EVALUATING ASSET MANAGEMENT FOR NON-MOTORIZED TRANSPORT

SUPERVISED RESEARCH PROJECT

By

JANNAT NAIN

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Supervised by Dr. Madhav Badami

Second Reader: Dr. Lisa Bornstein

ABSTRACT

Cities worldwide have developed a large stock of capital assets as a result of rapid growth and urbanization but have yet to modernize asset management practices. Transportation assets are at a risk of premature decline and spiking liabilities if they are not managed properly. This paper illustrates how Transportation Asset Management (TAM) can be used as a tool to optimize and prioritize non-motorized transport assets in advance. The paper highlights the TAM approach, process and implementation framework along with benefits and challenges of using it as a decision-making tool. Drawing from the literature, and interviews with asset management professionals, the City of Portland's asset management strategy for non-motorized transport (NMT) is evaluated based on an evaluation criteria for good asset management practices. It is concluded that TAM for NMT assets is essential to set a long-term vision for a city's asset inventory. A successful asset management strategy should build public trust and allocate resources in an effective and transparent manner through a well-defined institutional structure. This enables maximized extraction of value from non-motorized transport assets and delivers cost-effective public services.

RÉSUMÉ

Les villes du monde entier ont développé un important stock d'actifs financiers en raison de la croissance rapide et de l'urbanisation, mais doivent encore moderniser leurs pratiques de gestion de ceux-ci. Les actifs de transport, risquent de décliner prématurément et de faire monter les passifs s'ils ne sont pas gérés correctement. Cette recherche montre comment la gestion des actifs de transport peut être utilisée comme un outil d'optimisation et de valorisation des actifs de transports non motorisés. Elle analyse l'approche, le processus et le cadre de mise en œuvre de gestion des actifs de transport, ainsi que les avantages et les inconvénients de l'utilisation de cette pratique comme outil de prise de décision. Basée sur de la littérature scientifique et des entretiens avec des professionnels de la gestion d'actifs, la stratégie de gestion des actifs de transport non motorisé de la ville de Portland est ici analysée sur la base de critères d'évaluations des bonnes pratiques de gestion d'actifs. La recherche conclut que la mise en œuvre d'une stratégie de gestion des actifs de transport non motorisé est essentielle pour définir une vision à long terme de l'inventaire des actifs d'une ville. Une stratégie de gestion des actifs réussie doit susciter la confiance du public et allouer les ressources de manière efficace et transparente au moyen d'une structure institutionnelle bien définie dans le but d'optimiser l'extraction de la valeur des actifs de transport non motorisé et de fournir des services publics rentables.

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INTRODUCTION

Urban transport systems are vital for economic development and improving citizens' quality of life by providing access to places and activities for residents to live, work and play. To establish affordable and high-quality transport systems, cities must ensure their transport systems are financially viable i.e. revenue must be enough to pay for new investments in infrastructure, while also funding maintenance and operations of existing facilities and services. Currently, many cities worldwide especially in developing countries are stuck in an 'underfunding trap' for urban transport management (Ardila-Gomez & Ortegon-Sanchez, 2015). The up-front investments required for new transport infrastructure are significant, while municipal revenue is insufficient to cover maintenance and operation expenses. Financing for urban transport is further stressed by the implicit subsidies for the use of private cars, which represent only a minority of trips but contribute significantly to social and monetary costs. These costs include infrastructure development, congestion, sprawl, accidents, and pollution. Even when financing is available, non-motorized or ancillary transport assets are usually the least prioritized assets (Akofio-Sowah, 2011).

This paper will highlight the importance of sustainable transportation and Transport Asset Management (TAM), especially for non-motorized transport (NMT) assets. The discussion will elucidate the need for better information management for effective decision making and the ability of non-motorized transport asset management to drive better allocation systems that focus on parts of the urban transportation system that are the most used, affordable and equitable. The City of Portland has been selected as a case study to show how cities are emphasizing maintenance over replacement of assets to get a greater return on investment. The TAM strategy for NMT assets in Portland is analysed with an evaluation criteria for good TAM planning practices, drawing out lessons for planners and policy makers.

LITERATURE REVIEW

Sustainable Transportation and Non-motorized Transport Planning

Transportation is an inescapable part of most urban resident's daily routines—from employment and obtaining essential services to shopping and recreation. It is inextricably linked to land-use and urban design and allows many benefits to individuals. However, some aspects of urban transportation also pose serious challenges for the environment and society at large. Sustainable transportation systems promote better and healthier ways of meeting individual and community needs while reducing the social and environmental impact of current mobility practices (Schiller & Kenworthy, 2017). This is done by adapting appropriate techniques and technologies to the type of service required to make everyday destinations closer and more accessible, rather than increasing mobility. Further, sustainable transportation provides a healthier way of getting around that improves an individual's health through more physical activity and the community's health through reduced traffic and its accompanying air pollution and safety hazards (Schiller et al., 2010; Woodcock et al., 2009). Sustainable transportation is not just technical but also a societal process that depends upon effective planning, policy, economics and public participation (Miller et al., 2016). In essence, it is a combination of several elements of transportation, land-use planning, urban design and public visioning processes that describe the desired future of a city. Sustainable transportation aims at lowering financial costs to society by reducing dependence on private automobiles as the main mode of individual mobility and instead maximizes efficiency in overall resource utilization by improving access to employment, goods and services (Schiller & Kenworthy, 2017). Currently, we are at the early stages of a 'paradigm shift' (Ibid.), of how urban transportation is understood, planned, financed and developed. This shift is away from automobile-oriented planning that focused on system growth—or "bigger is better" (Schiller et al., 2010), toward emphasizing more diverse modes, infrastructure and technologies that focus on "closer is beautiful" (Ibid.) in a quest to decelerate increasingly hypermobile cities.

Sustainable transportation arose from concerns about the counter-productivity of highway-oriented planning that began around the 1970s onward as pollution increased and the detrimental effects of highway expansion upon cities gained attention (Newman & Kenworthy, 2015). Planners recognized that environmental and mobility benefits could be attained by a reduction in traffic and related accidents through increased pedestrianization and traffic calming. Sustainable transportation also offered the potential to increase the number of active transport users including individuals walking, bicycling and using public transportation. This understanding was supplemented and further propelled by the growth of sustainability awareness following the Brundtland Commission's report (WCED,1987) on sustainable development as "development which meets the needs of current

generations without compromising the ability of future generations to meet their own needs". An international understanding of a shared vision for a better and more sustainable future was visible with the adoption of the Millennium Development Goals (2000), Sustainable Development Goals (2015) as well as the New Urban Agenda (2016) , all of which called for the integration of sustainability into mainstream transportation policy and planning, especially with the growing impact of climate change (Newman & Kenworthy, 2015). Since then, the growth of sustainability awareness, action on issues associated to climate change and a rise in citizen and civil society participation has led to an active effort to describe, characterize, define and work towards sustainable transportation goals (Schiller & Kenworthy, 2017).

Sustainable transportation builds upon on the "business as usual" approach (Schiller et al., 2010, p.2) to transportation planning as it broadens its focus from just mobility of people and quantity of transport modes to accessibility and quality of transport. This is done by emphasizing closer, slower and more compact transportation infrastructure (Ibid.) Compared to conventional approaches focused on a singular mode of transport, sustainable transportation promotes plurality through multi-modal transportation networks. Additionally, sustainable transportation emphasizes inter-modality by working backwards from a preferred vision to planning and provision or "deliberate and decide" rather "predict and provide" (Schiller et al., 2010, p. 3) , which is based on forecasts of likely transportation demand. Sustainable transport does not ignore social and environmental costs but instead incorporates full costs utilizing an integrated planning approach that combines transportation with other relevant sectors (Ibid.).

One of the most important components of sustainable transportation is non-motorized transport (NMT) - primarily walking and cycling. NMT is a dominant form of transport in terms of usage and sustainability, but only receives marginal recognition in policy, budgeting, resource allocation and legislation (Vanderschuren et al., 2016). Traditionally, public expenditures tend to focus on provision of infrastructure for the small minority that can afford to own a private car, subsidizing the wealthiest road users at the expense of NMT users (Iacono et al., 2010). NMT incorporates low-carbon modes of transport that enhance urban quality of life and facilitate social cohesion (Lucas, 2012); walking and cycling are convenient, cheap, flexible, personal modes without which the majority of people in low- and middle-income countries are unable to participate in the economy, access education, health-care and other urban services (Jennings, 2016). Well-designed NMT infrastructure is critical to the sustainable development of cities around the world. As established earlier, NMT facilities can help advance a several sustainable development goals, including pro-poor, gender-equity, low-carbon, climate-resilience and vision zero goals (Carrigan et al., 2018). This is why the provision of good NMT infrastructure is crucial for advancing equity, better public health, higher personal safety,

access to the economy and environmental goals. In their report 'Pedestrian Mobility for Urban Growth: Walking and its links to Transportation', Carrigan et al. (2018) discussed the importance of NMT infrastructure design as a critical component of reducing the global burden of injuries from road traffic accidents. The World Health Organization (2015) estimated that about 1.25 million people are killed in traffic accidents annually and these injuries are the ninth leading cause of death globally. A majority of these injuries are borne by NMT users, particularly pedestrians as they account for about 22 percent of all fatalities through traffic crashes globally (Ibid.). The main cause of extremely high rates of injury and death of NMT users is inadequate pedestrian and biking facilities (Carrigan et al., 2018). Apart from the loss of lives and its impact on communities, there is a significant economic burden of road crashes to public agencies. Sustainable and high quality NMT infrastructure that ihas the potential to improve road safety by reducing the total private vehicle kilometres travelled in a city, which further reduces NMT users' exposure to automobiles and road fatalities (Duduta et al., 2013, p.2). Well-designed NMT infrastructure includes streets and intersections that make active transport users, especially pedestrians more visible and predictable to drivers (Campbell et al., 2004). This includes effective safety measures such as pedestrian refuge islands, curb extensions, walk signal priority, and other urban street design and traffic calming elements (Ibid.). Thus, good design and development of an NMT network contributes significantly to improving road safety.

Adequate NMT facilities also advance the "less tangible" goal of social equity (Manaugh et al., 2015, p.168) by serving all people, including women, lower income populations and people with disabilities, who experience compounding disadvantages (Carrigan et al., 2018). Considering a large number of trips in urban areas worldwide are completed by foot, providing universally accessible connections improves greatly improves equity for a city's residents (Manaugh et al., 2015). NMT infrasture complements a public transportation network as most public transport trips begin and end with NMT. As a result, investments in universally accessible NMT infrastructure especially benefits vulnerable groups like people with disabilities by providing them with increased mobility and independence. Currently more than one billion people or about fifteen percent of the global population, live with some form of disability (WHO, 2011). This percentage is higher amongst vulnerable groups including women, elderly and children from poor and ethnic minority backgrounds (Ibid.). Therefore, providing accessible trip chains through a well-developed NMT infrastructure is essential to advance social equity. This will ensure that all NMT users have equitable access to opportunities for education,employment and social growth.

Well-designed NMT facilities contribute to improved personal security for NMT users. According to a 2014 survey, 37 percent of Americans, nearly half of them women (48 percent compared to 27 percent men) felt unsafe walking alone at night near their homes (Carrigan et al., 2018). Personal

safety concerns can dictate travel choices and mobility by restricting where, when and how individuals travel. It is possible that NMT users may restrict their travel based on perceived safety. Therefore, well- designed, well-lit, unobstructed, and accessible NMT assets are crucial to improve pedestrians' personal safety.

Adequately developed NMT infrastructure is a strong stimulant for economic growth. Well-designed complete streets reduce the use of motorized vehicles and associated costs of traffic congestion, leading to increased retail sales, business transactions and rising property values (Allocated & Core, 2013). Considering NMT is a lower cost alternative to automobile tranportation, it reduces the cost of transportation for households (Ibid.). Traffic congestion can also be expensive in terms of loss of productivity and higher transportation costs (Carrigan et al., 2018). In 2013 alone, traffic congestion was estimated to cost each private car-owning household in USA an average of $1,700 USD (Carrigan et al. 2018; NACTO, 2016). NMT infrastructure enables a shift from driving to walking, biking and using public transport. This can increase labour productivity, market competitiveness and ultimately boost economic growth. Well-connected pedestrian infrastructure tends to attract more customers, resulting in higher retail sales (Allocated & Core, 2013). For example, a 2013 study in Portland, Oregon concluded that bicyclists, pedestrians and transit riders are competitive consumers and make "more frequent trips than patrons who arrive by automobile, resulting in a higher spending pattern over the course of a month" (OTREC, 2013, p. 43). Similarly, in New York City, street improvements that brought more NMT users to an area, were associated with higher retail sales compared to unimproved streets and the neighbourhood or city as a whole (NYCDOT, 2013). Improved walkable and connected streets also contribute to reduced vacancies and increase surrounding land values by "by changing the perceived desirability of a street or neighborhood" (NYCDOT, 2013, p. 8). Higher property values then lead to increased tax revenues for public agencies, furthering economic growth for the city. Additionally, construction of NMT facilities is significantly cheaper than road infrastructure (Akofia-Sowah, 2013). Therefore, it is beneficial for cities to guide new growth in a way that it supports and encourages NMT use. According to Mason et al. (2015), well integrated NMT and public transport infrastructure can reduce the global societal cost of infrastructure development, operations, and maintenance by up to 40 percent by 2050. Therefore, NMT assets have a significant economic impact and give people an affordable mobility option.

Community public health has a positive co-relation with an increase physical activity of NMT users. Globally, there is a an epidemic of obesity (Haslam & James, 2006; Berke et al., 2007), cardiovascular disease and high blood pressure (Murtagh, 2010). These diseases are either caused or exacerbated by inactive lifestyles (Ibid.). Compact neighbourhoods encourage active lifestyles and improve the overall health of residents. NMT connections to public transport can also increase physical activity

as public transport users tend to walk more daily than non-users (Carrigan et al., 2018). This increased physical activity can reduce the incidence of chronic diseases by about five percent by walking just one kilometre per day (Murtagh, 2011). NMT use also has a positive impact on mental health with a reduction of anxiety and depression (Sharma et al., 2006). As NMT asset development reduces reliance on private automobiles, a reduction in associated air pollution also reduces the likelihood of respiratory problems. Residents of walkable neighbourhoods have been shown to have higher measures of social capital as NMT users have opportunities to interact and communicate with other community members, where the presence NMT infrasturcture or "third places" (Rogers et al, 2013, p. 3477) influences social capital levels and makes positive contributions to their community.

