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INCORPORATION OF
SOCIAL EQUITY
CONSIDERATIONS INTO
TRANSPORTATION ASSET
MANAGEMENT



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Incorporation of Social Equity Considerations into Transportation Asset Management

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ABSTRACT

There is increasing awareness among transportation professionals about the importance of incorporating social equity into their practices. While the transit sector has made notable progress, other areas, such as asset management, are still lagging in integrating social equity into decision making. This project aimed to address this gap by conducting a literature review and gathering insights through interviews and surveys with personnel from local governments, transportation agencies, and community-based organizations. The research team explored how social equity is currently operationalized by transportation departments and agencies, and assessed how it is considered across various fields. They developed a tailored definition of equity for asset management, identified both existing and missing indicators for this definition, and proposed decision-making tools as initial methods for integrating social equity into transportation asset management. The project culminated in a refined understanding of social equity in transportation asset management and an initial framework to guide local governments and agencies in incorporating equity into their decision-making processes.

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EXECUTIVE SUMMARY

As transportation professionals work to provide safe modes of travel to community members in the U.S., there is a growing understanding of transportation's impact on people and the environment. In the past decade, calls for equity in and through transportation have pressed for a change in current transportation practices. Despite advancements, such as the Federal Transit Administration's increased emphasis on equity and the U.S. Department of Transportation's Equity Action Plan, traditional transportation asset management (TAM) practices often neglect equity, leading to persistent disparities. Recent studies highlight that TAM practices frequently fail to address these issues adequately. To remedy this, there is a growing call to integrate equity into asset management frameworks, ensuring that equity is a central consideration throughout the decision-making process, with clearly defined and measurable goals.

This study tackled the issue by interviewing transportation professionals from local governments, transportation departments, and community organizations. Additionally, it gathered insights from TAM professionals via online surveys. The data collected were analyzed through thematic analysis and compared with existing literature on transportation equity and advancements in TAM practices. This approach enabled the study to define equity within the context of TAM and identify relevant equity indicators for enhancing decision-making processes in asset management.

The suggested definition of equity to be used in TAM as proposed by this study is, "Socially equitable TAM assesses both existing and future assets through the lens of community needs and their impacts on various populations. This approach necessitates active community engagement and involvement in decision-making processes. Equitable TAM integrates social equity criteria into all aspects of asset management, including investment decisions, resource allocation, and maintenance strategies, to ensure equitable distribution of benefits and burdens of transportation assets and systems. It recognizes that assets can disproportionately affect underserved communities and ensures that these impacts are considered in the evaluation and management of assets."

The proposed indicators are divided into two categories: user-related and system-related. User-related indicators focus primarily on demographic data to identify community needs and highlight disadvantaged populations. System-related indicators evaluate the benefits and burdens associated with a transportation project, asset, system, or alternative, covering impacts across health, social, economic, environmental, and transportation dimensions. The choice and application of these indicators vary based on the alternatives being considered. Additionally, indicators related to staffing and contracting within an organization or agency are also relevant. Effective equity assessment also requires examining budgeting and resource allocation across different asset classes, regions, and demographic groups. The study underscores the importance of integrating qualitative indicators, such as community feedback, into the decision-making process to ensure a comprehensive approach.

These definitions and indicators can be incorporated into existing TAM decision-making tools and methodologies. Ongoing research is exploring how equity indicators can be utilized to establish criteria for more equitable decision-making processes.

1. INTRODUCTION

The U.S. transportation system is characterized by its extensive network of highways and interstates, which has long depended heavily on automotive vehicles. The interstate system, established more than half a century ago, prioritized road development over other urban infrastructure such as buildings, sidewalks, and alternative transportation methods. The goal was to enhance connectivity between states and stimulate economic growth. However, this transportation model has had profound social and environmental impacts, influencing the nation's economy, urban planning, and public health (Wtazel & Steil, 2003).

While the highway and interstate system has driven substantial economic growth by facilitating the efficient movement of people and goods, it has also brought about significant environmental and social challenges. For example, the initial construction of these roads displaced over 475,000 households and more than a million individuals, predominantly from low-income and minority communities, according to the U.S. Department of Transportation (USDOT) (Evans, 2021). This displacement and disruption sparked what became known as the freeway revolts, which opposed highways that cut through cities and neighborhoods or ran close to communities, resulting in various forms of disturbance and pollution, including air, noise, and visual pollution (Phelps, 2021). The issues extended beyond highways; public transit networks developed over time have also been unevenly distributed, leading to disparities in access to jobs, healthcare, and education (Litman, 2007).

Transportation plays a crucial role in shaping social and economic outcomes, yet these factors are not always fully considered by planners and professionals. Key impacts include accessibility, mobility, safety, health, economic growth, and workforce development (Samimi & Mohammadian, 2010). By addressing these diverse aspects—economic, environmental, and social—planners can adopt a more sustainable approach. The concept of sustainability has gained increasing attention among professionals, driven by a growing awareness of transportation's broader social and environmental impacts (Mihyeon Jeon & Amekudzi, 2005; Khalife et al., 2023).

Over the past decade, several sustainability rating systems for the transportation industry have been developed (Oluwalaiye & Ozbek, 2019). This reflects a growing recognition of the need to address factors beyond mere economic considerations, including environmental and social impacts. However, a research project by the Mountain-Plains Consortium, which evaluated various transportation sustainability rating systems, found that social factors often receive the least attention. This was evident from the credit/point distribution across the economic, environmental, and social categories, with social factors being relatively underrepresented (Simpson et al., 2014).

In 2020, the U.S. experienced significant social movements advocating for equity and was also confronted with the COVID-19 pandemic, both of which underscored existing disparities in various practices, including transportation. The protests, which gained momentum following the murder of George Floyd, an unarmed Black man, by a Minneapolis police officer, were part of a broader movement against systemic racism and police brutality, reflecting long-standing issues of racial injustice (Kovasic, 2023). Simultaneously, the COVID-19 pandemic exposed deep-seated inequities in healthcare and access to essential services. Data collected by the Centers for Disease Control and Prevention (CDC) revealed that certain communities were disproportionately affected by the virus, with clear patterns related to income, race, and age among these impacted groups (Ambrose, 2020; M. Raifman & J. Raifman, 2020).

The COVID-19 pandemic profoundly impacted the transportation sector, bringing to light both the vital role transportation plays in supporting communities and the ongoing issues of social equity. During the pandemic, transit agencies stepped up to assist vulnerable populations by facilitating access to vaccination sites and converting buses into mobile hotspots to provide internet access for students during school closures. However, the pandemic also highlighted systemic inequities, particularly through lockdowns and reductions in transit services. Research by Kar et al. (2022) revealed that communities with significant social vulnerabilities—such as low-income, carless, and Black populations—experienced disproportionately higher losses in transit access.

The Federal Transit Administration (FTA) noted an increased focus on social equity among local and state agencies in 2021, likely having occurred in response to these challenges (FTA, 2021). As the pandemic continued and social movements for equity gained momentum, the U.S. government recognized the urgent need to address these disparities. In January 2021, President Biden signed Executive Order 13985, which aims to advance racial equity and support underserved communities through federal policies (Office of the President, 2021). Following this, in 2022, the USDOT released its first Equity Action Plan, underscoring the administration’s commitment to addressing inequities in transportation (USDOT, 2022).

These recent advancements in transportation, especially in the transit sector, offer promising examples of considering social equity. However, it is crucial to extend this focus to other areas, such as asset management. Traditionally, transportation asset management (TAM) has prioritized safety, functionality, and cost efficiency, often neglecting social and equity considerations. This oversight has contributed to perpetuating or worsening social inequities. Recent studies have highlighted significant disparities related to socioeconomic status. For example, Gandy et al. (2023) found that bridges in lower-income and disadvantaged communities are more likely to be in poor condition, based on their analysis of National Bridge Inventory (NBI) ratings and U.S. Census Bureau tracts. Similarly, Rajaei et al. (2021) discovered that sidewalks in Pontiac, Michigan, are of lower quality in neighborhoods with lower socioeconomic status and higher proportions of Black and Latinx residents. These findings underscore that current TAM practices are not yielding equitable outcomes.

As the transportation sector increasingly prioritizes equity, traditional asset management approaches often fall short of delivering equitable outcomes. The Transportation Research Board (TRB) 13th National Conference on Transportation Asset Management, held in August 2021, emphasized the need for performance measures that integrate equity considerations and advocated for enhanced community engagement to address these disparities (TRB, 2021). Additionally, the FHWA’s TAM Expert Task Group underscored the importance of incorporating equity into asset management practices in their 2023 report, “Equity Considerations in Asset Management: Case Studies” (FHWA, 2023). These developments underscore the urgent need for a critical reassessment of current TAM practices to better address social equity.

