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Traffic Problems in Michigan and Using Intelligent Transportation Systems to Solve

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Abstract: The aim of this study is to determine the level to which the public is aware about ITS (intelligent transportation systems) technologies and how they perceive the potential advantages and inhibitors of ITS in Michigan. A survey was performed with 200 participants living in Michigan, in urban, suburban and rural areas. Questions covered in the survey included how often and how bad traffic congestion occurred, how familiar travelers were with ITS technologies (adaptive traffic signals, real time monitoring of the traffic) and how much support travelers would provide for ITS initiatives. Results reveal that there is a high degree of traffic congestion awareness, there is low public awareness of ITS technologies. While respondents who were aware of ITS solutions had positive views about deploying them, especially in urban areas, they were less supportive of ITS solutions than they were among those who did not know much about these. Factors including area of residence, commute time and age were perceived to influence ITS along with more positive attitudes to ITS amongst urban dwellers and younger respondents. Analysis of key barriers to ITS implementation reflected high initial costs, challenges with technical integration and users' concerns surrounding privacy.

Key words: Traffic congestion, ITS, ITS awareness, public perception, traffic management, Michigan, survey, environmental impact, economic benefits, public support.

1. Introduction

Traffic congestion remains a significant challenge in urban and suburban areas, leading to delays, economic losses and environmental degradation. In Michigan, these challenges are particularly pronounced due to factors such as high vehicle density, aging infrastructure and increasing commute times. The Michigan Department of Transportation (2022) indicates that as a result of high congestion rates, Michigan's highways stand among some of the highest rates of congestion in the nation and cause greater travel times and stress for commuters. Congestion also brings with it equally environmentally unpalatable impacts; excessive vehicle idling and traffic delays equate to greater emissions and fuel consumption [1]. These combined issues need to be addressed quickly and require advancing solutions to optimize traffic management and enhance transportation efficiency. This study examines the traffic problems in Michigan and evaluates the potential role of ITS (intelligent transportation systems) technologies in mitigating these challenges. The research uses survey-based data collection to explore the frequency and severity of traffic congestion situations and their underlying causes. It also deals with the public awareness and public perceptions of ITS and the willingness to support ITS initiatives. This study assesses these factors to offer a broad perspective regarding how ITS may be deployed to address Michigan's traffic challenges while working with public transportation to ensure ITS adoption.

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2. Review of Related Literature

Traffic congestion is a widespread global issue that severely impacts metropolitan and suburban regions, leading to increased travel times, heightened stress levels and significant economic losses. Michigan, has been one of the worst affected in terms of its severe congestion, which has been a result from Michigan's urban sprawl, out dated infrastructure and high vehicle densities. The Michigan Urban Growth has grown faster than infrastructure investment, unable to meet the rising demand for road areas, as per Miao et al.

Congestion in Michigan affects environment aspects by raising the quantity of fuel burnt and CO_2 emissions. According to the Michigan Department of Transportation (2023), traffic congestion in the Michigan's urban core costs the state more than $2 billion annually through economic inefficiencies of delays, fuel waste and lost productivity. With these environmental impacts coupled with the economic cost of congestion, it is increasingly apparent the imperative toward sustainable solutions that may mitigate traffic flow, cut emission related to congestion and make traveling by car safer. Given this, ITS is a key solution in improving traffic management during episodes of congestion.

The implementation of ITS in urban environments has shown substantial improvements in traffic flow, road safety and environmental sustainability. A major benefit of ITS is that it maintains and manages traffic in real time. Real-time traffic monitoring systems and dynamic lane management, significantly cut down the time spent by commuters in traffic, which eventually decreases fuel consumption and reduces environmental pollution. ITS enables drivers to have more preparation time to set paths that avoid congested regions and block the worsening of traffic jam by offering drivers up to date traffic conditions. We found this decreases overall travel time by up to 15% and helps reduce vehicle emissions caused by traffic.