Complete and continuous NMT infrastructure increases environmental sustainability by reducing greenhouse gas (GHG) emissions and improving climate resilience. A walkable environment increased accessibility to public transport options, reducing private motor vehicle trips and inducing a an increase in ridership to more efficient mass transportation (NACTO, 2016). This leads to a well trafficked public transportation system as a high number of potential passengers are within walking distance of public transport facilities. The provision of NMT facilities ensures that potential passengers are able to safely reach public transportation links, increasing their likelihood to use such systems (Bachand-Marleau, Larsen & El-Geneidy, 2011). Thus, reliable public transport and walkable neighbourhoods reinforce each other's use. By shifting transport demand from private vehicles to public transport, NMT infrastructure contributes to lower carbon emissions in a city while continuing to facilitate economic growth.

Now that is has been established that NMT infrastructure advances several goals of sustainable transportation, cities are continually adding to their NMT asset portfolio in a quest to be more safe, equitable, prosperous, healthy and resilient. Although it is necessary to continue to expand sustainable transport infrastructure, it is even more important to maintain, repair and rehabilitate (MR&R) the existing infrastructure, especially NMT infrastructure to ensure cost savings for the municipality and a high return on investment of taxpayer dollars. The decision-making process for optimizing NMT management is vital and decisions must be based on a structured information management system. For this, Transportation Asset Management (TAM) continues to gain ground in agencies as a decision-making tool for capital investment and the maintenance, rehabilitation, and replacement of transportation assets, and as a core business process for broad agency decision making. Although the term asset management is used in different contexts by different agencies, all uses tend to have the same objective of upgrading, preserving and maintaining infrastructure over the lifecycle of an asset.

Transport Asset Management (TAM) and its Principles

Cities make significant investments in developing transportation infrastructure. However, over time as this infrastructure is used and exposed to natural forces, its condition tends to deteriorate. Public agencies find it challenging to preserve the functionality of their existing transportation asset base while at the same time funding expansions of the transportation network to handle increasing demand. The Federal Highway Administration defines TAM as "a systematic process of maintaining, upgrading, and operating physical assets cost-effectively. It combines engineering principles with sound business practices and economic theory, and it provides tools to facilitate a more organized, logical approach to decision making" (NCHRP Report 632, 2006, p.5). TAM is systematic in its approach (Hawkins, 2013), allocating resources based on the entire life cycle of the infrastructure (FHWA, 2019). Typically, TAM has the objective of being policy driven, tracking performance and providing a system of accountability (NCHRP Report 632, 2006). In pursuit of these objectives, governments use different TAM practices depending on their prioritized needs. TAM is performance-based and is developed from policy implementation directed towards data-driven decisions (NCHRP Report 551, 2006). Data-driven decisions require quality information from inventory analysis of asset conditions and historical cost data (Ibid.). This data is used to develop cost-effective maintenance alternatives for the asset infrastructure and continuous analysis and monitoring of an asset's life. TAM is a "living organism" (AASHTO, 2013, p. 12) for local communities as the system builds on existing processes and tools to develop, morph, accomodate and better a communities' overall network of assets. TAM has the following principles (AASHTO, 2002; NCHRP 20-68, 2007):

1. *Policy driven*: Well-defined policy goals dictate resource alllocation decisons for decision makers. These goals are tied to community, economic, and environmental objectives and consider desired system condition, levels of service for assets, and safety provided to users.
2. *Performance based*: Policy goals are adaped into system performance measures , which are further translated for both short- and long-term strategic management.
3. *Analysis of options and trade-offs*: Allocation of funding within and across different types of investments (e.g., preventive maintenance versus rehabilitation, capacity expansion versus operations, different modal mixes, safety etc.) are based on an analysis of how resource allocation impacts the achievement of desired policy objectives. Alternative methods for achieving objectives are also explored and evaluated by public agencies.
4. *Decisions making is based on quality information*: The pros and cons of all options with respect to an agency's policy objectives are evaluated using credible and current data. To enable rational decion making, decision-support tools (typcially computer softwares) are used to provide easy access to information and to assist with performance prediction and tracking.

5. Monitoring to provide feedback: System performance results are monitored, evaluated and and reported to understand effectiveness of decisions. Feedback based on actual performance can influence agency goals, resource allocation and utilization decisions for the future.

Transport Asset Management (TAM) Process

TAM engages, reviews and communicates financial information between multiple stakeholders. The TAM process cycles between planning, implementation and assessment and can be divided into four components as illustrated below in Figure 1.

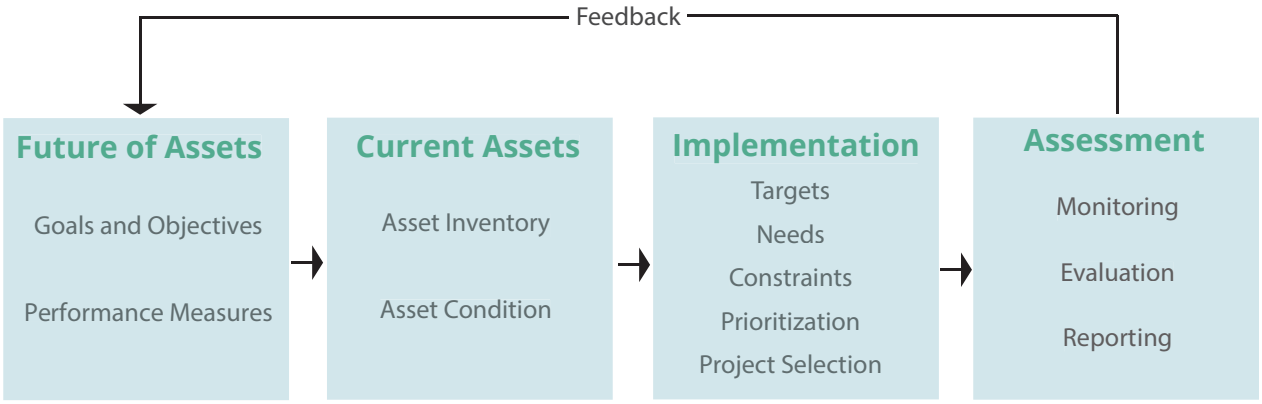

Figure 1: TAM Process Map (Source: FHWA, 2012)

The TAM process begins with goal setting for public agencies to work towards for the future. These goals are based on carefully selected performance measures that are monitored regularly for the achievement of results (AASHTO, 2013). When agencies are developing a data collection methodology, it is challenging but vital to balance the right set of performance measures while keeping in mind the data collection effort. As the TAM process matures over time, performance measures tend to change. So, it is important to not only assess the impact through performance measures but also the suitability of the performance measures themselves as the TAM process evolves. Goals are meant to capture the overall desired state in broad terms (FHWA, 2013). Strategic goals are usually set in a long-range transportation plan (or metropolitan/regional transportation plan); based on those priorities a Metropolitan Planning Organization identifies transportation projects for the next few years (Ibid., 2013).

Once the goals and intermediate objectives are known, the public agencies focus their attention on understanding the inventory of assets, their current condition and predicting their performance over the transportation planning period (AASHTO, 2013). Following an assessment of inventory, a gap analysis is conducted to understand the path from the current state of assets to the ideal state

as required by targets set earlier (Ibid.). However, there are instances when there is a lack of sufficient resources to pursue all the work required. This is when alternative budget-driven scenarios are evaluated based on priorities (AASHTO, 2002). Priorities can differ; for example, new construction usually has the priority, however some transportation agencies now are taking an alternative approach by choosing to "preserve the condition of existing assets, rather than to expand system capacity" (Caltrans 2018, p.7-3). Typically, the trade-offs across different types of assets for the alternative "Target-Driven and Budget-Driven scenarios" (Chang & Vavarova, 2015, p.4) are analyzed to finally prioritize funding and select projects over the planning period.

The implementation of TAM practices based on performance measures and indicators accountability and transparency, fostering an effective allocation of funding. Performance measures sucessfully communicate the value of asset managemet to all stakeholders, serve as a measuring tool to track the state of an asset and help to erformance measures are used to set up a specific level of service that is desirable and measurable over time (Ibid.). So, it is crucial to have well defined performance measures that are specific and measurable, have specific target values and an appropriate level of detail (Ramani, 2013; Chang & Vavarova, 2015, p.4). A performance measurement framework within TAM can be utilized to reach sustainability goals such as safety, accessibility, equal mobility, efficiency, security, prosperity and economic viability (NCHRP Report 708, 2011). Implementation of TAM activities is then followed by a process of monitoring and evaluation of results to ensure the targets have been met (Chang & Vavarova, 2015).

Transport Asset Management (TAM) Implementation Framework

The implementation of TAM practices is key for the TAM process to be successful in any city. The development of conceptual frameworks for TAM originated during the decade between 1980 - 1990 in several parts of the world including the United Kingdom, Australia, New Zealand, and Canada (Campanaro et al., 2017). Their origin was a result of trying to address economic inefficiencies and the lack of accountability associated with poor government property management (Kaganova and McKellar, 2006) as well as a reaction to the privatization of former public utilities (IWR, 2013). As transportation agencies began to formalize rules associated to TAM to optimze costs, risk and performance, private business discipline was introduced to transportation investments (IAM, 2014). Following this, international frameworks were developed to facilitate the implementation of best practice TAM by providing checklists of elements and implementation guidance. These standards include the 'Public Available Specification 55 (PAS 55)', which was developed and by the British Standards Institution and then transformed into an international standard, the ISO 55000 series (IAM, 2015, p.9). The most popular version- ISO 55001: 2014 provides 71 requirements for good asset management, which are aligned with six subject groups—strategy and planning, asset information, asset management decision making, lifecycle delivery, organization and people, and risk review (IAM, 2015). More implementation tools included the '17 International Infrastructure Management Manual', developed collectively by public agencies in New Zealand and Australia, and the 'Assessment of Tangible Capital Assets (PSAB 3150)', which was developed in Canada (Campanaro et al., 2017). Cities that adopt these standards, commit to be compliant with the set of requirements in the relevant checklists.

Although these standards originated in different parts of the world, they have two common concepts embedded within them. First, in order to be successful, a TAM program should be fact based, strategic and systematic, and fact-based (Campanaro et al., 2017). Compliant transportation agencies should design a TAM system that is aligned with their strategic goals and make management decisions based on accurate and high quality information. For this, transportation agencies require an asset strategy that includes a forward thinking approach, good governance, transparent financial planning, a well defined aset iventory and a reliable information system (Ibid.). The second concept embeded in most TAM standards is life cycle management of assets (NCHRP Synthesis 494, 2016; Campanaro, 2017). Since maintenance, repair and rehabilitation (MR&R) expenses are have a life cycle pattern, excercising financial stewardship by tracking and proactively maintaining an asset during its entire useful life has significant financial and practical implications for public agencies (Ibid.). Even in diverse institutional contexts, good TAM programs engage in strategic financial planning, have an transparent and well defined institutional structure and optimize asset MR&R.

Non-Motorized Transport (NMT) Assets

As mentioned previously, NMT assets are an integral part of the transportation system of any city and help to advance sustainable transportation goals. From an economic standpoint, NMT infrastructure disproportionately benefits the poor because they rely more heavily on walking and biking to reach their destinations. It is not only the main mode of transport for the poor, but sometimes also a significant source of income for them (Jennings, 2016). It therefore has a very significant poverty impact. Even where public agencies are resource-constrained, a continued commitment to NMT asset development and management can act as a catalyst to change the experiences of numerous pedestrians and cyclists every day.

Improving NMT infrastruture conditions (better sidewalks, crosswalks, paths, bikeways, bike parking etc.) directly benefits existing and new users by enhancing mobility and providing access and connections to other modes of transport. As a result, improving NMT infrastructure through through MR&R improves a city's transportation system's diversity and efficiency (Litman, 2013). NMT modes tend to be the most equitable and affordable for residents as users of the transportation system. In a typical community, about 20-40% of residents cannot drive due to age, disability or poverty, and thus depend on NMT modes, or are forced to rely on motorists for rides (Litman, 2013). This means the the quality of NMT assets significantly "affects the ability of mobility disadvantaged people to access critical goods and activities, and their independence" (Litman, 2013, p.17). Improving NMT environments creates more attractive communities by improving the utility and enjoyment of activities in the public realm. Although NMT travel represents only 5 - 15 percent total trips in North America, it typically represents about 15 - 30 percent of their time, so NMT travel conditions have the ability to impact people's travel experience. Additionally, as established earlier, NMT modes give people opportunities for physical activity and recreation. If NMT infrastructure conditions improve, there is a potential to add more such users utlizing NMT facilities (ABW, 2010). Therefore, there is a definite need for NMT asset improvement and although government agencies strive to provide funds for NMT asset maintenance, such resources are insufficient, leading to the need for developing adequate methods to support effective management of NMT infrastructure.

Management of NMT assets requires "condition assessment, deterioration modelling, and maintenance decision-making" (Mishalani & McCord,2008; Sousa et al., 2017, p.2). NMT asset condition assessment provides information for an updated inventory that can be monitored, which is required by public agencies for MR&R acitivies. Unlike roadways, even though NMT assets are considered as primary infrastructure, they have failed to be prioritized for for TAM funding (Ardila-Gomez & Ortegon-Sanchez, 2015). Typically, fiscal resources are allocated to infrastructure that

poses a threat to life or property with respect to motorized users (Sousa et al. 2017). In the past few years there has been interest in the concept of walkability, that can be described as the extent to which the built environment is walking-friendly (Abley, 2005) or, more strictly, as "a 'match' between residents' desires and expectations for types of destinations, their willingness to walk a given distance and the quality of the required path" (Manaugh & El-Geneidy, 2011, p.3). Significant research has been undertaken to define, assess, compare and improve walkability indexes for neighbourhood units (Ewing & Handy, 2009), including from a public health viewpoint (Ibid.), or focusing on people with disabilities (Rodrigues et al., 2012). Walkability indicators often include sidewalk-related factors in their definition, increasing the need to consider NMT asset infrastructure (Sousa et al, 2017). The rising importance of NMT infrastructure is expected to continue, especially if its supporting infrastructure is improved (Ibid.). This necessitates an assessment of NMT asset conditions, of which sidewalks are perhaps the most important element. In this context, there is a need for prudent resource allocation so that adequate funding, strategy and implementation mechanisms are used for NMT asset management.

Benefits of Non-motorized Transport Asset Management

Utilizing an asset management approach for NMT assets has three primary benefits. First, when asset management is a critical component of the planning process, cities are able to have better quality assets and services. This is a result of "rational, data-driven, and well-informed decision-making strategies" (Haas & Hensing, 2005, p.16) when allocating resources or making investment-related decisions by public agencies. This is done by quantifying the condition of key assets. Through data collection, TAM drives the government's decision making that determines the best use of limited funds within the city's budget (AASHTO, 2002). In the long run, successful asset management programs lead to appropriate maintenance, repair and rehabilitation (MR&R) of infrastructure which improves asset performance while simultaneously reducing MR&R costs (Mizusawa et al. 2009). Overall, "more timely decisions and other efficiency improvements combine to reduce the costs of acquisition, maintenance, upgrade, and replacement of assets" (Haas & Hensing, 2005, p.3). These improvements in asset conditions provide a better environment for NMT.