To effectively integrate social equity, asset management frameworks must embed equity into their decision-making processes regardless of the specific tools used. Decisions should evaluate how different options align with equity goals and values (Kizner & Lee, 2021). Kizner and Lee argue that equity should be a fundamental aspect of asset management, considered throughout the entire life cycle of transportation assets. Furthermore, equity goals must be clearly defined and measurable. This requires evolving the traditional SMART criteria—Specific, Measurable, Achievable, Realistic, and Timely—into SMARTIE criteria by adding “Inclusive” and “Equitable” targets (Kizner & Lee, 2021).

2. PURPOSE

Current TAM practices fail to adequately address social impacts and equity concerns, often overlooking the needs of disadvantaged populations. This shortfall contributes to the continued adverse effects of transportation assets and systems on marginalized communities, underscoring the urgent need for more comprehensive strategies that incorporate social equity. Such transformation in TAM practices is essential to guarantee equitable treatment and access to transportation for all communities. In this study, the authors aim to equip transportation professionals with insights on integrating social equity into TAM practices and decision-making. The findings are intended to support ongoing and future initiatives to transform TAM practices to incorporate social equity.

2.1 Research Objectives

To effectively integrate social equity into TAM, it was crucial to first grasp the conceptual aspects of social equity and examine how it is operationalized in other transportation sectors. Subsequently, the study aimed to develop a definition and set of measures for equity tailored to the context of TAM, thereby enabling its incorporation into TAM practices and decision-making. The study will address the following objectives.

- RO1.** Identify **key concepts in social equity** as defined by academic literature, by the state of practice in local governments, and by members of community-based organizations.
- RO2.** Inventory **existing practices used to consider social equity in transportation-related areas of decision-making**, including their strengths and limitations.
- RO3.** Establish a **definition of social equity** that fits the context of asset management decision-making.
- RO4.** Select **indicators (both quantitative and qualitative)** that can be used to assess the level of social equity based on the definition established in Objective 3.
- RO5.** Propose a **preliminary framework** that begins to integrate various indicators of social equity into a **decision-making process** that can be applied to transportation assets.

3. METHODOLOGY

To achieve objectives one and two, which involved defining social equity and inventorying existing practices to incorporate social equity into transportation decision-making, the authors utilized a literature review and conducted interviews and surveys with transportation professionals from local governments, departments of transportation (DOTs) and metropolitan planning organizations (MPOs), and community-based organizations (CBOs). The literature review utilized traditional academic databases and journal publications, and a concerted effort was made to search more broadly for examples of cities, counties, and other jurisdictions working to integrate equity into their work, as well as community-based organizations specifically advocating for transportation and infrastructure equity.

For the interviews, the authors developed tailored question sets for each type of entity: CBOs, local governments, and transportation agencies. Following these interviews, a survey was designed to gather data on equity in asset management and engineering decision-making from a wider range of DOTs, MPOs, and local governments. Both the interview and survey procedures were reviewed and approved by the Colorado State University (CSU) Institutional Review Board (IRB) before implementation. After data collection, a thematic qualitative analysis was conducted to examine the findings from the surveys and interviews. These responses were then compared with academic definitions of equity identified in the literature review, leading to the synthesis of an equity definition specifically tailored for asset management. Commonly used indicators were subsequently assessed for their relevance and applicability in the TAM context. Lastly, a preliminary decision-making framework to integrate these equity indicators was proposed.

Figure 3.1 demonstrates how the methods employed address each of the research objectives.

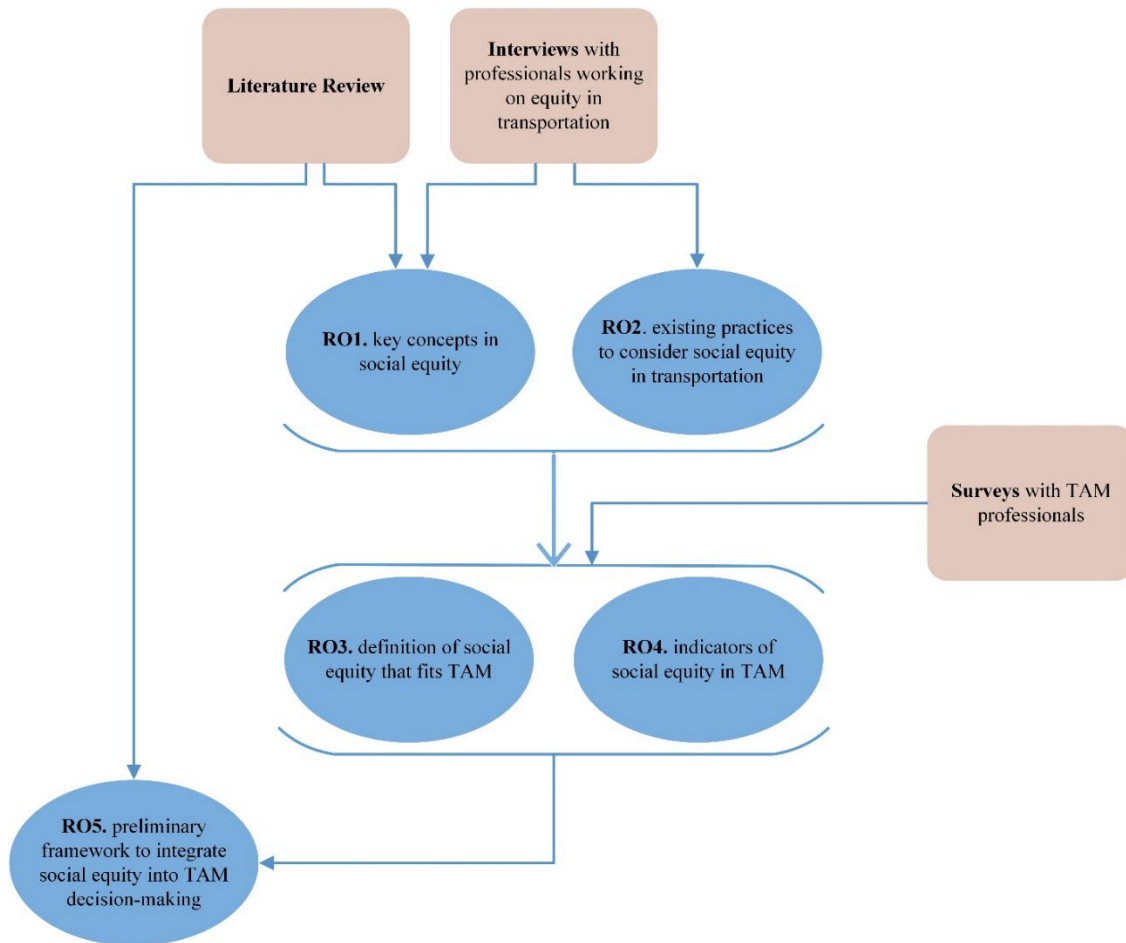


Figure 3.1 Research Objectives and Methods Used

3.1 Interviews

3.1.1 Participants & Recruitment

The authors conducted 20 interviews with 29 professionals (with some interview sessions including more than one professional) engaged in equity work within the transportation sector. The sample comprised a diverse range of organization types: (1) state DOTs (n = 5), (2) MPOs (n = 4), (3) transportation agencies (n = 1), (4) cities (n = 10), (5) counties (n = 3), (6) CBOs (n = 5), and (7) research/consulting firms (n = 1). These organizations spanned seven states across the contiguous U.S.

Recruitment was conducted via email invitations, with addresses obtained from public online directories and through authors' connections. Some cities were selected from the Rockefeller Foundation's 100 Resilient Cities list, while additional invitations were based on referrals from initial participants, utilizing snowball sampling—a common qualitative research method for accessing hard-to-reach samples, such as transportation professionals focused on equity (Naderifar et al., 2017).

The response rate was notable, with 50% of the contacted professionals agreeing to participate in the interviews. This high response rate suggests a strong commitment among transportation professionals who work on advancing social equity, reflecting the increasing national and governmental focus on equity issues.

3.1.2 Data Collection

The data were collected through semi-structured interviews lasting approximately 60 minutes each. This method, based on open-ended questions, provided flexibility to explore emerging topics while addressing the specific questions and objectives of the study (Galletta & Cross, 2013). The authors developed three sets of questions tailored to different types of agencies: one for MPOs and DOTs, another for cities and counties, and a third customized for CBOs. While there were many overlapping questions, each set included specific questions relevant to the respective organization type. The question sets received IRB approval under CSU Protocol #3121 prior to the interviews and are included in Appendix (A): Interview Questions. The World Health Organization's (WHO) definition of equity was included in the question sets to provide a reference for interviewees who might request a specific definition.

