Arizona Department of Transportation's Contributions to the UN SDGs

A report by Arizona State University's Fall 2023 Transportation Systems Planning course.

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Executive Summary

Overview

In an increasingly connected and populated world, the efficient and effective movement of goods, services, and people is essential to maintaining and improving everyday standards of living. Arizona plays a uniquely important role in this process within the United States, having been positioned as a prominent air, land, and rail freight thoroughfare, being a major international Port of Entry with Mexico, and containing one of the fastest-growing cities in the United States. This highlights the importance of the Arizona Department of Transportation (ADOT) in meeting this demand, as the primary operator and maintainer of transportation networks statewide. Concurrently, there is a global push towards economic, social, and environmental sustainability, with aspirational goals and associated specific metrics outlined by the United Nations in the Sustainable Development Goals (SDGs).

The Fall 2023 Transportation Systems Planning class at Arizona State University analyzed a suite of ADOT plans and reports against the SDGs, assessing where these plans aided in achieving or harmed progress towards these goals. From this analysis, the class proposed recommendations to improve ADOT alignment with the SDGs. The findings and recommendations have been organized in this report. The ADOT plans and reports analyzed include:

- Sustainability
- Pedestrian Safety
- Complete Transportation
- Arizona-Sonora Master Plan
- Operationalizing Sustainable Transportation
- Aviation System Plan
- Asset Management
- Tribal Transportation
- Freight Plan
- Complete Transportation
- Carbon Reduction Program
- State Rail Plan
- Lone Range Transportation Plan
- Rural Areas
- Tribal Transportation
- Freight Plan
- Complete Transportation
- Carbon Reduction Program
- State Rail Plan
- Long Range Transportation Plan
- Rural Areas

The class was split into seven teams, each assessing two ADOT plans. The teams utilized the United Nations Sustainable Development Goals Assessment Tool to guide and collect their analysis, and conduct uniform comparisons. This approach standardized the teams' analyses and provided an objective framework to aid in recommendation formulation.

Results

The analyses of ADOT reports provide insight into which SDGs are currently addressed, the degree to which they are addressed, and areas for potential improvement. In line with the UN SDG Impact Assessment Tool, each review categorizes the type of influence of each ADOT initiative on the SDGs. This includes impact types of *direct positive*, *indirect positive*, *no impact*, *indirect negative*, and *direct negative*. The vast majority of relevant SDGs are shown to be directly positive or indirectly positive to some degree. SDGs determined to have no impact are categorized as such if impacts are so indirect as to be negligible, or fall well outside the scope of ADOT authority or the authority of frequent ADOT collaborators. While it was found that the relevance of each ADOT report to specific SDGs varies, a few SDGs

and recommended strategies appear across our report analyses.. This indicates strong potential for coordination between ADOT initiatives to efficiently address a few pervasive SDGs. This review leads us to recommend a series of strategies for ADOT to maximize progress towards the SDGs through institutional, planning, and design methods.

The goals most commonly addressed across the ADOT reports include SDGs 3 (Good Health and Well-Being), 8 (Decent Work and Economic Growth), 9 (Industry, Innovation, and Infrastructure), 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production). ADOT initiatives largely have direct positive impacts on these SDGs, with isolated cases found to have indirect positive effects. These align with the expected progress towards achieving the SDGs, as those with the clearest, most direct effects are the easiest to address with relatively simple, in-house planning and coordination. Common strategies across ADOT reports to address these SDGs include improving roadway safety design (SDGs 3, 11), expanding dedicated public transit and active transportation infrastructure (SDGs 3, 8, 9, 11, 12), transitioning to resource-efficient and low-emission construction and maintenance methods (SDGs 8, 9, 12).

SDGs with indirect positive relationships to ADOT efforts are also significant. Such SDGs can be more difficult to evaluate as ADOT efforts represent a small component of influence by multiple stakeholders. Such groups fall across a variety of structures (public, private, non-profit) and scales (local, state, federal, international). However, this can also mean that ADOT's scope of influence on these SDGs is broader than the more directly addressed SDGs. Such goals with more indirect positive impacts include SDGs 1 (No Poverty), 8 (Decent Work and Economic Growth), 10 (Reduced Inequalities), and 12 (Responsible Consumption and Production). These connections emphasize that ADOT decisions exist within complex social, ecological, and technological (SETs) systems, meaning that initiatives can be leveraged to catalyze SDG impacts beyond the direct authority of ADOT. An example of these effects include expansion of public transit leading to decreased poverty (SDG 1) through reduced car dependency, a reduction in personal transportation costs, and

expanded access to jobs for disadvantaged groups. This report provides several examples of similar strategies.