Second, TAM for NMT produces real savings and additional revenues for the local municipal budget. This is because maintaining and rehabilitating NMT infrastructure is significantly cheaper than road infrastructure (Ardila-Gomez & Ortegon-Sanchez, 2015). Agencies are able to assess the implications of different investment options in the overall transportation network (Mizusawa et al. 2009). This creates the ability to determine the impact of various funding levels on infrastructure condition over the long-term. By integrating several assets including NMT, public agencies are able to apply

advanced scenario and trade-off analyses to better understand investment strategies, improving system performance with constant or declining dollars ((FHWA, 2007; Mizusawa et al. 2009). This approach to resource allocation means that agency investment decisions are more efficient and cost-effective. With this level of informed decision making that integrates all the levels of infrastructure making up a transportation system, agencies can increase their effectiveness and efficiency in relation to infrastructure MR&R.

Third, the consistent use of asset management practices generates trust between people and government (Kaganova and McKellar, 2006). Using TAM improves confidence in agency performance by clearly reporting achievements-and failures-and progress toward established goals (Ardila-Gomez & Ortegon-Sanchez, 2015; Campanaro et al., 2017). It clearly defines, communicates, and links performance measures to the agency's vision and mission so that they have meaning to its customers. TAM allows for a well-articulated needs and gaps analysis of inventory that should be supplemented with public engagement to understand people's needs and priorities (De Luca, 2014). Justifying investment decisions is a critical aspect of agency accountability and transparency, especially in relation to the public. Furthermore, the public can "see how the budget drives the outcome on net assets and other services provided" (Kraus, 2004, p.18) increasing credibility of the agency to its users.

Quantifying Benefits of Asset Management for Non-motorized Transport

As stated earlier, quantifying the benefits of TAM for NMT is a primary objective of a transportation agency. This is followed by an assessment of how formal management procedures for NMT assets contribute to the achievement of their strategic objectives. Through their research, Amekudzi et al. (2011) showed the most common performance measures and strategic objectives in state departments of transportation to be system preservation, safety and mobility. As a result, evaluating the benefits of asset management would be linked to the Agency's strategic objectives – some of which can be quantified more easily than others. It is critical to note that the benefits of any asset management program, especially for NMT are expected to be a function of the maturity of the program, and that TAM programs tend to evolve in maturity over time. Fig 2 shows the maturity scale for asset management programs presented in the AASHTO Transportation Asset Management Guide (AASHTO, 2011).

TAM Maturity Scale Level	Description
Initial	No effective support from strategy, processes or tools. There can be a lack of motivation to improve.
Awakening	Recognition of a need and basic data collection. There is often a reliance on the heroic effort on an individual.
Structured	Shared understanding, motivation and coordination. Development of processes and tools.
Proficient	Expectations and accountability drawn from asset management strategy, processes and tools.
Best Practice	Asset management strategies, processes and tools are routinely evaluated and improved.

Figure 2: Transport Asset Management Maturity Scale

The maturity scale shows that the data analysis results understanding costs and benefits of a TAM program should be interpreted carefully, because the inability to make a business case for a program at a lower level on the maturity scale does not serve as a basis to write off that program (Akofio-Sowah, 2011). This is because it may be significantly more financially viable to make a business case for that program when it is at a higher level of maturity. There are two important measures for the value being added by TAM in public agencies. The first is the evolution of the benefits relative to the costs of the system and the second is understanding whether these costs and benefits are moving in the right direction where "benefits start outweighing the costs" (Akofio-Sowah, 2011, p.9). Using these measures in a time-sensitive manner can provide more useful data in the long run for a TAM program as it continues to be developed deliberately at high maturity level. Further, transport agencies are considering TAM for NMT, have a tendency to look at other agencies to find out the relative costs and benefits they have experienced in implementing similar programs for similar assets (S.H. McBeth, Personal Communication, June, 2019). However, the caveat is that analysis results for different agencies are based on relative levels of maturity and the extent to which TAM decision support information available and used in decision making. So, transportation agencies should be cautious in their use of ex-ante evaluations due to the factors that influence the results of such evaluations, which are dependent on the use of cost and benefit data from other agencies (Mizusawa et al, 2009). Transportation agencies can determine similar or different results after implementation, depending the type of information available, what tools, practices and methods are adopted and how the agency applies the perfromance information for decision making (Akofio-Sowah, 2011).

It is also important to consider the combination of transportation assets that have formal TAM programs implemented. Since several assets work together to improve sytem performance overall, different combinations of assets have the potential to produce differing results (Akofio-Sowah, 2011). Quantifying the benefits of specific assets such as a sidewalks or bikeways, isolated from the entire transportation system is difficult, in which case performance outputs can be considered as a function of different asset maturity levels, and assessed to understand if benefits have accrued with growth in the maturity of the asset management program (Ibid.). In essence, the evaluation of benefits depends on the maturity-level and quantified benefit - in the form of a benefit-cost ratio, as a dynamic number. This also leads to the question of whether there is an optimum maturity level for a TAM program where the net benefits can be maximized.

Benefit and cost factors outline the type of data that should be collected when designing or selecting a method of quantifying benefits. Usually, costs are easier to determine because there is some direct cost associated with TAM program development and implementation, whereas "benefits are usually measured in terms of cost reduction" (Akofio-Sowah, 2011, p.38), thus, relying on the same cost factors. Typically, cost factors are categorized into three classifications: agency costs, customer costs and external costs. Tranportation agency costs include costs for data collection, software development and maintenance, staffing, and any other expenses connected with program maintenance (AASHTO, 2011). They are represented by the out-of-pocket budget of the transportation agency (Hudson et al., 1997). User costs are the costs incurred directly by the users of the NMT asset. This includes occupancy time, crash costs and the time delay as a result of MR&R activities (Hudson et al., 1997 ; Mizusawa & McNeil, 2009). Last but not the leaset, external costs are those costs that do not affect NMT users directly but may eventually become significant. External costs are typically correlated with environmental and social impacts, including emissions, noise, visual pollution and other disruptions in the neighborhood (Hudson et al., 1997; Akofio-Sowah, 2011). All together, these costs are essential for the quantification of the benefits of asset management.

From the literature reviewed, several studies have made previous attempts at quantifying the benefits of asset management programs. Unfortunately, no documented processes for NMT assets were found. There are two kinds of evaluation design that could be utilized to quantify TAM advantages based on pavement management schemes created by Mizusawa & McNeil (2005-2008). The first is ex-post facto evaluation, which is retrospective, comparing conditions before and after implementation of a TAM program or conditions with and without it. This form of evaluation is useful in situations where a TAM for NMT assets has already been implemented (Mizusawa & McNeil, 2009). The second and more commonly used is the more prospective - ex-ante evaluation design, which compares scenarios based on predicted data where a TAM program has not been implemented (Akofio-Sowah, 2011).

Challenges of Non-motorized Transport Asset Management

Although TAM for NMT has gained popularity over the past few years, there exist several challenges to implementing asset management practices to realize their benefits. Each of the challenges is unique, yet they are interrelated. For an asset management program to be successful, the transportation agency must overcome these technical and organizational challenges.

First, TAM for NMT requires extensive data collection and analysis for the creation of an inventory database which has to be updated with new data after regular intervals of time to make sound financial decisions (AASHTO, 2013). Considering NMT infrastructure is extensive, the key to assessing program effectiveness is measuring the right things (Camparano et al., 2017). Therefore, the challenge lies in identifying appropriate and meaningful performance indicators. When it comes to data collection and management, public agencies find that they are "data rich but information poor" (FHWA, 2007, p.8). This is problematic as agencies end up collecting data that is ultimately not used for decision making and analysis (Halfawy, 2008). A re-evaluation and inventory of the data collected is often required to overcome this challenge. Data integration and sharing for asset management involves bringing in data from various sources. Typically, when a public agency is just starting with an asset management program, data is often scattered across a variety of disconnected systems (Ibid.).

Transportation agencies also possess extensive quantities of variable and heterogeneous data in several different formats and structures (FHWA, 2007). This makes it hard for city staff and private agencies to access and process data in an orderly fashion. Most transport infrastructure data is shared through between software tools through file exchange, using neutral or proprietary formats. By requiring the use of proprietary information models and software applications, the use of these information exchange techniques imposes unnecessary restrictions (Halfway, 2008). Transportation agencies find it challenging to develop and implement data standards for data formats, models, and protocols when existing databases are extremely diverse (Ibid.). Therefore, the challenge is to create an information management system that can address disparities in data sources and formats, incorporate all the data items required to perform TAM functions and be flexible to evolving data requirements. Another issue with data collection is that it fails to capture the qualitative aspects of NMT assets especially considering most data is captured in economic or monetary terms. For example, it is difficult to put a monetary value on human life or the betterment of the natural environment, and therefore relying only on quantitative data can be problematic.

Second, the introduction and success of TAM for NMT has a significant financial cost on a transportation agency during its development and implementation. In order for an agency to justify investing in TAM for NMT assets, there needs to be evidence that the benefits outweigh the costs significantly (Akofio-Sowah, 2011). Considering most benefits are realized in the long-term, the rationale to set up an asset management program poses difficulties for advocates of these programs because positive impact not recognized early (Kaganova and McKellar, 2006). Generally, upper-level managers are interested in benefits that can be translated into monetary values which would help in convincing them of the importance of these programs. As a result, it is necessary to communicate the importance of NMT and quantify the benefits of the TAM program implementation in order to demonstrate clearly, how these benefits exceed the costs associated with program development. Although a rationale can be built using economic cost analysis (Hawkins & Smadi, 2013) , these principles have been developed fairly recently so models, methods and tools to analyse economic trade-offs are still being developed.

Third, coordination with private companies can be challenging as they need to be included in the TAM process for NMT. Private companies are an important source for mobility data collection and deliver much of the maintenance and minor capital construction programs. Contractor ownership of asset management in delivered programs is encouraged and thus strong asset management principles need to be incorporated in public-private partnership agreements (Amos, 2004).

Fourth, introducing asset management practices in a public agency can face resistance as it changes the trajectory of managing assets in the transportation system. Asset management is heavily dependent upon agency and staff coordination and communication. However, most agencies are functionally segregated (Campanaro et al, 2017). The challenge is for the staff to understand the benefits of the TAM process from the perspective of the entire agency rather than the viewpoint of their individual units (FHWA, 2007). Another challenge is building organization-wide commitment to being open to change. For a successful result, transportation agencies need to create an interest and enthusiasm at both the executive and operations levels of the organization is critical to success (Ibid.). This can be particularly hard when power dynamics come into play as agencies might feel that TAM practices are developed by international agencies may not be the best approach for their transportation network. TAM practices are based on data analysis and rational decision making through decision making tools (AASHTO, 2002). However, this approach may face backlash as some staff members may prefer to prioritize existing and trusted practices and vendors (patron-client system) over rational choices (FHWA, 2007). Further, to be effective, an asset management program must have a strong human resource element (Ibid.). Training by an asset management professional, including the development of manuals and best-practice procedures is an important part of an asset management implementation strategy.

Fifth, public agencies are often competing against other government programs for resources. These agencies also must serve a variety of stakeholders, many of whom hold strong opinions based on their own understanding of asset management (Kaganova & McKellar, 2006), coupled with their beliefs and expectations. These differences lead to a range of differing goals and objectives, which are often in competition. It is possible to resolve this through alignment of policy objectives, an understanding of the trade-offs, and consensus- building amongst stakeholders (FHWA, 2007). However, a consistent focus on short-term budgets makes it difficult to meet the long-term capital investment planning needs of asset management.

EVALUATION CRITERIA

It is becoming increasingly crucial to understand whether or not a TAM program for has the ability to be effective. The lack of a commonly acceptable set of criteria for evaluation, hinders aggregating this knowledge. A TAM program should always be within the purview of state and local planning policy and metropolitan region planning priorities. It should also have the ability to adapt to dynamic political agendas that have the ability to shift transportation planning in different directions. Drawing from TAM literature and interviews with asset management professionals, the following criteria has been developed to evaluate a good NMT asset management strategy:

Regular data collection and inventory analysis: In order to make efficient, fact-based, and long-term decisions for NMT assets, it is essential to develop and maintain comprehensive records of asset inventory regularly. This is because TAM for NMT begins with an understanding of a comprehensive and updated inventory and rational classification (Halfawy, 2008). An effective database management system can be facilitated by information management and accounting reforms within the transportation agency. For example, after the reforms within the public sector in New Zealand in the 1990s, all government agencies complied with generally accepted accounting principles (GAAP) and had to maintain up to date records of their assets and their precise valuation. (Campanaro et al., 2017). Further, information about the location, planning, ownership, and current condition should be included in an asset database/inventory registery (Kaganova & McKellar, 2006). Similarly, in Canadian cities that adopted PSAB 3150 standards were required to conduct a baseline valuation of all tangible capital assets (Camparano & Masic, 2018). This was supplemented by a requirment to record comprehensive information about the city's asset portfolio, its value and its remaining useful life to the entire transportation network (Ibid.). All this data rich information enables decison makers to understand if an infrastructure deficit exists, and how long-term plans can be developed to address that deficit (Jamer, 2015).

Strategic resource management: A strategic resource management approach, including financial planning is crucial to maximize extraction of value from NMT assets and deliver cost-effective services (Halfawy, 2008). The transportation agency should have both short- and long-term plans to be able to achieve its development goals (AASHTO, 2002). Effective asset management "improves the economic well-being of an area, maintains built assets, generates efficiency gains, and improves the quality of the public realm" (U.K. Department of Communities and Local Government, 2008, p.9). For these targets to be achieved, the transportation agency should identify steady revenue streams and funding mechanisms for the MR&R activities of NMT assets and appropriately allocate the funding as per short- and long-term plans.

Public dialogue and communication: A successful TAM program for NMT should have a citizen participation component where the users of NMT assets feel that they are a part of the decision process. Usually, the quantitative/instrumental rationality approach relies on the classical approach of decision-making based on mathematical formulations and scientific empiricism (Stangl, 2008; Lowry 2010). However, it is a one-way approach, where analysts design 'solutions', estimate benefits and costs, and propose the best performing solution to the stakeholders or to the public (De Luca, 2014). This can be problematic if the plan is not coherent with the priorities of the public. Instead, considering the public from the beginning of the process helps to better understand the needs of the people (De Luca, 2014), who are the users of the NMT infrastructure, and helps to render the final options more acceptable since they have been determined by the public's needs. Public engagement activities regarding NMT such as the prioritization of where MR&R is required on the NMT network can be done as a complementary activity to other public engagement activities conducted by the transportation agency (Camparano et al., 2017). In addition, techniques such as scenario testing can be used to develop entrenched positions as individuals deliberate over TAM practices for NMT (De Luca, 2014). This process helps to simplify the actualisation of the planning process itself (Ibid.) since public needs will be reflected in the TAM program. It is also the transportation agency's responsibility to communicate the progress of the program at regular intervals of time through reports and assessments (AASHTO, 2011).

