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CTS Research E-News brings you the latest research project milestones, published reports, and seminar coverage.

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Policy & Planning

Funding China's urban infrastructure: Private sector playing significant role

The need for urban infrastructure in China is on the rise, and funding sources are changing with the times, report researchers from the University of Minnesota.

Assistant Professor **Zhirong "Jerry" Zhao** and graduate student **Chengxin Cao** from the [Humphrey School of Public Affairs](#) recently completed a CTS-supported study on national trends and regional patterns of urban infrastructure funding and financing in China. The researchers' analyses show that the government and market are now playing equally significant roles in supporting urban infrastructure development.

Zhao was one of the researchers in the CTS-led [Value Capture for Transportation Finance](#) study, which identified potential strategies to raise funding for transportation infrastructure investment in Minnesota. The study, completed in 2009, was funded by the Minnesota legislature.

Urban infrastructure development has not kept pace with China's strong economic growth and rising population. In fact, several major infrastructure projects, such as paved local roads and streets, have grown at a much slower pace since the economic reforms of 1978, the researchers say.

The economic reforms, which began moving the country away from central planning, also sparked a transition in China's infrastructure investment from conventional budgetary funding to a much more diversified system. Throughout the process of decentralization, China's local governments have increased their ability to fund urban infrastructure both by widening revenue resources and diversifying financing approaches. These trends and patterns, however, have raised questions: Are these approaches theoretically reasonable, and are there more efficient ones?

For instance, China's Urban Development and Investment Company (UDIC) acts on behalf of the government to borrow funds from banks and other sources, issue bonds when allowed, enter into joint ventures with private companies for infrastructure development, and sell local infrastructure assets. The main resources of UDIC funding come from domestic loans and land-transfer fees.

The researchers posit that with this approach, fees and user charges are not being used for efficient resource allocation, and the UDIC still gives the government the dominant power in urban infrastructure funding and financing. Although the UDIC-leading mode is deemed a market approach, the mere fact that the UDIC is attached to (or even an agent of) the government has led it to become a monopoly with no incentive to provide public goods and services at marginal cost levels, the researchers say.

Zhao and Cao's evaluation found that overall, market financing is growing faster than fiscal revenue. Further, the main source of fiscal revenue has converted from primarily budgetary allocation and local earmarked taxes to land-transfer fees. By 2005, land-transfer fees accounted for 11 percent of total urban maintenance and construction revenue. Also, domestic loans and self-raised funds have increased faster than average.

The study also found alarming regional disparities. The municipalities and the east gained a much larger share in the total resources due to their political importance and economic advantages. The west, which used to be the area with the slowest development, benefited from the central government's policy of prioritizing development there in the past decade. The central region, although it has a higher per capita income than the west, has developed the slowest due to lack of policy and financial support.

The researchers believe that future research should concentrate on the reason for the distribution of funding mechanisms in different areas and investigate whether there is a correlation between the funding mechanism and expenditure mode.

A final report on the project, [*Funding China's Urban Infrastructure: Revenue Structure and Financing Approaches*](#) (CTS 11-10), is available on the CTS website.

Intelligent Transportation Systems

Teens, parents evaluate TDSS in usability study



Speed limit alert display

Researchers from the [ITS Institute](#) have completed a usability study on the [Teen Driver Support System](#) (TDSS), a smartphone-based system that provides real-time, in-vehicle feedback about risky driving behavior to teens. The system also immediately communicates with parents via text message if the behavior continues and makes summary information available online.

As part of the study, participating teens and their parents evaluated TDSS functions and interfaces, including the system's visual and auditory warnings about speeding, excessive maneuvers, upcoming curves, stop sign violations, seat belt use, and the presence of other passengers. Participants were also asked whether they believed the TDSS could help improve overall driving safety for teen drivers.

The TDSS research team includes research fellow [Janet Creaser](#) and director [Mike Manser](#) of the HumanFIRST Program, research fellow [Alec Gorjestani](#) of the Intelligent Vehicles Laboratory, and ITS Institute director [Max Donath](#). Project funding was provided by the [Minnesota Department of Transportation](#) and the ITS Institute.

Thirty teen-parent pairs from Washington County, Minnesota, participated in the TDSS usability study. Teens ranged in age from 16 to 17 years old, and they reported a total of 13 at-fault crashes between them. Several of the teens reported engaging in risky driving behavior, such as not wearing a seat belt, having three or more passengers in the car, and speeding.