The interviews were conducted, recorded, and transcribed using Microsoft Teams. To maintain confidentiality, all identifiers of participants and their organizations were removed from the transcripts before analysis. This approach not only ensured participant privacy but also positively influenced both the participation rate and the quality of the data provided. Additionally, a linked list was created to separate identifiers from the data, with the de-identified data securely stored in a OneDrive folder accessible only to the research team. The total recording time from the 20 interviews amounted to over 17 hours, averaging 51 minutes per interview.

3.2 Surveys

3.2.1 Participants & Recruitment

The list of individuals contacted consisted primarily of TAM professionals from DOTs and MPOs, as well as professionals from cities, transportation agencies, and research institutions. Their email addresses were sourced as follows:

- DOT professionals: emails were obtained from the American Association of State Highway and Transportation Officials (AASHTO) TAM portal, the FHWA Asset Management Contacts webpage, and the TRB TAM committee.
- MPO professionals: emails were collected from the FHWA MPO database.
- Other professionals: emails were gathered from various sources, including the National Association of City Transportation Officials (NACTO, 2023) and various local government websites.

In total, the list comprised 728 email addresses of TAM professionals across the U.S. A formal invitation and a reminder were sent to all contacts. The survey yielded 55 complete responses and 15 partial responses, resulting in an approximate response rate of 10%.

3.2.2 Data Collection

Data collection was conducted via online surveys using Qualtrics. The survey was meticulously designed to address the research questions, focusing on the unconventional topic of equity within the established field of TAM. Given the novelty of equity in TAM and the standardized nature of TAM practices, crafting the questions posed a challenge. To ensure clarity for respondents unfamiliar with equity concepts, definitions of key terms were provided in proximity to their first occurrence in the survey.

The development of survey questions was guided by:

- A literature review of TAM practices
- A review of equity in transportation, including definitions, measures, community engagement, and practices
- USDOT's 2022 survey on Equity and Meaningful Public Involvement in Transportation Planning
- FHWA's 2017 survey on Improving TAM Practices

This process resulted in a set of 30 questions, detailed in Appendix (B): Survey Questions, and received IRB approval under Protocol #3121. The questions were categorized into four sections:

- i. Information about the respondent's organization
- ii. Current practices within the asset management department
- iii. Equity in the organization's and asset management department's work
- iv. Expert opinions on equity-related issues in TAM

The survey employed a combination of multiple-choice, open-ended, and ranking questions to gather both qualitative and quantitative data, aimed at addressing the research questions. Qualtrics was utilized to build the survey, incorporating essential features such as skip logic, question randomization, and survey branching, as highlighted by Fogli and Herkenhoff (2018). Qualtrics also facilitated the distribution of the survey, including sending invitation emails and reminders, and provided tools for data visualization and analysis.

3.3 Data Analysis

The data collected from the interviews and surveys were analyzed using thematic analysis, a widely accepted method for examining qualitative data such as interview transcripts and survey responses. Thematic analysis involves identifying and interpreting patterns, themes, and ideas that emerge from the data to provide insights into the research objectives (Braun & Clarke, 2006).

The data analysis began with researchers immersing themselves in the material to understand its content and context, achieved by thoroughly reading the interview transcripts and survey responses, highlighting key points, reviewing interview recordings, and taking detailed notes. Next, initial codes were generated by identifying and labeling relevant themes and concepts, which helped in identifying broader patterns and overarching themes. These codes were then grouped based on similarities and differences to form comprehensive themes addressing the research objectives. The identified themes were reviewed and refined by revisiting earlier steps to gather additional evidence, ensuring they accurately reflected the data. Finally, the refined themes were clearly defined and named, using the relevant codes to capture the essence of each theme (Braun & Clarke, 2006).

The study adhered to these steps to maintain a systematic and rigorous approach. During the data familiarization phase, the researchers transcribed and recorded interviews and took notes both during and immediately after the interviews. This thorough approach helped with understanding the discussions' context, particularly given the complex nature of equity in transportation.

4. FINDINGS FOR SOCIAL EQUITY CONCEPTS

4.1 Historical Background of Social Equity in the U.S.

Social equity has evolved alongside other key social concepts, including environmental justice (EJ) and civil rights. In the context of the built environment, its applications have adapted to advancements in technology, the complexity of systems, and growing populations. To fully understand social equity in transportation, it is essential to grasp how it intersects with concepts like environmental justice and civil rights and how these relationships inform equity. This section provides a concise overview of these foundational ideas.

The quest for social equity has deep historical roots, tracing back to the era of slavery in North America. Historians often divide the U.S. civil rights timeline into three major periods: slavery, segregation, and the contemporary era. The first era concluded with the ratification of the 13th Amendment in 1865, which abolished slavery (Smith, 2023). However, despite this legal end to slavery, discriminatory laws and hate crimes continued to target Black individuals and other marginalized communities. As the nation expanded southward and westward, additional amendments were introduced to promote equal treatment. For instance, the 15th Amendment of 1870 granted Black men the right to vote, while the 19th Amendment of 1920 extended that right to women (Smith, 2023; U.S. Archives, 2022).

The mid-20th century saw a surge in civil rights movements and protests in response to ongoing racial discrimination. A notable example is the 1955 Montgomery Bus Boycott, sparked by Rosa Parks' refusal to surrender her bus seat to a white man, resulting in her arrest. This incident catalyzed widespread protests and contributed to the larger civil rights movement advocating for equitable treatment, particularly against systemic injustices embedded in laws and policies. Almost a decade later, the Civil Rights Act of 1964, signed by President Lyndon B. Johnson, marked the end of the "segregation era," also known as the Jim Crow era, by empowering the federal government to combat racial discrimination in public facilities, voting, and employment (Britannica, 2023; History.com, 2023).

Since 1964, the civil rights movement in the U.S. has continued to evolve, bringing about significant changes that impact various aspects of American life. One notable development from this ongoing movement is the Environmental Justice (EJ) movement. The Environmental Protection Agency (EPA) identifies the 1968 Memphis Sanitation Strike as a pivotal event that sparked the EJ movement. This strike, which demanded fair wages and improved working conditions for sanitation workers, highlighted broader issues of inequality and EJ.

In the years leading up to the 1990s, protests emerged across the country against waste management practices and facilities that disproportionately affected low-income and historically marginalized communities. During this time, various committees and local groups formed to challenge these unfair environmental and health impacts. Notable initiatives included the West Harlem Environmental Act, the Indigenous Environmental Network, the University of Michigan's Conference on Race and the Incidence of Environmental Hazards, and the Southwest Network for Environmental and Economic Justice. Simultaneously, academic research on EJ gained momentum. Key publications such as "Dumping in Dixie" (1990) and "Race and the Incidence of Environmental Hazards" (1992) provided critical insights into environmental inequities, marking significant contributions to the field (EPA, 2023).

These efforts culminated in establishing the Office of Environmental Equity in 1992, later renamed the Office of Environmental Justice following President Clinton's signing of Executive Order 12898 in 1994. This executive order aimed to "focus federal attention on the environmental and human health effects of federal actions on minority and low-income populations, with the goal of achieving environmental

protection for all communities” (EPA, 2023; USDOT, 2016). Today, social equity is associated and confused with EJ. The next section provides definitions of these concepts and explains the relationship between them and their types.

4.2 Social Equity versus EJ and Types

While social equity and EJ share historical roots and are often integrated into similar programs and plans, they represent distinct concepts. Although they overlap and are sometimes conflated—particularly by professionals outside the social sciences—clarifying these terms is crucial for this research. Properly defining and explaining these concepts will aid readers in understanding the results and discussions presented.

Terminology related to justice and equity can vary across the literature, so it is important to first define and explain these terms to minimize confusion and provide a clear overview. For reference, the 2022 “ITE Foundational Equity Glossary” by the Institute of Transportation Engineers offers a compilation of equity-related terms, drawing from diverse sources beyond transportation alone. This study incorporates some of these definitions, citing the original source (ITE Equity Committee, 2022).

According to the American Institute of Architects (AIA), equality involves treating everyone the same regardless of differing starting points, which can perpetuate existing inequities. In contrast, equity considers individual needs and aims to provide tailored support to disadvantaged groups, ensuring equal opportunity and access based on those needs. The AIA defines justice as ensuring fair treatment, equal economic, political, and social rights, and equitable opportunities and outcomes for all. Justice also includes addressing past wrongs, transformative justice, and accountability (AIA, 2020). While equity and equality are approaches to fairness, justice focuses more on the outcomes of those approaches. Race Forward, an organization established in 1981 to work on structural racism, describes equity as a measure of justice (Race Forward, 2023).