The analyses also found that there is strong potential for ADOT to improve strategies to address some SDGs, including those commonly or uncommonly addressed with current initiatives. These include SDGs 3 (Good Health and Well-Being), 9 (Industry, Innovation, and Infrastructure), 11 (Sustainable Cities and Communities), and 13 (Climate Action). These goals are the focus of recommendations across many of the teams' analyses. Much like the currently implemented strategies, recommended strategies emphasize the value of coordinating efforts within ADOT and between stakeholders to most efficiently achieve the SDGs.

Finally, several SDGs are found to be negligibly impacted by ADOT efforts. The most common include SDGs 4 (Quality Education), 5 (Gender Equality), 6 (Clean Water and Sanitation), 14 (Life Below Water), and 16 (Peace, Justice, and Strong Institutions). These goals generally fall well outside the scope of ADOT authority or influence. It is important to note that due to the interdependent nature of SETs systems, ADOT actions likely impact these goals to some degree. However, due to limited resources and in the interest of efficient progress, the more directly relevant goals are the focus of this report. Continuous evaluation of ADOT connections to all SDGs should be conducted to consider goals and strategies previously not considered.

Recommendations

From what was observed in the findings, we consider further steps ADOT could take are related to prioritization of the projects and respective measures that will be deployed to better address sustainability within the scope of the UN SDGs. At first, we suggest addressing SDGs that are directly impacted by the assessed projects, mostly the ones that are currently having negative relationships. Next, tackling the SDGs that initially received no impact, and could eventually be part of ADOT's scope, could be a logical track to pursue.

Lastly, we recommend that other actions could be designed to enhance the benefits in SDGs that are already impacted positively. Along these lines, SDGs 3, 6, 7, 12, 14, and 15 are the ones that, across all the projects assessed, are more prone to suffer negative impacts from ADOT's initiatives, even though the character of the interrelationships vary from one project to another.

For instance, actions for the development of a transition to clean fuels within the Aviation System Plan, besides supporting more reliable access to clean energy for aviation in Arizona, could also positively impact clean water and sanitation, as well as life below water. Additionally, the allocation of financial and planning resources to ecosystem and biodiversity protection within the Freight Plan, plus increasing reconstruction efforts of habitats surrounding infrastructure developments, could shift the current negative relationship of Arizona's Freight Plan with SDG 15. Furthermore, cross-cutting actions are outlined in assessments of different projects, so that ADOT initiatives could have a bigger positive impact across a larger range of SDGs. Actions such as the integration of sustainability projects into planning processes, as well as embracing sustainability design, continuous sustainability monitoring and evaluation and considering collaboration with stakeholders (especially opening dialogues with local communities) fit into examples of that.

During the assessment of 13 different ADOT efforts it has been clear that the impacts of the projects developed by the organization are multidimensional. Therefore, it is wise for ADOT to prioritize actions that could have positive impacts on several different SDGs, even though recommendations sections also provide specific actions, that are somewhat more intrinsically related to the projects assessed, but more limited in impact over SDGs. Nonetheless, a brief analysis of context for each recommendation should be necessary before selecting them for further phases of implementation.

Accordingly, the efforts presented in this report are extensive and provide useful insights on how ADOT could improve its approach when it comes to the SDGs. However, they

should also be considered as an initial step along the process of defining the best sustainability strategies to be implemented by ADOT. In this sense, the availability of more data and more specific information along the lines of how ADOT sees sustainability within its projects could even derive new discoveries and more accurate decision-making for long-term sustainability improvements.

Introduction

The Arizona Department of Transportation (ADOT) has repeatedly shown national and international leadership and innovation in sustainability and resilience. The organization has implemented sustainability, climate adaptation, emerging and disruptive technology integration, justice, and equity planning formally and informally into many initiatives. ADOT is nationally recognized as an innovation leader in these challenges.

The United Nations Sustainable Development Goals (SDGs) have emerged as a critically important framework for assessing how governmental agencies and private organizations are assisting developing nations towards sustainable outcomes. The SDG framework was released by the United Nations in 2015 and has become important guidance towards wicked and complex challenges including responsible infrastructure development, economic development, water and air quality, and clean and affordable energy use. There are 17 SDGs (Figure A) and for each, there are targets and indicators to objectively assess progress towards the goals.

Figure A: UN Sustainable Development Goals

With leadership and innovation in sustainability, there is significant value in characterizing how ADOT is contributing to the SDGs. Many ADOT programs and policies informally address SDG goals and targets, and a formal assessment would describe where and how the organization is meeting SDG outcomes.