Transparency: Asset management is resource intensive, especially in the initial stages and uses significant public funding to operate well. This necessitates transparency between government agencies, staff and with the public.Transparency is a critical, easy and cheap means of facilitating excellent asset management and eliminating corruption. Transparency is also a major requirement of the ISO 55001 standards as public disclosure of asset information enables public monitoring and engagement as well as stimulates governments to cautiously manage assets (Kaganova & Mihaly, 2014). This helps public agencies to project a positive image and build trust with the public. According to Butler et al. (2009), there is a positive correlation between political integrity and municipal financial performance, especially in municipal bond sales. Further, improving transparency and curbing corruption has positive impacts on city's budget (Campanaro et al., 2017). Therefore, it is essential to review the transparency mechanisms that exist within a public agency to enhance government disclosure of municipal assets, their condition and performance.

Institutional structure with clear responsibilities: Fragmentation of governance in an institutuonal structure can result in a lack of clear roles and responsibilities and, ultimately, affect the efficiency and effectiveness of TAM. Although governance structures for TAM vary greatly, a key principle is that a senior manager must be made responsible for the TAM program across the transportation agency. This senior asset manager should report to an "asset champion at board level" (Jones & White, 2008, p.53). The senior manager should also coordinate and communicate horizontally with asset managers in other public agencies that might have overlap of assets with transportation (Jones & White, 2008). In order to enable this, a city asset management group,with representatives from different departments can be established to collaborate on asset management issues and prepare annual reports (Kaganova & McKellar, 2006). This helps to improve efficiency and minimize the impacts from fragmentation of governance.

Optimizing and prioritizing NMT maintenance: NMT MR&R should be prioritized as it serves a majority of the population and advances goals for sustainable transportation. Maintenance activities also increase a transportation agencies' savings and improve accountability in the long term (Campanaro et al., 2017). Publci agency officials are biased toward building new infrastructure rather than making the capitalizing on the existing capacity, leading to less sustainable and more expensive and infrastructure solutions (Jamer 2015). However, a TAM program for NMT assets should focus on optimizing maintenance of existing NMT infrastructure. This will result in less frequent or less comprehensive repairs and can increase the ability and longevity of the infrastructure (Jamer, 2015) as well as reduce long- term costs (AASHTO, 2011). Planning for major repair and replacement expenses for municipal assets, should be accounted for with general maintenance expenses (Campanaro et al., 2017). Public agencies ought to regularly assess and catalogue the condition of infrastructure assets, using a "total cost of ownership approach to allocate maintenance budgets" (McKinsey, 2013, p.69) . This will help to capture savings and avoid losses due to improved maintenance operations (McKinsey, 2013). This will minimize costs over the useful life of an asset, tailor maintenance strategies and policies to NMT asset objectives and needs and dedicate a proportion of funds for maintenance.

CASE STUDY: NON-MOTORIZED TRANSPORT ASSET MANAGEMENT IN PORTLAND, OR

Background and Context

The City of Portland has an asset management program for each of its municipal assets, including transportation assets. The asset management program is based on the development of asset management plans that provide general information on current asset status and trends in inventory, condition, and asset value. This case study will highlight the NMT asset management strategy of Portland, Oregon that is a result of systematic financial planning, an organized institutional structure and transparency between several bureaus of the city.

Portland is the largest and most populous city in the U.S. state of Oregon with a population of about 2.4 million people in the Portland metropolitan statistical area (U.S Census, 2018). Portland's transportation planning promotes NMT modes essential to preserving the city's liveability and for the protection of the natural environment (TSP, 2018). The city has set a precedent by prioritizing pedestrians over automobiles in its transportation strategy (Ibid.). Recently, the city recognized the need to reduce the cost of spending on constructing new roads to accommodate an increase in automobile capacity, and instead focus on supporting a safer, affordable and more complete multimodal transportation network (Ibid.). As a result of compact, short blocks and conscious decisions to reclaim areas from the automobile, Portland has a history of creating a pedestrian scale. Civic planning in Portland is strong and owes its vitality to the care and creativity that went into the Downtown Plan of 1972 and the Central City Plan of 1988 (IBPI, 2016). As the rest of the United States, bicycle use in Portland reduced during the middle of the 20th century. However, Oregon's city planning in the 1970s laid the groundwork for a bicycling renaissance (Dill & Voros, 2007). The existing built environment, changes in transportation policy and the cultural acceptance of alternative modes of travel catapulted bicycling as a pillar of Portland's identity. Changes in the state of Oregon's land use laws to encourage urban forms conducive to bicycling were followed by the development of Portland's first Bicycle Master Plan in 1973 (IBPI, 2016). Throughout the 1980s, the Bicycle Program produced route maps, installed bike racks, wrote bike parking codes and began organizing bicycle encouragement events and programs (IBPI, 2016). Later, the program shifted its focus to the development of bike paths and the installation of on-street active transport improvements (Ibid.). Through the 1980s, the city developed dedicated bikeway facilities and connected gaps in the bikeway network. Public support, concerted advocacy efforts, and strong political leadership enabled the city's bicycle program to undertake more aggressive projects (Dill & Voros, 2007).

Portland's bikeability is a result of strong bicycle advocacy groups, the city's commitment to turn the bicycle into a viable mode of transportation and most importantly the cyclists who regularly ride their bicycles. This collaboration, fuelled by the City's participatory planning process and bike master plan, has resulted over the years in the creation of an effective bicycle system. Portland was named a 'platinum' bicycle friendly community by the League of American Bicyclists - its highest rating as about 6.3% of Portlanders commute by bike as compared to the national average of 0.5% (PBOT Fact Sheet, 2018). This is the highest percentage of bike commuters for a large US city and means that approximately 22,647 workers in Portland choose to bicycle (PBOT Fact Sheet, 2018). Deliberate policies and infrastructure investments in NMT have led to a 374% increase in the number of people that biked to work in 2017 as compared to 2000 (Ibid.). Portland's bikeways comprise 94 miles of Neighbourhood Greenways, 162 miles of bike lanes, 85 miles of paths and 9 miles of shared roadways marked with shared lane markings (Ibid.). Currently, the city is in a state of transition due to investment in operations and maintenance of NMT assets to increase the 9% trips of all trips taken by NMT (Ped PDX, 2019). Most recently, the Ped PDX pedestrian master plan was published and that provides emerging understanding of transportation equity and a Vision Zero approach to pedestrian safety (Ped PDX, 2019). The Portland Bureau of Transportation (PBOT) manages transportation assets with a replacement value of $13 billion (PBOT Asset Report, 2018). Paved streets, the sidewalk system, bridges, traffic signals, and streetlights make up the majority of the dollar value. This case study will look into how the city effectively manages NMT assets which consist of 3155 miles of sidewalks, 5333 crosswalks, 371 centreline miles of bikeways, 125 bikeshare stations and 1000 bikes and 6500 bike racks (PBOT Asset Report, 2018).

FACILITY	STATUS	REPLACEMENT VALUE	CONDITION*						TOTAL UNMET NEED**
SIDEWALK SYSTEM			VG	G	F	P	VP	TBD	
Sidewalks	9,018,702 sq yds	$1,217,524,770	10%	25%	30%	25%	10%		N/A
Curbs	3,150 centerline miles	$623,700,000	12%	50%	16%	12%	10%		$158,880,759
Corners									
Improved Corners	38,035	$304,280,000	10%	18%	17%	28%	27%		$72,325,000
Corners with Ramps	27,167	N/A							N/A
		$2,145,504,770							$231,205,759
BICYCLE NETWORK			VG	G	F	P	VP	TBD	
Bikeways	352 centerline miles	(included with pavement)		100%					TBD

Figure 3: NMT assets managed by the Portland (Source: PBOT Asset Management Strategy)

Financing Non-Motorized Transport Asset Infrastructure

The Portland Bureau of Transportation's (PBOT) asset management practices exercise sound financial stewardship over transportation infrastructure by establishing clear, transparent, and standardized processes for prioritizing asset investments. These processes include a prioritization methodology for reinvestment into asset maintenance, rehabilitation and repair (MR&R). Business case evaluations (BCEs) are completed to justify asset investments, inform capital projects, budget development, and for decision-making within asset classes (PBOT Asset Management Plan, 2019). Sound financial decision making is also exercised by accounting for lifecycle costs when planning, rehabilitating or replacing, assets, including their ongoing operations and maintenance (Ibid.). The asset management approach uses a Life-cycle cost analysis (LCCA) approach to ensure that an alternative is not selected only based on the initial costs, but also considers the future costs and the lifetime of the NMT asset (Ibid.). Further, the maintenance backlog is reduced by leveraging investments and coordinating with public and private utilities (E.Tristch, Personal Communication, June, 2019).

In terms of funding for asset management of NMT assets, Oregon State Highway Fund dollars are distributed to each region for bicycle and pedestrian projects on state roadways (E.Tristch, Personal Communication, June, 2019). The city may be able to use some of the funds such as SWIP dollars for pedestrian and bicycle facilities on state highways through an intergovernmental agreement (Ibid.). The Safe Routes to Schools Infrastructure program also provides funding to the NMT asset management program to ensure safe walking and biking routes to schools (Ped PDX, 2019). However, the the major source for TAM funding for NMT assets remains a local ten-cent gas tax on motor vehicle fuels, which was levied in 2016 as a source of funding dedicated to street repair and traffic safety projects (Measure 26-173). The collection of the tax began on January 1, 2017 and is expected to raise an estimated $64 million over four years (E.Tristch, Personal Communication, June, 2019). Additionally, a Heavy Vehicle Use Tax will add approximately $10 million over the same four year period (ibid.). The money brought in through this program, known as 'Fixing Our Streets', is directed to expensive rehabilitation projects, including base repair, and safety improvements, which include shoulder widening and sidewalk improvements (Ibid.). PBOT is a general fund bureau, where most funds are derived from taxes, federal grants and local grants. A majority of the discretionary resources are allocated to operations and maintenance of the transportation system, with about $11 million allocated to infrastructure improvements (PBOT Budget Report 2019- 2020).

The following figure elucidates the funding structure of PBOT:

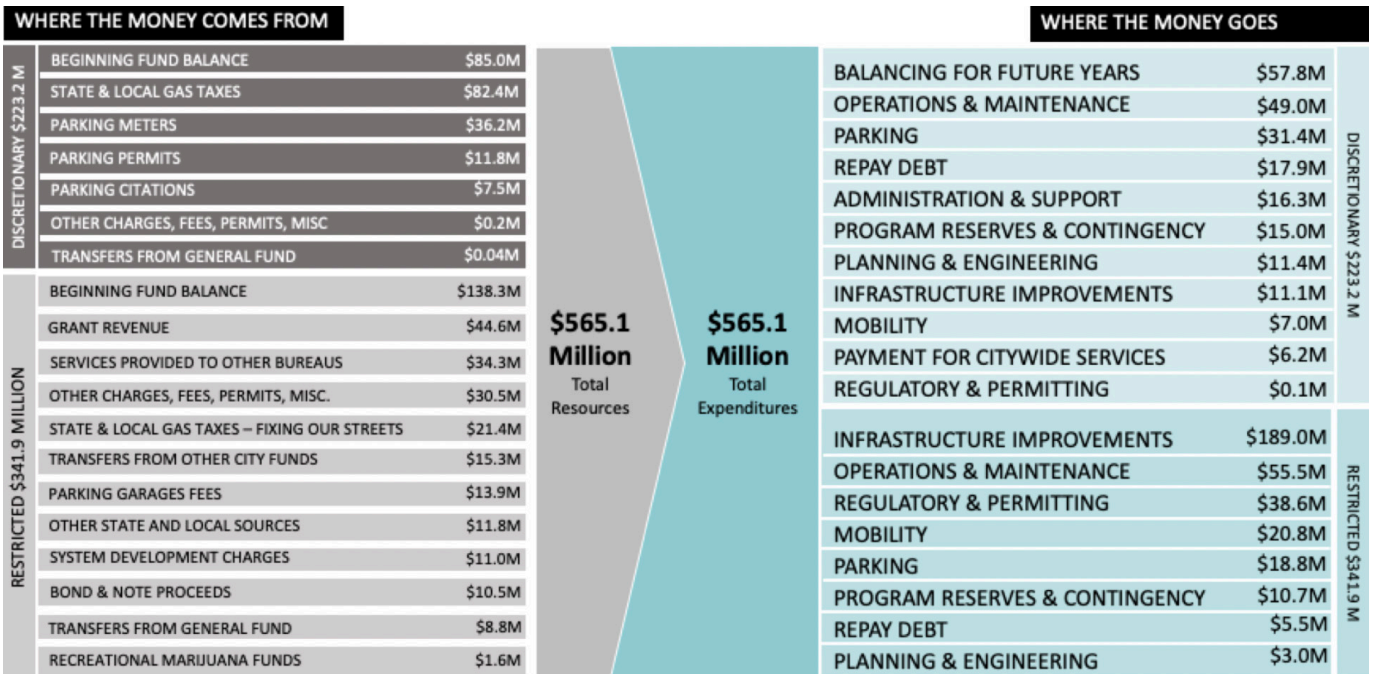

Figure 4: PBOT Funding and Resource Allocation (Source: PBOT Budget Report 2019 - 2020)

Biketown PDX, Portland's bikeshare system is owned by the City of Portland. It was initially funded by a private firm - Nike, that signed a $10 million, five-year deal to be the bikeshare program's sponsor. Biketown PDX is operated and maintained by another private contractor - Motivate (S.H. McBeth, Personal Communication, June, 2019). Motivate is paid by the city using the initial funding by the sponsor as well as money received as revenue (Ibid.). The city has been able to successfully introduce and manage a bikeshare system without adding significant cost to taxpayer dollars or stressing existing funding sources.

Non-Motorized Transport Asset Development Strategy

In order to understand Portland's asset management program, it is essential to understand how assets are developed. The City of Portland and the State of Oregon publish short- and long-term plans to guide NMT infrastructure investment and set priorities. These plans are created after public consultation about what is important to Portlanders and residents throughout Oregon. Plans are updated over time as the transportation network, community priorities and technology evolve.

