Semi Annual Progress Report for University Transportation Centers

Prepared for the USDOT Office of the Assistant Secretary for Research and Technology (OST-R)

OST-R Sponsor Award Number: 69A355174110

Project title: **Pacific Northwest Transportation Consortium (PacTrans): Providing Data-Driven Solutions for the Diverse Mobility Challenges of the Pacific Northwest**

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Submission Date: April 30, 2019
DUNS: 605799469 **EIN:** 91-6001537
Report #4, SAPR reporting for six months (October 1, 2018 – March 31, 2019)

Project/Grant Period: November 30, 2016 - September 30, 2020
Reporting Period End Date: March 31, 2019
Report Term: Semi-Annual

Accomplishments

What are the major goals and objectives of the program?

Pacific Northwest Transportation Consortium (PacTrans) consists of institutions from all four states in our region with the University of Washington (UW) as the lead and Oregon State University (OSU), University of Alaska Fairbanks (UAF), University of Idaho (UI), and Washington State University (WSU) as research partners, as well as Boise State University (BSU) and Gonzaga University (GU) as education partners. PacTrans' theme centers on "Developing Data Driven Solutions for the Diverse Mobility Needs of People and Goods in the Pacific Northwest". PacTrans serves as a focal point within Region 10 to develop initiatives and facilitate collaborative activities with regional partners to maximize the effectiveness of their collective services and programs toward the U.S. Department of Transportation (USDOT) strategic goal of mobility. Major goals and objectives of PacTrans include:

Research – serving as Region 10's research engine, PacTrans is committed to funding research in both the categories of advanced and, more importantly, applied research.

Technology Transfer – PacTrans strives to be an applied technology showcase, providing additional funds to projects that are deemed as "Success Stories" to ensure dissemination of results to policy makers, educators, practitioners, other transportation professionals, and the general public.

Education – As a consortium of five prestigious universities, PacTrans is devoted to being an education leader. This involves continued evaluation and evolution of our transportation engineering programs as well as providing state-of-the-art research laboratories, student conferences and seminars, mentoring, and scholarship opportunities for our students and future workforce trainees.

Workforce Development – PacTrans endeavors to be a workforce development base: hosting activities that focus on the development of transportation professionals, building strong partnerships with transportation agencies and companies in our region, and designing training programs to address the workforce development needs, while connecting our students with quality jobs where they can implement the knowledge they gained through their education.

Outreach – Throughout all of these other goals and objectives, PacTrans seeks to be in a continual process of outreach: promoting and building the educational student base, making new industry and agency partners, attracting new research, and providing opportunities to share and learn about key outcomes and achievements that have been learned through research.

Collaboration – PacTrans desires to be a platform for participation and is always on the lookout for potential new partner and new opportunities with current partners to collaborate on transportation related endeavors.

What was accomplished under these goals?

During the period from October 1, 2018 – March 31, 2019, PacTrans was actively engaged in each goal and objective identified above. This was achieved through a breadth of activities that were conducted to ensure our transportation expertise contributes to the advancement of the region's transportation

research, technology transfer, education, workforce development, outreach, and collaboration.

Research

As Region 10's research engine, PacTrans has been actively engaged in two broader categories of research projects. We engage in multi-institutional research projects that require participation from at least two consortium universities, and typically have a larger budget. Such projects include multi-institutional general research projects, as well as a multi-institutional educational project, and a multi-institutional outreach project. We also engage in single institutional projects (referred to as small research projects) that only require participation from a single consortium university and typically have smaller budgets. Both categories of research are geared towards the goal of enhancing mobility of people and goods in the Pacific Northwest. Our research covers all four aspects of mobility which includes safety, efficiency, effectiveness, and accessibility.

PacTrans endeavors to begin research performance periods in coordination with the academic school year. During this reporting period PacTrans released the 2019 Request for Proposals for our third year of research funding, which is expected to begin at the beginning of the 2019-2020 academic year. For multi-institution projects, we received twenty abstracts which were then reviewed by our Board of Directors (BOD) for their relevance to our theme and by our External Advisory Board (EAB) for comments. Based on these two reviews, we made recommendations to seventeen of the twenty abstracts to proceed to the full proposal stage. In total, twelve PIs submitted full proposals, each of which was sent out for three academic peer reviews and the top three projects were selected based on those reviews. Each university is also currently in the process of selecting the small projects at their respective universities for funding.

During this reporting period we asked for research project progress reports from all active PIs with Year 1 (2017 – 2019) and Year 2 (2018 – 2020) funding, and several of those projects have already wrapped up. For those Year 1 (2017 – 2019) projects whose draft technical reports have been submitted, they are currently going through the peer and technical review process and the rest will be due by August 2019.

A few great examples of Year 1 projects that have submitted draft technical project reports include:

- OSU Associate Professor Kate Hunter-Zaworski has been using 3D modeling to assist in the design of next generation passenger rail cars. Specifically, the modeling helps with spatial analysis of accessible seating areas for two- and three-wheeled mobility devices. This work is being done for Federal Railroads.
- UW Professor Anne Goodchild pilot tested an innovative improvement strategy at the heart of the final 50 feet dilemma of urban goods delivery. They partnered with the Seattle Department of Transportation to place a common carrier locker in the lobby of the municipal tower in Seattle. They then analyzed the difference in delivery statistics such as: successful delivery rates, length of time spent delivering in a single building, occupancy of load docks/curbside load zones, etc.

Technology Transfer

As PacTrans has described in previous PPPRs, one of our main avenues for technology transfer is

through identification of success stories. Once a sufficient pool of projects have been completed, the center will solicit submissions for "success stories." Success stories are just that, research that merits the added funding and effort to make sure that the findings and conclusions of the project are disseminated to the appropriate entities. Thus PIs will submit proposals on how they would further disseminate and/or apply their findings in thoughtful and useful ways. After the close of our Year 1 research performance period, PacTrans will circulate an RFP asking for submission for these additional dollars.

As part of our recently created technology transfer plan, PacTrans is continuing to work to establish a formal technology transfer advisory committee. We have developed guidelines for that group and their mission and process, and have identified ideal candidates for this committee. We are currently working to set up our first technology transfer workshop this spring.

During the reporting period, PacTrans PIs took many opportunities through conference, seminars, and workshops to showcase our accomplishments of the ongoing research projects.