Arizona State University's Fall 2023 Transportation Systems Planning class led a study to assess how ADOT programs and policies contribute to SDGs. The 34-student class split into 7 teams to assess the following ADOT programs:

- Sustainability
- Pedestrian Safety
- Complete Transportation
- Arizona-Sonora Master Plan
- Operationalizing Sustainable Transportation
- Aviation System Plan
- Asset Management
- Tribal Transportation
- Freight Plan
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For each program the team used the United Nations SDG Impact Assessment Tool, a formalized process for assessing an organizational policy or project and how it contributes to goals. The Impact Assessment Tool reduces subjectivity by creating a transparent and repeatable process. This report describes the assessment of ADOT's programs in detail. The Executive Summary synthesizes the findings into a summary assessment and conclusions.

Team 1 - Sustainability and Pedestrian Safety

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Overview

Sustainability Report

ADOT's approach on its Sustainability Report (SR) focuses on the three primary principles of sustainability: achieving the triple bottom line which pertains to the efficient use of economic, social, and environmental resources. ADOT developed an updated report for its Sustainable Transportation Program in 2020, as the need for efficient planning and prioritizing of resources becomes more critical. The primary purpose of the report is to discuss ADOT's Sustainable Program Operating Focus Areas (OFAs) for the years 2020 and 2021 and to establish metrics used for tracking its progress. Throughout the years, ADOT has been working on developing a strategic method of incorporating the US Department of Transportation Federal Highway Administration (FHWA) Infrastructure Voluntary Evaluation Sustainability Tool (INVEST) into tracking project development towards achieving sustainability goals.

The 2017-2019 ADOT INVEST Round 3 Work Plan sought to define and connect quantitative data for analyses at a project level, including economic analysis, benefit-cost analysis, and return of investment. The work plan would allow not only ADOT technical groups but also university research teams and companies to develop a set of practices and measures for sustainable transportation systems throughout the process of civil design and construction. INVEST evaluates the sustainability of a full transportation life cycle through design, construction, and end-of-life using criteria divided into three modules. These modules work alongside Life Cycle Assessment (LCA), Life-Cycle Cost Analysis (LCCA), and Environmental Product Declaration (EDP) to achieve project goals. The INVEST criteria has greatly improved since its initial pilot testing back in 2010. Various projects over the years have revealed certain aspects of project development that FWHA deemed as a point of consideration for

sustainability standards. Through applying the INVEST criteria as well as LCA, LCCA, and EDP to projects that are later discussed in case studies allowed for easy identification of common tasks between cases which resulted in improving the current INVEST criteria and its modules.

As mentioned earlier, INVEST modules are continuously enhanced through analyzing its application to existing projects. Specifically, quantitative results can be developed using benefit-cost methodologies to compare and contrast design alternatives from standard practices. Benefit-cost analyses are vital to state DOTs to prioritize proposed programs and projects. These aim to promote efficiency in resource and material use through informed cost, but do not consider sustainability in terms of environmental impact hence the need for the INVEST criteria. LCA and LCCA are subsets of benefit-cost analysis that are applied in the subsequent case studies.

These case studies commonly exhibit the efforts of ADOT to continuously implement the use of their developing criterion such as the INVEST tool to perform benefit-costs analyses in the process of achieving their OFAs. Through pursuing various sustainability benchmarks, ADOT has improved their tools to better fit future project development goals. This is recurrently applied towards resource efficiency, which is a main sustainability concern for ADOT. One specific example of a resource efficiency pursuit is the ADOT Queen Creek Tunnel LCA and LCCA. This project involved the first Arizona tunnel to utilize a Light-emitting Diode (LED) lighting system that would be cost and energy efficient. The benefit-cost methodologies identified impacts and potential tradeoffs that may seem inconspicuous. However, there was a lack in consideration of sustainability practices specific to roadway lighting. This led to the creation of INVEST Project Development 17 (PD-17), which promotes economic and environmental gains through alternative lighting or renewable power sources. This exhibits the flexibility in INVEST as a tool, as sustainability covers many different aspects of our world around us indicating that new issues and situations may arise at any time.

ADOT's I-11 Tier 1 Environmental Impact Statement (EIS) also called for a significant adjustment to the INVEST tool, as it was not precise in its criteria. Specifically, the INVEST

scorecard was adjusted to comparatively evaluate the results of the process instead of the process itself being followed. This was fixed due to three different I-11 Corridor Builds receiving the same scorecards despite design differences. It is a common theme throughout the case studies that resource efficiency is a sustainability goal through which the INVEST tool is continuously developed in order to accurately track the progress.