However, these concepts can vary in application and may sometimes lead to confusion due to their interrelated nature. For instance, consider the distinction between environmental equity and EJ. Ewall (2012) explores these differences in the context of the EJ movement from both legal and social science perspectives. They note that the “equity” versus “justice” debate is not just semantic but highlights a crucial difference: “The ‘equity’ versus ‘justice’ framing represents a fundamental shift from ‘poison people equally’ to ‘stop poisoning people, period!’”

While equity aims to distribute burdens more fairly, it may not always be practical or effective, particularly in cases like the distribution of toxins or fatalities. This is why the EJ movement evolved from focusing on equity to emphasizing justice, advocating for the elimination of pollution sources rather than merely redistributing them more fairly. Despite this shift, Ewall points out that actual implementation and policies often still reflect the concept of equity rather than justice. Most government agencies currently define EJ as “fair treatment and meaningful involvement.” Ewall argues that if there is no overt, intentional racism, the criteria for fair treatment are often considered met (Ewall, 2012). This example illustrates how theoretical differences between equity and justice can manifest in practice, with policies and actions potentially falling short of addressing the broader goals of justice.

To clarify the comparison between social equity and EJ, it is essential to specify the type of fairness being discussed, as both concepts can be applied across various sectors in different ways. The Handbook of Environmental Sociology (2021) identifies several types of EJ: distributional, procedural, recognition, restorative, and social (Maung & Pellow, 2021). Conversely, Kuehn (2000) categorizes EJ into distributive, procedural, corrective, and social types. These differing categorizations reflect the variety of

ways researchers describe and define EJ and its relationship with social equity (Maung & Pellow, 2021; Kuehn, 2000; Karner et al., 2020; Pereira & Karner, 2021).

For this study, the focus is on three relevant types of justice: distributional, procedural, and restorative. To differentiate between social equity and justice in transportation, the distributional type was specifically considered. This type addresses the allocation of benefits and burdens within a sector or service, and it is widely recognized by legal and transportation agencies (Maung & Pellow, 2021; Litman, 2019; Rowangould et al., 2016).

Definitions of benefits, burdens, and “target populations” vary between social equity and EJ. The TCRP guide on Equity Analysis in Regional Transportation Planning Processes indicates that EJ primarily focuses on environmental impacts affecting low-income and minority populations. In contrast, social equity encompasses a broader range of impacts, including accessibility and mobility within transportation, as well as social factors. It also includes a broader range of target populations, such as households without cars, individuals with disabilities, low-English literacy populations, and youth (Twaddell & Zgoda, 2020; ITE Equity Committee, 2022).

4.3 Status of Social Equity in Transportation

Equity has recently been identified as a critical issue in transportation, according to a report from the TRB Executive Committee (NASEM, 2024). Since the USDOT released its Equity Action Plan in 2022, there has been a surge in interest among state and local governments to integrate equity into their projects and plans. Although some states already had established equity programs, federal support and funding have significantly advanced these efforts.

The TRB report highlights that the ultimate goal in addressing transportation issues is to create a thriving society. To achieve this, the committee identifies five major challenges: economy, climate, safety, public health, and equity. The report acknowledges that while transportation infrastructure has improved access to essential services like employment, education, and healthcare, it has also exacerbated inequities by displacing communities, concentrating pollution, and harming properties and businesses. The report emphasizes that the most affected are people of color and marginalized communities, pointing out that social disparities persist across various dimensions, primarily income and race (NASEM, 2024).

Efforts to fund and develop equity programs and resources at all levels of government have been ongoing. The Infrastructure Investment and Jobs Act (IIJA), also known as the Bipartisan Infrastructure Law (BIL), passed in November 2021, authorizes \$1.2 trillion for transportation and infrastructure, with a focus on equity. This includes funding for public transit, electric vehicles (EVs), community-oriented design, and EJ initiatives (Dix et al., 2023). The USDOT supports these goals through programs like Justice40, the Disadvantaged Business Enterprise program, the Reconnecting Communities program, and the Rebuilding American Infrastructure with Sustainability and Equity (RAISE) grants. Justice40, for example, mandates that 40% of all benefits from federal grants and programs be directed to disadvantaged communities (Conley et al., 2023).

The integration of equity in transportation is still evolving, and professionals face several challenges. Research in recent years has focused on identifying strategies for implementing equity and addressing associated difficulties (Karner et al., 2020; Cantilina et al., 2021; Pereira & Karner, 2021; Roll & McNeil, 2022; Azmoodeh et al., 2023). Cantilina et al. (2021) highlighted challenges related to data availability and collection, as well as the measurement of equity outcomes. Similarly, Manaugh et al. (2015) found that while equity is a key component of sustainability in urban transportation plans, its objectives often lack clear indicators and are overshadowed by more tangible outcomes like congestion and safety.

5. FINDINGS FOR SOCIAL EQUITY IN TRANSPORTATION PRACTICES

To operationalize equity in TAM, professionals must embed equity considerations into asset management decision-making processes. The decision-making process, regardless of the tools employed, involves several key steps, including defining the problem, identifying alternatives, establishing criteria, and evaluating alternatives based on these criteria (Fülöp, 2005). To effectively implement these steps, clear definitions are essential for developing relevant indicators and criteria (Webb & Ayyub, 2017). This study, therefore, investigated how equity is defined and measured in transportation by interviewing professionals involved in integrating equity into transportation practices. The insights about equity definitions, indicators, and approaches gained from these interviews will guide the next phase of defining equity within TAM and identify suitable equity indicators for inclusion in TAM decision-making.

5.1 Definitions

The first step in incorporating equity into transportation would be to define it. This section presents the definitions shared by the participants during the interviews. It also discusses the different types of equity targeted by transportation organizations and agencies.

Table 5.1 lists the equity definitions shared or referred to during the interviews, as well as the USDOT definition from the USDOT Equity Action Plan.

Table 5.1 Equity Definitions Shared by Transportation Professionals

	Definition	Org(s) Type – Source
D1	Transportation equity means the benefits and burdens of transportation systems, services, and spending are fair and just, which historically has not been the case. Transportation equity requires ensuring underserved communities, especially Black, Indigenous, and People of Color, share in the power of decision-making.	DOT – Agency Document
D2	EJ at the FHWA means identifying and addressing disproportionately high and adverse effects of the agency’s programs, policies, and activities on minority populations and low-income populations to achieve an equitable distribution of benefits and burdens.	DOT & MPO – EJ FHWA Definition
D3	Equity is when a person’s identity or identities, or where they live, do not negatively affect their outcomes in life. Achieving equity means recognizing that not everyone starts from the same place, so leveling the playing field might involve providing different resources to different people or communities.	City – City Document
D4	Equity is a measure of fair treatment, opportunities, and outcomes across race, gender, class, and other dynamics.	City – City Document
D5	Equity means each person has the resources and services to thrive, such that racial and socioeconomic disparities are eliminated and outcomes improve for all.	City – City Document
D6	Equity: When one’s identity cannot predict the outcome.	City – City Document
D7	Equity is the absence of unfair, avoidable, or remediable differences among groups of people, whether those groups are defined socially, economically, demographically, or geographically or by other dimensions of inequality (e.g. sex, gender, ethnicity, disability, or sexual orientation).	County – World Health Organization
D8	Racial equity means eliminating disproportionalities based on race by using a racial equity framework, which improves outcomes for all groups.	County – Government Alliance on Race & Equity
D9	Equity means the consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as Black, Latino, and Indigenous and Native American persons; Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality.	USDOT Equity Action Plan

The definitions provided address various aspects of equity, target populations, and outcomes. Definition D1 encompasses both distributional and procedural equity. The first sentence focuses on the distribution of benefits and burdens associated with transportation systems and services, representing distributional equity. The second sentence emphasizes the importance of including underserved communities in decision-making processes, which relate to procedural equity. This definition effectively outlines the types of equity to be applied in practice and specifies the target population, namely “Black, Indigenous, and People of Color” (BIPOC), as indicated in D1.

D2 is the FHWA definition of EJ, and participants mentioned that they used it when talking about equity in transportation. Although equity and EJ share some common objectives and approaches, they are not completely the same. When defining target populations, EJ traditionally focuses on minority and low-income communities. In contrast, equity encompasses a broader spectrum, including populations with limited English proficiency, those without access to vehicles, and individuals with disabilities. The choice of definition will shape an organization’s equity metrics and guide the populations targeted through its investments and programs.

One challenge with using the EJ definition for equity is that it may be overshadowed within other initiatives, such as Title VI or sustainability programs. For instance, sustainability programs sometimes prioritize environmental goals over social goals, which can obscure the focus on equity. Therefore, it is crucial to establish a distinct and clear definition of equity, even if it intersects with other programs and plans. This ensures that equity remains a prominent and actionable focus within organizational strategies.

