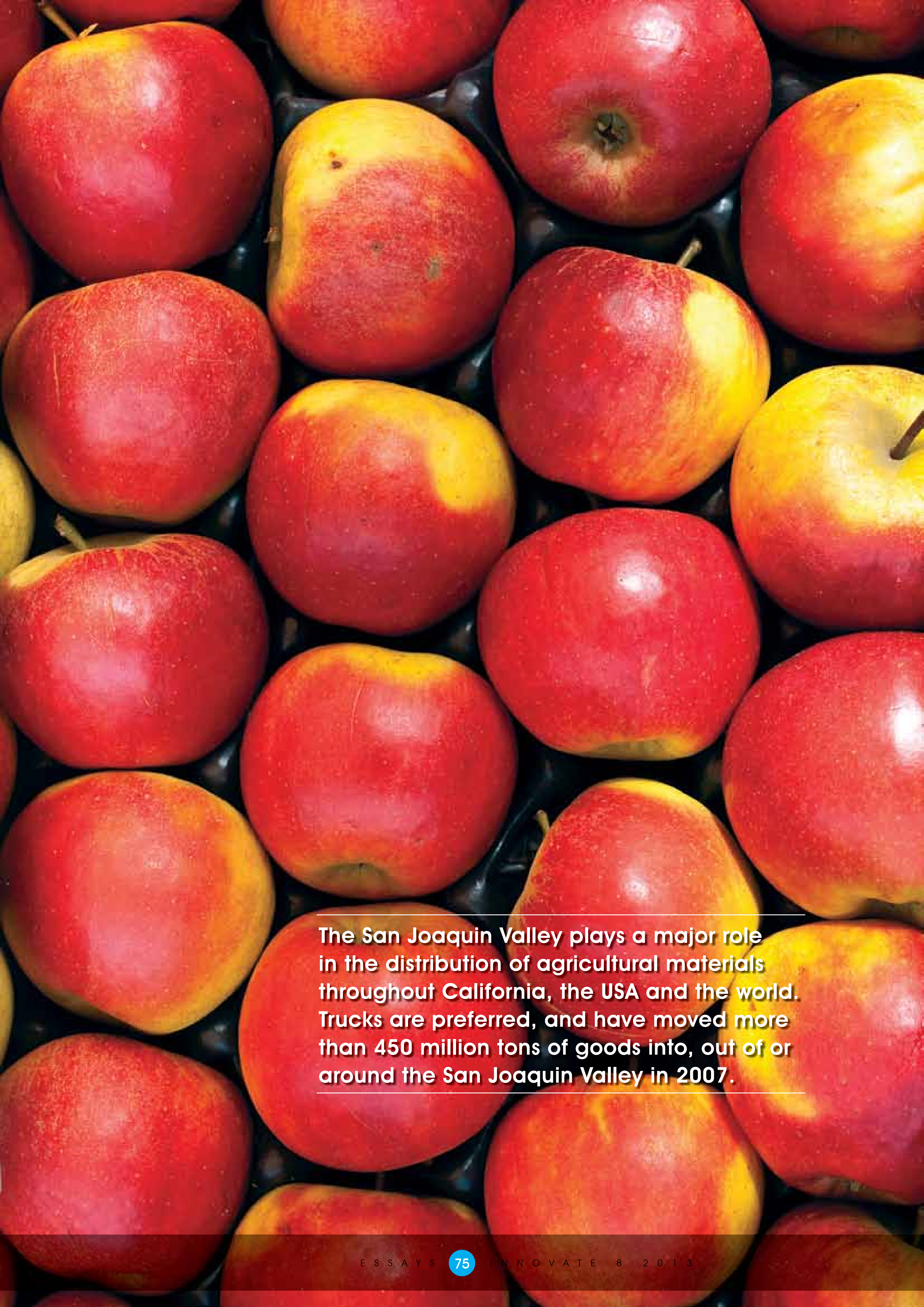
Challenges, operational concerns and strategies were also identified, as well as costs to the economy and the transportation network (delay, packaging and the environment). The results of the study could lead to improved pavement policies and practices, such as strategic recommendations that link pavement surface profiles, design, construction and preservation with V-PI principles.