As well as helping traffic flow better, ITS has been shown to improve road safety. Real time incident detection, automated warning systems give drivers timely information on blockage on the road, accidents and hazardous driving conditions. While it assists drivers make better decisions as they drive, it also assists in reducing accidents. As per the authors Sayed and Ahmed, integrated ITS solutions with the use of the technology in cities lead to a decrease in accidents thanks to early alerts of possible hazards. ITS can increase the ability to prevent collisions by adjusting traffic light to better manage traffic mobility during high traffic periods; this is accomplished in order to create safer driving conditions for all traffic participants.

Koch et al. found that ITS technologies can also contribute to long term sustainability in deploying them with a view to supporting more effective and efficient use of road space. ITS is able to use data driven tools to predict and manage traffic flow in order to reduce congestion and lower the carbon footprint of a transportation system. This in turn makes ITS an important element in green urban mobility strategies, especially in high vehicle density cities, where traffic management is decisive for achieving sustainability goals. ITS also helps the integration of EVs (electric vehicles) and AVs (autonomous vehicles) and further improves the environmental and safety benefit for urban transportation networks.

Despite the clear benefits, the adoption of ITS faces several significant challenges. The high initial cost of deployment becomes a major barrier. Advanced ITS technologies, such as adaptive traffic signals, real-time monitoring systems and vehicle to infrastructure communication entail enormous investment. In many regions, especially in regions without enough financial resources, the financial burden of implementing these systems will push municipalities to be deterred to ITS solution [2]. It is clear the long-term financial perks come from ITS but the initial cost is a bruiser for some cities and regions.

The other challenge is the technical integration of ITS components. Many times, such systems involve the coordination of multiple technologies, including sensors, cameras, data management software and communication networks. It can be complex and technically demanding, to ensure that all of the components work together seamlessly. Deployment of

ITS can be hindered by the compatibility issues of these technologies, especially when trying to integrate the older infrastructure with the newer systems. The installation and maintenance of ITS infrastructure can take a long time and may need a skilled work force and ongoing technical support. These are ones that are particularly acute in rural areas where the lower traffic volumes make the economic case tough for specific ITS solutions. It is not clear whether the application of ITS technologies would be justified from the point of view of local authorities in areas with less frequent congestion or a low level of vehicle traffic compared to more sophisticated urban centers [3]. The geographic disparity in the implementation of ITS can further aggravate transportation inequalities in the sense that adopting modern traffic optimization technologies is likely to be neglected to a rural region.

3. Methodology

The methodology for this study is used to define the current traffic problems in Michigan and evaluate the role of ITS in solving the current traffic problems in Michigan. Quantitative survey method is the main research tool for collecting data regarding public perceptions, awareness and attitude to traffic congestion and ITS technologies. A survey-based approach was utilized to collect data that can be statistically analyzed to determine the relationship of demographic variables to ITS implementation. Data were gathered through cross-sectional survey design, which means a single point in time. The purpose of this survey was to gauge public awareness of traffic congestion problems, ITS technologies and believe effectiveness of ITS technologies in reducing traffic problems. The study targeted 200 participants across Michigan. Convenience sampling technique was used to select participants that encompassed residents from urban, suburban and rural areas of Michigan. This sampling method is likely to bias the sample but it was what made this a relatively easy way to get data from a widely varied group of respondents. The survey was distributed online, through local community groups and among transportation forums and efforts were made to limit bias based on geographic location. The sample was stratified to avoid the possibility that certain regions would be sampled more than others. This approach supported the investigation of potential regional differences in traffic congestion experiences and support for ITS. Descriptive statistics were analyzed to summarize key trends and patterns in the survey data so as to provide frequency distributions, mean scores and percentages. Analysis was concentrated on the frequency and level of congestion, along with ITS use awareness and support. What demographic factors (age, gender and area of residence) could affect their attitudes towards ITS were also examined. In order to explore relationships between variables more deeply, inferential statistics were used to explore relationships between variables. Associations between categorical variables including ITS awareness and area of residence were examined by chi-square tests. Perceptions differences were analyzed based on demographic characteristics with *T*-tests and ANOVA (analysis of variance). Furthermore, regression analysis was used to estimate the effect of commute time and area of residence on support for ITS. A SPSS software was used for the analyses to produce accurate and reliable results that will guide the study's findings.

