**Title of TRB Paper Format Example**

**Carole Turley Voulgaris**

Assistant Professor of Urban Planning

Department of Urban Planning and Design

Harvard Graduate School of Design

Cambridge, MA 02138

Email: cvoulgaris@gsd.harvard.edu

**Charuvi Begwani**

Position

XXStateXX Department of Transportation

Department (if applicable)

City, State or Country, Postcode

Email: abc@dot.gov

**Private Practitioner Author Name**

Position

Company

City, State or Country, Postcode

Email: enj@abc.com

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*Submitted [Submission Date]*

**ABSTRACT**

The Abstract should be a stand-alone summary of the contents of the paper, equaling 250 words or less. It should present the primary objectives and scope of the study, techniques, methods or approaches briefly described and a concise summary of findings and/or conclusions reached.

**Keywords:** Format Example, Guide, Keyword, Keyword

**INTRODUCTION**

The development and widespread adoption of the general transit feed specification (GTFS) data format for transit route and schedule data has transformed the way travelers plan transit trips (McHugh 2013). In the fifteen years since this data standard was initially introduced by TriMET, the public agency operating mass transit in Portland, Oregon in partnership with Google, most –but not all—transit agencies have begun publishing their route and schedule information in this format. What might explain a transit agency’s decision about whether and when to adopt this data format?

Rogers’ (2003) work on diffusion of innovation highlights several characteristics of organizations that correlate with being early adopters of new technologies, including larger size, greater complexity defined as high level of knowledge and expertise among its members, social interconnectedness, presence of an innovation champion, and organizational slack recognizing the availability of additional resources, especially for high-cost innovations.

Little prior research has been done on the determinants of GTFS adoption. In one such study focusing on California, Frick et al. (2020) found that small transit agencies (reduced reporters) and rural transit agencies were less likely to have published GTFS feeds and independent public transit authorities are more likely to publish GTFS-r feeds than other types of agencies like departments within local governments.

Studies on the adoption of other technologies may be informative in identifying agency characteristics that are generally associated with openness to innovation. Existing literature on technology transfer and information sharing amongst transit agencies and more broadly, public institutions, is scarce. Iseki et al. (2007) have found that early adopters of smart cards for fare payment tended to be those with greater funding availability and those with established relationships with other transit agencies.

There is a need for empirical analysis to determine the factors that influence technology transfer and adoption. The purpose of this study is to evaluate the adoption of GTFS by 498 transit agencies in the United States that were providing scheduled transit service in 2006 at the time of its inception. The results of this analysis can inform efforts by state- and national-level agencies seeking to encourage innovation by identifying agencies most likely to be open to adopting new technology. It can also help local agencies identify peers who are likely to have experience with innovation and experimentation.

**DATA AND METHODS**

We identified 493 transit agencies in the United States that were providing scheduled transit services in 2006, when the GTFS data standard was initially published. Drawing on three sources of archived GTFS feeds (OpenMobilityData, GTFS Data Exchange, and transitland), we identified the earliest published GTFS feed for each agency, if any. We used the publication date of the earliest available feed for each agency to estimate the length of time it took for each agency to adopt the GTFS data standard. The figure below shows the percentage of transit agencies that adopted GTFS between its introduction in 2006 to 2020.

Chart

Description automatically generated

Diagram, map

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We compiled several variables from to understand their potential relationship with GTFS adoption. All our variables and data sources are mentioned in Table 1. We include variables that represent the following broad factors:

Size: Represents both agency size characteristics such as service area, passenger revenue miles, revenue, expenses and fare recovery rate, as well as city size and demographic characteristics such as urbanized area, population and density.

Institutional characteristics: Represents the type of agency, organization and institutional structure

Organizational slack: We use wages, salaries and expenses as a way of understanding organizational slack and the availability of resources at hand for the agency to adopt new technologies.

Technology penetration: We look at the existing adoption rate for GTFS to understand its potential influence on other agencies to adopt it.