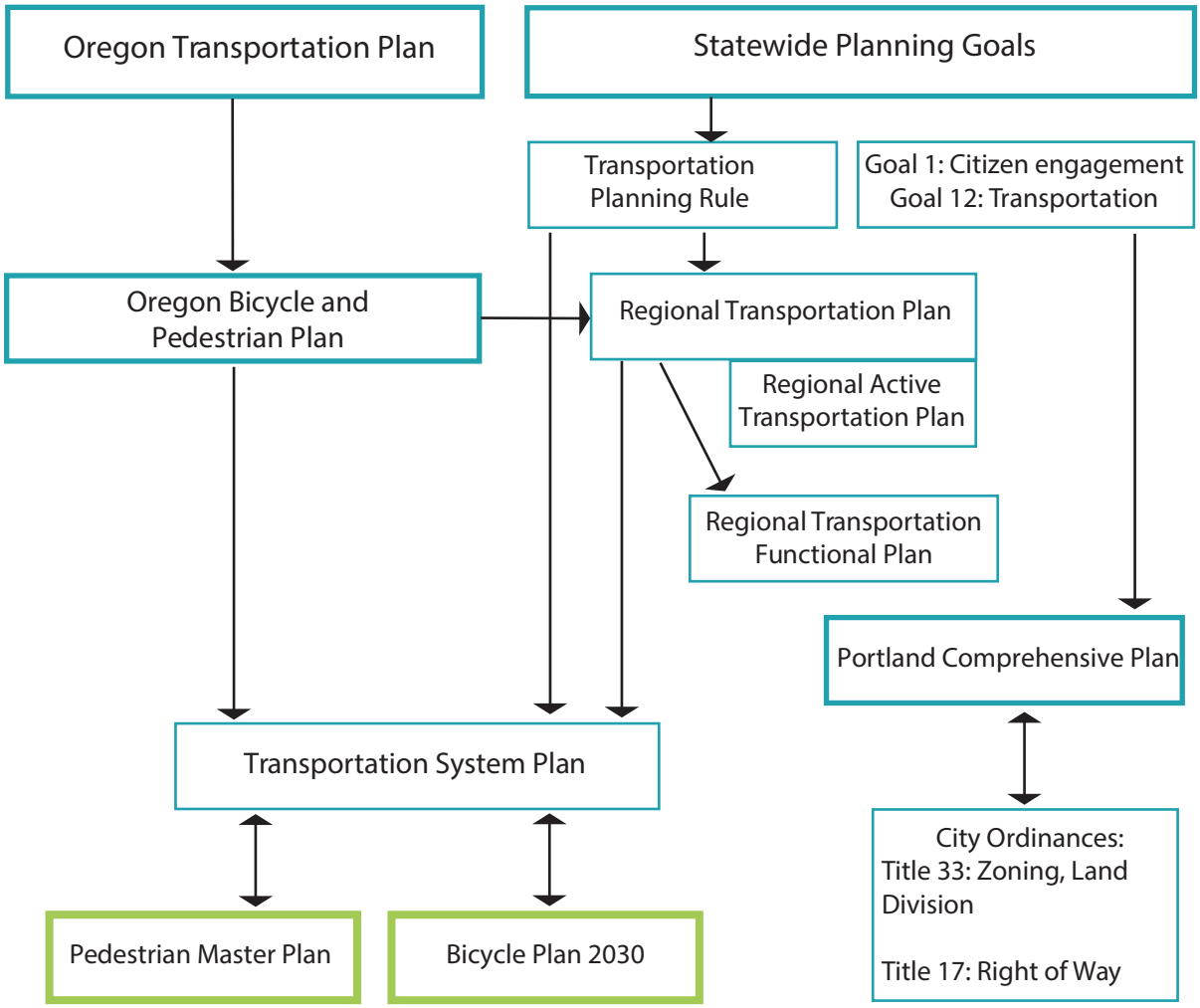

Figure 5: Transportation Planning Structure for Portland, Oregon

The Portland Transportation System Plan 2035 (TSP, 2018) is the 20-year plan to guide transportation policies and investments in Portland and was adopted by City Council in 2018. It is designed to help implement the City's 2035 Comprehensive Plan and the region's 2040 Growth Concept by supporting a transportation system that makes it more convenient for people to walk, bicycle, use transit, and drive less. Transportation improvements over $500,000 are listed individually as major projects within the TSP (TSP 2035, 2018). These major projects are identified from individual planning processes such as modal plans or local area plans. Pedestrian-related projects in the TSP may include

broad multi-modal "complete streets" corridor improvements that include pedestrian elements in their descriptions and cost estimates, or they may be specific large-scale projects, such as pedestrian district improvements, sidewalks, trails or NMT bridges (I. Stude, Personal Communication, June, 2019). The TSP also creates a series of programs intended to deliver smaller-scaled transportation improvements, generally under $500,000. One of these programs is the Pedestrian Network Completion Program (TSP 2035, 2018 - Policy 9.18). Citywide programs help the public and staff understand, track, and promote small-scale transportation investments. The plan aims to develop an interconnected, multimodal transportation system (TSP 2035, 2018 - Policy 9.47), increase the walking to work rate to 7.5% by 2025 (TSP 2035, 2018 - Policy 9.26.g) and increase the mode share of daily non-drive alone commute trips to 70 percent citywide by 2035 (TSP 2035, 2018 - Policy 9.26.h).

The Strategy for People Movement (TSP 2035, 2018 - Policy 9.6) prioritizes pedestrians and cyclists over other modes and states that transportation system decisions must prioritize modes of transport according to the following order: "walking, bicycling, public transit, fleets of electric/ fully automated multiple passenger vehicles, other shared vehicles and lastly low occupancy vehicles and fossil-fuel non-transit vehicles" (TSP 2035, 2018, pg. 19). This is consistent with Oregon state laws that establish requirements for consistency at the state, regional and local level. Therefore, the Portland metropolitan area's Regional Transportation Plan, Active Transportation Plan, and Transportation Functional Plan are consistent with the Oregon Transportation Planning Rule (TPR) requirements, the Oregon Transportation Plan and state modal and topical plans (E.Tristch, Personal Communication, June, 2019). The City Comprehensive Plan, Transportation System Plan, and all local modal plans also conform to the requirements of the regional transportation plans (Ibid.). Figure 6 is a simplified diagram of how plans focused on non-motorized transport use (Bicycle Plan 2030 and Pedestrian Master Plan) fit in with the city's transportation plans.

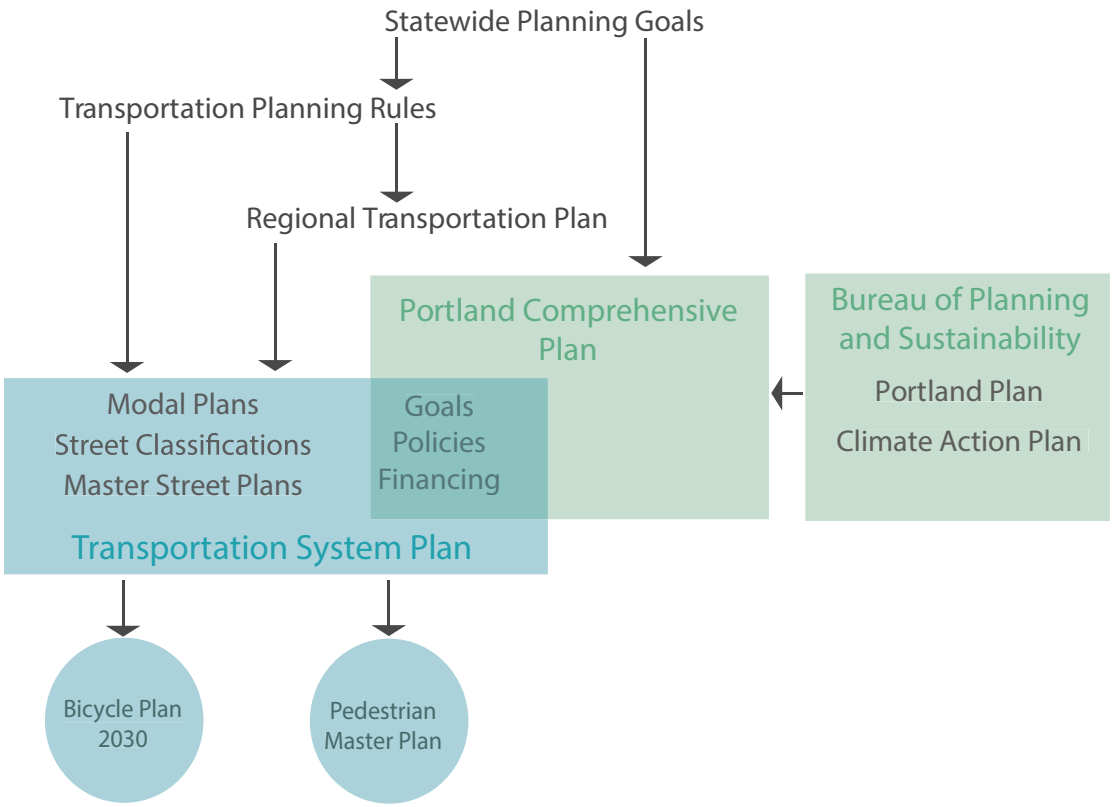

Figure 6: Transportation System Plan as it relates to Non-Motorized Transport

Portland has long had a strong set of policies supporting walking, regional and state plans have evolved in the past 20 years (M. Marx, Personal Communication, June, 2019). Some recent changes include:

1. Clearly defined directives around safety and equity in transportation
2. Updates to the State Transportation Planning Rule and Metro Regional Transportation Framework Plan, which serve as the main drivers of compliance requirements for local pedestrian planning
3. Updates to the City Comprehensive Plan and Transportation System Plan, which serve as the local planning framework for the local pedestrian plan

The Pedestrian Priority Network is a network of streets and paths that provide important pedestrian connections to transit and other key destinations (Ped PDX, 2019). This is the foundation for defining where there are needs for pedestrian infrastructure. These demand-based priorities are directly reflected in the pedestrian priority network. Public priorities relating to safety ("Streets where people walking have been killed or injured") and equity needs ("Areas that serve people who need to rely on walking the most") are overlaid on the Pedestrian Priority Network (Ped PDX, 2019, p.75). Each of the streets within the Pedestrian Priority Network is given a pedestrian classification that reflects the level of demand for pedestrian movement on that street (Ibid.). This demand-based approach ensures that improvements are prioritized on streets that provide access to the walking destinations that Portlanders say are most important to them (M. Marx, Personal Communication, June, 2019).

Consistent with the Transportation System Plan, 2018, three street classifications together make up the Pedestrian Priority Network from highest demand to lowest demand. These are major city walkways, city walkways and neighbourhood walkways (M. Marx, Personal Communication, June, 2019). Major city walkways usually are major arterials with a high number of transit and land use destinations. They also have a large number of pedestrians and cyclists due to the easy access to the public transit network, core downtown streets, and off-street trails in high demand corridors (Ped PDX, 2019). City Walkways include major traffic streets, collector's streets and transit roads that are not designated as major city walkways and have a modest demand for pedestrians and cyclists.(Ibid.). The third category, neighbourhood walkways, typically on local residential streets serve neighbourhood-level demand and are generally comprised of designated routes to school, neighbourhood greenways, and priority walking routes on local traffic streets identified in area plans (Ibid.). In addition to the street classifications, a Pedestrian District overlay indicates areas of additional pedestrian demand (M. Marx, Personal Communication, June 2019). Pedestrian Districts are comprised of designated centres, as defined by Portland's 2035 Comprehensive Plan, where high levels of pedestrian activity exist or is expected in the future (Ped PDX, 2019).

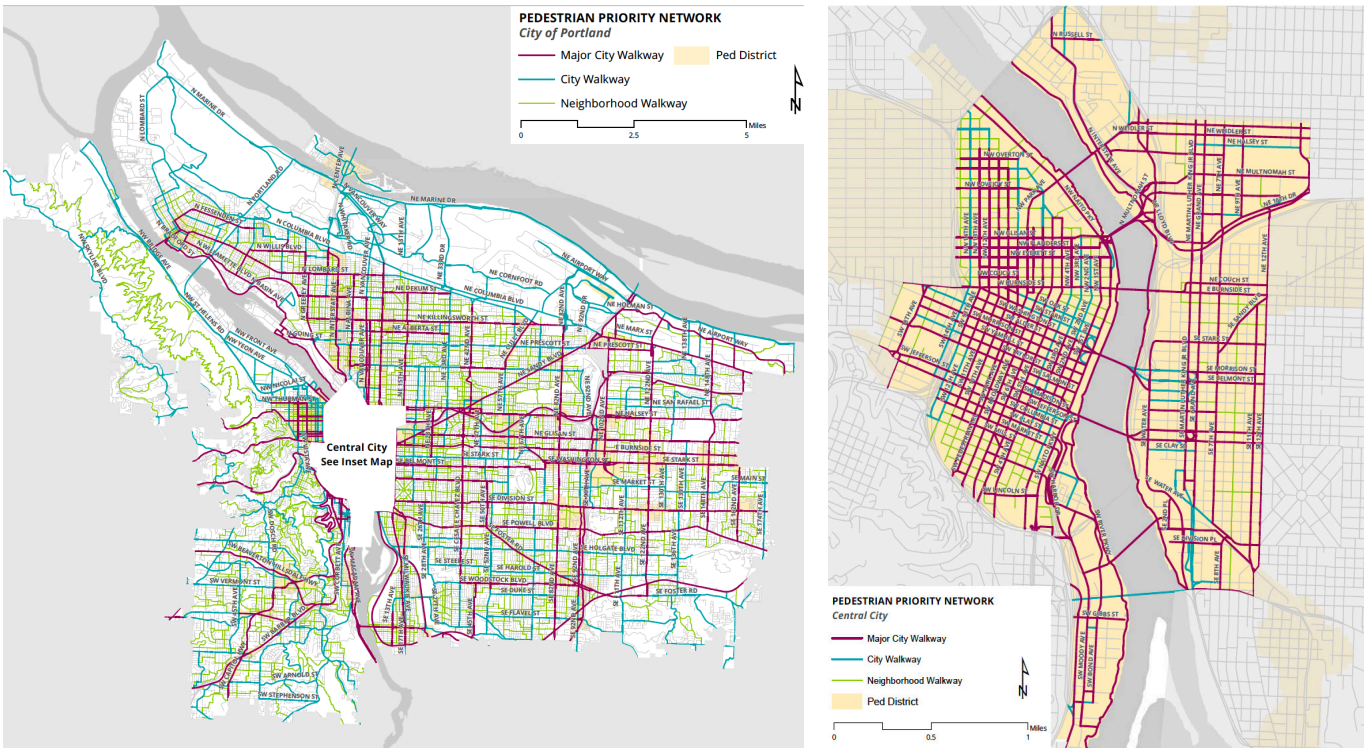

Figure 7: Pedestrian Priority Network (Source: Ped PEDX, 2019)

Prioritization of pedestrian infrastructure is required as the magnitude of pedestrian infrastructure needs is significant. Prioritizing needs using a data-based approach ensures limited resources are being directed to locations with the greatest needs first (M. Marx, Personal Communication, June, 2019). Prioritization aligns with public priorities and the spending priorities adopted by the City to create a process that is transparent and repeatable. For prioritization, the city considers factors such as "funding availability, project readiness, feasibility and key destinations and generators (such as affordable housing, transit stops, schools, senior centres, or community centres)" (Ped PDX, 2019, p.104). In order to reflect public priorities for asset development, the prioritization process assigns number values for equity, safety and pedestrian demand to give scores to all street segments within the network. When resources are being allocated for asset development, the city takes those scores into consideration as the street segments with the highest scores are prioritized for development (M. Marx, Personal Communication, June, 2019). Further, the prioritization and asset development must comply with the federally regulated Americans with Disabilities Act (ADA), which encompasses design guidelines to ensure that transportation facilities are developed to a specific set of standards ensuring accessibility for all. All new pedestrian assets are ADA compliant and older pedestrian assets are upgraded based on location, condition, and adjacency and routinely installed as part of City paving projects (Ibid.).