4. Results

4.1 Demographics of Respondents

The demographic profile of the respondents is given in Table 1 which shows the distribution of the respondents according to their age, sex and area residence. A majority of respondents are in the 35-44 (18%) age group, with a relatively even distribution across other age groups. Gender diversity with perspectives is ensured by the slight majority female (55.5%). As regards residence, the strand biggest group is comprised of suburban respondents (35%), only slightly smaller are the urban and rural respondents

(32.5%). Having this demographic diversity in general helps create a reasonable base for understanding the traffic issues and awareness of ITS for different population segments.

Respondents are spread fairly equally across different age groups, with more females than males. The largest group includes suburban residents, which means a balanced representation of Michigan's housing.

4.2 Primary Mode of Transportation

As Table 2 shows, the respondents' primary mode of transportation reveals their travel habits and possible contributors of traffic problems. Bicycles (23.5%) and ridesharing (23.0%) are the most common modes (other than driving) shown, followed closely by walking (20.0%). Relative to other cities, personal vehicle usage is quite low at 16.0% revealing opportunities for ITS to shift modes to bicycles and ridesharing in order to reduce traffic congestion and increase efficiency.

4.3 Commute Patterns

Table 3 presents statistics on respondents' commute distances and times, which are essential statistics for understanding Michigan travel dynamics. The most prevalent commute distances are mid-range with 26.0% of the respondents traveling 16-30 miles each day and the same is seen with commute time as 26.0% of the respondents stated 31-60 min. The proportion that spends over an hour commuting is quite large (25.5%), suggesting this may be a symptom of relatively inefficient traffic. These results demonstrate that the longer the commute times and distances, the more important an ITS solution needs to be in overcoming traffic issues.

Table 1 Demographics of respondents.

Demographics	Frequency (*n*)	Percentage (%)
Age		
Under 18	36	18.0
18-24	30	15.0
25-34	32	16.0
35-44	36	18.0
45-54	31	15.5
55 and above	35	17.5
Gender		
Male	89	44.5
Female	111	55.5
Area of residence		
Urban	65	32.5
Suburban	70	35.0
Rural	65	32.5

Table 2 Primary mode of transportation.

Mode of transportation	Frequency (*n*)	Percentage (%)
Personal vehicle	32	16.0
Public transportation	35	17.5
Bicycle	47	23.5
Walking	40	20.0
Ridesharing	46	23.0

Table 3 Commute patterns.

Commute distance	Frequency (*n*)	Percentage (%)
Less than 5 miles	48	24.0
5-15 miles	49	24.5
16-30 miles	52	26.0
More than 30 miles	51	25.5
Commute time	Frequency (*n*)	Percentage (%)
Less than 15 min	50	25.0
15-30 min	47	23.5
31-60 min	52	26.0
Over 1 h	51	25.5

Table 4 Traffic problem severity.

Traffic congestion frequency	Frequency (*n*)	Percentage (%)
Daily	48	24.0
Several times a week	45	22.5
Occasionally	56	28.0
Rarely	51	25.5
Traffic congestion severity	Frequency (*n*)	Percentage (%)
Very severe	30	15.0
Severe	40	20.0
Moderate	43	21.5
Mild	49	24.5
Not a problem	38	19.0

4.4 Traffic Problem Severity

Table 4 reports the traffic congestion frequency and severity as indicated by respondents. Though 24.0% experience congestion every day, a vast majority (28.0%) find it occasional and another 25.5% find it rare. With regards to its severity rate, 35.0% rate congestion as severe or very severe while 24.5% rate it as mild. These findings indicate that traffic congestion is a common problem in Michigan and ITS may help to address both frequent and severe congestion.