The definitions provided by participants from various cities—D3, D4, D5, and D6—tend to be more generic, focusing on fairness and outcomes. These definitions suggest that equity approaches should ensure fair treatment based on individual needs and aim for equal outcomes for all. While these definitions offer useful guidelines for DOTs in framing their approach to equity, they lack specificity regarding target populations and measurable outcomes. To be more effective, these definitions should detail what constitutes the target population and clearly define the expected outcomes.

Definition D7, provided by WHO, characterizes equity as the absence of inequities among communities. It addresses both outcomes and populations, identifying groups based on traits such as economic, demographic, and social factors. Definition D8, derived from the Government Alliance on Race & Equity, similarly emphasizes the need to eliminate disproportionate outcomes but focuses specifically on racial equity rather than broader social equity. Both definitions share a focus on addressing inequities but lack clarity on whether they pertain to past or future outcomes. This distinction is important as it influences the type of equity to be addressed—whether restorative, aimed at correcting past injustices, or distributional, focused on equitable distribution of resources and opportunities.

The USDOT definition of equity (D9) outlines the characteristics of populations targeted by their equity programs but does not specify the type of equity or the outcomes to be improved. It identifies the communities that could benefit from equity initiatives and provides guidance on the traits of these populations for state and local DOTs. However, the absence of specific outcome definitions means that other organizations must determine what outcomes to pursue. While this flexibility allows for customization based on local needs, it may also present challenges for transportation professionals as they work to plan and implement equity-focused programs.

These definitions illustrate the varying approaches to defining equity in transportation across different governmental levels. They provide valuable insights for this study, guiding the development of a tailored definition of equity that aligns with the context of TAM in Section 6.

5.2 Indicators

Incorporating equity into TAM decision-making processes requires not only defining it but also measuring it effectively. The interview participants provided various approaches and indicators for measuring equity in transportation, which are detailed in this section. Due to the diverse types of equity and the need to address different community needs, the shared indicators span a wide range. One participant highlighted the inherent challenges in this area, noting “A lot of our approach to equity is very subjective based. It is very values-based. It inherently becomes a choice whether or not to adopt an equity framework... I think for equity, challenging-wise, [it is] very difficult to track, very difficult to measure.” This reflects the complexity and subjectivity involved in quantifying equity.

After analyzing the data provided by the participants, the indicators were categorized into two main groups: user-related and system-related, as follows:

- User-related (reflect demographics & needs):
 - wealth, income, housing, race, ethnicity, age, physical ability, education level, level of English proficiency
- System-related (reflect costs and benefits):
 - Social & Economic: affordability, social exclusion, economic growth, workforce development
 - Health: accidents, fatalities, respiratory diseases, proximity to toxic sites, noise, safety
 - Environmental: emissions, pollution, waste, air quality
 - Transportation: walkability, accessibility, mobility, travel time, level of multimodal accessibility
 - Budget: funds allocated for community engagement or active transportation and non-car modes – funds for equity training and education

This classification reflects the discussion on equity definitions and types. A widely adopted approach to measuring equity in transportation is grounded in distributional theory. This method involves analyzing how the benefits and costs of transportation systems are distributed across different communities. It focuses on identifying whether any communities, particularly disadvantaged ones, are disproportionately adversely affected by these systems (Maung & Pellow, 2021; Litman, 2019; Rowangould et al., 2016). Consequently, the equity indicators provided by participants were grouped by considering both dimensions of this equity equation: users and systems.

On one hand, transportation professionals must identify and select characteristics of the communities targeted by equity programs, referred to here as user-related indicators. These include demographic factors pertinent to system users and affected communities, such as wealth, income, race, ethnicity, age, physical ability, education level, and English proficiency. This approach mirrors current practices in EJ programs, which identify EJ communities based on specific indicators. The primary distinction for equity is that it incorporates a broader set of user-related indicators and may target different communities requiring additional support to achieve equitable outcomes. This expanded focus helps address both past and present inequities more comprehensively.

On the other hand, practitioners also need to consider system-related indicators, which assess the benefits and costs associated with transportation systems and services. Since transportation significantly affects many aspects of daily life, evaluating its impact from multiple perspectives is crucial. The indicators and indices shared by participants were categorized into five groups: social, economic, health, environmental, and transportation. Some indicators may fall into more than one category. For example, social impacts

can include elements like affordability (economic) and safety (health), highlighting the interconnected nature of these indicators.

Another key set of indicators pertains to the budgeting and allocation of funds within an organization. Participants emphasized that effective equity programs necessitate dedicated funding. To truly drive change, these programs must influence financial decisions, ensuring that funds are directed in ways that benefit communities, address disparities, and promote equitable outcomes. Participants noted that incorporating equity into an organization's budgeting processes can significantly impact decision-making. Equity considerations should serve as criteria or indices that adjust the prioritization and allocation of resources based on their equity impact. Additionally, examining how funds are allocated for community engagement is crucial for assessing procedural equity as it reflects the organization's commitment to involving and benefiting diverse communities. Similarly, evaluating the investment in equity-related education and training is another important indicator of an organization's dedication to incorporating equity.

These indicators will be explored in greater detail in Section 6, where they will be examined within the context of TAM. Quantifying equity within TAM is essential for integrating it into decision-making processes and effectively operationalizing it.

6. FINDINGS FOR SOCIAL EQUITY IN TAM

6.1 TAM Background

The AASHTO defines TAM in its TAM Guide as “a strategic and systematic process for operating, maintaining, upgrading, and expanding physical assets effectively throughout their lifecycle. It emphasizes business and engineering practices to optimize resource allocation and utilization, aiming for improved decision-making based on high-quality information.” Major assets commonly managed by DOTs include pavements, bridges, sidewalks, drainage structures, and tunnels. TAM adheres to several key principles: policy-driven, performance-based, risk-based, transparent, and information-driven. Frequently used terms within TAM include performance measures, performance targets, level of service, asset condition, state of good repair, and resource allocation (AASHTO, 2024).

TAM encompasses numerous procedures and decision-making processes. For instance, two primary management approaches are usually employed: policy-based and performance-based. A policy-based approach prioritizes decisions according to organizational guidelines and policies. For instance, an agency may prioritize the maintenance of existing infrastructure over new construction based on its policies. In contrast, a performance-based approach focuses on achieving specific performance targets. For example, maintaining pavements with an international roughness index (IRI) of 95 inches per mile or lower on certain highways exemplifies a performance-based strategy that relies on measurable performance indicators (Liz, 2018).

Investment strategies in TAM also vary. For highway and bridge projects, agencies can choose from preservation, modernization, and expansion methods. Similarly, maintenance strategies may include preservation, worst-first, or hybrid approaches (Liz, 2018). The choice of these approaches depends on the agency’s defined objectives and performance measures. These decisions will influence how assets are managed over time and their impacts on both the environment and society. Each year, agencies assess their progress toward meeting their objectives and may adjust their methods or adopt new approaches as necessary (AASHTO, 2024). Consequently, the selection of management approaches and objectives, such as safety and equity, are deeply interconnected in TAM.

6.2 Status of Social Equity in TAM

Equity continues to be a marginal consideration in TAM. Recent studies underscore this issue by revealing significant disparities in asset conditions relative to socioeconomic status. The previously mentioned research by Gandy et al. (2023) and Rajaei et al. (2021) found that transportation assets in lower-income and disadvantaged communities are disproportionately more likely to be in poor condition. This disparity highlights a critical gap in current TAM practices, which often fail to address the unequal distribution of infrastructure quality.

Further examination of TAM practices and plans reveals that equity is not adequately incorporated. In a study by the authors, a content analysis of the 2019 Transportation Asset Management Plans (TAMPs) from all 50 states, Washington D.C., and Puerto Rico was conducted. The analysis demonstrated that equity-related terminology was largely absent from TAMPs. This finding indicates that while TAM is essential for managing transportation assets, it frequently overlooks the equitable distribution of resources and the impact of asset conditions on marginalized communities (Khalife et al., 2023).

The survey findings supported this claim. Figure 6.1 illustrates the distribution of years of experience in TAM and equity among the survey participants. Over 60% of participants had more than five years of experience in TAM, whereas only about 30% had equivalent experience in equity. Additionally, 25% of

participants reported no experience in equity at all. The survey also inquired about the integration of population-related data—such as income, disabilities, language proficiency, and social vulnerability—into departmental management of systems and assets. As shown in Figure 6.2, approximately half of the departments do not incorporate such data into their practices. Furthermore, although 70% of organizations include equity in their broader plans (e.g., TIP, LRTP, safety), only 25% of organizations have equity explicitly addressed in their TAM plans (TAMPs).