The study included a road inventory and a vehicle inventory. The purpose of the road inventory was to determine the condition of each of the routes in each district that has the necessary data available. Certain routes in California were identified and a database containing road profiles and riding quality data was developed. The purpose of the vehicle inventory was to provide a summary of the current vehicle population per standard Federal Highway Administration (FHWA) vehicle classification by Caltrans. Based on the FHWA truck classifications, commodity flow analysis and weigh-in-motion (WIM) data, the following was determined:

- The most common truck types used were FHWA Class 9 and 12 (up to 48% of the trucks on selected routes), followed by Class 5.
- High truck flows were observed in District 6 in the San Joaquin Valley.
- Axle load spectra were heavier at night than during the day.
- Axle load spectra and truck type distribution showed very little seasonal variation.
- Axle load spectra were much higher in the Central Valley than in the Bay Area and Southern California, particularly for tandem axles.
- More than 90% of truck traffic travelled in the outside (two-lane highways) or two outside (three-lane highways) lanes.
- Truck speeds ranged between 80 and 120 km/h.
- Steering axles and trailer axles mainly used leaf suspension, while drive axles used air suspension.

The study produced a detailed report on the available data sources and required analyses for the project, which included indications of the potential links between the outputs of this project and the inputs for various economic and planning models.

A commodity flow survey provided data that indicated that the highest percentage of commodities (in terms of value, tons and ton-miles) transported by truck for the whole of California consisted of manufacturing goods, wholesale trade and non-durable goods. Truck transportation is the most frequent mode of freight transportation in California, and trucks are used to transport 82% of the freight shipped from California. Information on the



The San Joaquin Valley plays a major role in the distribution of agricultural materials throughout California, the USA and the world. Trucks are preferred, and have moved more than 450 million tons of goods into, out of or around the San Joaquin Valley in 2007.

Trucks are used to transport 82% of the freight shipped from California.

San Joaquin Valley revealed that this region of California comprises eight counties and 62 cities. It has a diverse economy and plays a major role in the distribution of agricultural materials throughout California, the USA and the world. Trucks are preferred, with more than 450 million tons of goods having been moved into, out of or around San Joaquin Valley in 2007. This is more than 85% of all tonnage associated with transportation of this type in the San Joaquin Valley. Trucks in this region rely on a combination of all levels of highways and roads. Key regional highways include the primary north-south corridors and the east-west corridors.

There are over 2 700 lane miles of truck routes in the San Joaquin Valley, with over 80% designated Surface Transportation Assistance Act (STAA) national truck routes. Mainly farm products (comprising 33% of the total outbound movements) are carried from the San Joaquin Valley. Stone and aggregates account for 18%, food and tobacco products around 10%, waste 6% and mixed freight 4% of the total tonnage. The region contributes over 8% of the total GDP for the state of California and accounts for higher output in sectors such as agriculture (nearly 50%) and mining (25%).

The California Life Cycle Benefit/Cost Analysis Model (Cal-B/C) is used by Caltrans to conduct investment analyses of proposed projects for the interregional portion of the State Transportation Improvement Programme (STIP), the State Highway Operations and Protection Programme (SHOPP), and other analyses that require cost-benefit analysis. The following are potentially affected by the work conducted in this pilot study: roadway type, the number of general traffic lanes, the number of high-occupancy vehicle (HOV) lanes, HOV restriction, highway free-flow speed, current and forecast average daily traffic (ADT), hourly HOV and high-occupancy toll (HOT) volumes, truck speed and pavement condition.