In early October, PacTrans hosted our annual Region 10 Transportation Conference. For the first time this year we partnered with the Center for Safety Equity in Transportation (CSET) Tier 1 University Transportation Center. Also for the first time, we hosted this conference at one of our partner universities, University of Alaska Fairbanks. This provided an excellent opportunity for people within our region to attend who might not have been able to travel to Seattle in the past. Several PacTrans PIs had the opportunity to present their work during our technical session, and, as usual, PacTrans hosted a poster session where each ongoing PacTrans funded projects is displayed. In total, there were forty posters presented during the seventy-five minute session.

In early January, PacTrans investigators and student researchers presented at over 130 lecturns, posture sessions, workshops, committees, and subcommittees, and had over 110 papers accepted to the Transportation Research Board (TRB) 98th Annual Meeting. This meeting continues to be a great outlet for disseminating PacTrans funded research to practitioners and public agencies.

PacTrans' STAR Lab was in the news several times throughout the fall and winter as they installed several of their smart road stickers on a major trail that connects Northwest Seattle to the UW and then out to Redmond, WA. This technology, along with the STAR Lab detection app, allows drivers, cyclists and pedestrians to be aware of one another's presence, even in low visibility situations.

In March PacTrans hosted the first of our Technology Transfer Seminar featuring Laura Dorsey, Senior Technology Manager at the UW CoMotion, UW's technology transfer office. In her talk she provided an overview of how UW's technology transfer process works including discussion of patents, trademarks, and copyright, and the resources available to support commercialization of innovations created by UW employees. We are currently working with our partner universities to facilitate similar seminars with their technology transfer offices.

Education

During this past summer, students and faculty from the UW and the Norwegian University of Science and Technology had a peer exchange and technology competition with the help of Norwegian Public Roads Administration, PacTrans, the Supply Chain and Transportation Logistics Center, and the Valle

Foundation. Students and faculty from each university had the opportunity to travel to the other respective university of a week of learning about pressing mobility challenges, a team competition to address some of those mobility challenges, lab presentation, and guest lectures.

During this past six month performance period, PacTrans has been actively engaging students with a wide variety of activities and opportunities to further their education, experience, knowledge, and networks. For example, PacTrans offered a new fellowship, called PacTrans Undergraduate Research Fellowship, to undergraduate students who are interested in exploring transportation research. Two students received this fellowship and investigated topics relevant to transportation safety and mobility under the supervision of PacTrans PIs.

In coordination with our annual conference each October, PacTrans also hosts a Region 10 Student Conference. This event was also co-organized by CSET and hosted on the UAF campus. Over fifty students spent the day hearing from government and industry professionals, such as Mark Luiken, the commissioner of Alaska DOT + Public Facilities. They also had a student poster competition with over twenty posters where the invited speakers judged the posters on content as well as effectiveness of communication.

Last November the Oregon State ITE Student Chapter, supported by PacTrans, competed in the Bill Kloos Traffic Bowl and successfully won the event.

In November, the American Public Works Association student chapter from the University of Washington organized an evening event called MPAC night. The theme this year was *Transportation in the Twenty-First Century*, and featured Washington State Department of Transportation (WSDOT) assistant secretary Patty Rubstello, King County Metro General Manager Rob Gannon, and Sound Transit Deputy CEO Mike Harbour. Aside from our students and researchers getting to hear about contemporary mobility opportunities and challenges from government and industry leaders, this even provides a wonderful opportunity for future transportation professional (students) to network with potential employers. PacTrans sponsored this event.

This past January, PacTrans supported almost seventy students from consortium universities to travel to Washington D.C. for the 98th TRB Annual Meeting. Among those students was a team from OSU who participated in the Traffic Control Devices Challenge, a TRB-Standing-Committee-on-Traffic-Control-Devices hosted content which, this year, was conducted like the television show *Shark Tank*. PacTrans also presented this year's Region 10 Michael Kyte Outstanding Student of Year Award to UI PhD student, Maged Mohammed. Lastly, during the Council of University Transportation Center (CUTC) Winter Banquet, PacTrans had two students win CUTC Outstanding Student of the Year Awards. These went to OSU PhD Student, Zachary Barlow, and UW PhD Student, Parastoo Jabbari.

This spring, UW PhD student and PacTrans student researcher, Gabriela Giron, was selected for the ENO Future Leaders Development Conference.

Finally, PacTrans extended fellowship offers to six incoming domestic graduate transportation students with outstanding records over the past months and four of those invitations were accepted to date.

Workforce Development

PacTrans had a number activities geared at workforce development during this reporting period. Notably, an ongoing multi-institutional education project titled *Workforce Development Institute*, is an ongoing project to scope the current and future continuing education needs of agencies and private industry in Region 10. The research team has been making a solid progress toward the final goal of this project. PIs have scanned the resources and programs that are currently available nationwide, surveyed transportation professionals across the region about current and future continuing education needs, and began developing a business plan for the institute. Over the reporting period, PIs talked to local transportation agencies and companies to prioritize the first group of courses to offer. Transportation agencies, such WSDOT and Alaska Department of Transportation and Public Facilities (ADOT&PF), clearly see the value of the institute and communicated their needs to the PIs to consider.

PacTrans hosted a number of great seminars during this reporting period to offer students the opportunity to hear from academic researchers and working professionals from public agencies and the private sector:

1. In October, PacTrans hosted a talk from senior engineer/project manager at the Norwegian Public Roads Administration (NPRA), Ane Dalsnes Storsæter. Her talk was titled, *Transportation Technology in the Norwegian Public Roads Administration.*
2. In November, PacTrans hosted our Fall Regional Transportation Seminar featuring Ram Pendyala, Professor of Transportation in and the Interim Director of the School of Sustainable Engineering and the Built Environment at Arizona State University. His talk was titled, *It's All About the Size of the Effects: The Case of the Millennials Difference and the Influence of the Built Environment*.
3. Also in November, PacTrans hosted vice president and Senior ITS Manager for WSP USA, Les Jacobson for a talk titled, *Impacts of Emerging Technologies on Transportation Operations*.
4. In January, PacTrans hosted C. Y. David Yang, Executive Director of AAA Foundation for Traffic Safety. His talk was titled, *Emerging Transportation Technologies and Their Potential Impacts to Traffic Safety*.
5. In March, PacTrans hosted our Winter Regional Transportation Seminar featuring Darrin Grondel, Director of the Washington Traffic Safety Commission. His talk was titled, *Washington's Strategic Highway Safety Plan, Target Zero: Current Issues and Potential for Future Research*.

