ABSTRACT

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Traffic is inevitably a major source of air pollution, particularly in urban areas. Efforts are made towards reducing emissions by improving vehicle and fuel technology and promoting alternative, sustainable modes of transportation. The emergence of electric vehicles (EVs) is among those technological innovations that can ameliorate fuel efficiency and decrease levels of emissions to a significant extent compared to other ways. Although the emergence of EVs has shown capabilities of decreasing energy use and emissions levels, the EV market is developing slowly mainly due to drivers' range anxiety and charging time. Electric roadways (ERs) have been proposed as a solution to overcome the concerns related to EVs by converting road segments into powered lanes where vehicles can be charged as they move along the roadway. This technology has the potential to increase driving range, decrease battery size and thus, lower the weight and the cost of EVs. In this context, exploring the challenging concept of ERs comes natural.

Since data on the market acceptance and the environmental implications on this technology are limited to non-existent, this thesis has the following objectives: 1) identify the factors that affect the short- and long-term intention to drive on ERs and purchase an EV, knowing about the availability of ERs, 2) estimate the level of adoption of the ER technology and identify characteristics of the market segments and 3) assess the impact of electric roadways on criteria pollutants and greenhouse gas emissions based on the market adoption results.

To achieve these objectives, a survey of the general population in Los Angeles, California was conducted, gathering 600 responses representative of gender and age in the area. Los Angeles is considered a leader in electro-mobility and thus, a natural choice for the implementation of ERs. The survey included sections related to the level of awareness regarding electro-mobility or ERs; respondents' travel characteristics, familiarity with EVs and charging habits, general opinions or possible factors affecting technology adoption of ERs, respondents' willingness to pay for the ER technology and sociodemographic characteristics. The short- or long-term intention to drive on

ERs and purchase an EV knowing about the availability of ERs were found to be correlated and thus, were modeled simultaneously using a bivariate ordered probit model. The degree to which the ER technology is in line with respondents' lifestyle, needs, personal values or attitudes (compatibility) and respondents' tendency towards using sustainable forms of transportation were important factors that positively affect the short-term intention to travel on ERs or purchase an EV, knowing that ERs are currently available. Respondents' innovativeness and the perceived environmental benefits of the technology were highly significant determinants of the long-term intention to travel on ERs or purchase an EV, knowing that ERs will be available in the foreseeable future. In general, familiarity with the new technology was concluded to be the key factor for achieving public acceptance.

The level of adoption of the ER technology and corresponding market segments were identified using a combination of Principal Component Analysis (PCA) and Cluster Analysis. The resulted clusters were appropriately labeled based on the mean scores of each cluster across the principal components. The principal components were related to: opinions on ERs, environmental consciousness, safety concerns and habits towards driving a car. Three clusters emerged from the analysis: early adopters (48.5%), mid-adopters (27.67%) and late adopters (23.83%) that differed in terms of demographics and socioeconomic characteristics, travel and EV charging characteristics and level of awareness.

In order to estimate the emissions change due to the implementation of the ERs by 2050, the California Air Resources Board's (CARB) 2017 EMissions FACtor model (EMFAC) was used for a specific corridor of the study area. Two scenarios were examined considering light-duty vehicles (LDVs): "with" and "without electrification" scenarios, based on the corridor traffic data and the adoption rates found from the survey. The results suggested that the ER technology for LDVs has the potential to provide energy and emission savings, taking into account the scenarios of early (optimistic) and late adoption (pessimistic). Overall, the emissions reductions of criteria pollutants and greenhouse gases by fuel type (gas and diesel) at an average speed of 65 mph ranged from around 4% for the pessimistic scenario to 24% for the optimistic scenario, depending on the pollutant. A sensitivity analysis was also conducted and showed that speed can cause variations in the emissions levels of pollutants and gases and that the ER technology could significantly contribute to reducing traffic emissions even at lower speeds during peak hours.

Turning to the practical implications, this thesis can provide a foundational framework for the evaluation of the ER technology in terms of environmental and economic viability and set the groundwork for future research. Ultimately, the short-term and long-term intention analysis can be used as a draft guide by state and local agencies and inform their strategic short- or long- range plans for mobility. By segmenting potential users, policy makers and transport operators can be informed about the main challenges regarding the promotion of the ER technology to distinct market segments and devise ways to accelerate its adoption. The findings from the impact analysis of ERs on criteria pollutants and greenhouse gases can also inform long-range transportation plans and existing regulations and policies in California and beyond.