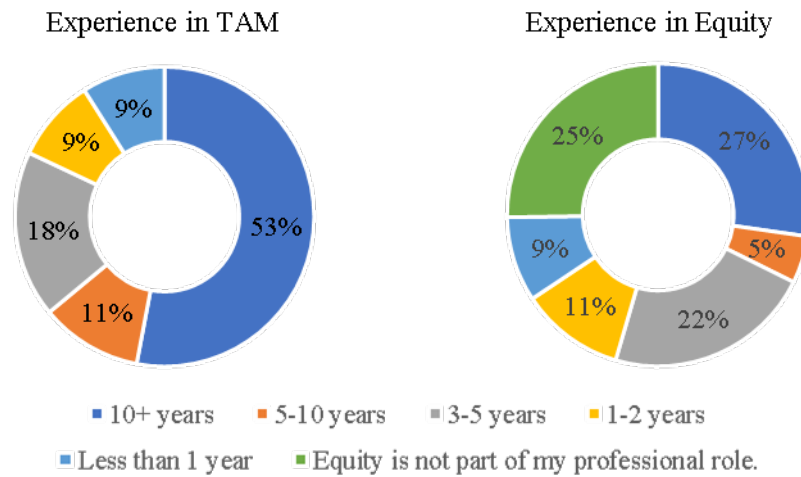


Figure 6.1 Distribution of Years of Experience Among Survey Participants

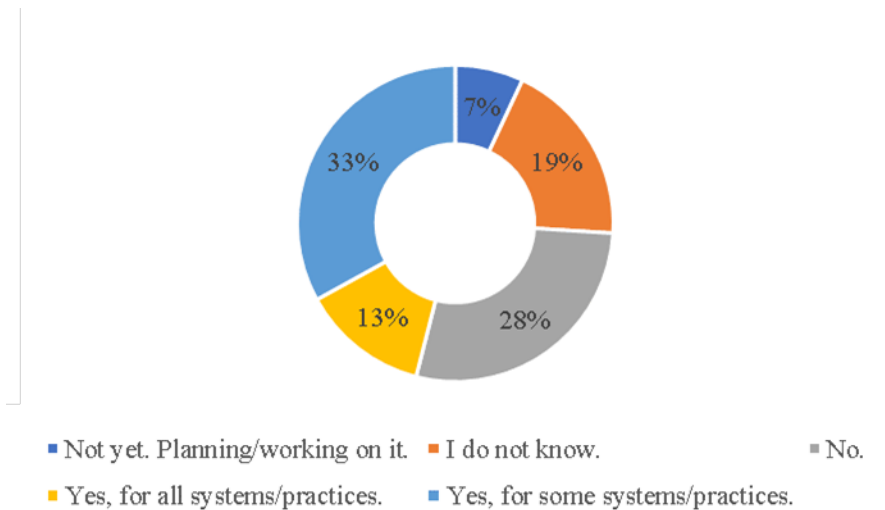


Figure 6.2 Integration of Population-Related Data into TAM Systems

The absence of equity-focused language and measures in TAMPs reflects a broader issue where TAM practices do not sufficiently address or prioritize the needs of disadvantaged populations. This ongoing marginalization of equity within TAM underscores the need for more comprehensive approaches that integrate equity to ensure fair treatment and equal access to transportation for all communities. While some resources incorporate equity through related programs such as EJ and sustainability, there remains a significant gap in directly addressing and embedding equity issues within TAM itself. This gap calls for a focused effort to develop and implement specific equity measures within TAM practices and decision-making. The following sections will present results from the conducted survey and interview studies, providing insights into how these findings can inform and enhance the integration of equity into TAM.

Recently, the AASHTO TAM Guide was updated to include a subsection about equity in TAM. In subsection 2.6.1, the guide provides a definition of equity and differentiates it from equality and justice by defining those concepts as well. In subsection 2.6.2, the guide briefly explains steps to integrate equity into TAM practices. Seven steps were recommended as follows: (1) define equity, (2) integrate equity in policies and plans, (3) establish clear equity objectives, (4) identify measurable criteria, (5) identify performance gaps/inequities, (6) engage communities, and (7) assess implementation and improve implementation (AASHTO, 2024). These recommendations align with this report’s approach to incorporating equity in TAM. The results include discussions on how to define equity in TAM, ways to measure it, and a framework to integrate it into decision-making.

6.3 Recommended Equity Definition for Use in TAM

This report employs a framework based on three dimensions of equity—restorative, procedural, and distributional—to analyze equity within TAM. Each dimension is examined in relation to TAM practices and scope of work. The responses collected from the survey study with TAM professionals are analyzed and compared against results from the interviews and equity literature. This analysis helps professionals understand and define equity in the context of TAM.

In addition to the equity definitions provided in 5.1, the report considers the definition provided in the FHWA report “Equity Considerations in Asset Management: Case Studies.” The report refers to a 2019 study by the Minnesota DOT and the University of Minnesota that examined equity and, based on input from local communities, defined transportation equity. The definition is composed of three parts: “multimodal options that are affordable, sustainable, reliable, efficient, safe, and easy to use”; “quality transportation services that are accessible to all populations for reaching destinations”; and “decision-making processes that incorporate inclusive public engagement to reduce the longstanding socioeconomic disparities experienced by underserved and underrepresented communities” (Van Dort et al., 2019).

Comparing the 2019 definition with the other definitions presented in Table 5.1 reveals several similarities, particularly in terms of the distribution of transportation benefits (distributional equity) and the emphasis on inclusive decision-making and community engagement (procedural equity). However, the 2019 definition introduces the term “multimodal,” which could enhance the conceptualization of equity within TAM. Considering equity across different transportation modes is crucial, as highlighted in the TAM Guide, which identifies modal inequity as a significant disparity requiring attention in equity analyses within TAM.

The survey responses introduced additional components to the definitions previously discussed. One response framed equity in terms of investments, defining it as: “Transportation Equity: Transportation investments developed through an inclusive process that promotes equitable outcomes.” This definition incorporates both the procedural aspect of equity through the mention of “an inclusive process” and the distributional aspect through “equitable outcomes.” Another response referenced the equity definition provided by the Washington D.C. DOT (DDOT). The DDOT definition encompasses three elements: a statement on distributional equity, emphasizing a “just distribution of benefits and burdens”; a statement on procedural equity, highlighting collaboration with the community; and a statement about DDOT’s focus on “historically underserved communities,” specifying targeted groups for attention.

To better understand how all these definitions fit the context of TAM, the survey participants were asked about their expert opinion on whether the USDOT definition of equity (D9 in Table 5.1) adequately addresses equity within TAM. Several participants emphasized the need for a language that acknowledges the disproportionate needs in underserved communities and the past disparities in investments and transportation impacts. They explained that the current definition reflects equality more than equity.

Participants argued that an equity-focused approach should center on community needs rather than merely asset conditions. As one participant explained, “Equity is more about a focus on user needs and less about a focus on fairness (equality—maintaining assets in a state of good repair regardless of location).” This participant also pointed out that existing TAM practices often assume that current assets meet user and community needs, which may not always be accurate. “We are managing what we have, not necessarily what our users in certain areas need now,” the participant noted in a comment on how the USDOT’s definition of equity applies in the context of TAM. From the interview responses, one participant also mentioned this, stating, “[Asset management] is very data-driven. It is [about] what needs it [and] where, more than who needs it.” Another survey response emphasized that for equity in TAM to address the needs of underserved communities, this focus should be reflected both in the definition and the data used in practice. The current data collected only reflect asset conditions and cost estimates.

Returning to AASHTO’s definition of TAM, it stated that TAM “emphasizes business and engineering practices to optimize resource allocation and utilization, aiming for improved decision-making based on high-quality information.” Traditionally, TAM focuses on the cost and physical condition of assets. However, equity demands a broader perspective that incorporates social impacts and fairness considerations. While traditional TAM practices prioritize the financial and technical aspects of asset management, an equitable approach, as backed by the discussion about equity definition, requires integrating social dimensions into decision-making processes. This shift involves considering how asset management decisions affect different communities, particularly those that are underserved or historically disadvantaged, thus ensuring that resource allocation also promotes social equity.

Given all this understanding of equity types and TAM practices from the literature, interviews, and surveys, professionals can better understand and define equity in the context of TAM.

Table 6.1 provides a breakdown of equity types that could be applied in TAM and an example of each.

Table 6.1 Types of Equity and TAM Examples

Equity Type	Description (Maung & Pellow, 2021; Ramsay, 2009)	TAM Example
Procedural	Ensures that all stakeholders, particularly marginalized or affected communities, have meaningful participation and influence in decision-making processes	Collecting feedback on the community’s need and satisfaction with existing assets.
Restorative	Addresses and corrects past and present injustices by repairing historical harms and providing targeted support to disadvantaged communities	Developing a park in a historically disadvantaged area where highways have displaced communities and diminished quality of life.
Distributional	Ensures that the allocation of benefits and burdens from policies or projects is fair and equitable, addressing disparities to achieve balanced outcomes across various populations	Prioritizing the maintenance of assets in underserved areas and communities with high social vulnerability.