What opportunities for training and professional development have the program provided?

Many of the specific details of these opportunities have been discussed above. More generally, PacTrans provides training and professional development opportunities through multiple channels:

Research: Through the lifespan of this grant, PacTrans annually selected research projects that offered faculty and student researchers (including undergraduate students) funding to conduct cutting edge research in a variety of areas directly tied to the USDOT strategic goals.

Education: PacTrans consortium partners offer a variety of other on-campus and online courses designed for professional development in addition to the regular degree programs. The online

programs, such as the online master's program of sustainable transportation, are particularly good for working professionals because of the flexibility in schedule and location. As an example, PacTrans student Elyse O'Callaghan Lewis was selected to attend the 2018 Eno Leaders Development Conference. PacTrans sponsored her to participate in this important education and leadership development event.

Outreach: PacTrans offers training and educational opportunities to K-12 students through its outreach activities. For example, the UW hosted Tyee Middle School robot team's on-campus visit and offered product improvement suggestions to the student team. Also, Dr. Don MacKenzie of the UW integrated real-world problems into a senior level cape stone class to link PacTrans faculty and students to practitioners how look for practical solutions in transportation.

Funding assistance: PacTrans has supported student education and research activities. Beyond our PacTrans fellows, for whom we fund tuition, we also give a significant amount of assistance to students to participate in competitions, conferences, and seminars such as the Hyperloop competition and the TRB Annual Meeting. This aides them with funds for presentation materials, travel expenses, and registration fees.

Seminars, workshops, and conferences: As outlined above, PacTrans offers many opportunities for training and professional development through its seminar series and various workshops. Furthermore, PacTrans also uses its Region 10 Transportation Conference and Region 10 Student Conference as important opportunities for training and professional development.

Internships: PacTrans internship program offers students training opportunities by partnering with local agencies and private industries. We have internship programs with WSDOT, Seattle DOT, Bellevue Transportation Department, Transpo Group, Zillow, FEHR & PEERS, Parsons Brinckerhoff, Puget Sound Regional Council, Oregon Department of Transportation (ODOT), etc. Additionally, PacTrans also offers intern opportunities for high-school, graduate and undergraduate students to work in university labs to gain hands on experience in transportation.

Partnerships: PacTrans has a partnership program with Institute of Transportation Engineers (ITE). PacTrans has developed strong partnerships with local ITE chapters in student mentoring and training. ITE Washington has a mentor program for university students. They offer student fellowships and also host events for student training.

How have the results been disseminated? If so, in what way/s?

PacTrans has a strong outreach program to local and state transportation agencies and private partners in the region, where PacTrans research outcomes are presented and demonstrated. Research outcomes are posted on the PacTrans website, distributed through our *quarterly newsletter* and *annual reports*, and promoted through social media such as *Facebook* and *Twitter* and the UW *press media*. We also disseminate news, events, and results via our website at www.pactrans.org.

Another avenue for dissemination that PacTrans leans on heavily is presentations at conferences, workshops, and symposia. Already mentioned in this report was the PacTrans organized Region 10 Transportation Conference as well as the TRB Annual Meeting, both of which provide substantial opportunities for our researchers to disseminate their research findings.

As has been mentioned above, PacTrans also encourages new, innovative dissemination materials through the identification of success stories, where PacTrans offers limited additional funds to projects that have results with potentially strong impacts. These funds can then be used to explore new and innovative opportunities to get knowledge, methods, and products gained, into the hands of practitioners. This year these funds have been used to host workshops/training, produce informational videos, build online tools and procedure manuals, etc.

New to PacTrans upcoming 2019 – 2021 research cycle, each PI will be required to host a seminar/webinar at the conclusion of their project. They were already asked during the proposal period to name invitees to their seminar/webinar which further reinforced the focus on technology transfer from the beginning stages of their research. Also, several technology transfer advisors have been identified and an advisory board will be formed to help PacTrans' tech transfer process.

Finally, per our obligation as a UTC, research results are posted on our website and are disseminated to all of the required repositories that include, TRID, USDOT, Transportation Library, Volpe National Transportation Systems Center, Federal Highway Administration (FHWA) Research Library and the US Department of Commerce National Technical Information Service.

What do you plan to do during the next reporting period to accomplish the goals and objectives?

PacTrans is excited for the busy season ahead. Below are the center's identified plans and strategies for accomplishing its goals and objectives over the next reporting period.

Research

During this next reporting period PacTrans will wrap up Year 1 (2017 – 2019) funded projects, monitor Year 2 (2018 – 2020) projects, and finish selection of all Year 3 (2019 – 2021) project. Funding and the performance period for Year 3 (2019 – 2021) projects will commence at the beginning of the 2019 academic year. As Year 1 (2017 – 2019) project technical reports are submitted, we will send them out for peer review, and then to a technical editor before considering them complete. We will then post the reports on our website and send them to TRID and Research Hub. Finally we will begin implementation of our data management plan and make sure access to the data used in our funded projects is available via project profiles on our website. Year 3 (2019 – 2021) projects will have profiles created on our website and they will also be uploaded to RiP.

Technology Transfer

PacTrans will form its technology transfer advisory board to ensure an effective procedure and implementation plan for technology transfer. PacTrans Board will discuss whether to release an RFP for success stories based upon our completed Year 1 (2017 – 2019) projects.

During this next reporting period, PacTrans has several great opportunities for technology transfer. Two such examples are the Mobility Summit of University Transportation Centers and the ASCE International Conference on Transportation and Development (ICTD):

In April, PacTrans assistant director, Cole Kopca, will travel to Washington D.C. to take part in the

Mobility 21 UTC hosted Mobility Summit of University Transportation Centers. This event is a great opportunity to share the great research our UTC has been involved in and here from government and industry leaders about the opportunities and challenges in the mobility space.

In June, several faculty and student researchers will travel to Alexandria, Virginia to attend the ASCE ICTD. There will be an UTC Smart City Activities Workshop as well as several technical session and poster presentations based on PacTrans funded research.