For the Portland bike network, the city employs a three-pronged strategy for creating a more complete network. First, a finer-grained bikeway network with several route options is formed and maintained, allowing cyclists of different skill and comfort levels to identify routes best suited to their needs (Portland Bicycle Plan, 2010). Second, low-stress bicycle routes including trails, low-traffic shared roadways and cycle tracks are emphasized, where bikeways are separated (physically/ spatially) from higher-volume roadways (Ibid.). Third, the city ensures access to common destinations. Bikeway development prioritization is based on parameters such as connectivity, classification conflicts with other modes, existing NMT infrastructure, traffic conditions and directness of routes (I. Stude, Personal Communication, May, 2019). To complete the network the 'Missing Links' program has been very successful in opportunistically and efficiently developing city bikeways in conjunction with other projects, particularly working with regularly scheduled pavement overlays (Ibid.).

Non-Motorized Transport Asset Management Strategy

NMT asset management in Portland is carried out by several public agencies. Although a majority of the programs are implemented by the Portland Bureau of Transportation (PBOT), other important stakeholders include the Portland Bureau of Planning and Sustainability (BPS), Portland Bureau of Environmental Services (PBES), Oregon Department of Transportation (ODOT), The Portland Development Commission (PDC) and Portland Parks & Recreation (P&R). The Oregon Bicycle and Pedestrian Advisory Committee (OBPAC) is an eight-member committee appointed by the governor that acts as a liaison between the public and Oregon Department of Transportation. It advises ODOT in the regulation of bicycle and pedestrian traffic, the establishment of bikeways and walkways, and other state-wide bicycle and pedestrian issues. The bikeshare network - Bike Town has two major stakeholders that are private entities. The first is Nike, the sponsor of Bike Town and the second is Motivate - operator of the Bike Town rideshare system. Figure 8 highlights institutional responsibilities and asset management programs undertaken by different government agencies.

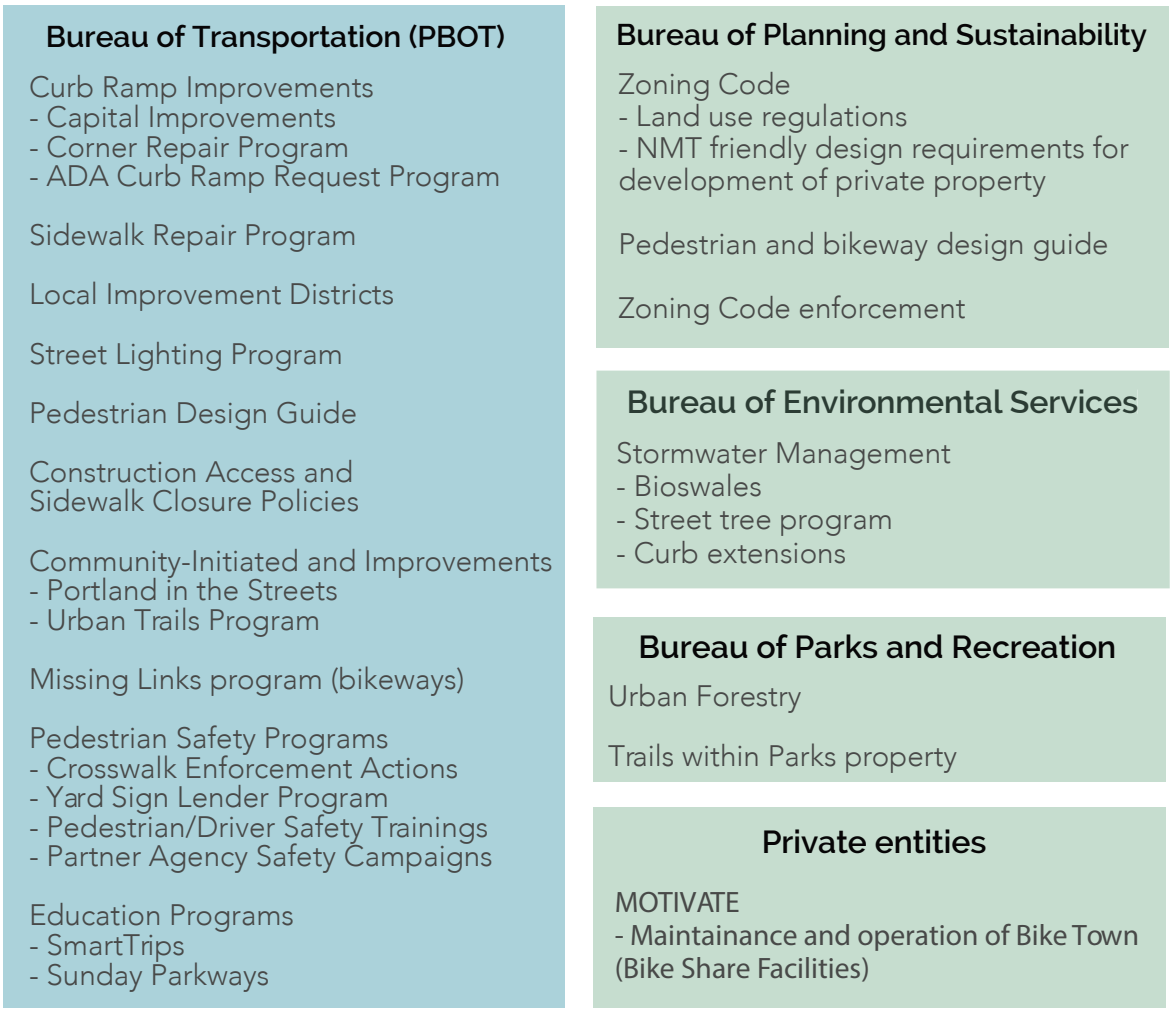

Figure 8: Public agencies involved in Transport Asset Management for Non-motorized Transport

In 2002, Portland's asset managers formed the City Asset Managers Group (CAMG) to collaborate on asset management issues and prepare an annual report on the city's physical assets. The report is presented to the Planning and Development Directors' Group, which represents the infrastructure bureaus and the bureaus responsible for development permits, finance, and planning (E.Tristch, Personal Communication, June, 2019). The CAMG oversees policies and funding allocation, coordinates long-range planning, and manages certain cross-bureau planning and development initiatives (Campanaro et al., 2017). After reviewing the findings, recommendations are provided to the City Council (Ibid.). Each asset management report is presented to the City Council at the start of the annual budget work session (E.Tristch, Personal Communication, June, 2019). Although the city's various infrastructure bureaus continue to use different asset management strategies, they collaborate actively with the long-term goal of improving asset management practices citywide.

For NMT, asset management is utilized as a planning tool to efficiently allocate resources, measure performance, and track transportation infrastructure needs in the city. PBOT's Asset Management Advisory Committee sets the priorities for asset management within the bureau and helps implement those priorities into business practices (E.Tristch, Personal Communication, June, 2019). The continuous cycle of inventory, condition, value, performance, risk and cost assessment provides data and information to develop and implement an asset management plan for NMT assets (PBOT, 2013). The asset management plan describes the MR&R strategies and includes a project list that includes the project type, location, estimated costs and estimated start and finish dates (Ibid). This approach maximizes the value of capital, operations and maintenance expenditures within current revenues, while continuously maintaining levels of service the public desires and decision makers require.

Portland's asset management strategy has a public engagement component to understand asset performance expectations by NMT users (E.Tristch, Personal Communication, June, 2019). This is done by communicating progress and providing opportunities to engage in infrastructure management through surveys and public meetings. In order to advance equity, the bureau prioritizes communities of colour in asset reinvestment decisions and builds partnerships with underserved communities in defining intended asset performance and evaluating infrastructure performance at a system level (PBOT, 2016; E.Tristch, Personal Communication, June, 2019). An Equity Matrix is used to assess investment priorities and support those most in need. Changing historic inequity is a conscious exercise in each NMT asset decision (E.Tristch, Personal Communication, June, 2019). Further, maintenance schedules developed are complementary to public priorities to maximize return on investment (Ibid.). PBOT's Asset Status and Condition Report provides annual data on the condition of physical assets and progress made in managing them, improving communication and enhancing public trust.

To use asset management as a decision making tool in Portland, asset assessment is based on status (how critical an NMT asset is to the overall system based on costs and impact), condition (current physical state), level of service (matching user expectations with willingness to pay) and unmet needs (minimum cost to maintain an asset at the targeted level of service and condition) (PBOT, 2013). To maintain NMT assets, the City utilizes a data-driven strategy for closing MR&R gaps. Data driven rational decisions help to maximize the use of available funding across their asset portfolio and deliver better-maintained, safer, and more reliable transportation infrastructure at a lower cost to Portlanders (E.Tristch, Personal Communication, June, 2019). Data collected is used to develop a digital asset registry and guide risk-informed investment and decision-making by defining asset State of Good Repair (SGR) (Ibid.). Asset data collection is centralized for all transportation assets and this data is used to evaluate asset criticality and prioritize reinvestment accordingly (Ibid.).

The asset management strategy for Portland follows the international standard - ISO 55000 (E.Tristch, Personal Communication, June, 2019). The City has developed performance measures for NMT assets that are incorporated in business and decision processes as a basis for accountability, reporting internally and externally, and to support policy formulation, prioritization and trade-off analyses, resource allocation, and public feedback. NMT asset condition is measured using monitoring mechanisms including public reporting using PDX Reporter, public engagement and regular inspection (Ped PDX, 2019). Data from the Bike Town trips is also used to assess where people are travelling to prioritize sections of the NMT network (S.H. McBeth, Personal Communication, June, 2019). The condition assessment includes a walking survey that examines seven types of distresses giving information about severity, area, sections, and stresses (PBOT Asset Strategic Plan, 2019). Various parameters such as date, thickness, square footage, and rehabilitation history allow the user to easily locate and compare similar projects (Ibid). The data is updated by inspectors using spreadsheets, which later informs the inventory registry (E.Tristch, Personal Communication, June, 2019).

Once the asset condition data is gathered, the staff ar PBOT use a Computerized Maintenance Management System (CMMS) - Street Saver, which helps to streamline maintenance operations by tracking NMT assets, scheduling repairs, monitoring work orders, managing costs, and adhering to compliance standards (E.Tristch, Personal Communication, June, 2019). A decision tree budgeting analysis is performed according to the bureau's budget, specifications, and ratings (Ibid). The decision tree describes the local policy goals for maintenance strategies. This is one of the main steps in which the trigger values are predefined in terms of rating values and available budgets for existing NMT assets (PBOT Asset Strategic Plan, 2019). The analysis module allows for evaluation and comparison of different scenarios. So, Street Saver helps to prioritize areas and assets, increasing

productivity, enhancing work order management and making data driven maintenance decisions. PBOT also utilizes the Maximo enterprise asset management tool which helps to make better decisions based on insights from enhanced analytics (E.Tristch, Personal Communication, June, 2019). The software helps to centrally manage transportation assets and parts, meeting regulatory requirements and service level agreements, optimizing planned maintenance, and extending asset life.

As Per City charter and City code, property owners are responsible for constructing, maintaining, and repairing the sidewalks abutting their property (Portland City Code; Ped PDX, 2019). This applies to homeowners, business owners, schools and other large institutions including homeowners' associations (E.Tristch, Personal Communication, June, 2019). Traditionally the requirement to construct sidewalks where they are missing or deficient is triggered when development or redevelopment projects are proposed. As part of the development, property owners are required to construct or improve the sidewalks fronting their property in accordance with City standards (Portland City Code). The City of Portland also has the authority to require the construction and maintenance of sidewalks outside of the development process. If a sidewalk inspector finds a safety hazard attributable to cracked or broken sidewalks, the owner of the adjacent property is notified and is required to repair the sidewalk. Local Improvement Districts (LIDs) are a means by which the City can assist a group of property owners with constructing and maintaining sidewalks (Ped PDX, 2019). However, property owners are still responsible for paying for the cost of the sidewalk improvements, especially on streets not prioritized for public investment. Since City investment priorities are often on busy arterial and collector streets, LIDs serve as a good option for property owners who would like to improve sidewalks on local residential streets (PED PDX, 2019;). With an LID, the City assists by setting up financing and payment structures (E.Tristch, Personal Communication, June, 2019), and by assisting with project design, engineering, and delivery. LIDs are approved by the City Council.

Non-Motorized Transport Asset Management Processes and Practices

The implementation of the TAM program for NMT in Portland utilizes a three-pronged strategy for efficient allocation of resources and decision making that best serves the interests of all stakeholders. These comprise of MR&R operations undertaken by the City of Portland, resource partnerships with private entities and effective communication for operations and maintenance activities.

1. Maintainance, Repair and Rehabilitation (MR&R) processes undertaken by the City:

As mentioned earlier, the City utilizes the 10-cent gas tax and the heavy vehicle use tax for a program called 'Fixing our Streets' to leverage their investments and maintain safe and reliable streets (Fixing our Streets PDX, 2017). Fixing Our Streets funds paving, maintaining high crash corridors, adding and maintaining 'missing links' to the bikeway network including protected bike lanes, neighbourhood greenways, crossings and sidewalk improvements (ibid.). While the prioritization framework identifies asset development needs at specific locations, cost effective and creative solutions leverage existing infrastructure and combine projects with planned other infrastructure improvements (S.H. McBeth, Personal Communication, June, 2019). This is done by leveraging paving projects for pedestrian improvements and maintenance activities. When roads are scheduled to be repaved, maintenance crews install roadway striping, improve corner curb ramps to meet current standards (PBOT, 2017). In conjunction with this, maintenance activities take place for pedestrian crossings, walkways and bikeways, allowing the city to stretch the impact of taxpayer dollars. There are also cost savings from taking advantage of work crews already being mobilized and on-site (S.H. McBeth, Personal Communication, June, 2019). The bicycle 'Missing Links' Program has successfully leveraged paving projects to help fill small gaps in the bike network (Ibid). Paving projects are evaluated from a complete street perspective, identifying opportunities to reconfigure newly paved roadways in ways that enhance safety for all road users (Ibid).

