NTC Program Progress Performance Report (PPPR) Information Form

For P.I.'s Use

On a semi-annual basis the NTC sponsored P.I. must report Program Progress Performance Report (PPPR) using the format specified in this PPPR Information Form. The form must be submitted electronically to the corresponding NTC Associate Director by 3/10/2015.

Cover Period: 10/1/2014 – 3/10/2015

NTC Funded Project Information (Round/Year 1, 2013-2014)	
University Name	University of Maryland
Project Title	Revenue Management and Operations Optimization for High Speed Rail
Principal Investigator	Cinzia Cirillo
PI Contact Information	ccirillo@umd.edu

The form includes the following six parts:

- Part I – Performance Indicators
- Part II – Accomplishments: What was done? What was learned?
- Part III – Products: What has the program produced?
- Part IV – Participants & Collaborating Organizations: Who has been involved?
- Part V – Impact: What is the impact of the program? How has it contributed to transportation education, research and technology transfer?
- Part VI – Changes/Problems

Supplementary documents/materials can be attached to this form with the submission.

Part I – Performance Indicators	
Reporting Period	10/1/2014 – 3/10/2015
1. Transportation-related courses offered during the reporting period that were taught by faculty and/or teaching assistants who are associated with the UTC	N/A
Undergraduate courses	ENCE – 370 Introduction to Transportation Engineering and Planning
Graduate courses	ENCE – 688I Discrete Choice Analysis
2. Students supported by this grant	N/A
Undergraduate students	[Student Name]
Masters students	Kartik Kaushik
Doctoral students	Jean-Michel Tremblay Michael Maness
3. Students participating in transportation research projects funded by this grant (but not supported by this grant)	N/A
Undergraduate students	[Student Name] [Supervisor]
Graduate students	[Student Name] [Supervisor]
4. Students supported by this grant who received degrees	N/A
Undergraduate degrees	[Student Name]
Masters degrees	[Student Name]
Doctoral degrees	[Student Name]

Part II – Accomplishments: What was done? What was learned?	
The information provided in this section allows the OST-R grants official to assess whether satisfactory progress has been made during the reporting period.	
Reporting Period	**10/1/2014 – 3/10/2015**
1. What are the major goals of the program?	This project studies revenue management (RM) methods and optimal operation techniques for application to the railways industry. While numerous RM studies have focused on airline and hotel industries, the applications to the railway sector are relatively limited. Train is a green alternative compared to other transportation modes and might play a significant role in policies that aims at reducing GHG emission reduction. In the US, $8 billion have been made available under the American Recovery and Reinvestment Act of 2009 for rebuilding high speed rail links throughout the country. The Amtrak Northeast Corridor Infrastructure Master Plan of 2010 called for $52 billion in investment to cover needed system repair, upgrades, and capacity enhancements to accommodate passenger demand in 2030 which is projected to increase 60% from 2012. As in the airline industry, the goal of railway RM systems is to find the optimal number of passengers travelling along each leg in order to maximize the overall revenue. This can be achieved by implementing ticket pricing or by limiting the availability of certain ticket class or certain market to passengers. However, the problem is very complex due to its probabilistic and dynamic nature. A multidisciplinary approach that uses concepts and methods derived from engineering, economics, operation research, and statistics is proposed to study the economic competitiveness of the railway industry in the US.
2. What was accomplished under these goals?	Major activities: During the second and final phase of the project, we have been able to implement in a computer program written in R the dynamic discrete choice modeling framework developed in the preliminary phase of the project. We have also run multiple tests on simulated data and estimated a revenue management model on real data. Significant results: Intensive validation tests have been performed. Results from both simulated and real data attest that the estimation of the dynamic discrete choice model for railway RM is feasible and that results

	obtained are superior to static estimation. In terms of forecasting exchange and cancellation for railway tickets we found that static MNL drastically over predicts exchange decisions throughout all time periods considered, while dynamic model are able to reproduce quite well real behavior.
3. How have the results been disseminated?	The PI and her students are going to present the results at the upcoming IATBR conference in London (the extended abstract has already been accepted) and at the INFORMS conference in Montreal. They are also writing the documentation of the software under this project and they will make it available to all interested parties by summer 2015. The PI and Jean Michel Tremblay have also organized a summer school at the University of Montreal on Dynamic Discrete Choice models. Professor John Rust, who is the pioneer of DDCM has agreed to give a keynote presentation.
4. What do you plan to do during the next reporting period to accomplish the goals? (10/1/2014 – 3/10/2015)	The project is terminated and a final report has been submitted. For the next reporting period we plan to: - Write a journal publication on the results obtained - Present our methods and results at the summer school to be held in Montreal in June 2015 - Disseminate our results and get industrial partners involved in this effort to optimize revenue and ridership from the railway sector.