Education

During this next reporting period, PacTrans will be very busy with education endeavors. Each consortium partner receives some money each year for education and outreach activities. Those funds are at the discretion of the Associate Director (PI of the subaward) from each of the partner institutions. Those funds tend to be used to support the following:

1. We support professional organization student chapters, such as the ITE UW Student Chapter, and student competition teams, such UI's clean snowmobile team and UW's Hyperloop team. Most of these teams have regional and national competitions during the spring.
2. Some of these funds are historically used to support the travel of students to conferences such as the ASCE ICTD to present their work.
3. Most of our consortium partner universities have student outreach opportunities during the spring. PacTrans will host a booth at the UW Engineering Discovery Days, OSU will take part in their annual Student Expo, and UAF will play a major role in Engineering Days.

Workforce Development

PacTrans has a few important focuses for workforce development over this next reporting period:

1. The center will continue working with agency, industry, and academic partners to develop the PacTrans Workforce Development Institute (WDI). This includes analysis of survey and outreach results on workforce needs around the Pacific Northwest, as well as development of an administrative structure, business plan, and at least three courses.
2. PacTrans will host the Spring Regional Transportation Seminar featuring Paul Waddell, Professor of City & Regional Planning at UC Berkeley. This event with coincide with the UW Urban Planning PhD 50th anniversary.

Outreach

The majority of opportunities for PacTrans consortium partners to engage in outreach activities geared toward younger students occur in the spring, however, during this upcoming reporting period PacTrans will focus heavily on outreach to prospective and potential partners.

PacTrans director, Dr. Yinhai Wang, was invited to present PacTrans research on transportation safety and mobility at Washington State Traffic Commission on March 22. Soon after the presentation, he was invited to join Washington State Autonomous Vehicle Work Group (AVWG) Executive Committee. This AVWG involves in many agencies and companies and is going to be a great venue for PacTrans outreach. In addition, the PacTrans outreach research project team will produce some products that summarize its first two years' research effort. These products will be great for PacTrans to use in the outreach efforts to local legislation for possible policy revisions and developments.

Participant and Collaborating Organizations: Who has been involved?

What individuals have worked on the program?

- PacTrans Director, **Yinhai Wang**, Ph.D., Professor of Civil and Environmental Engineering at the UW, devotes 30 percent of his time directing PacTrans. Dr. Wang has overall responsibility for program management, oversight of PacTrans operations, including the Research Committee, the Education and Workforce Development Committee, and the Outreach and Technology Transfer Committee, and Student Leadership Council. He is the regional and national leadership for PacTrans, and the contact person for management relationships with USDOT Office of the Assistant Secretary for Research and Technology (OST-R) and other USDOT organizations.
- PacTrans Associate Director in Research, **Jeff Ban**, Ph.D., Associate Professor of Transportation Engineering in Civil and Environmental Engineering at the UW spends 5 percent of her time managing the research program for PacTrans and coordinates the research collaboration across the five partner institutions.
- PacTrans Associate Director in Education and Workforce Development, **Anne Vernez-Moudon**, Dr. es SC, Professor of Architecture, Landscape Architecture, and Urban Design and Planning, Adjunct Professor of Epidemiology and in Civil and Environmental Engineering, devotes 5 percent of her time leading the Education and Workforce Development Committee. She is involved in curriculum changes, training program development, and educational enhancements among the partner institutions.
- PacTrans Associate Director in OSU, **David Hurwitz**, Ph.D., Professor of Civil and Construction Engineering at OSU, devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within OSU. He coordinates all results and outcomes with the UW on a regular basis.
- PacTrans Associate Director in UAF, **Billy Connor**, Director of the Alaska University Transportation Center (AUTC), devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within UAF. He coordinates all results and outcomes with the UW on a regular basis.
- PacTrans Associate Director in UI, **Ahmed Abdel-Rahim**, Ph.D., Associate Professor of Civil Engineering at UI, devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within UI. He coordinates all results and outcomes with the UW on a regular basis.
- PacTrans Associate Director in WSU, **Eric Jessup**, Ph.D., Associate Professor and Transportation Economist in the School of Economic Sciences at WSU, devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within WSU. He coordinates all results and outcomes with the UW on a regular basis.
- Assistant Director, **Cole Kopca**, devoted 90 percent of his time to the day-to-day operations in support of the PacTrans mission. His responsibilities include project management, grant management, events coordination and outreach, and managing the PacTrans operations team.
- PacTrans full-time Program Coordinator, **Melanie Paredes**, devoted 90 percent of her time to the Center's fiscal matters, support with events coordination and outreach and day to day administration.
- **Leona Vaughn**, undergraduate student in the College of Communications at the UW was recently hire

to do communications work for PacTrans. She's spends 20 percent of her time on website upkeep and social media networking and posting.

- **Ying Jiang**, Ph.D., Research Associate in the PacTrans STAR Lab at the UW, devotes 30 percent of his time in providing research support and oversight.
- The Student Leadership Council, composed of graduate students at all Consortium partner universities, is an active part of the PacTrans management structure. The Student Leadership Council facilitates student and center communications and plans their own activities such as the Region 10 Student Conference.
- PacTrans has 28 fulltime faculty at the UW directly engaged in transportation research. Our consortium partners (OSU, UI, WSU, UAF, GU, and BSU) have 43 fulltime faculty directly involved in PacTrans research.

What other organizations have been involved as partners?