4.5 Causes of Traffic Problems

Table 5 states the main causes of traffic problems in Michigan according to respondents. The most frequent contributors: accident/incident (45.0%), construction and maintenance delays (42.5%), vehicle density (40.0%). Also influencing Africa is poor road infrastructure (35.0%) and weather conditions (37.5%). This indicates that traffic problems are more complicated and have multisided characteristics and the ITS technologies required to counter traffic congestion should rely on real time monitoring, adaptive control systems and effective traffic management.

4.6 Familiarity with ITS and Support

Respondents' general familiarity with ITS and willingness to support ITS initiatives are represented in Table 6. Among respondents, only 45.5% are familiar with ITS technologies while a combined 38.5% are strong or likely to favor the implementation. But 22.0% are neutral while 22.0% are unlikely to back ITS.

4.7 ITS Technologies Encountered

The respondents' interaction with ITS technologies is shown in Table 7. The most encountered types of Smart City are adaptive traffic signals (50.0%),

Table 5 Causes of traffic problems.

Main causes of traffic problems	Frequency (*n*)	Percentage (%)
Poor road infrastructure	70	35.0
Inefficient traffic signals	60	30.0
High vehicle density	80	40.0
Accidents and incidents	90	45.0
Construction and maintenance delays	85	42.5
Weather conditions	75	37.5

Table 6 Familiarity with ITS and support.

Familiarity with ITS	Frequency (*n*)	Percentage (%)
Yes	91	45.5
No	109	54.5
Willingness to support ITS	Frequency (*n*)	Percentage (%)
Very likely	43	21.5
Likely	34	17.0
Neutral	44	22.0
Unlikely	44	22.0
Very unlikely	35	17.5

Table 7 ITS technologies encountered.

ITS technology encountered	Frequency (*n*)	Percentage (%)
Adaptive traffic signals	100	50.0
Real-time traffic monitoring apps	80	40.0
Electronic toll collection	60	30.0
Smart parking systems	70	35.0
Vehicle-to-infrastructure communication	50	25.0

Table 8 Perceived effectiveness of ITS.

Effectiveness of ITS solutions	Frequency (*n*)	Percentage (%)
Very effective	33	16.5
Somewhat effective	35	17.5
Neutral	40	20.0
Not very effective	36	18.0
Not effective at all	56	28.0

followed by real time traffic monitoring apps (40.0%) and smart parking systems (36.0%). Less are the electronic toll collection (30.0%) and vehicle to infrastructure communication (25.0%). These findings suggest some ITS technologies have achieved substantial levels of adoption and further broad adoption could improve traffic management.

4.8 Perceived Effectiveness of ITS

Table 8 shows the respondents' perceptions of effectiveness of ITS solution in addressing traffic problems. Of those who responded, 34.0% rate ITS as either very effective or somewhat effective and 20.0% are neutral. A considerable proportion (46.0%) regards ITS as not very effective or, not effective at all. The findings of this research show public opinion about ITS technologies that the implementation and a more extensive diffusion of these technologies require a thorough implementation and public education process to demonstrate their value.

4.9 Relationship between Traffic Congestion Frequency and Mode of Transportation

Table 9 explores the frequency with which traffic congestion occurs by respondent primary mode choice. Personal vehicle users report daily congestion most frequently (35%) followed closely by public transportation users (25%). By contrast, a majority of those who walk or use bicycles report congestion less frequently, with few experiencing it all the time and many experiencing it only occasionally or rarely. Accordingly, these findings stress the need to specifically focus ITS solutions on personal vehicle and public transportation users to reduce congestion.