The goal of TAM for is to use available maintenance funds to maximize effectiveness. The pavement (including bikeways) maintenance policy is to carry out the right treatment in the right place at the right time (PBOT Asset Strategic Plan, 2019). This implies prioritizing early repair that can prevent the road from falling into bad or very poor condition (PBOT Asset Strategic Plan, 2019). As illustrated in figure 9, it costs roughly ten times more to rebuild a road that has fallen into very poor condition than to carry out renovations while the road is still in the fair to good stage (American Public Works Association). When it comes to more extensive maintenance, PBOT chooses which streets to repair first based on 'Streets of Citywide Significance' (SCS) (PBOT Asset Strategic Plan, 2019), which are major city walkways where traffic volume is high across all modes.

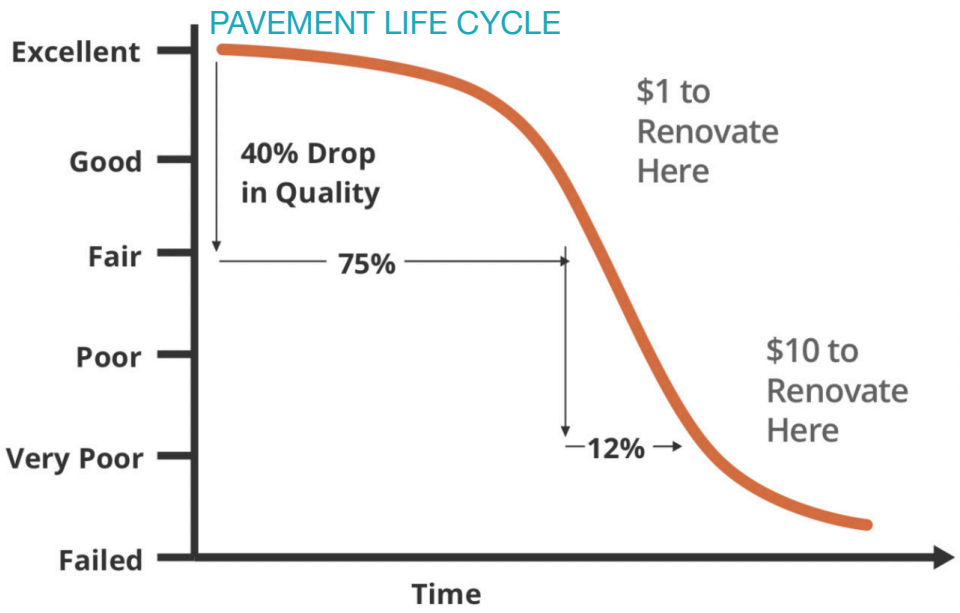

Figure 9: The cost of deferred street maintenance (Source: American Public Works Association)

Debris in the roadway at corners and crosswalks interferes with pedestrian accessibility, whether it be leaves, mud, gravel, ice, or snow. Maintenance activities ensure pedestrian facilities including curb ramps and crossings are debris-free (Ped PDX, 2019). PBOT Maintenance ensures that the City's street cleaning and maintenance activities extend to and include corners, curb ramps, and crossings (PBOT Asset Strategic Plan, 2019).

PBOT also actively maintains spaces where bicyclists operate ensuring bicyclist safety and riding comfort. Hazards along the roadside, such as debris, improper drainage grids, potholes, overgrown vegetation and loose gravel can endanger bicyclists (M. Marx, Personal Communication, June, 2019). Poor maintenance can increase the likelihood of conflicts between bicyclists and motorists. For example, when accumulated debris is allowed to remain in bike lanes and paved roadway shoulders, it forces cyclists to use the roadway (Ibid.). Gravel present during snow and ice events can present serious hazards in bike lanes. Therefore, PBOT maintenance operations groups prioritize streets with bike lanes when performing gravel recovery after a snow or ice event (S.H. McBeth, Personal Communication, June, 2019). Existing bikeways are continually preserved and improved by enhancing bicycle facilities in street rehabilitation and signal maintenance projects. The city conducts periodic assessment of signal operations in key bicycle, transit and freight corridors (Ped PEDX, 2019). Roadway shoulders are maintained, and all signage is standardized (ibid.). Bicycle parking facilities (such as bicycle parking corrals) are maintained and maintenance agreements with adjacent businesses are always kept current (S.H. McBeth, Personal Communication, June, 2019).

Bicycle support infrastructure is also used to serve pedestrians. Multi-modal design solutions provide added safety benefits and cost-efficient solutions for multiple modes. For example, bicycle signals hold vehicle turning movements, so cyclists can pass by the intersection and provide a protected phase for pedestrians crossing the street (Ped PDX, 2019). Similarly, protected bicycle lanes separate cyclists from automobiles in motion and serve as pedestrian refuge islands at intersections, increasing visibility of pedestrians, close crossing distances and pedestrian exposure time (Ibid). The Neighbourhood Greenways Program provides opportunities to develop safety improvements that serve all NMT users. Neighbourhood Greenways improvements typically include traffic calming, reducing automobile speeds and volumes on designated streets, providing pavement markings and signage alerting people driving to expect NMT users (Ibid). Further, unimproved rights-of-way (street segments that have a dirt, gravel, or substandard pavement surface) are improved and maintained for pedestrian only travel (M. Marx, Personal Communication, June, 2019). These underutilized right-of-way segments present low-cost opportunities to increase pedestrian connectivity, particularly in neighbourhoods where the street grid is irregular or widely spaced and pedestrian connectivity is limited (Ibid.). Providing pedestrian walking improvements on these rights-of-way presents a cost savings over improving the street for all modes. Since many of these unimproved rights-of-way tend to be narrow, they can often serve as designated, pedestrian-only paths (Ped PDX, 2019).

MR&R also includes lighting level guidelines in conjunction with all capital projects and private development. Dark streets and sidewalks can impact residents' sense of safety and personal security in the public realm, while dark crossings and intersections can significantly reduce pedestrian visibility, contributing to the frequency and severity of pedestrian crashes. Visibility is an important issue for pedestrian safety in Portland (Ped PDX, 2019), especially where there is a big swing in the number of daylight hours depending on the time of year. Increasing the amount of lighting at pedestrian crossings is therefore critical for preventing future pedestrian crashes. There is a 42 percent crash reduction factor when appropriate lighting on intersections is provided (ODOT Crash Reduction Factor Appendix). In response, Portland's lighting guidelines includes target light levels and lighting level requirements especially on streets with higher pedestrian demand (Ped PDX, 2019). These lighting levels are regularly inspected and maintained for the sidewalk corridor behind the curb and for marked crossings and intersections (Ibid.). When inspections are being conducted for MR&R activities on NMT infrastrcuture, a lighting analysis is included in the Project Delivery Checklist (Ibid.). This checklist is used by project managers for scoping new projects to ensure guidelines are being implemented and there are no lighting gaps (S.H. McBeth, Personal Communication, June, 2019).

Large trees can present a safety problem when they block street lighting at night, particularly in Spring and Summer months. Portlanders can report trees blocking street lighting, and these street trees are trimmed by Urban Forestry or PBOT maintenance crews since. However, Portland City Code (11.60.060) requires property owners to trim or remove trees on private property or on the adjacent street planting areas (in the right-of-way) when trees branches block streetlights. Private property owners are responsible for costs associated with such maintenance (M. Marx, Personal Communication, June, 2019). There is coordination between public agencies to develop joint practices for addressing tree/sidewalk conflicts resulting in solutions that prevent recurrent costly repairs for property owner. Cracked and buckled sidewalks due to overgrown tree roots also present a significant accessibility concern for pedestrians with disabilities. Coordination between bureaus includes a process for joint evaluation by PBOT and Urban Forestry staff when tree/sidewalk conflicts arise, and developing a joint solutions "toolkit" for addressing tree/sidewalk conflicts, including root pruning, expanding tree planting zones into on-street parking zones, expanding the right-of-way to relocate the sidewalk, grinding or raising sidewalks, and tree removal as needed.

Sidewalk maintenance and management includes addressing utility poles and vaults creating obstructions in the through zone of the sidewalk (Ped PDX, 2019). The Portland Pedestrian Design Guide (1998, p.A-8) establishes that the through pedestrian zone, the area of the sidewalk intended for pedestrian travel, "be entirely free of permanent and temporary objects". If utility poles on narrow sidewalks provide obstruction for a person using a mobility device or low/no vision, franchise agreements by the city require that utility poles be located in accordance with City right-of-way guidelines, with the cost for relocation of poles borne by utility providers (M. Marx, Personal Communication, June, 2019).

2. Resources provided to private property owners for Maintainance, Repair and Rehabilitation (MR&R) activities

Since it is the responsibility of property owners to maintain and repair sidewalks along their property, the sidewalk repair program provides financing strategies and cost-saving opportunities to help low-income households and other property owners address sidewalk repair (E.Tristch, Personal Communication, June, 2019). Maintaining sidewalks is critical to providing accessible walkways and preventing potentially dangerous tripping hazards, particularly for those with mobility challenges or sight impairments. PBOT's Sidewalk Repair program investigates reports of broken or missing sidewalks as submitted by residents. After inspection, the owner of the adjacent property is notified and is required to repair the sidewalk (Ped PDX, 2019). The average cost of sidewalk repair for a full sidewalk frontage currently ranges from $900-$1,200 (PBOT Asset Strategic Plan, 2019).

To ensure Portland's sidewalks are safe and accessible, particularly for vulnerable pedestrians, and to ease the financial burden on property owners, PBOT Utilities, Construction, and Inspection coordinates with the Commissioner's Office to identify and initiate financing and cost-reduction strategies to help low-income households and other homeowners address sidewalk repair obligations (Ibid). Such strategies include - waiving all permit fees for voluntary sidewalk repair, requiring sidewalk repair when properties are sold as a condition of sale, establishing a revolving 'micro-loan' fund, with options for deferred payment when properties change hands, neighbourhood-scale sidewalk repair efforts that help property owners address sidewalk maintenance (ibid; E.Tristch, Personal Communication, June, 2019). Batching together pedestrain infrastructure repairs across a neighbourhood creates economies of scale and potential cost savings over addressing sidewalk repair needs property by property (S.H. McBeth, Personal Communication, June, 2019). PBOT addresses all sidewalk repair needs along city-owned properties by conducting regular assessments and repairs of sidewalk conditions along all City-owned properties (Ped PEDX, 2019). The Active Transportation Division of the City leads an initiative to develop a pathway for residents, property owners, and business to self-fund pedestrian improvements not prioritized for investment and maintenance (Ped PDX, 2019). This includes distributing resources to help residents seek grants or fundraise, developing systems that allow maintenance crews to work on privately funded improvements, working with city officials and the Commissioner's office to establish financing mechanisms such as revolving micro loans for small-scale improvements (M. Marx, Personal Communication, June, 2019).

For effective management of sidewalks, there is enforcement of pedestrian access requirements around construction work zones and a system for notifying residents of construction-related changes to pedestrian access. PBOT Administrative Rule 8.12 (2016), details guidelines for providing safe accommodations for pedestrians through work zones. Currently, City policy requires that all those who have an impact on the right of way notify neighboring businesses and residents. This has led to a dramatic increase in projects with pedestrian walkways. Enforcement for compliance is undertaken throough policies such as education and penalties.

3. Information dissemination about MR&R activities

Maintaining NMT assets is critical to providing an accessible transportation network in Portland. The City currently distributes seasonal reminders via social media, email, and print regarding the need to clear snow and ice and remove leaf litter from storm drains and sidewalks (M. Marx, Personal Communication, June, 2019). PBOT Communications and PBOT Utilities, Construction, and Inspection continues to expand communications and materials educating property owners about sidewalk maintenance responsibilities. Expanded education efforts include coordination with neighbourhood

and business associations and leveraging PBOT's Smart Trips mailings (Ibid.). Additionally, the City undertakes driver education about parking violations on driveways, sidewalks and crosswalks (Ped PDX, 2019). Vehicles parked in a driveway in a manner that obstructs pedestrian or bike travel on the sidewalk, is not just an inconvenience to people walking, but an accessibility issue for people with disabilities. The PBOT ADA Coordinator provides educational materials for illegally parked cars about the importance of keeping the sidewalk clear (Ped PDX, 2019). The city works with the disability community and advocacy groups to develop trip planning assistance through a trip planning mobile based application (M. Marx, Personal Communication, June, 2019). Additionally, Portland has a public reporting system – PDX Reporter, for addressing drainage issues at curb ramps with pooling water. Curb ramps with pooling water can create an inconvenience for pedestrians walking through or cyclists riding around large puddles. This usually occurs at older ramps where roadways have been repaved many times, altering roadway slopes and drainage patterns. PDX Reporter allows Portlanders to report problems and maintenance issues to City bureaus (Ped PDX, 2019). TAM for NMT assets includes implementation of 'creative crosswalks' by giving information, permitting community uses and connect residents to grant resources to help fund community-initiated placemaking efforts (Ibid.). Marked crosswalks provide clear indication of where people driving can expect pedestrians to cross the street. This also provides a special opportunity for creative placemaking, harnessing the creative energy of the community, cultivating a sense of neighbourhood identity, and activating the right of way for NMT users. The 'Portland in the Streets' program helps residents activate underutilized spaces with community uses including play streets, street seats, community events and farmers' markets, block parties, pedestrian plazas and street painting (Ped PDX, 2019). The program guides community members through the process for permitting community uses and place-making in the right-of-way (Ibid). All requests for creative crossings are reviewed and permitted through the 'Portland in the Streets' Program.

The City engages community partners to organize events that encourage residents to embrace new infrastructure and build a sense of ownership and community around it. The 'Portland in the Streets' program develops strategies for encouraging residents to sponsor and provide more street seating in the right-of-way to contribute to the vitality of a streetscape, enhancing local business, and social activities (Ped PDX, 2019), increasing eyes on the street, and softening the streetscape as a place to be rather than just pass through. Residents can temporarily close streets to vehicle traffic for community uses, creating a higher quality of place and multi-sensory experience of walking/biking in the city (M. Marx, Personal Communication, June, 2019). Moreover, the city is in the process of developing a multi-modal way finding system that facilitates easy transfer between several modes of transportation (I. Stude, Personal Communication, May, 2019). For this, the city is integrating static maps within the right-of-way with an online digital interface to be beneficial to active transport users.