Before completing the TDSS evaluation, each pair of participants was introduced to the system via a short presentation and a demonstration drive with members of the research team. After the drive, each teen drove a 30-minute route (accompanied by a researcher) involving in-town and rural roads while the TDSS was active. While teens completed the route, parents reviewed the parental summary website.

The majority of teen participants found TDSS functions to be accurate and felt the system would help them drive more safely. They also believed it would have an overall positive effect on how driving was discussed with their parents. In addition, teens appreciated that the TDSS offered them the opportunity to cancel notifications to parents by modifying their behavior.

Parents also held positive opinions of nearly all TDSS functions, with more than 95 percent saying they would recommend the system to other parents and teens. Most parents also said they thought using the TDSS during a teen's first two years of licensing would help the teen adopt safer driving habits and lead to permanent changes in behavior, even after the system was removed. In addition, parents liked the immediacy of the text message alerts informing them of their teen's behavior.

Most teens preferred the visual messages displayed on the screen of the smartphone to the auditory messages, which they found more distracting due to message length and the sound of the voice used to deliver them. Some teens also reported that the speeding thresholds were difficult to adhere to, as the first speed warning is triggered at any speed over the speed limit. Teens felt this threshold would require them to drive slower than regular traffic and below the speed limit to avoid unintentional warnings triggered by natural fluctuations in vehicle speed.

As a result of the study, the research team plans to reevaluate certain aspects of the TDSS, including the length of auditory messages and the system's speeding thresholds. The goal of the design changes will be to balance safety concerns with parent and teen expectations of how the system should operate.

A final report on the project, [*Usability of a Smart Phone-Based Novice Teen Driver Support System \(TDSS\)*](#) (MnDOT 2011-13), is available on the ITS Institute website.

More information about the TDSS, including a video highlighting the system, is also available on the [ITS Institute website](#).

Safety & Security

New prototype helps visually impaired pedestrians

Individuals with vision impairments often have difficulty crossing intersections, largely due to the lack of traffic information available to them. Locating the crosswalk, determining when it is safe to cross, and maintaining alignment to the crosswalk are typically the most difficult tasks. Existing accessible pedestrian signals (APS), which indicate the onset of the walk signal at an intersection with audio cues, are often insufficient to help visually impaired pedestrians orient themselves and cross safely.

In an [ITS Institute](#)-sponsored study, University of Minnesota researchers have developed a prototype of a mobile accessible pedestrian signals (MAPS) system to better meet the needs of blind and visually impaired pedestrians. MAPS uses the pedestrian's smartphone to collect traffic signal information and broadcast auditory messages about when it is safe to cross. The research team was led by [Chen-Fu Liao](#), senior systems engineer at the [Minnesota Traffic Observatory](#), and also included former [HumanFIRST Program](#) research associate [Michael Rakauskas](#) and graduate student [Avanish Rayankula](#).

The MAPS prototype integrates smartphone sensors with Wi-Fi and Bluetooth technologies to collect environmental and personalized signal information relevant to the pedestrian's desired direction of travel. To request information about an intersection, the pedestrian taps once on the screen of the smartphone. MAPS then provides the street name, direction, and number of lanes so the individual can correctly identify which

direction he or she needs to go.

To confirm a direction of crossing, the pedestrian taps twice on the screen while pointing in the desired direction. MAPS then sends a wireless request to the traffic controller for the pedestrian walk signal and collects signal phase and timing information to help the pedestrian cross safely. The system uses a digital map stored on the phone as a navigational reference to help accurately identify each corner of the intersection.

The researchers believe that MAPS has the potential to enhance, if not replace, existing APS. MAPS can be deployed on a larger scale and more cost-effectively than APS, and it also has the ability to help pedestrians navigate more complex intersections by providing geometry information via audio messages. In addition, although the proposed system is targeted primarily toward blind pedestrians, the researchers believe MAPS could also provide assistance to elderly and low-vision individuals.

Future work will focus on MAPS usability testing and evaluating the effectiveness of a MAPS prototype compared to existing APS in a field study. The team also plans to develop an algorithm to help pedestrians maintain alignment to the crosswalk while crossing the street.

Development of Mobile Accessible Pedestrian Signals (MAPS) for Blind Pedestrians at Signalized Intersections (CTS 11-11) is available on the ITS Institute website.