Locational characteristics: This represents the regional location of the transit agency which is also a proxy for its distance from Portland where GTFS was first introduced.

|  |  |  |
| --- | --- | --- |
| **Variable Category** | **Name of Variable** | **Source** |
| Institutional characteristics | Agency Type | National Transit Database; Data Category: Agency Information (2005 – 2020)  2005 – 2007: agency\_info.xlsx  2008 – 2011: Agency\_Information.xlsx  2012 – 2013: Agency\_Information\_0.xlsx  2014: Agency-Information.xlsx  2015: Agency\_information\_1.xlsx  2016: Agency Information.xlsx  2017 – 2018: Agency Info\_1.xlsx  2019: Agency Info.xlsx  2020: Agency Information.xlsx |
| Organization Type |
| Institution Type |
| Agency Size | Service Area |
| Passenger Car Scheduled Revenue Miles | National Transit Database; Data Category: Annual Database Service  2005 – 2011, 2014, 2016 – 2020: Service.xlsx  2012 – 2013, 2015: Service\_0.xlsx |
| Vehicle Scheduled Miles |
| Unlinked Passenger Trips |
| Vehicle Revenue Miles |
| Vehicles Operated in Annual Maximum Service | National Transit Database; Data Categories:  Table 26: Fare per Passenger and Recovery Ratio (2005 – 2014)  Annual Database Service (2015 – 2020)  2005, 2007: Table\_26.xlsx  2006: Table 26 - Fare per Passenger and Recovery Ratio.xlsx  2008 – 2011: T26\_Pass\_Fare\_Recovery\_Ratio.xlsx  2012 – 2013: Table 26 Pass Fare Recovery Ratio.xlsx  2014: Table 26 Pass Fare Recovery Ratio\_2.xls  2015: Service\_0.xlsx  2016 – 2020: Service.xlsx |
| Fare Revenue | National Transit Database  Table 26: Fare per Passenger and Recovery Ratio (2005 – 2014)  Annual Database Fare Revenues (2015 – 2020)  2005, 2007: Table\_26.xlsx  2006: Table 26 - Fare per Passenger and Recovery Ratio.xlsx  2008 – 2011: T26\_Pass\_Fare\_Recovery\_Ratio.xlsx  2012 – 2013: Table 26 Pass Fare Recovery Ratio.xlsx  2014: Table 26 Pass Fare Recovery Ratio\_2.xls  2015: Fare\_Revenue.xlsx  2016 – 2020: Fare Revenue.xlsx |
| Operating Expenses | National Transit Database  Table 26: Fare per Passenger and Recovery Ratio (2005 – 2014)  Annual Database Operating Expense (2015 – 2020)  2005, 2007: Table\_26.xlsx  2006: Table 26 - Fare per Passenger and Recovery Ratio.xlsx  2008 – 2011: T26\_Pass\_Fare\_Recovery\_Ratio.xlsx  2012 – 2013: Table 26 Pass Fare Recovery Ratio.xlsx  2014: Table 26 Pass Fare Recovery Ratio\_2.xls  2015: Operating\_Expenses\_0.xlsx  2016 – 2019: Operating Expenses.xlsx  2020 Operating Expenses\_0.xlsx |
| Fare Recovery Rate | Fare revenue / Operating Expenses |
| City Size | Urbanized Area | National Transit Database; Data Categories:  Appendix D: 2000 U.S. Urbanized Areas (UZAs), Populations, Square Miles and Densities Reported by Transit Agencies (2005 – 2013)  Annual Database Agency Information UZAs (2014 – 2018)  Annual Database Agency Information (2019 – 2020)  2005: Appendix\_D.xlsx  2006: Appendix D – 2000 US Urbanized Areas, Populations, Square Miles and Densities Reported by Transit Agencies.xlsx  2007: AppendixD.xlsx  2008 – 2011: xD\_UZA\_Pop\_SqMiles\_Dens.xlsx  2012 – 2013: Appendix D.xlsx  2014: Agency UZAs.xlsx  2015: Agency\_uza.xlsx  2016 – 2018: Agency UZA.xlsx  2019: Agency Info.xlsx  2020: Agency Information.xlsx |
| Population |
| Area (Square miles) |
| Population Density |
| Total Number of Households | 2000 Decennial Census (Variable code: H004001)  2010 Decennial Census (Variable code: H004001) |
| Total Number of Renter-occupied Households | 2000 Decennial Census (Variable code: H004003)  2010 Decennial Census (Variable code: H004004) |
| Percentage of Renter-occupied Households | Total number of renter-occupied households / Total number of households |
| Locational characteristics | US Census Region | 4 US Regions (Northeast, Midwest, West, South)  9 US Divisions (New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, Pacific) |
| Technology Penetration | Date of adopting GTFS data standard | Retrieved earliest published GTFS feed date from GTFS Data Exchange, OpenMobilityData, and Transitland |
| Number of Agencies that adopted GTFS Data Standard | Summary of agencies by year and GTFS status |
| Total Number of Agencies | Summary of agencies by year and GTFS status |
| Percentage of Agencies Adopting GTFS Data Standard | Number of agencies that has adopted GTFS data standard / Total number of agencies |
| Organizational slack | Expense Category | National Transit Database; Data Category: Annual Database Operating Expense  2005 – 2011: Operating\_Expenses.xlsx  2012, 2015, 2020: Operating\_Expenses\_0.xlsx  2013: operating expenses.xls  2014, 2016 – 2019: Operating Expenses.xlsx |
| Operator’s Salaries and Wages |
| Other Salaries and Wages |
| Fringe Benefits |
| Total Salary of General Administration | Summary of the total salary of general administration (sum of operator’s salaries and wages, other salaries and wages, and fringe benefits) by agencies’ ID |