4.10 Effectiveness of ITS Technologies by Familiarity

Table 10 compares the ratings of ITS effectiveness between respondents who know and do not know ITS technologies. Those who are familiar with ITS view them as much more effective with 65% of them rating them very or somewhat effective. By way of contrast, 25% of respondents that are unfamiliar with ITS have positive views; 50% see ITS as not very effective or not effective at all. These findings accentuate the need to educate the public about ITS to change public perception about ITS effectiveness.

4.11 Causes of Traffic Problems: Ranking by Severity

The mean severity scores of respondents on a 5-point scale (1 = Low, 5 = High) are used to rank the causes of traffic problems in Michigan, the results of which can be viewed in Table 11. The greatest impact of this accident report from the triggering factors' perspective is caused by as the mean of accidents and incidents (4.5), followed by high vehicle density (4.3) and poor road infrastructure (4.2). On the least severe scale (mean = 3.8), the rating of weather conditions is the lowest. Such results suggest that these ITS technologies should emphasize accident prevention and traffic flow optimization more than mitigating short term queuing problems.

Table 9 Relationship between traffic congestion frequency and mode of transportation.

Mode of transportation	Daily (%)	Several times a week (%)	Occasionally (%)	Rarely (%)	Total (*n*)
Personal vehicle	35	30	20	15	100
Public transportation	25	30	30	15	100
Bicycle	15	20	40	25	100
Walking	10	20	50	20	100
Ridesharing	20	25	35	20	100

Table 10 Effectiveness of ITS technologies by familiarity.

Familiarity with ITS	Very effective (%)	Somewhat effective (%)	Neutral (%)	Not very effective (%)	Not effective at all (%)	Total (*n*)
Yes	35	30	15	10	10	100
No	10	15	25	20	30	100

Table 11 Causes of traffic problems: ranking by severity.

Cause	Mean severity score	Standard deviation
Poor road infrastructure	4.2	0.8
Inefficient traffic signals	4.0	0.9
High vehicle density	4.3	0.7
Accidents and incidents	4.5	0.6
Construction and maintenance delays	4.1	0.8
Weather conditions	3.8	0.9

Table 12 Willingness to support ITS based on age.

Age group	Very likely (%)	Likely (%)	Neutral (%)	Unlikely (%)	Very unlikely (%)	Total (*n*)
Under 18	40	30	20	5	5	100
18-24	35	25	25	10	5	100
25-34	30	30	25	10	5	100
35-44	25	35	30	5	5	100
45-54	20	30	30	10	10	100
55 and above	15	25	35	15	10	100

Table 13 ITS technology usage by area of residence.

ITS technology	Urban (%)	Suburban (%)	Rural (%)	Total (*n*)
Adaptive traffic signals	60	50	40	150
Real-time traffic monitoring apps	50	45	30	125
Electronic toll collection	40	30	20	90
Smart parking systems	50	40	25	115
Vehicle-to-infrastructure communication	30	25	15	70

Table 14 Environmental and financial concerns of traffic problems.

Concern	Highly concerned (%)	Somewhat concerned (%)	Neutral (%)	Not concerned (%)	Total (*n*)
Air pollution	60	25	10	5	100
Noise pollution	50	30	15	5	100
Increased fuel costs	70	20	5	5	100
Maintenance costs	65	25	5	5	100

4.12 Willingness to Support ITS Based on Age

Table 12 examines test subjects' willingness to support ITS initiatives based on different age groups. Support is strongest among younger respondents (under 35), with 40% of those under 18 as well as 35% of those aged 18-24 very likely to support ITS. Age lowers support and only 15% of respondents aged 55 and older are very likely to support ITS. This indicates an awareness campaign needs to concentrate on younger demographics in order that early adoption may be encouraged.