Transportation Infrastructure

Monitoring systems and structural response devices help extend bridge life



The Cedar Avenue Bridge in Burnsville, MN

Many bridges across the U.S. are in need of rehabilitation or replacement. In Minnesota alone, 1,537 trunk highway and local bridges are classified as structurally deficient or functionally obsolete. To help bridge owners extend the lives of these structures while funds are allocated for repair or replacement, researchers from the University of Minnesota's Department of Civil Engineering suggest using bridge health monitoring and structural response modification techniques.

Professor [Arturo Schultz](#), Assistant Professor [Steven Wojtkiewicz](#), and graduate student [Andrew Gastineau](#) suggest that many structurally deficient bridges have components prone to fatigue damage, which is caused primarily by repeated stress. Study results indicate that reducing stress cycles through bridge health monitoring and structural response modification techniques can help increase bridge life safely and affordably. The research was funded by the [Center for Transportation Studies](#).

Schultz has also conducted related research on bridge health monitoring systems, funded by the [Minnesota Department of Transportation](#). In a previous project, Schultz led a research team that surveyed commercially available bridge health monitoring systems and developed a spreadsheet-

based software application to help bridge engineers select the right monitoring system for a given bridge. In another study, Schultz and his team demonstrated the selection system by evaluating the monitoring needs of the Cedar Avenue Bridge in Burnsville, Minnesota.

Bridge health monitoring systems are becoming more widely used to help researchers better understand bridge response, the researchers say. Monitoring systems can be used to verify a bridge's response to known loadings, monitor individual components on a local level, or monitor the entire structure's global health. Such systems include accelerometers, acoustic emission, strain gauges, and fatigue sensing devices.

Monitoring systems provide feedback on bridge behavior and help researchers identify vulnerable components. They can also help optimize stress cycle reductions when used with structural response modification devices. When choosing a monitoring system for a bridge, the researchers say it is important to consider cost, accuracy, range, environmental conditions, and reliability, among other factors.

Structural response modification can help reduce stress cycles by providing added stiffness and damping to bridges. The researchers suggest that semi-active devices, which have changeable parameters that can change bridge response under various conditions, are the most applicable because they use small amounts of energy while maintaining adaptability. Semi-active devices include mass, liquid, and friction dampers, vibration absorbers, and stiffness control devices.

To demonstrate the effectiveness of response modification techniques, the researchers conducted a modeling study of the Cedar Avenue Bridge. The Cedar Avenue Bridge—a steel tied arch bridge—is fracture critical, which means that the failure of a single critical component could compromise the entire structure.

Previous research on the bridge has shown that stress concentrations exist at the joints where the hangers and floor beams are attached to the steel box girders that serve as tension ties. Using a simulation of response modification on the Cedar Avenue Bridge model, stress ranges have been reduced on these components. Modeling using a scissor jack and simple damping device has shown that stress ranges can be reduced by approximately 39 percent, which can lead to a bridge life extension of more than 300 percent.

Response Modification for Enhanced Operation and Safety of Bridges (CTS 11-14), a final report on the project, is available on the CTS website.

Transit, Bicycling, and Walking

The future of automated transit at airports: Here and abroad

A team of researchers from the [Humphrey School of Public Affairs](#) recently investigated the status of automated rapid transit (ART) applications in airport environments. ART, a public transportation mode featuring automated vehicles operating on specially built guideways, includes small subway systems as well as group and personal rapid transit. Such systems are well-suited to address the unique congestion and transit challenges faced by busy airports and activity centers.

The study, sponsored by the [Minnesota Department of Transportation](#) (MnDOT), examined a number of existing systems in an effort to determine whether ART would be a viable addition to the Minneapolis-St. Paul (MSP) International Airport. The research team was led by research fellow [Ferrol Robinson](#) and also included [Lee Munnich](#), director of the State and Local Policy Program, and research assistant [Matt Schmit](#).

The researchers studied two ART systems in development—one at Heathrow Airport in London, and one being evaluated for installation at the



Automated rapid transit car at Heathrow Airport
(Photo by Chris Pinnock)

Mineta Airport in San Jose, California—and examined two transit systems currently operating at the MSP airport.