ADOT's 2020 Sustainable Transportation Program's key take-away is the ability for INVEST to work in tandem with other policies and standards. The flexibility and comprehensiveness of FHWA's INVEST tool allows application to conventional quantitative methods (LCA, LCCA, EDP, etc.), resulting in informed decisions regarding sustainability targets.

Active Transportation Program

The assessment of the topic of ADOT's 'Active Transportation Program' is based on the 2017 edition of the Pedestrian Safety Action Plan (PSAP), which has one overarching purpose: to provide a strategic action plan pertaining to pedestrian safety. ADOT's 2017 edition of the PSAP serves as a continuation of the goals from 2009's PSAP, while also establishing new goals and values pertaining to pedestrian safety. The main goal of ADOT's 2017 PSAP is to reduce the frequency of all pedestrian-involved crashes on Arizona's State Highway System (SHS) by 25% by the year 2025. Data analysis, risk assessment, potential countermeasures, recurrence of crash sites across previous PSAP reports, and funding sources were taken into consideration for the recommendations made by ADOT's 2017 PSAP.

The study performed in ADOT's 2017 PSAP analyzed crash data involving pedestrians on roadway segments and intersections, taking into consideration physical characteristics of the crash sites, including lighting conditions and roadway geometrics. Crashes involving pedestrians were analyzed on the KABCO scale, which rates the intensities of resultant injuries. Deficiencies in the reporting of crashes on tribal lands were recognized. ADOT reached out to Native American tribes in January of 2017 to request input on tribal pedestrian safety issues with their PSAP in mind. In total, 29 statewide intersections and segments with

high rates of pedestrian crashes, their involvement in ADOT's 2009 PSAP, and their physical characteristics were identified.

A risk assessment methodology was employed to identify the state highway segments and intersections where the investment of funds could help lower the risk of pedestrian crashes. Two steps, including an initial GIS-based screening and a final aerial visual screening were utilized to review potential segments and intersections for characteristics. Characteristics that are associated with pedestrian crashes, including number of lanes, speeds of traffic, volumes of traffic, population density, and highway geometry were identified. In total, 70 SHS locations with a high pedestrian crash risk were identified, with 17 of these locations falling into the most prominent risk tier.

As a result, countermeasures to be implemented for these high-risk segments were first identified. Potential countermeasures were selected based on similar characteristics to the risk assessment step, and consulting government resources as well as potential countermeasure reports. The selected preliminary countermeasures were organized into three categories: engineering solutions, education, and enforcement. Countermeasures involving engineering solutions would involve changes to the roadway environment and operations. Countermeasures involving education measures would involve raising awareness of traffic laws, practices, and behaviors. Countermeasures involving enforcement would involve the promotion of compliance with pedestrian-related traffic laws, ordinances, and regulations. For instance, potential countermeasures range from pedestrian education campaigns to the widening of roadway shoulders. Unit costs for countermeasure implementation, sources of identification, and their Crash Modification Factor (CMF) are also listed.

Countermeasures and respective locations for implementation were prioritized with the assistance of a benefit-cost ratio (BCR), which is based on project costs, monetary value of benefits, number of crashes reduced, and purely BCR. The intensity of pedestrian crashes was incorporated in the BCR calculation, with different intensities of pedestrian crashes

leading to vastly different payouts required by ADOT. A total of 13 non-tribal projects were identified, reporting their location, description, number of total pedestrian crashes, and annualized benefits. Safety assessments were recommended to be performed at 13 high-crash and high-risk locations.

To determine whether there were programmed projects near high-crash and high-risk segments, ADOT reviewed the 2017-2021 ADOT Five-Year Transportation Facilities Construction Program. In total, ten projects were identified in areas where ADOT's 2017 PSAP determined there were pedestrian safety needs. Two of them identified incorporated improvements that will directly benefit pedestrians. Areas where pedestrian safety improvements can overlap with programmed projects were also identified.

Another important aspect of the report is the identification of funding sources for pedestrian infrastructure and programs on the federal, state, and regional levels. They were sorted in accordance with the involvement of construction, required matching funds, eligible projects, and various comments about the source of funding. Sources of funding on the federal level were found to be more abundant than sources of funding on the state and regional levels, where federal funding delegates a certain amount of grant money to the state of Arizona. Sources of funding on the state and regional levels primarily come in the form of taxes. These taxes come from monetary transactions such as the purchase of gasoline, vehicle registration fees, and business activities.

Essentially, ADOT's 2017 PSAP recommendations were made on policies and programs to be implemented to provide a safer experience for Arizona's pedestrians. Successes from the 2009 PSAP were detailed, and recommendations were made in accordance with six PSAP objectives stated at the beginning of the report. Education and outreach recommendations were made, along with legislative, research, engineering, and enforcement recommendations.