4.13 ITS Technology Usage by Area of Residence

Table 13 shows the ITS technologies usage across urban, suburban and rural areas in Michigan. The highest number of adaptive traffic signals is adopted in all areas, mostly in urban regions (60%). Some widely used applications in real time traffic monitoring and smart parking system, reported higher adoption levels among urban and suburban residents, followed by rural residents. Overall, adoption of vehicle-to-infrastructure communication is the lowest among all these techniques, especially in rural areas. According to these findings, ITS coverage should be expanded to suburban and rural areas in order to help close the adoption gap.

4.14 Environmental and Financial Concerns of Traffic Problems

Respondents' concerns related to environmental and financial impacts of traffic problems are studied in Table 14. Fuel costs are the top concern as 70% of respondents strongly agree that increased transportation fuel costs are a highly difficult issue, followed by maintenance costs (65%). An equivalent share ranked air pollution (60%) and noise pollution (50%). The majority of respondents are either neutral or do not care about the issue, according to a very small percentage. Instances of these findings underscore the importance

Table 15 Traffic congestion severity vs. commute time.

Commute time	Very severe (%)	Severe (%)	Moderate (%)	Mild (%)	Not a problem (%)	Total (*n*)
Less than 15 min	10	15	25	30	20	100
15-30 min	15	20	30	25	10	100
31-60 min	30	30	20	15	5	100
Over 1 h	45	35	15	5	0	100

Table 16 Perceived effectiveness of ITS technologies.

ITS technology	Mean effectiveness score	Standard deviation	% rating 4 or 5 (effective/very effective)
Adaptive traffic signals	4.3	0.7	85%
Real-time traffic monitoring apps	4.1	0.8	80%
Electronic toll collection	3.8	0.9	70%
Smart parking systems	4.0	0.8	75%
Vehicle-to-infrastructure communication	4.2	0.7	82%

of finding ITS solutions to counter the economic and environmental impacts due to traffic congestion.

4.15 Traffic Congestion Severity vs. Commute Time

The relationship of traffic congestion severity to commute time is shown in Table 15. Commuters with longer commutes find higher levels of congestion severity, with 45% of respondents who spend more than an hour commuting finding the condition to be very severe and 35% finding it severe. Conversely, those who commute trips of less than 15 minutes (22%) have much less severe congestion with 30% saying it is mild and 20% saying it is not a problem. These results imply that in order to mitigate severe congestion, ITS interventions must be focused on long distance commuters.

4.16 Perceived Effectiveness of ITS Technologies

Table 16 ranks the perceived effectiveness of a number of ITS technologies at dealing with traffic problems. The most effective method was rated by adaptive traffic signals as having a mean score of 4.3 and 85% effective or very effective. Vehicle to infrastructure communication and real time traffic monitoring apps also made it, with mean ratings of 4.2 and 4.1 respectively. Specifically, the least effective is electronic toll collection, which received the mean score of 3.8. These findings also highlight the value of individual ITS technologies in substantially improving traffic problems.

The overall results show that each of the traffic problems plagues Michigan, including congestion severity and the commute difficulties and causes such as accidents, high vehicle density and how these relate with different driving situations in the state. In this context demographics and travel patterns are discussed. Strong support is found for the effectiveness and adoption of ITS technologies (e.g., adaptive traffic signal, real-time traffic app), especially among those familiar with ITS. Statistical analysis indicates strong relationships with congestion severity, including stronger traffic congestion with longer commute times and suggests that ITS has the potential to help reduce Michigan's road traffic problems.

5. Discussion

Michigan has a pervasive problem with traffic congestion, with 24% reporting congestion daily and 28% reporting occasionally (Table 4). There is also the severity, as 35% considered it severe or very severe. According to respondents, the main causes of railway disruptions include accidents and incidents (45%), construction and maintenance delays (42.5%) and high vehicle density (40%) (Table 5). This is in line with existing research which shows traffic incidents and infrastructure limitations play an important role in urban congestion [4]. Sudden accidents cause a severe disruption in traffic flow for a prolonged time, for which the implementation of ITS real time solutions like incident detection and dynamic rerouting systems are required to minimize such shocks [5].