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**Level 2 Header**

We estimated a Cox proportional hazards model to determine how geographic and agency characteristics correlate with time between the availability of the GTFS data standard and its adoption by a given agency. In suscipit, tortor non pulvinar dignissim, sem nisi aliquet urna, at ullamcorper metus nisl sit amet mauris. Maecenas tempor, augue quis gravida suscipit, tortor nulla euismod turpis, at sagittis leo nisi quis justo. Etiam placerat massa aliquam elit sodales sagittis. Ut ut elementum velit. Ut nec feugiat urna.

*Level 3 Header*

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**Figure 1 Caption for figure**

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**RESULTS**

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**TABLE 1 Measurement Conversion**

|  |  |  |
| --- | --- | --- |
| **When You Know** | **Multiply by** | **To Find** |
|  |  |  |
| **Length** |  |  |
| inches (in.) | 25.4 | millimeters (mm) |
| feet (ft) | 0.305 | meters (m) |
| yards (yd) | 0.914 | meters (m) |
| miles (mi) | 1.61 | kilometers (km) |
|  |  |  |
| **Area** |  |  |
| square inches (in.2) | 645.1 | millimeters squared (mm2) |
| square feet (ft2) | 0.093 | meters squared (m2) |
| square yards (yd2) | 0.836 | meters squared (m2) |
| acres | 0.405 | hectares (ha) |
| square miles (mi2) | 2.59 | kilometers squared (km2) |
|  |  |  |
| **Volume** |  |  |
| fluid ounces (fl oz) | 29.57 | milliliters (mL) |
| gallons (gal) | 3.785 | liters (L) |
| cubic feet (ft3) | 0.028 | meters cubed (m3) |
| cubic yards (yd3) | 0.765 | meters cubed (m3) |

**DISCUSSION**

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 (1)

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 (2)

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**CONCLUSIONS**

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**ACKNOWLEDGMENTS**

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**AUTHOR CONTRIBUTIONS**

The authors confirm contribution to the paper as follows: study conception and design: X. Author, Y. Author; data collection: Y. Author; analysis and interpretation of results: X. Author, Y. Author. Z. Author; draft manuscript preparation: Y. Author. Z. Author. All authors reviewed the results and approved the final version of the manuscript.

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