Given all of the previous discussion and findings, one possible way of defining equity in TAM can be proposed as: “Socially equitable TAM assesses both existing and future assets through the lens of community needs and their impacts on various populations. This approach necessitates active community engagement and involvement in decision-making processes. Equitable TAM integrates social equity criteria into all aspects of asset management, including investment decisions, resource allocation, and maintenance strategies, to ensure equitable distribution of benefits and burdens of transportation assets and systems. It recognizes that assets can disproportionately affect underserved communities and ensures that these impacts are considered in the evaluation and management of assets.”

6.4 Recommended Equity Indicators for Use in TAM

In addition to defining equity-related terms in TAM, a crucial and challenging task is identifying appropriate indicators to measure equity and integrating these measures into decision-making processes. This study has identified such equity indicators in transportation through interviews with transportation professionals, as detailed in subsection 5.2. Building on the earlier discussion of equity definitions in TAM, the following subsection will explore equity indicators that are relevant to the TAM context.

Equity indicators can be categorized as user-related and system-related. User-related indicators refer to the communities served by the transportation entity and describes their characteristics, such as income, wealth, race, English literacy, physical ability, vehicle ownership, and age. To incorporate equity into TAM, practitioners should be able to assess community needs and identify vulnerable communities, and such indicators are necessary to do so. USDOT’s Equitable Transportation Community (ETC) Explorer is one of several recently developed tools designed to assist agencies and organizations in mapping demographics and assessing community burdens. Other tools include the EPA Environmental Justice Screen (EJScreen), FEMA National Risk Index, USDOT Planning & Equity Tool, Screening Tool for Equity Analysis of Projects (STEAP), CDC Social Vulnerability Index (SoVI), and Census American Community Survey (ACS). These tools provide data on various community characteristics and highlight

disadvantaged populations based on different criteria. Some tools, such as the ACS, are integrated into multiple other tools.

The other set of indicators pertains to the benefits and costs associated with the transportation system or its assets. Quantifying the impacts of a specific transportation system or component can be challenging, particularly when these impacts are indirect, long-term, or related to social and environmental factors that are difficult to measure.

Interview participants identified several indicators that can capture the broad range of transportation impacts on communities, including health, environmental, social, and economic effects, as detailed in Section 5. In the context of TAM, not all indicators may be relevant to every asset or practice. The applicability of these indicators depends on the specific scope and objectives of the project or plan under consideration for equity.

A commonly mentioned approach to assessing equity in transportation involves analyzing budgets and expenditures, which aligns well with the cost-focused nature of TAM. Budget analysis allows for evaluating equity from various perspectives, including spatial, modal, and socioeconomic dimensions. By examining how funds are distributed geographically, equity can be assessed between different regions, such as rural versus urban areas. Additionally, spending can be analyzed in relation to income levels and other social factors to ensure that investments are equitable across diverse populations, particularly underserved and vulnerable communities. Furthermore, budget analysis can evaluate equity across different transportation modes or, within the context of TAM, among various asset categories.

Incorporating equity into TAM effectively requires not only quantitative indicators but also qualitative ones. “Equitable outcomes” often extend beyond what numbers alone can represent. To address this, an equitable approach should include community engagement and feedback. Community feedback serves as a key qualitative indicator by capturing subjective insights from residents and stakeholders regarding their experiences, needs, and perceptions of transportation systems and assets. This form of feedback provides valuable context and depth, highlighting issues such as accessibility, safety, and overall satisfaction that may not be fully captured by quantitative metrics. Engaging with community members helps ensure that equity considerations are well-informed and comprehensively addressed in TAM practices.

In the context of community engagement, the extent and resourcing of engagement efforts serve as key indicators of procedural equity in TAM. Beyond analyzing the distribution of benefits and costs associated with assets, it is crucial to implement a robust outreach strategy. This approach should aim to understand community needs, gather feedback on impacts and satisfaction, and actively involve community members—particularly those who are underrepresented, vulnerable, or underserved—in the decision-making process. Additionally, investing in education and training programs for TAM professionals is essential and is another indicator of equity in TAM. These programs would equip TAM professionals with the knowledge and tools needed to effectively gather and interpret both quantitative and qualitative data.

Another indicator of equity in TAM practices is related to contracting and staffing. This includes programs and plans to distribute benefits through hiring disadvantaged-, women-, or minority-owned businesses. In terms of staffing, this includes efforts to create an inclusive and diverse workforce, which would improve the ability to understand community needs and create a collaborative environment to engage communities effectively and incorporate their feedback into decision-making. One interview participant mentioned that their organization is moving with an initiative to “include an equity criterion with our asset management structure.” They explain, “For asset management, you’re thinking cost, performance, safety, but in addition to that, what we’re going to include in 2023 is an equity criterion which is predicated on Title 6, environmental justice, DBE, or Disadvantaged Business Enterprises, and then also ADA.”

7. MCDM APPLICATIONS AND FUTURE RESEARCH

Incorporating equity indicators into TAM decision-making involves a variety of strategies, as shared by interview and survey participants. One approach involves creating an equity index or score for projects, which aggregates various equity indicators into a single metric. This equity score is then assigned a specific weight in the decision-making process, complementing traditional criteria such as agency costs, user costs, and asset conditions. By quantifying equity impacts in this manner, organizations can systematically evaluate how projects address or contribute to social disparities and ensure that equity considerations are given appropriate importance in project evaluations.

Alternatively, equity can be integrated into existing indicators, such as safety, by applying an equity lens. This means enhancing traditional safety metrics to assess not only general safety outcomes but also how these outcomes vary across different demographic groups, particularly those that are underserved or vulnerable. For instance, while a standard safety indicator might measure overall accident rates, an equity-enhanced version would examine how accident rates differ among various communities and identify any disproportionate impacts on marginalized groups. This approach ensures that equity concerns are addressed within the framework of established indicators, providing a more nuanced understanding of how transportation projects affect different populations and supporting more equitable outcomes.

Incorporating equity into multi-criteria decision-making (MCDM) tools and methods for TAM requires clear definitions and well-defined indicators to identify relevant criteria. The literature highlights various MCDM methods used in the transportation sector, but a state-of-the-art review and a systematic review identify the analytic hierarchy process (AHP) as the most commonly employed method (Yannis et al., 2020; Mardani et al., 2016). Equity can be integrated into these MCDM methods either as a standalone criterion, based on an equity index or score, or embedded within existing criteria such as safety, accessibility, or health impacts.

An illustrative example of integrating equity into TAM decision-making is provided by Mohamadiazar et al. (2024). Their study incorporated equity and justice considerations into a spatial MCDM tool to prioritize bridge rehabilitation projects. This approach demonstrates how equity can be effectively embedded within decision-making frameworks to address spatial and social impacts.

Future research could explore the compatibility and applicability of equity indicators with various existing MCDM methods. Comparative studies could analyze how different MCDM techniques handle equity criteria and weights, revealing insights into their effectiveness in promoting equitable outcomes. Such research would help refine equity definitions and indicators to enhance the integration of equity into TAM practices, ensuring that decision-making processes better reflect social equity considerations.

8. LIMITATIONS

This study faced several limitations related to participants' backgrounds, sample size, and data analysis. First, the participants represented a wide array of organizational types, geographic locations, and governmental levels—spanning from state to local entities—and were engaged in various transportation sectors. Although this diversity provides a broad spectrum of experiences and expertise, it also means that the findings may not be fully generalizable to all contexts of equity implementation in transportation and TAM.

The sample sizes for the interviews and surveys could be considered a limitation of the study. Specifically, the research involved conducting 20 interviews with 29 participants (with some interview sessions including more than one professional) and gathering 70 survey responses. Although qualitative methods were employed for data analysis, it is still important to ensure that sample sizes are adequate to achieve data saturation and capture a range of perspectives. According to Hennink and Kaiser (2022), saturation in qualitative research is generally reached with 9 to 17 interviews, suggesting that the sample size in this study was likely sufficient to achieve meaningful insights and diversity.

For the survey sample size, there is no one range or number of responses that satisfies the dataset richness requirement. According to Braun et al. (2020), the sample size is shaped by the research question, the scope and breadth of the topic, the characteristics of the population, and the depth and detail of the individual responses. The study also explains that the qualitative survey sample sizes vary, and they range from a lower end of 20–49 to a mid-range of 60–99 to an upper end of well over 100. The right range depends on the aforementioned factors related to the research objective, the scope, and the responses collected (Braun et al., 2020). In this study, 55 complete responses and 15 partial responses were collected. In a relatively niche topic like social equity in TAM, this sample size could be considered representative. The data collected were also detailed enough to allow the authors to address the research objectives. The participants also represented a diverse set of professionals and organizations.