Requirements

Sustainability Report

The Arizona Department of Transportation (ADOT) Sustainable Transportation Program Report highlights the organization's use of the Federal Highway Administration (FHWA) Infrastructure Voluntary Evaluation Sustainability Tool (INVEST) as it relates to transportation life cycle assessment (LCA) and life cycle cost analysis (LCCA). Various case studies are presented which focus on the specific use of the INVEST tool and recommendations for future implementation. The scope of each case study is variable such that all social and economic facets of the projects cannot be effectively analyzed using the same framework. Therefore, a few common design considerations between the projects (e.g. ecological connectivity, energy efficiency, and economic analysis) will be studied to determine if ADOT's implementation of these practices is conducive to sustainable development, as characterized by the SDGs.

The SDG assessment of the ADOT sustainability report requires a holistic approach that considers social and economic impacts of engineering solutions. As such, there will be certain aspects of ADOT's sustainability efforts that will address multiple of the 17 SDGs. For instance, ADOT's implementation of LEDs in infrastructure updates could fall under responsible consumption and production (SDG 12) because of lower associated CO_2 emissions compared to existing HPS systems. This could also apply to affordable and clean energy (SDG 7), sustainable cities and communities (SDG 11), and climate action (SDG 13) among others. While it is important to draw connections between ADOT's sustainability efforts and the various SDGs, an "everything is connected to everything" attitude would result in an unproductive assessment. Each sustainability effort will be assessed using the SDGs, but indirect effects will not be the focus. For example, while LED implementation could likely be connected to other SDGs such as eliminating poverty (SDG 1), this connection would be weak and the resulting analysis would not be productive to the assessment.

On a similar note, it is important to recognize the limitations of the SDGs themselves. The SDGs are meant to provide objectives for sustainable development and therefore cover a

wide range of possible social implications. Due to the breadth of these goals, some may not be applicable to the sustainability study, such as gender equality or zero hunger. Ultimately the goal of the SDG assessment is not to force conclusions to each SDG, but rather to determine if the objectives (i.e., ADOT's sustainability perspectives) align with the general philosophy of sustainable development.

The life cycle of each case study is incredibly variable. For instance, the LCA for the LEDs that ADOT showcased in their Queen Creek Tunnel case study is very different from the LCA for their SR 30 project. Instead of focusing on ADOT's LCAs for each project, ADOT's sustainability protocols as a whole will be analyzed to determine if they adhere to existing LCA standards and the SDGs. Analyzing ADOT's life cycle philosophy is more beneficial than trying to assess each case study individually. It is assumed that ADOT follows a similar resilience and sustainability roadmap for every project.

The scale of implementation as it pertains to sustainability plans differs from the traditional view. With physical infrastructure, the scale of implementation generally describes how the infrastructure system can be applied under certain physical limitations. With sustainability efforts, the scale of implementation is typically governed by economic or political constraints. Sustainability efforts can theoretically always be applied whereas physical infrastructure cannot. Whether or not sustainable alternatives are actually favored is a more complex decision. As noted in the Queen Creek Tunnel case study, LEDs were not implemented for a long time in the tunnel, because during the early stages of the technology it was not economically viable. However, the actual sustainability plans that undergirded the consideration were always present. This distinction between the scale of implementation of infrastructure versus the implementation of sustainability standards will be important during the assessment process.

ADOT's influence is primarily contained to the state of Arizona, therefore, the assessment will be focused on the impacts ADOT's sustainability efforts have on Arizona residents. That is, the negative and positive impacts will be analyzed for Arizonan stakeholders and not

broader groups, such as the whole United States. Notably, other areas may realize benefits from ADOT's sustainability efforts and the construction of new infrastructure. For instance, the construction of SR 30 may extend social and economic benefits to neighboring states including California. While special cases may be considered, it is important to limit the scope to a particular group to ensure a focused assessment. Because the scale of implementation is limited to the state of Arizona, the geographical scope should be limited in the same way. This again assumes that benefits from ADOT's sustainability efforts will not traverse state boundaries. This assumption will be assessed during the process to ensure its validity and relevance to the project.

ADOT's efforts within the SR do not adhere to a strict time frame. While there is certainly urgency to develop sustainable practices, the implementation of these practices does not have an established deadline the way that standard infrastructure projects do. This limitation must be identified when analyzing ADOT's SR using the SDG framework. Given this difference, "time frame" as it relates to ADOT's sustainability efforts will be characterized by the rate of implementation and not a single length of time.