ANALYSIS AND KEY TAKEAWAYS

It has now been established that the City of Portland has a proficient TAM for transportation assets, where expectations and accountability for NMT assets is drawn from the asset management strategy, processes and tools. The TAM program for NMT assets is coherent with policies, laws and planning priorities of the state of Oregon as well as the metropolitan region of Portland. The program is also adaptable to change in policies and priorities (E.Tristch, Personal Communication, June, 2019). However, it is important to evaluate the asset management strategy, processes and practices with respect to the TAM evaluation criteria for NMT assets set up earlier to understand the strengths as well as weakness of the program.

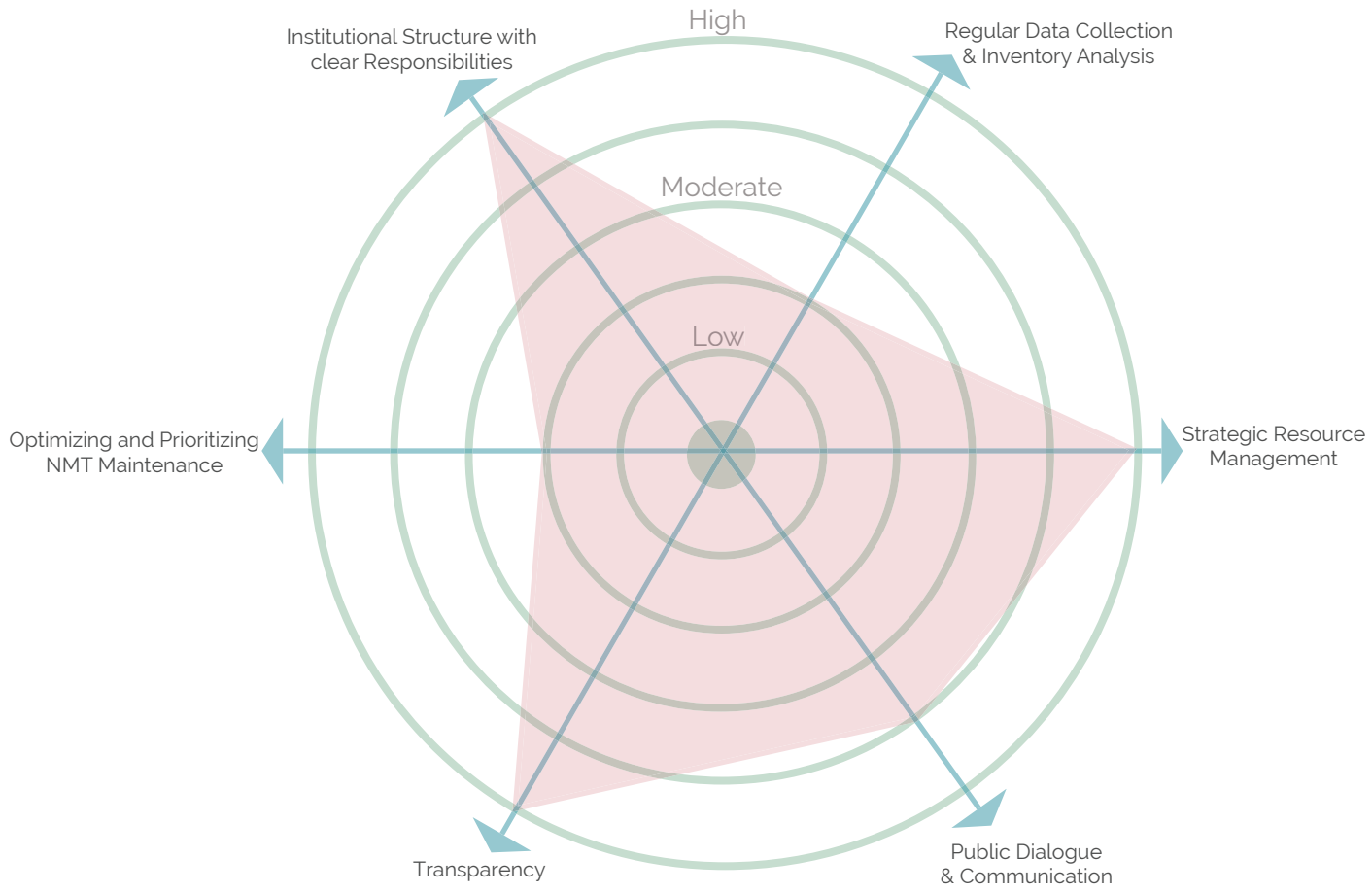

Figure 10:Evaluation of the TAM Strategy for Non-Motorized Transport in Portland, Oregon

Data collection analysis: Although the city of Portland has a mature TAM strategy, the NMT asset strategy still needs improvement. Since Portland is one of the first cities in the United States to develop a comprehensive asset management plan for ancillary assets like NMT assets, the city staff rely on an ex-ante evaluation strategy for planning TAM for NMT assets (E.Tristch, Personal Communication, June, 2019), which is dependent on the use of data from other agencies. This is problematic as different contexts can determine similar or different benefit-cost results after implementation, depending on what practices and methods they adopt and how they actually apply decision-support information in decision making. Another factor the city needs to consider is what is the combination of assets being employed by the agency to get the desired results. This is especially challenging in Portland as there is very little bikeway asset data that is disaggregated from pavement MR&R data (S.H. McBeth, Personal Communication, June, 2019) . In terms of data collection, the city has classified all NMT assets (pedestrian/bike) by planning and public priorities, demand and access to public transportation. Although these assets are inspected by PBOT inspectors and the asset registry is updated, a majority of the service requests have to be placed by NMT users and residents. This can be problematic as a complaint driven program presents equity concerns. The majority of complaints to the City tend to come from higher-income, inner Portland neighbourhoods (ibid.). Consequently, pedestrian conditions in outer neighbourhoods (where a large proportion of disabled residents live) are less frequently addressed than in inner neighbourhoods (Ibid.). Further, the City's Transportation Demand Specialist also expressed concerns over the significant asset data missing for outer neighbourhoods that cannot frequently serviced (Ibid.). Bikeway asset demand data is collected by the city as well as in partnership with private entities such as the bikeshare network operator - Motivate as well as e-scooter companies that are using bikeway infrastructure. Once the data is collected, it is analysed through a Street Saver decision, which helps to streamline maintenance operations by tracking NMT assets, scheduling repairs, monitoring work orders, managing costs, and complying to ISO 55000 standards. This decision tree then helps decision makers to take rational and data driven decisions based on local policy goals, budgetary constraints, and enhanced analytics. However, the current system converts everything to numbers for analysis and this can be problematic as it loses aspects of qualitative significance. Therefore, data collection and inventory analysis still have significant scope for improvement to enable the city to identify an overall infrastructure deficit and to manage assets effectively for the long term.

Resource Management: TAM for NMT assets in Portland utilizes two major revenue streams (gas tax and heavy use vehicle tax), along with other general funding from the bureau. The TAM framework is expensive in terms of software and human resources cost, but significantly cheaper than asset rehabilitation costs without data driven decision making. Before asset development, a scenario analysis is conducted, and business case developed to justify asset the investments decision (E.Tristch,

Personal Communication, June, 2019). Data driven decisions help conserve resources as budgetary constraints are important for decision making. As mentioned earlier, a life-cycle cost analysis approach is utilized to ensure not only initial costs are taken into account but also the future costs during the lifetime of the NMT asset. Financially, the MR&R burden of NMT asset maintenance is reduced as bikeway assets are maintained in conjunction with roadways and sidewalk maintenance is the responsibility of private property owners. Although the city does provide financial tools for private property owners to maintain pedestrian assets, the city is able to save a significant amount of resources through the same. Further, the city has been able to effectively sponsor the bikeshare network for a five-year term and has contracted out the operations to MOTIVATE. Even though the city owns the bike share system, all MR&R activities are undertaken by MOTIVATE (S.H. McBeth, Personal Communication, June, 2019). Therefore, by sharing financing risks, the city benefits from the private sector with advantages such as economies of scale, efficiency-driven performance due to their obligation to reward shareholders, flexibility in regulation, and extensive experience in commercial activities. From the private sector's perspective, their main motivation is the participation in projects of the magnitude of transport projects and having the guarantees provided by the City of Portland. Therefore, by partnering with private equity firms, the city has effectively combined the security and commitment of the public sector with the expertise and efficiency of the private sector, while distributing risks and responsibilities between both parties based on their capabilities for managing them.

Public dialogue and Communication: The TAM program in Portland effectively utilizes citizen participation from the beginning of the TAM process so that residents take ownership over investments in NMT infrastructure and use it for their transportation needs. In historically underserved communities, investments in walking and biking infrastructure could be associated with threats of gentrification, rising rents, and too little investment too late. While fear of future impacts should not deter them from making critical safety investments in neighbourhoods that critically need them, pedestrian maintenance should be seen as investments in existing residents, rather than forces for displacement. To ensure a participatory process, PBOT works with community partners to organize events such as 'Sunday parkways' that encourage residents to embrace new infrastructure and build a sense of ownership and community around it (I. Stude, Personal Communication, May, 2019). For MR&R priorities, residents can engage directly through the PDX reporter mobile application or express opinions through annual 'Walking and Biking Priorities Survey' (Ibid.). The survey is conducted online, through a paper survey as well as in person at public events. In order to hear from young Portlanders, engagement activities are extended to high school students participating in the City of Portland Teen Force program. Additional stakeholders engaged are District Coalitions, City of Portland Pedestrian Advisory Committee (PAC), City of Portland Commission on Disabilities (Ped

PDX, 2019 ; TSP 2015, 2018). The city publishes a draft asset management strategy every five years, reflecting the needs and priorities of the residents (E.Tristch, Personal Communication, June, 2019). This draft is open for public comment for two months before it is finalized. Once the asset management decisions take place, an interactive status and condition report is published for residents to monitor progress.

Transparency: The City of Portland follows the ISO 55001 international standards and TAM program is extremely transparent. The standards have 71 requirements for good asset management, which are aligned with six subject groups- strategy and planning, asset information, asset management decision making, lifecycle delivery, organization and people, and risk review (E.Tristch, Personal Communication, June, 2019). There is a public disclosure of financial and NMT asset information on the PBOT website. This enables public monitoring and ensures cautious management of assets that are developed using taxpayer funds. The asset data sets are available to all bureaus of the city enabling transparent decision making at all levels of the government regarding NMT assets (ibid.). PBOT also has an extremely active social media presence where they inform residents of all MR&R activities through various social media channels as well as email and newsletters. All NMT demand data collected by private companies is also visualized to make it publicly accessible and shared monthly through the same channels. The results of the asset management program are publicly accessible through the annual report or online where residents can monitor and review progress in an interactive format.

Optimizing and prioritizing NMT maintenance: In Portland, the MR&R processes for NMT assets have been optimized to a good extent. MR&R decisions are based on NMT user reports, service requests and inspections. The city helps private property owners find solutions to paying for maintenance and repairs. For bikeways, MR&R usually takes place at the same time as paving projects to optimize financial and human resources. Further the city works with other public agencies to ensure NMT assets are complete, well lit, safe, compliant with ADA requirements, free from debris, snow, improperly designed drainage grates, potholes, overgrown vegetation and loose gravel. However, the city still has a long way to go with respect to prioritizing TAM for NMT assets. Currently, NMT assets receive the lowest amount of resources as compared to any other transportation assets (PBOT Asset Budget Report 2018-2019). This is expected to change with the new Asset Management Strategy that prioritizes maintaining NMT assets over new asset development to raise the NMT infrastructure's capacity and longevity.

Institutional structure with clear responsibilities: TAM activities for NMT assets in Portland are carried out by several public agencies. However, the funding, data collection and analysis, decision making,

budgeting and operations activities are all the responsibility of PBOT. PBOT liaises with Oregon Department of Transportation to ensure the TAM strategy is coherent with state policies and laws. Within the organization, all maintenance and operations for NMT assets (including inspection results) are managed by the Portland pedestrian coordinator, the Portland bicycle coordinator, the neighbourhood greenways coordinator and the missing links program manager. They report to PBOT's asset manager who is dedicated to refining asset management processes and practices within the organization. The asset manager is also a part of the City Asset Manager's group and coordinated TAM plans with other public agencies that might have overlap of assets with transportation. This helps to improve efficiency and minimize the impacts from fragmentation of governance. The asset manager reports to the Deputy Director who approves all major decisions before they are made public. Thus, the institutional structure is well organized and defines responsibilities clearly.

The case of Portland shows how a city can develop a TAM program and prioritize NMT assets by not just securing funding for innovation and investment but also for MR&R. Even though the implementation of TAM for NMT is still in its early phases in Portland, the city has some lessons to offer to cities that are charting a path towards TAM for NMT assets. Some key takeaways from this case are that planners should recognize the need for NMT assets as being vital to the city, and therefore report status and condition of NMT assets to build trust and accountability between the city and residents. TAM for NMT should be integrated with planning efforts including community visioning, strategic planning, and long-term capital planning. A plan should be in place to continue improvement of NMT assets by completing an evaluation of current asset management practices, identifying key gaps based on bureau needs. This should be followed by prioritized implementation steps and schedule. In order to create more equitable processes and outcomes, planners should incorporate public engagement as an important part of TAM for NMT assets to go beyond convening, and instead work towards a more emancipatory citizen participation model. As seen in the case of Portland, it is important to recognize that the barriers to community control extend beyond decision making. Therefore, community participation must include strategies to dismantle these complex and entrenched barriers that prevent power sharing. Community engagement and power sharing are long-term endeavours and cannot be created overnight or without significant changes to existing power and resource distributions. Planners are uniquely positioned to sustain public trust given their resources, local knowledge, technical expertise and future-oriented approach. By developing a transparent strategy and financing mechanisms for NMT asset management, planners should extend participation beyond engagement and inclusion and toward resource sharing as a means to ensure that local communities gain both self-determination and the skills necessary to translate their power into results.

CONCLUSION

Preventive maintenance, like the proverbial stitch-in-time saves nine, has instinctive appeal to those responsible for maintaining municipal infrastructure. Governments are realizing that maintenance and repair of NMT assets is vital and can effectively extend the service life of NMT infrastructure. This paper proposes that good asset management practices begin setting a long-term vision for asset infrastructure and developing an understanding of an entity's assets, that is, the establishment of a comprehensive and updated inventory. This should be followed by strategic resource allocation, which is crucial to maximize extraction of value from assets and deliver cost-effective public services. This is only possible when there is an institutional structure with clear responsibilities and a high level of transparency and coordination between the institutions. NMT assets are used by residents as a convenient, affordable and equitable way to get around. Therefore, the public must be engaged in the decision-making process for better serviced NMT assets that are used frequently. In all, an effective NMT asset management plan encompasses strategic and systematic financial planning, an organized institutional structure with clearly defined responsibilities and coordination and transparency between all stakeholders.

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