While this iteration of our center is still very young, PacTrans has continuing relationships with many partners that have been cultivated over the years. The table below highlights the many partnerships that PacTrans has built over the duration of the center:

Partner	Type	Fund Match		Serve on EAB	Project Collaborator	Event Collaborator
		Financial	In Kind			
Alaska Department of Transportation and Public Facilities	Government	X		X		
Idaho Transportation Department	Government	X		X		
Oregon Department of Transportation	Government	X		X		
Washington State Department of Transportation	Government	X		X		
City of Bellingham	Government					
City of Seattle	Government	X				
City of Lynnwood	Government				X	X
City of Bellevue	Government				X	X
City of Everett	Government					X
King County	Government				X	X
Snohomish County	Government					
Pierce County	Government				X	
Sound Transit	Government Agency			X	X	
Washington Traffic Safety Commission	Government Agency					X
Washington State Transportation Insurance Pool	Government Agency	X				X

University of Alaska, Anchorage	Educational Institution		X		X	X
University of Washington Transportation Services	Educational Institution				X	
Washington State Department of Ecology	Government	X				
Puget Sound Regional Council	Government			X		
Washington State Transportation Investment Board	Government Agency					X
American Society of Civil Engineers	Professional Association					X
Institute of Electrical and Electronics Engineers	Professional Association					X
Institute of Transportation Engineers	Professional Association					X
Port of Portland	Government			X		
BMW Group	Private Industry			X		
Western Trailers	Private Industry			X		
Coral Sales Co.	Private Industry	X				
National Institute for Transportation and Communities	University Transportation Center				X	X
Transportation for Livability by Integrating Vehicles and the Environment	University Transportation Center				X	X
Center for Environmentally Sustainable Transportation in Cold Climates	University Transportation Center				X	X
Aichele and Associates	Private Industry				X	
Alstom Grid Inc.	Private Industry				X	
Alta Planning and Design	Private Industry				X	
Battelle	Private Industry				X	X
Cascade Bicycle Club	Non-profit/ Foundation				X	X
Feet First	Non-profit/ Foundation					X
DKS Associates	Private Industry	X				X
Fehr and Peers	Private Industry				X	X
FLIR	Private Industry				X	
Inrix Inc.	Private				X	

	Industry					
Nokia	Private Industry	X				
Transpo Group	Private Industry	X				X
Intelligent Transportation Systems of Washington	Professional Association					X
Luum	Private Industry				X	X
Kittelson and Associates	Private Industry			X		X
Microsoft	Private Industry				X	X
BlackBerry	Private Industry				X	X
PACCAR, Inc.	Private Industry				X	X
West Salem High School	Educational Institution				X	X

Outputs

	Total	UW	WSU	UI	OSU	UAF	GU	BSU
Publications: peer reviewed journal articles	**97**	33	15	15	30	1	3	0
Publications: Book chapters and other edited manuscripts	**6**	2	0	1	3	0	0	0
Conference papers	**97**	20	22	25	24	4	2	0
Conference presentations	**119**	40	14	28	26	4	7	0
Lectures/Seminars /Workshops/ Invited Talks	**79**	29	5	8	24	7	5	1
Policy Papers	**9**	2	0	2	3	2	0	0
Websites or Other Internet Sites	**7**	4	0	1	2	0	0	0
New Methodologies, Technologies or Techniques	**32**	7	1	12	10	1	1	0
Inventions, patent applications, and/or licenses	**0**	0	0	0	0	0	0	0
Other products: data or databases, physical collections, audio or video products, software or NetWare, models, educational aids or curricula, instruments, or equipment	**21**	9	2	3	6	1	0	0

As part of the PacTrans' newly adopted Technology Transfer Plan, we committed to tracking the following output metrics:
(1) Number of publications, presentations, and posters made at conferences or workshops explaining or promoting the research outputs: **during this reporting period PacTrans had a total of 398 such instances reported by our Principal Investigators (refer to the table above and examples highlighted below)**.
(2) Number of software tools and technologies made available to practitioners: **during this reporting period PacTrans had a total of 37 such instances reported by our Principal Investigators (refer to the table above and examples highlighted below).**

Examples of peer reviewed journal articles

Maalej, Yassine, Sameh Sorour, Ahmed Abdel-Rahim, and Mohsen Guizani. "VANETs Meet Autonomous Vehicles: Multimodal Surrounding Recognition using Manifold Alignment." IEEE Access (2018).

Ammous, Mustafa, Syrine Belakaria, Sameh Sorour, and Ahmed Abdel-Rahim. "Optimal Cloud-Based Routing With In-Route Charging of Mobility-on-Demand Electric Vehicles." IEEE Transactions on Intelligent Transportation Systems (2018)

Mohebifard R.* and A. Hajbabaie, 2019. Optimal Network-level Traffic Signal Control: A Benders Decomposition-Based Solution Algorithm. Transportation Research Part B: Methodological, Vol. 121, pp 252-274.

Tajalli M.* and A. Hajbabaie, 2018. Distributed Optimization and Coordination Algorithms for Dynamic Speed Harmonization in Connected Urban Street Networks. Transportation Research Part C: Emerging Technologies, Vol. 95, pp 497-515.

Abadi. M.G, Hurwitz, D. Sheth, M. McCormack, E., and A Goodchild (2019) Factors Impacting Bicyclist Lateral Position and Velocity in Proximity to Commercial Vehicle Loading Zones: Application of a Bicycling Simulator, Accident Analysis and Prevention, 125: 29-39

Abadi, M.G.* & Hurwitz, D. (2019) "Operational Impacts of Protected-Permitted Right-Turn Phasing and Pavement Markings on Bicyclists Performance during Conflicts with Right-Turning Vehicles," Transportation Research Record: Journal of the Transportation Research Board.

Abadi, M.G.*, Hurwitz, D., Sheth, M., McCormack, E., & Goodchild, A. (2019) "Factors Impacting Bicyclist Lateral Position and Velocity in Proximity to Commercial Vehicle Loading Zones: Application of a Bicycling Simulator," Accident, Analysis, & Prevention, Volume 125,29-39.

Abadi, M. G.*, Hurwitz, D., & Macuga, K. (2nd submission 11/25/2018) "Towards Safer Bicyclist Responses to the Presence of Truck near an Urban Loading Zone," Journal of Safety Research.

Chen, P., & Shen, Q. (2019). Identifying high-risk built environments for severe bicycling injuries. Journal of safety research, 68, 1-7.

S. Belakaria, M. Ammous, S. Sorour, and A. Abdel-Rahim, "Fog-Based Multi-Class Dispatching and Charging for Autonomous Electric Mobility On-Demand," accepted for publication in IEEE Transactions on Intelligent Transportation Systems.

M. Ammous, S. Belakaria, S. Sorour, and A. Abdel-Rahim, "Optimal Cloud-Based Routing with In-Route Charging of Mobility On-Demand Electric Vehicles," accepted for publication in IEEE Transactions on Intelligent Transportation Systems.