To summarize, analyzing ADOT's SR through the lens of the Sustainable Development Goals (SDGs), a set of assumptions and limitations must be exercised due to the scope of breadth of the report and also the extent of the SDGs themselves. Life-cycle perspectives, scale of implementation, and time frame manifest themselves differently in the SR than in physical infrastructure. As such, the framework that is used for typical SDG assessments has to be refined. In doing so, some of the criteria that are used to determine sustainable development will not be applicable to ADOT's SR. For instance, zero hunger and gender equality will likely not be impacted by sustainability efforts. Ultimately, the goal of the SDG assessment is not to draw connections to every SDG goal but rather to determine whether ADOT's infrastructure planning promotes resiliency and sustainability. Due to the variety in ADOT's sustainability report, it is beneficial to highlight a few common design considerations between the projects (e.g. ecological connectivity, energy efficiency, and economic analysis) rather than assessing each individual case study separately in the report. The purpose of

doing so is to effectively capture ADOT's sustainability philosophy and assess that general ideology using the SDGs.

Active Transportation Program

The primary objective of ADOT's 2017 Pedestrian Safety Action Plan (PSAP) is to achieve a 25% reduction in the occurrence of pedestrian involved accidents on Arizona's State Highway System (SHS) by the year 2025. The plan outlines six specific objectives aimed at enhancing pedestrian safety: reduce crashes at high-crash locations, prevent crashes at high-risk crash locations as identified through the risk assessment process, reduce pedestrian crossing roadway crash types, reduce number of pedestrian-involved crashes in which the pedestrian was 20-34 years of age, reduce the number of crashes in dark-not lighted conditions, and reduce pedestrian crashes on controlled access or interstate facilities. These six objectives can be grouped into two overall goals including enhanced education programs and transportation infrastructure improvements. Due to the nature of the active transportation plan, a set of assumptions must be made to successfully analyze the life-cycle perspectives, scale of implementation, geographical scope, and time frame of the PSAP.

Firstly, we must assume that some of the life-cycle perspectives cannot be measured for the PSAP factors in a typical manner. The life-time perspective of a structure analyzes the life-expectancy of buildings, infrastructure, equipment, and more, in order to predict when the design might fail. The longevity of infrastructure is essential due to its implications for society, the economy, the environment, and pedestrian safety. Infrastructure, ranging from bus stops and bike paths to highways, serves as a backbone to urban areas. A longer infrastructure lifespan not only justifies the substantial initial investments, but also ensures sustained functionality reducing the need for costly replacements or repairs. A longer lasting structure minimizes disruptions, enhancing reliability and overall safety. Extended infrastructure life contributes to the overall prosperity of an area and can foster economic growth. Not only does the lifetime of a structure support growth of cities and safety of individuals, but it significantly reduces consumption. With increasing population and

urbanization, it is crucial to consider the over-consumption, waste generation, and carbon emissions generated from continuously repairing transportation infrastructure.

Because ADOT is aiming to implement some non-traditional practices such as education systems, we must assume the lifetime cannot be measured the same way infrastructure can be measured. ADOT is seeking to raise awareness of traffic laws, practices, and behaviors through promotion of compliance with pedestrian-related traffic laws, ordinances, and regulations. Since these elements do not have a conventional lifetime, we must consider other factors like sustainable and accessible teaching practices. It is crucial that resources and data surrounding effective teaching are gathered in order to ensure all groups of individuals have access to quality traffic education.

ADOT is also considering implementing a variety of transportation infrastructure improvements such as properly located bus stops, raised medians, crosswalk adjustments, over-head lighting, and shoulder widening. Not all these factors have a lifetime that can be traditionally measured. The majority of said improvements have a lifetime that depends on the jurisdiction and the future goals of the city. Assuming all street lights are the same in each jurisdiction, and the light frequency is at a constant use, a street light pole lasts about 90 years, and a light is usually replaced every 4 to 6 years. Additionally, crosswalk adjustments, median improvements, and bus stops can alter based on the future goals of the city. For example, a city can incorporate a median into a roadway design if there are future plans to expand the roadway to account for population growth. Roadway improvements are frequently made and heavily rely on adaptation to city growth, therefore making their lifetime predictions unreliable.

The scale of implementation for transportation infrastructure such as bus stop locations, raised medians, crosswalk adjustments, over-head lighting and shoulder widening varies significantly depending on geographical factors. For example, in urban areas with higher population density, shoulder widening may be prioritized on highways to accommodate

passing freight traffic and enhance pedestrian safety. The scale of implementation tends to be more extensive in rural areas due to the long stretches of road, but because the active transportation program is focusing on pedestrian safety, the infrastructure implementation will increase in urban areas. Additionally, traffic education programs in rural areas may target specific issues like animal crossings while ADOT aims to target traffic and pedestrian laws, catering to the unique challenges of these regions.