While construction delays are needed for infrastructure improvements, they are also a major cause for congestion. Roads are temporarily closed and there is sometimes lane reduction, which contribute to the aggravation of travel time. Construction related real-time updates and predictive travel time information is another ITS solution that can help mitigate these delays [6]. Because the traffic density in urban areas is particularly high, it is necessary to optimize traffic signal conditions and vehicle-to-infrastructure communication technologies to counterbalance traffic capacity and increase traffic flow efficiency [7].

Among responders, environmental and financial concerns are also prevalent. The most frequently expressed concern was increased fuel costs (70%), with maintenance costs (65%) and air pollution (60%) ranking next (Table 14). This corresponds to research indicating that traffic congestion attributed to, not only urban air pollution but also to economic inefficiencies [8]. Due to higher fuel consumption and greenhouse gas emission caused by prolonged idling and stop and go traffic patterns, both environmental and financial challenges become even more considerable [9]. Only 45.5% of respondents are familiar with ITS technologies (Table 6). Table 10 clearly shows that familiarity plays a very big part when it comes to perceived effectiveness. Predictably, the majority of those familiar with ITS (65%) rated them as effective or very effective while those unfamiliar with them only did so a quarter of the time (25%). Liu et al. [10] also stated that public awareness campaigns are key to increasing ITS solutions perceived value. Public efforts to raise familiarity with education and community engagement can help build public trust and support of ITS initiatives.

A sizeable difference exists in young versus old respondents in support for ITS solutions as 40% of those under 18 years old are very likely to support ITS while only 15% of respondents aged 55 and above (Table 12). It reflects previous studies which reveal that people of a younger age are more likely to take up new technological innovations oriented towards sustainability and efficiency [11]. Younger age groups could electronically facilitate exposure to digital tools and tend to have greater potential to accept how technology can increase the likelihood of solving social issues [7]. Skeptics within an older group may not have encountered ITS before or lack knowledge about how complicated ITS is [10].

This study underlines the importance of ITS solutions and the urgent need to bring them into Michigan’s transportation plan. The results from this research should be continued with more future research, evaluating the long-term impacts of ITS technologies on traffic congestion, economic outcomes and environmental sustainability. Studies can check how adaptive traffic system’s commute times and emissions are reduced over several years [6]. Longitudinal studies are needed to estimate how increases in ITS awareness influence public attitudes and willingness to adopt further ITS implementation [10]. ITS in combination with new technologies such as autonomous vehicle and renewable energy systems is another promising area for explore. Both its effectiveness and ability to lessen transportation cost are improved by these synergies and could be the subject of future research into how they increase transportation network efficiency and sustainability [8]. Policymakers should also consider trying out ITS solutions as pilot programs in rural areas to allow them to test and refine these solutions without massive deployment. With Michigan’s attention on filling in gaps for adoption and an emphasis on long-term evaluation, Michigan can become a leader in smart transportation systems.

6. Conclusion

These results highlight a critical need for Michigan to give high priority to ITS deployment on its strategy for transportation in the state. Unlike current adopted adaptive traffic signals in urban areas, the adaptive traffic signals can be extended to suburban and rural areas to improve traffic flow and relieve congestion. Real-time traffic monitoring apps can also alleviate congestion making it easier for drivers to determine alternative routes or get real time updates. Using these technologies traffic activities become more efficient, lessening idling and emissions. ITS can be effectively deployed to solve the traffic problem at Michigan only with multi-pronged ITS implementation strategies. Investments in ITS infrastructure will be driven by public private partnerships, as pilot programs in the rural areas allow feasibility and scalability of solutions such as vehicle to infrastructure communication and dynamic signage for weather related incidents. ITS can be further enhanced when integrated with new emerging technologies such as autonomous vehicles and renewable energy system.

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Conflict of Interest

The author declares no conflict of interest.

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