Shangjia Dong, Alireza Mostafizi, Haizhong Wang, Jianxi Gao, and Xiaopeng (Shaw) Li. Measuring the Topological Robustness of Transportation Network Under Random Failures: A Percolation Approach. Under second-round review with ASCE Journal of Infrastructure System, Nov. 9, 2018.

Shangjia Dong, Haizhong Wang. A Network-of-Networks Percolation Analysis of Cascading Failures in Spatially Co-located Road-Sewer Infrastructure Networks. Under Revision with Physica A: Statistical Mechanics and Applications, January 2019.

Shangjia Dong, Haizhong Wang. A Percolation-based Robustness Modeling Framework for Transportation Network Under Targeted Attack and Probabilistic Infrastructure Failures: Post-disaster Accessibility to Critical Facilities. Under third-round review with Journal of the Royal Society Interface, Jan. 2019.

Alireza Mostafizi, Haizhong Wang, and Shangjia Dong. Understanding the Multimodal Evacuation Behavior for a Near-field Tsunami. Accepted by Journal of Transportation Research Record, Jan. 2019.

Harith Abdulsattar, Alireza Mostafizi, and Haizhong Wang. Measuring the Impacts of Connected Vehicles on Travel Time Reliability in a Work Zone Environment: An Agent-based Approach. Journal of Intelligent Transportation Systems. Jan, 2019.

Alireza Mostafizi, Haizhong Wang, Dan Cox, and Shangjia Dong. An Agent-Based Model of Vertical Tsunami Evacuation: Sheltering Behavior, Locations, and Life Safety. International Journal of Disaster Risk Reduction. December. 2018.

Zhuang*, Yifan, Ruimin Ke*, Yinhai Wang. "Innovative Method for Traffic Data Imputation Based on Convolutional Neural Network", IET Intelligent Transport Systems, In press, Nov 2018.

O'Banion, M., Olsen, M., Rault, C., Wartman, J., and Cunningham, K. (2018) Suitability of structure from motion for rock-slope assessment, The Photogrammetric Record, 33, pp 217-242

Example of book chapters and other edited manuscripts

Yinhai Wang and Ziqiang Zeng (2018). Data-Driven Solutions to Transportation Problems. Elsevier. eBook ISBN: 9780128170274, Paperback ISBN: 9780128170267.

Joseph Claveria (2018). Evaluating Distracted Driving Behavior Among Drivers of Large Trucks Through Econometric Modelling: A Pacific Northwest Case Study. Oregon State University, Thesis, published.

Jason Anderson (2018). Unobserved Heterogeneity and Spatial Correlation: Statistical and Econometric Analyses of Heavy-Vehicle Hard Braking and Crash Frequency by Crash Type. Oregon State University, Dissertation, published.

Nabeel Al-Bdairi (2018). Modeling Unobserved Heterogeneity and the Injury Severities of Truck Drivers in Run-Off-Road (ROR) Crashes: Econometric Methods and Applications. Oregon State University, Dissertation, published.

Yinhai Wang and Michael McNerney (2018). Proceedings of the ASCE International Conference on Transportation and Development 2018. American Society of Civil Engineers.

Examples of conference papers and presentations

Rafael Akio Alves Watanabe, Sameh Sorour, Mohamed Hefeida, and Ahmed Abdel-Rahim, "Towards Real-Time Traffic Monitoring using Airborne LiDAR", IEEE Wireless Communications and Networking Conference (WCNC 2019), Marrakech, Morocco, April 2019.

Mohamed Mohamed, Maged Mohamed, Ahmed Abdel-Rahim, and Kevin Chang, "Safety Impact of Edge Lines Wider Pavement Marking" Transportation Research Board 98th Annual Meeting, January 13-17, 2019, Washington D.C.

Amin E.*, P. Olson, A. Hajbabaie, and M. Lowry. Stop-Bar and Advance Detection Design for Left-Turn Operations. The 98th Annual Meeting of the Transportation Research Board, Washington, DC, January 13-17, 2019 (Poster).

Mohebifard R.*, S. Islam*., and A. Hajbabaie. Cooperative traffic signal and perimeter control in semi-connected urban-street networks. The 98th Annual Meeting of the Transportation Research Board, Washington, DC, January 13-17, 2019 (Poster).

Mohebifard R.*, S. Islam*, and A. Hajbabaie. Integrated Signal Timing and Traffic Metering Optimization in Connected Urban Transportation Networks. INFORMS Annual Meeting 2018, Phoenix, AZ, November 4 – 7, 2018 (Lectern).

Kim, H., A. Goodchild, B. Ivanov, M. Sheth "Can Common Carrier Lockers Ease the E-Commerce Delivery Explosion in Cities?" Annual Meeting of the Transportation Research Board, Washington D.C. (January, 2019)

Kim, H., B. Ivanov, A. Goodchild "Will Common Carrier Lockers in Public Spaces Ease the E-Commerce Delivery Explosion in Cities?"VREF Urban Freight Conference, Gothenburg, Sweden (October 2018)

Louis, J. (2019) "AR Sandboxes for Civil and Construction Engineering Education" Presented at 87th Annual Pacific Northwest Section ASEE Conference, Corvallis OR, March 2019

Jung, J., Che, E., Olsen, M.J., Parrish, C. (2019). Using lidar for retro reflectivity evaluations, Professional Land Surveyors of Oregon

Annual Meeting, Eugene, OR.

"Building an Effective Community of Practice for Transportation Engineering Education." Presented at the 2019 Annual Meeting of the Transportation Research Board, Washington, D.C., January 2019.

Y. Xu, Y. Turkan, Bridge Inspection using Bridge Information Modeling (BrIM) and Unmanned Aerial Vehicles (UAVs), Proceedings of 35th CIB W78 Conference, IT in Design, Construction, and Management Chicago, IL, October 2018, pp. 617-624. (47% acceptance rate) https://doi.org/10.1007/978-3-030-00220-6_74

Invited Paper 2019 Asilomar Conference, Pacific Grove, CA https://www.aconf.org/conf_161420.html "Vehicular Radar Networks" S. Jin, S. Roy, G.Xing and H. Liu (to appear)

R. Alves Wantabe, S. Sorour, M. Hefeida, and A. Abdel-Rahim, "Towards Real-Time Traffic Monitoring Using Airborne LiDAR", in proc. of IEEE WCNC' 19, Morocco, April 15-18, 2019.