The Heathrow ART system will begin offering passenger revenue service at the airport in summer 2011. The ART system will consist of about four kilometers of guideway that links one station in Terminal 5 to two remote stations in the business car park. Because project managers were hesitant to discuss certain aspects of the system before its launch, the researchers say questions remain, such as implementation principles and technology selection affecting guideway and traction, as well as various risks and risk mitigation approaches.

The San Jose system, still early in its feasibility stage, is designed to be an extensive ART system that will connect major hubs within two miles of the airport by 2015. It is also expected to connect to the Bay Area Rapid Transit system and the anticipated 800-mile California high-speed rail system by the end of the decade. Despite its lack of specific design and concept parameters at this point, the researchers believe it will exceed the London Heathrow system both in scope and overall level of services.

The researchers also summarized the C-Concourse and Hub trams at the MSP airport, discussing potential impacts from the expected increase of 23 million more passengers per year by 2030. This growth will require significant improvements in the airport's internal and external transportation systems. In fact, there are plans to build another automated system for Concourse G by 2015-2020. The

researchers believe that ART could be one of the options considered, provided that the issues of security, capital cost, and passenger loading, among others, are resolved.

In addition to following up on the progress of the above airport ART systems, the researchers state that several important issues at MSP need to be investigated further. Considerations should include potential impacts on MnDOT right-of-way, system security, disruptions to everyday airport activities, performance criteria, emergency back-up systems, capacity potential, system costs, and available funding. However, the Heathrow and Mineta experiences—added to the news that the Masdar personal rapid transit system is now in service in Abu Dhabi—provide several lessons for a potential future implementation of ART at the MSP airport.

A final report on the project, *Potential Viability of Automated Rapid Transit at the Minneapolis-St. Paul Airport* (MnDOT 2011-14), is available on the CTS website.

TCRP research publications available online

The federal Transit Cooperative Research Program (TCRP), administered by the Transportation Research Board, provides practical transit research to address technical and operational issues. TCRP emphasizes putting research results into the hands of organizations and individuals that can use them to solve problems.

Recent TCRP publications include:

- ◆ *Strollers, Carts, and Other Large Items on Buses and Trains* (TCRP Synthesis 88)
- ◆ *Funding for Infrastructure Maintenance: Achieving and Sustaining a State of Good Repair* (TCRP Research Results Digest 101)
- ◆ *Public Transportation Systems and the Foundation for Economic Growth* (TCRP Research Results Digest 102)
- ◆ *Legal Arrangements for Use and Control of Real-Time Data* (TCRP Legal Research Results Digest 37)

Upcoming Events

Conference on Performance Measures for Transportation and Livable Communities

This conference, held September 7-8 in Austin, Texas, will focus on topics related to performance measures for transportation and livable communities. The two-day event will highlight current research projects and future research needs to address transportation and livability goals.

This conference is sponsored by the [University Transportation Center for Mobility](#) and the [Texas Transportation Institute](#), and co-sponsored by the [Transportation Research Board](#), the [Center for Transportation Studies](#), and the [Transportation Economics Center](#) at the Texas Transportation Institute.

More information and online registration are available on the [event web page](#).

Fall 2011 Transportation Seminar Series

CTS and the Intelligent Transportation Systems (ITS) Institute invite transportation professionals and students to join University of Minnesota researchers and guests for presentations offered this fall. The seminars are open to anyone interested in learning more about current transportation research at the University of Minnesota. There is no cost to attend, and registration is not required. Each seminar qualifies for one Professional Development Hour (PDH).

The CTS Seminar Series combines the following seminars:

- ◆ [CTS Research Seminars](#), held as part of CTS research council meetings
- ◆ [Advanced Transportation Technologies Seminars](#), sponsored by the Intelligent Transportation Systems (ITS) Institute each fall semester

Beginning September 15, seminars will be held on Thursday afternoons from 3:30 p.m. to 4:30 p.m. CDT, in 1130 Mechanical Engineering. Most seminars are broadcast live online, and they are also recorded for later viewing. Most seminars are also available on [iTunesU](#) (iTunes required to view).

Complete details will be posted on the [seminar series web page](#) as they become available. For more information, contact Shawn Haag, haag0025@umn.edu, 612-625-5608.

Additional Upcoming Events

August 25 and 26

[CTS and the ITS Institute at the Minnesota State Fair](#), St. Paul, MN

October 6-7

AirTAP Fall Forum, Breezy Point, MN

October 12-14

Minnesota Public Transit Conference, St. Paul, MN