Each of these discussed components will play a role in achieving the SDGs. The SDG assessment tool provides a comprehensive framework when evaluating progress toward seventeen global development goals. Assessing progress in pedestrian safety is an integral part of evaluating a region's commitment to achieving global goals outlined in the SDG tool. Some of these goals include no poverty, good health and well-being, quality education, sustainable cities and communities, and much more. To successfully analyze the impact of pedestrian safety on these goals we must assume that poverty is linked to almost every global objective. For example, poverty directly affects good health and well-being, and quality education. Therefore, when assessing the impact of pedestrian safety on the SDGs, many of the objectives will be defined as relevant due to their strong connection to poverty, and pedestrian's relevance to low-income areas. Pedestrian safety is directly related to SDG 3 which focuses on ensuring health and well-being. High rates of pedestrian accidents and fatalities can strain healthcare systems and disrupt the well-being of individuals and communities in poverty. Similarly, ADOT has a goal to implement higher quality education surrounding traffic education, but individuals in low-income areas may not have access to such education. It is important to recognize all factors, especially poverty when determining which SDGs are relevant to the PSAP.

When analyzing ADOT's 2017 PSAP against the SDGs, a set of assumptions must be made while identifying the life-cycle perspectives, scale of implementation, geographical scope, and time frame. Some of these assumptions include that life-cycle perspectives cannot be measured for the PSAP factors in a typical manner, all street lights are the same in each

jurisdiction, the light frequency is at a constant use, and poverty is linked to almost every global objective. Through analyzing these assumptions, it becomes evident that pedestrian safety is a critical component of the SDGs, as it not only directly supports specific goals related to development, sustainable transportation, and health, but also has a ripple effect on broader sustainable development objectives.

Findings

Sustainability Report

The SDG Assessment of ADOT's 2020 Sustainability Report revealed which SDGs were addressed directly by ADOT and which could be improved. Before the assessment was conducted, all 17 SDGs were categorized as either relevant or not relevant. "Not relevant" SDGs were goals not addressed directly by the SR, and included the following:

- Goal 2: Zero Hunger
- Goal 4: Quality Education
- Goal 5: Gender Equality
- Goal 10: Reduced Inequalities
- Goal 16: Peace, Justice, and Strong Institutions

It should be noted that the goals listed above may have connections to specific ADOT initiatives and projects. Infrastructure is intertwined with social and economic development, so it is likely that ADOT could impact Goal 10, for example. However, the scope of the assessment is limited to ideas contained within the SR. If ADOT's sustainability initiatives did not directly address the targets associated with a particular goal, that SDG was labeled as "not relevant" or "no impact". Some of the other irrelevant goals are due to limitations in ADOT's jurisdiction. For instance, many of the targets for Goal 16 include remedying international policy or addressing nationwide social crises such as exploitation and trafficking. These are issues that ADOT may not be able to address directly and are consequently not addressed in the SR. While these SDGs are labeled "not relevant", that is

not necessarily a critique of ADOT's practices, but rather a way to limit the scope of the assessment.

The following SDGs were directly impacted by ADOT's sustainability efforts:

- Goal 3: Ensure healthy lives and promote well-being for all at all ages
- Goal 6: Clean water and sanitation
- Goal 7: Affordable and clean energy
- Goal 8: Decent work and economic growth
- Goal 11: Sustainable Cities and Communities

Not all targets in SDG 3 were applicable to ADOT. However, ADOT specifically addressed Target 3.6 (Halve global injuries from road traffic accidents) and Target 3.9 (Reduce illnesses from hazardous air, water, soil pollution). Although ADOT may not have an immense global presence, the organization still progresses Target 3.6 especially through their Bicycle and Pedestrian Program. ADOT frequently analyzes crash history and other vehicular accidents to improve safety measures and problem areas. The organization addresses Target 3.9 primarily by reducing air pollution. Aside from the implementation of LEDs, one of ADOT's current study areas is the implementation of solar technology on ADOT right-of-way, which could reduce the demand for other means of fuel.

In SDG 6, ADOT directly progresses Targets 6.3 (improve water quality), Target 6.6 (protect water-related ecosystems), and Target 6.B (support participation of local communities in improving water management). ADOT addresses Targets 6.3 and 6.6 in the project development process by prioritizing ecological studies, stormwater management, and run-off management, evident in planning for SR 30 and SR 189. ADOT addresses Target 6.B with their prominent university and public outreach. In January 2020, ADOT participated in Stormwater Awareness Week to inform the public about the effects of trash and stormwater

run-off on water quality. The application of social media and local news outreach showed that ADOT has and continues to educate the community about sustainable water management.