Besides the limitations related to the data collection methods, there were limitations related to the data analysis. Thematic analysis is inherently shaped by researcher subjectivity, which influences how data are interpreted. Rather than being seen as a flaw, this subjectivity should be recognized as a reflection of the researcher's perspective, integral to the analysis process. In Thematic analysis, data analysis is guided by theoretical assumptions that affect how themes are identified and understood, particularly with complex and subjective concepts such as equity. It is essential to acknowledge these assumptions to maintain transparency and contextualize the findings effectively. Reflexivity is crucial in thematic analysis, as it involves researchers critically examining and acknowledging their own perspectives and biases throughout the analysis. By being aware of and addressing their viewpoints, researchers can enhance the credibility and depth of their thematic analysis (Braun & Clarke, 2006; Finlay, 2021).

9. CONCLUSIONS

As the transportation sector evolves to address social and environmental impacts, there is an increasing emphasis on incorporating social equity. Recent initiatives at local, state, and federal levels reflect this shift, though one area—transportation asset management (TAM)—is still in the early stages of integrating equity considerations. Traditionally, TAM has focused on asset conditions and cost indicators, often overlooking equity.

This study aims to address this gap by exploring how equity can be integrated into TAM decision-making. To achieve this, the study first defined and measured equity within the context of TAM. The research involved a thorough review of existing literature as well as interviews and surveys with transportation and TAM professionals. This comprehensive approach led to a definition of equity in TAM and the identification of relevant indicators for decision-making.

The findings provide a comprehensive definition of equity that includes procedural, distributional, and restorative dimensions. Based on this definition, the study identifies key indicators, including user-related metrics that focus on demographic data and system-related metrics that assess the benefits and costs associated with assets and systems. Additionally, the study recommends analyzing the distribution of resources across assets, regions, and demographic groups to evaluate the equity of current TAM systems and practices.

With a clear definition and relevant indicators, TAM professionals can better integrate equity into their decision-making processes. This study suggests that equity considerations could be incorporated into MCDM tools used in TAM. Whether as an independent criterion or as part of broader criteria, having a precise understanding of equity and its quantitative and qualitative indicators is crucial for effective integration.

Ultimately, this study equips TAM professionals with the tools and insights needed to define and measure equity effectively. By adopting these practices, TAM can better address community needs, mitigate disparities, and promote equitable outcomes.

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APPENDIX A: INTERVIEW QUESTIONS

Communities

- Do you perform public/community engagement? If so, what are your preferred strategies? (meetings, social media, events, surveys, ...)
- *Which communities do you work with? Are these communities vulnerable? If so, according to which indices? (EJ, ADA, Title VI, ...)
- **Do you identify specific vulnerable communities and their presence in your service area to use the data in analyses and plans?
- **Which standards/tools (EJ, ADA, Title VI, CDC, FEMA, EPA, USDOT...) were used to identify the vulnerable communities?
- **Do you have any specific programs for vulnerable communities during the pandemic? What were they?

Equity

- Do you have an established definition for equity? If yes, what is it? (provide document/reference)
- What was the reason for adopting equity? When was it adopted?
- Which standards or documents do you use for work related to equity? Do you use Title VI?
- Is equity explicitly incorporated in the goals or as a guiding principle in your organization? In what ways?
- Do you measure equity? If yes, what are the measures? and how do you use them? Are you satisfied with these measures/tools?
- What additional challenges have you encountered when incorporating equity into your work?
- Do you see your organization moving in this direction in the future? Or what changes will happen to your equity strategies?

Definition: According to the World Health Organization (WHO), equity is defined as “the absence of avoidable or remediable differences among groups of people, whether those groups are defined socially, economically, demographically or geographically.” (Equity vs. Equality: What’s the Difference? | Online Public Health (gwu.edu)) Equity recognizes that each person has different circumstances and allocates the exact resources and opportunities needed to reach an equal outcome.

Transportation

- Do you see any relation between equity and transportation? If so, which areas of transportation (highways & bridges, interstates, public transport systems, railways, AV, EV, air transport, water transport, etc.) and how?
- *Did/do you work on transportation projects? If so, what kind and what are they?
- **AM: How do you manage your assets (tools, departments, metrics, targets, etc.)? Which resources/guides help you with asset management?
- **Do you conduct equity analysis? Or social/environmental impact studies?
- **Do you use the Title VI service equity analysis or a customized one, if any?
- **Process: Which department(s) does the equity work/analyses? How does this department collaborate with other departments?
- **Do you include, or do you plan to include, equity-related metrics in your measures of post-implementation success? Why or why not?
- **Do you incorporate information gathered through stakeholder and community engagement in your equity analysis (es) / plans? If yes, how?
- **Are you able to provide any examples of equity analyses, social/environmental impact studies, equity-inclusive or focused public participation plans or reports on public participation conducted, and Title VI service equity analysis?

- ***Which USDOT programs/tools related to communities and equity do you use? Or plan to use in the future? Ex. Justice 40, EJ, USDOT map for disadvantaged communities, RAISE Grants, NEPA....

Other

- Equity Funding: How are you able to fund your efforts related to social equity?
- Education: Do you see a need for equity incorporation in education for civil engineers, managers, and planners? If so, how?
- Research: Are there things academics could study to help you in your work or support equitable practices?
- Any recommendations for individuals or entities to talk to about transportation equity?
- Open: Do you have anything you would like to share or ask about?

*: CBO-specific questions

** : Local governments & DOT-specific questions

***: DOT-specific questions

APPENDIX B: SURVEY QUESTIONS

A. Information about the organization

1. Select the type of organization where you currently work:
2. Select the region you primarily work in
3. What is the population size that your organization serves/targets? (Please enter approximate number)
4. How many years of work experience in transportation asset management do you have?
5. For how long has equity been part of your professional role?

B. Current work of the asset management department.

6. What assets does your department manage? Check all that apply:
7. Which asset data are used for prioritization of projects and/or alternatives at your department?
Check all that apply:
8. Based on your answer, please rank the selected asset data by order of importance.
9. Does the asset management department integrate population-related data, i.e. income, disabilities, language proficiency, social vulnerability, etc. into its systems and maps (GIS)?
10. Does the asset management department conduct community/public engagement?
11. Does the asset management department collaborate with other department(s) to conduct community/public engagement or collect relevant data?
12. For which purpose(s) does your department employ community/public engagement?

C. Equity in the work of the organization and the asset management department

The following questions ask about the incorporation of equity into transportation. Note that some questions are at the level of the organization while others are at the level of the asset management department.

13. At your organization, is there an equity task force or a committee on issues related to equity?
14. At your organization, is equity mentioned or explicitly addressed in any of the plans (for example as an objective or a measure in STIP, TIP, or other plans)?
15. If yes: (Optional) Please provide brief key example(s) on how equity is mentioned or addressed in your organization's plans:
16. At your organization, do you have/use a definition for equity?
17. If yes: (Optional) Since you answered with a "Yes" to the previous question, please provide the equity definition used by your organization (or a link to it):
18. At your asset management department, is equity mentioned or explicitly addressed in the asset management plans - TAMP or other plans (for example as an objective or a measure)?
19. If yes: (Optional) Please provide brief key example(s) on how equity is mentioned or addressed in the department's plan(s):
20. Please select all the characteristics of population groups considered in your organization's work for underserved communities, if any.
21. Please select all the characteristics of population groups considered in your department's work for underserved communities, if any.

D. Expert opinion on issues related to equity within transportation asset management

In this section, please provide answers based on your expert opinion on equity-related topics within TAM.

22. How would you describe disparities in the distribution of benefits and costs of transportation systems in the U.S.?
23. How would you describe disparities in the distribution of benefits and costs of transportation systems in your area, i.e. state or city level?
24. Does this definition suffice to explain the concept of equity in the context of TAM?
25. From the following list, please rate the challenges facing the incorporation of equity into TAM.
26. (Optional) If there are other challenges, please add them here and rate their severity.
27. Which of these TAM approaches is more equitable than the others? Please briefly explain your reason(s).
28. For each of the following equity outcomes from TAM practices, select the response that best reflects your department's current status with respect to implementing TAM processes to address the outcome.
29. How would you describe the amount of emphasis your organization currently puts toward achieving equity?
30. How would you describe the amount of emphasis your department currently puts toward achieving equity?

Optional section

- (Optional) Please share with us in the space below any comments, suggestions, or questions related to equity in transportation asset management that you might have. Thank you.

Thank you for filling out the survey. We are interested in understanding the experiences of TAM decision-makers. Therefore, we have 4 more short questions on demographics (Optional).

- What is your race/ethnicity? Select all that apply.
- What is your age?
- What is your gender identity?
- Do you and/or your household identify with any of these characteristics? Select all that apply.