The potential involvement of industry includes the following:

- GPS tracking and acceleration measurements on selected trucks travelling on designated state highway segments
- Truck trailer information, as entered into computer simulations of vehicles travelling over a range of pavements

The Models for Rolling Resistance in Road Infrastructure Asset Management Systems (MIRIAM) project aims to research sustainable and environmentally friendly road infrastructure by reducing vehicle rolling resistance and subsequently lowering CO_2 emissions and increasing energy efficiency. Links between the MIRIAM project and the pilot study lie in the potential use of selected rolling resistance models originating from MIRIAM in the evaluation of the effects of pavement roughness on vehicle energy use, emissions and rolling resistance. Initial MIRIAM studies indicated the following:

- Rolling resistance is a property of tyres and the pavement surface.

- A tentative source model for the pavement influence on rolling resistance contains the mean profile depth (MPD), pavement roughness (IRI) and pavement stiffness as significant pavement parameters.
- For light vehicles, the pavement roughness effect on rolling resistance is a third of the effect of the MPD, and it appears to be higher for heavy vehicles.

An origin-and-destination truck study for the primary north-south corridors indicated the following:

- Traffic volumes were mostly consistent for autumn and spring. Overall truck percentages were mostly higher in spring than in autumn.
- Little variance was observed in truck travel patterns between autumn and spring.
- The majority of trucks (83.8%) were of the five-axle double-unit type.
- About 70% of trucks were based in California and 47% of the California-based trucks were based in the San Joaquin Valley. Another 34% were based in Southern California.
- The top five commodities are food products (21%), empty trucks (18%), farm products (14%), miscellaneous freight (12%) and transportation equipment (4%).

The state of logistics in South Africa revealed that, for many years, the riding quality of a road has been used as the primary indication of the road quality. Studies on the effect of riding quality in terms of vibrations and responses in vehicles have shown that a decrease in the quality of a road is a major cause of increased vibrations and subsequent structural damage to vehicles.

These vibrations and structural damage to vehicles can have a negative effect on the transportation costs and economy of a country. Most transportation companies are affected by the increase in logistics costs due to inadequate road conditions. As these costs increase, the costs of products in the global marketplace increase, which affects the country's global competitiveness. The potential savings in vehicle operating costs is significant when roads are in a good condition, compared to the estimated annual road maintenance costs per kilometre. The vertical acceleration when travelling over rough road surfaces may damage vehicles and cargo.

Damaged freight results in direct and indirect losses in revenue.

The economic impact of damaged agricultural cargo is absorbed differently by large-scale and small-scale farming companies.

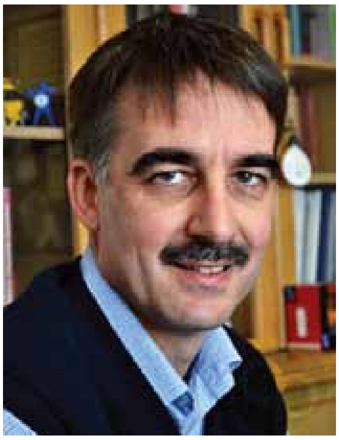
Freight logistics revealed that damaged freight results in both direct and indirect losses in revenue. These operational repercussions depend on the type of freight, as well as the standard operating procedures of the shipper and receiver. These repercussions include the following:

- The product is sent back to the shipper for replacement, repair or repackaging, placing a burden on the reverse supply chain.
- The product is "written off" and the receiver disposes of it.
- The product must be reclassified as "damaged" before being sold.

Implications for the freight logistics aspect is the link to the Cal-B/C model. To perform a cost-benefit analysis of upgrading a stretch of road, potential freight damage savings accrued by the upgrade must be included in the Cal-B/C model. This requires cost calculations, which include calculations related to the type of goods, type and attributes of the truck or trailer, and attributes of the roadway. The expected freight damage cost incurred by a particular type of shipment must first be quantified. The individual shipment costs are then calculated to provide higher-level cost estimates.

Based on the information obtained in this study, a good understanding was obtained of the SHS pavement conditions in California. This included riding quality and the major truck types, as well as the operational conditions on these pavements.

About the author



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