Rockfall activity rates following the Canterbury New Zealand Earthquake Sequence. 7th International Conference on Earthquake Geotechnical Engineering. 2019.

Bahadori, A., Zhang, K., Li, X., Muhunthan, M., "Development of Asphalt Materials to Mitigate Studded Tire Wear of Pavements"-Pactrans Meeting 2018, Fairbanks

R. Watanabe, S. Sorour, M. Hefeida, and A. Abdel-Rahim, "Real-time Monitoring of Transportation Corridors using Airborne LiDAR," in Proc. of IEEE Wireless Communications and Networking Conference (WCNC'19), Marrakech, Morocco, April 2019.

Alireza Mostafizi, Haizhong Wang, and Shangjia Dong. Understanding the Multimodal Evacuation Behavior for a Near-field Tsunami. Presented at the 98th Transportation Research Board Annual Meeting, Washington D. C., Jan. 2019.

Haizhong Wang, Rayeedul Kalam Siam, Yong Wang, and Shejun Deng. A Multi-agent Modeling of Human-Like Socially Intelligent Signalized Intersections with Memory and Learning: A Machine Learning Approach. Presented at the 98th Transportation Research Board Annual Meeting}, Washington D. C., Jan. 2019.

Rayeedul Kalam Siam, Changqiao Shao, and Haizhong Wang. An Efficiency-Based Formulation of Freeway Capacity: Analytical Properties and Practical Implications. Presented at the 98th Transportation Research Board Annual Meeting}, Washington D. C., Jan. 2019.

Lang, X., Jessup, E., Hernandez, S. (2019). An Analysis of Driver's Injury Severity Related to Commercial Truck Parking Availability. 98th Transportation Research Board, Washington D.C., USA, January 2019

Robins, G., Hernandez, S., (2018) .An Optimal Route Risk model for improved Safety and Operational Efficiency: A New Zealand Case Study. International Road Federation Annual Conference, Las Vegas, Nevada.

Example of lectures/seminars/workshops/invited talks

Keynote Speaker, 2nd International Conference in Sustainable Construction and Project Management – Sustainable Infrastructures and Transportation for Future Cities" December 16-18, Aswan Egypt.

WSU's Research Week on 10/17/2018. The workshop title was Matchmaking Flash Talks: Native American Interests. "Inspiring Transportation Careers with K–12 Curriculum Activities" and my participation in that workshop led to the right contacts and communications for us to have a table at the 9th annual Nez Perce STEM Fair in December. Michelle Akin

Anne Vernez Moudon, 2 – Wheeler Transport and Health, Fourth Symposium on Land Use/Transport, Infrastructure and Sustainable Development CAUP Tongji University December 12, 2018

Anne Verne Moudon, Mobility patterns, urban form, & health,First International Conference on Urban and Rural Development and Planning in the Water Network Area (2018 ICURDP), SUST – Suzhou University of Science and Technology, December 15, 2018.

Examples of Website(s) or other Internet site(s)

https://uidaho.maps.arcgis.com/apps/CrowdsourceReporter/index.html?appid=a0d9806557c8458691cf0185ba71e018

Examples of New Methodologies, Technologies or Techniques

Alaska Test Method - Dust Column Test - March 2019

New mix designs for 3D printed concrete

A traffic simulation is being developed that enables users to interact with the simulation in real time using augmented reality.

We have developed an algorithm to extract complex markings from pavement. We have also begun development of a GUI for rockfall analysis code.

Improved techniques for optimizing real time evacuation of cities in a disaster while responding to constantly changing conditions in the disaster and in the transportation network.

Developed new, computationally-efficient software that reads raw UAS-based lidar data files, performs geo-referencing, and detects vehicles.

Developed new methods for quantitative comparison and analysis of UAS-based lidar and UAS-based structure from motion (SfM) photogrammetry, described in the MS thesis of Chase Simpson (supported through this project)

Independent testing methodologies for RSU/OBU communications

Techniques for Multi-Class Management with Sub-Class Service for Autonomous Electric Mobility On-Demand Systems.

Techniques for Fog-Based Multi-Class Dispatching and Charging for Autonomous Electric Mobility On-Demand.

Techniques for Optimal Cloud-Based Routing with In-Route Charging of Mobility On-Demand Electric Vehicles.

Techniques for Real-time Monitoring of Transportation Corridors using Airborne LiDAR.

Examples of Data/Database/Video/Software/Educational Aids/Curricula/Equipment

New large-scale concrete printer.

We have acquired an additional dataset at our long lake Alaska field sites

We created a small database of all the communities with bike share, e-bike share, and e-scooter systems in Washington, Oregon, and Idaho.

Software for real-time city evacuation optimization.

Produced new UAS-based lidar data (georeferenced point clouds) acquired with a Phoenix LiDAR Systems MiniRanger, incorporating a Riegl VUX-1 lidar for an intersection near the University of Washington campus.

Currently developing airborne lidar simulator for K-12 education and outreach (not directly funded through this project, but anticipated to be beneficial for multiple outreach initiatives)

Tutorial on Evaluating and Testing of Communication Techniques in Autonomous Vehicle Environments

We have provided data from multiple years (6+) of laser scanning for our sites in Alaska on DesignSafe. We expect to do the same of the next few collects.

PacTrans website for UAS in Transportation Expo (held on OSU campus in Summer 2018, website updated November 1, 2018): http://depts.washington.edu/pactrans/pactrans-technology-transfer-success-story-2018-1-uas-in-transportation-expo/

https://depts.washington.edu/funlab/projects/center-on-satellite-multimedia-and-connected-vehicles/

Database of state and local laws for bicycle transportation.

Beet-brine spectral library

Webinar of FSI modeling of bridges using OpenSees

Outcomes

As part of the PacTrans' newly adopted Technology Transfer Plan, we committed to tracking the following output metrics:

(1) Number of early adopters of our research outputs: **during this reporting period we have had 3 such instances reported by our Principal Investigators (please see text below for further description).**

(2) Changes made to the transportation system, or its regulatory, legislative, practice manuals, design standards, or policy frameworks: **during this reporting period we had 0 such instances reported by our Principal Investigators.**

When our researcher from the University of Alaska speak with residents of rural communities about their largest transportation concerns, dust pollution is continually listed among their top three. Loss of fine soil fraction from vehicles driving on gravel roads accelerates road deterioration, and poses significant health and environment impacts to the communities they affect. Thus, PacTrans funded a UAF-led project titled *Development of a Laboratory Procedure for Measuring the Effectiveness of Dust Control Palliatives*. Since that projects completion, and during this reporting period, the methods developed have been submitted to the AASTO Subcommittee on Materials to be published in the Full Standard Test Method, and has also been taught to and implemented by engineers at the Alaska Department of Transportation.