Part III – Products: What has the program produced?	
Publications are the characteristic product of research projects funded by the UTC Program. OST-R may evaluate what the publications demonstrate about the excellence and significance of the research and the efficacy with which the results are being communicated to colleagues, potential users, and the public, not the number of publications. Many research projects (though not all) develop significant products other than publications. OST-R may assess and report both publications and other products to Congress, communities of interest, and the public.	
Reporting Period	**10/1/2014 – 3/10/2015**
1. Journal publications:	Hetrakul, P. and C. Cirillo (2014) "A latent class choice based model system for railway optimal pricing and seat allocation" *Transportation Research Part E,* 61(1), pp.68-83 Pratt Hetrakul, Cinzia Cirillo, "Customer heterogeneity in revenue management for railways services", *Journal of Revenue and Pricing Management*, 2015, 14(1), pp. 28–49.
2. Books or other non-periodical, one-time publications	Nothing to Report
3. Other publications, conference papers and presentations	Nothing to Report
4. Website(s) or other Internet site(s)	Nothing to Report
5. Technologies or techniques	Software for the calibration of dynamic discrete choice models.
6. Outreach activities	Nothing to Report
7. Courses and workshops	Summer School on "Dynamic Discrete Choice Models: Econometric Models and Operations Research Methods" that will be held at Université de Montréal (Montreal, Canada) June 10-12, 2015.

8. Inventions, patent applications, and/or licenses	Nothing to Report
9. Other products	• Databases on railway ticket purchase over time, and on cancel and exchange behavior. • Software on dynamic discrete choice models • Discrete choice models for revenue management • Summer school on advanced discrete choice models

Part IV – Participants & Collaborating Organizations: Who has been involved?	
OST-R needs to know who has worked on the project to gauge and report performance in promoting partnerships and collaborations.	
Reporting Period	**10/1/2014 – 3/10/2015**
1. What organizations have been involved as partners?	The research team is actively working with a group of scientists at the University of Montreal (Canada), Department of Operational Research.
2. Have other collaborators or contacts been involved?	This multidisciplinary collaboration has strength our optimization capabilities.

Part V – Impact: What is the impact of the program? How has it contributed to transportation education, research and technology transfer?	
DOT uses this information to assess how the research and education programs: • **increase the body of knowledge and techniques;** • **enlarge the pool of people trained to develop that knowledge and techniques or** • **put it to use; and,** • **improve the physical, institutional, and information resources that enable those people to get their training and perform their functions.**	
Reporting Period	**10/1/2014 – 3/10/2015**
1. What is the impact on the development of the principal discipline(s) of the program?	The project is has developed a dynamic framework for discrete choice modeling on finite horizon, which extends existing static framework that are largely used in a number of different disciplines (Impact on theory advancement). The modeling framework has been applied to exchange/cancel behavior for revenue management (Impact on methods for real case studies). Students involved in the project and those attending the classes developed under this project are being trained to dynamic and stochastic programming concepts, advanced statistics and optimization methods (Impact on pedagogical methods). This has increased the multi-disciplinary capabilities of the students and their ability to deal with problems that require the use of advanced modeling techniques.
2. What is the impact on other disciplines?	The methodology and the results obtained have been presented during two invited seminars at the Erasmus Business School in Rotterdam and at the Department of Economics, Vrije Universiteit, Amsterdam (NL). Both groups have found our methodology highly innovative and have expressed interest in our methods and our results. We are also working with the department of mathematics at the University of Maryland under and Advance program; the objective is to establish close collaboration between the Clark School of Engineering and the Applied Math Program (AMSC).
3. What is the impact on the development of transportation workforce development?	The methods, data and results that will be obtained under this project will be part of the classes that the PI regularly teaches at the University of Maryland: ENCE 688G Survey Methods in Transportation and ENCE 688L Advances in Transportation Demand Analysis. Moreover a new class in under development at the UMD,

	which is mainly based on the new techniques developed: ENCE 688L Computational methods for transportation demand analysis. The PI has been also invited to present dynamic discrete choice models at the University of Taiwan and at the KTH in Stockholm where she has taught a class of 60 PhD students from different European universities. Students at UMD have got the opportunities to spend short periods abroad (i.e. Canada) to participate to exchange activities and to advance their research on dynamic discrete choice models. The material developed during this project (both the theory and the results) have been part of a workshop offered by the PI to graduate students at the Politecnico di Torino (Italy). The PI and her collaborators in Canada are organizing a summer school that will be offered during the Informs international conference to be held in Montreal in June 2015.
4. What is the impact on physical, institutional, and information resources at the university or other partner institutions?	Nothing to report.
5. What is the impact on technology transfer?	The project team is preparing the documentation on the code developed to estimate dynamic discrete choice models. The code, together with the data and the papers that have resulted from the project will be made available to the public. A company and a very well known group of research have manifested interested in using our technology. We hope that the diffusion of the computer code will attract the interest of a large part of the transportation community and of other related disciplines.
6. What is the impact on society beyond science and technology?	Nothing to report
7. Additional impacts	Nothing to report

Part VI – Changes/Problems	
If not previously reported in writing to OST-R through other mechanisms, provide the following additional information or state, "Nothing to Report, if applicable:	
Reporting Period	**10/1/2014 – 3/10/2015**
1. Changes in approach and reasons for change	Nothing to Report
2. Actual or anticipated problems or delays and actions or plans to resolve them	Nothing to Report
3. Changes that have a significant impact on expenditures	Nothing to Report
4. Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards	Nothing to Report
5. Change of primary performance site location from that originally proposed	Nothing to Report