During this past reporting period, ODOT has elected to begin working on incorporating a new PacTrans-developed technique into their standard assessments state wide. In many previous PPPRs, PacTrans has written about a team of researchers that has been exploring slope stability and new methods for mapping and identifying critically vulnerable slopes for active response. They have developed a Rockfall Activity Index, as well as software for DOTs and others to be able to utilize these newly developed techniques. In the past, both Oregon and Alaska Departments of Transportation have tested the use of these developments.

During this reporting period, OSU Assistant Professor Sal Hernandez's PacTrans work titled, *Understanding Freight Behavior in the Pacific Northwest: An Evaluation and Application of EROAD Data to Freight Demand and Forecast Modeling,* lead to a conference presentation (listed above in the outputs section), which then led to the adoption and a subsequent Red Paper by EROAD. Red Papers are products that offer tips, insight and strategies to help the freight industry be prepared for the electronic logging device (ELD) mandate. Dr. Hernandez's Red Paper is currently being featured by EROAD for their subscribers (https://www.eroadglobal.com/global/resources/).

Impact

As part of the PacTrans' newly adopted Technology Transfer Plan, we committed to tracking the following output metrics:
(1) Number of research outputs that positively contribute to the reduced roadway vehicle to vehicle or vehicle to ped/bike crash rates: **during this reporting period we have had 3 such instances reported by our Principal Investigators (please see text below for further description).**
(2) Number of research outputs that positively contribute to improving roadway travel reliability, efficiency, and accessibility: **during this reporting period we have had 2 such instances reported by our Principal Investigators (please see text below for further description).**

What is the impact on the effectiveness of the transportation system?

Over the past several years, PacTrans has funded several projects from a multi-institutional team of researchers revolving around the use of public right-of-way in urban contexts, and more specifically interactions between different modes. This has included examination of the impact of increasing commercial parking utilization on cyclist safety, development of design guidelines for commercial vehicle envelopes, and most recently, a best practice scan on managing increasing demand for curb space. The results of these projects have been received with great interest from both the private sector and the public sector. The insights from these projects have already made their way into new design guidelines and are helping to create a safer urban right-of-way where all users are accommodated.

One of PacTrans' WSU principal investigators focuses on design of permeable pavements. Through a recent PacTrans funded project, her team has designed a more durable permeable pavement for sidewalks, parking lots, and shared-use paths. Implementation of these new permeable pavements will increase travel reliability and accessibility for users.

A UI research project, funded through PacTrans, has rigorously evaluated Roadside Unit/Onboard Unit communication infrastructure in different areas of Ada County as a part of their Signal Phasing and Timing (SPaT) challenge. The outcome of initial testing gave invaluable insight to the communication reliability (mainly via measuring PDR) of using Dedicated Short Range Communications (DSRC). This rigorous testing has provided Ada County the opportunity to compare different communication architectures and handover standards as well as different vendors. It has also helped to ensure that the deployment of connected technologies through the vehicles and infrastructure is reliable and efficient.

What is the impact on the adoption of new practices, or instances where research outcomes have led to the initiation of a start-up company?

As stated in the outcomes section above, we have a team of researchers currently working to develop a Graphical User Interface based on newly developed rockfall analysis techniques. They will offer ODOT a simple and user friendly, yet highly advances and sophisticated method, for assessing rockfall danger. The pilot tests for this method have already shown to be of utmost value in their ability to identify critical rock slopes which can then be actively controlled instead of reactive, saving lives and scarce resources.

Several years ago, PacTrans funded a research project from OSU titled, *Improved Safety and Efficiency of Protected/Permitted Right Turns (PPRT) for Bicycles in the Pacific Northwest*. Due to the outputs of this work, that team recently evaluated new PPRT signal displays and signal configurations for ODOT, and new designs were added to the signal policy design guide. Further, a new, quieter software requirement specification was evaluated, which is currently being adopted into design guidance for a technical memo to be circulated to all ODOT engineers.

What is the impact on the body of scientific knowledge?

PacTrans researchers published numerous research papers and reports that contributes to the scientific knowledge body on transportation safety and mobility. Two examples are:

PacTrans PIs has developed a new method and tool for Federal Highway Administration to use to update national highway speed limit database on an annual basis. This new method will be presented at the AASHTO 2019 GIS for Transportation Symposium in April 2019 per invitation from the conference organizers.

PacTrans PIs Dr. Yinhai Wang and Dr. Ziqiang Zeng published a new book entitled "Data-Driven Solutions to Transportation Problems" in December 2018. This is one of the earliest books that describe methods to address various transportation problems using data from various sources. It will assist both researchers and practitioners in developing solutions based on multi-source transportation data.

What is the impact on transportation workforce development?

PacTrans' educational research project focuses on developing a PacTrans WDI to address the workforce challenges in Region 10. The research team has communicated with local transportation agencies and companies and got very good inputs. Through the communications, PacTrans PIs have also showcased a hybrid method for deliver training to busy working professionals. At this point, WSDOT has committed to rely on PacTrans to do training on three subjects to their employees. WDI will make transportation training more accessible and timely for working professionals.

Changes/Problems

NONE.

Special Reporting Requirements

Research Project Requirements

Per our research update above, PacTrans is currently in the process of selected new projects for the 2019 – 2021 research performance period. Those projects are scheduled to begin in August, but records of these projects will be uploaded to RiP and put on our website within one month of final selection. Further, PacTrans has begun include the requirement for an ORCID number from each PI before their project funds are released.

Submission of Final Research Reports

The closer of PacTrans first year of research funding under the FAST Act does not occur until August 15, 2019. Within two month of project completions, PacTrans will publish technical reports on our website, update the submission in RiP, package and archive the project data, and submit the required materials to the three repositories listed in our grants and deliverables document.