Goal 7 seemed to be one of ADOT's priorities because of its recurring presence in various case studies. The largest application of Goal 7 was the replacement of high pressure sodium (HPS) luminaries to LEDs on various roadway segments, including the Queen Creek Tunnel. The new LED system has much lower lifetime carbon dioxide emissions and requires less maintenance due to the longevity of the bulbs. The benefits of the LEDs were determined using LCA and LCCA principles to determine whether the cost of upgrading the system would yield net social benefits. This ensured that the replacement would amend both technological and societal deficiencies. The implementation of LCA and LCCA also contribute to Goal 8, by ensuring that projects chosen by ADOT are the most beneficial for the community and contribute to sustainable economic growth.

As with other SDGs, not all targets in Goal 11 were implemented, but many of the endeavors in the sustainability report worked towards achieving the overall goal. For example, implementing resilience in the planning process, ADOT ensures that the funded developments will be adaptable to future events. Flood control for the planned SR 30 project used a 100-year flood event to control their design, even when a 50-year flood event was the ADOT standard. Other design measures including analyzing alternative locations and preventing freeway runoff into adjacent water bodies are also evidence of ADOT's commitment to resilient infrastructure. This design philosophy reduces the risk of damage and losses that may occur with future disasters, and has a key role in developing sustainable communities.

Active Transportation Program

As a result of a thorough analysis of ADOT's 2017 PSAP, multiple realizations regarding the action plan's stated goals were achieved. These realizations range from assumptions necessary to assess the PSAP to physical characteristics of the actions specifically detailed

within the PSAP. The realizations associated with the PSAP include the fact that poverty can be linked to nearly every global objective, the fact that life-cycle perspectives within the PSAP must be evaluated in a unique manner, and the fact that differences in traffic-related infrastructure across jurisdictions must be mitigated. To proceed with the identification of Sustainable Development Goals (SDGs) that are addressed within ADOT's 2017 PSAP, these assumptions and definitions of scopes relevant to the PSAP must be employed.

On the notion that poverty plays into nearly every global objective, ADOT implicitly addresses poverty in many instances throughout its 2017 PSAP. For instance, SDG 1 from the 2030 Agenda directly addresses poverty, with its most broad description stating, "end poverty in all its forms everywhere". While ADOT does not directly address solving the broad issue of poverty in its PSAP, the actionable goals it provides tie into the issue of poverty. ADOT suggests two types of implementations to improve the issue of poverty:educational-based and infrastructure-based. The educational approach ties into poverty, as providing pedestrian safety education can improve the overall level of education and competency for those who are impoverished. These educational improvements align with Goal 1.5, as resilience will be established, reducing the vulnerability of the impoverished to pedestrian-related crashes. While ADOT implicitly improves the conditions of those who are impoverished, it cannot be logically stated that ADOT is directly 'ending poverty' in accordance with SDG 1. So, a more liberal line of thinking must be applied to conclude that ADOT's 2017 PSAP contributes to the poverty aspects of SDG 1.

One SDG that ADOT's 2017 PSAP directly addresses is SDG 3, which has a broad definition stating, "Ensure healthy lives and promote well-being for all at all ages". The simple fact that ADOT aims to reduce the frequency of all pedestrian-related crashes by 25% by the year 2025 demonstrates a direct alignment with SDG 3. In a traffic-specific manner, SDG 3.6 states, "By 2020, halve the number of global deaths and injuries from road traffic accidents". Although the two timelines and percentages of pedestrian crash reductions do not line up, they share the same overarching goal. As a result, SDG 3 is directly addressed by ADOT's 2017 PSAP, although at different rates.

Another goal that requires a more liberal line of thinking when proclaiming that it is addressed by ADOT's 2017 PSAP is SDG 4. This goal broadly states, "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". While ADOT's recommendations involving educational efforts do ensure that quality education will be provided in an equitable manner, these recommendations do not promote learning opportunities that extend past their window of employment. No sub-sections of SDG 4 align with ADOT's transportation-related approach to educational opportunities, which is why stating that compliance with SDG 4 requires a liberal line of thinking. It is understandable that SDG 4 is not entirely met by ADOT, as the opportunities for education and pedestrian safety to intertwine are not plentiful.

The next SDG that is addressed by ADOT in the 2017 PSAP is SDG 9, which has the mission statement, "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation". Like SDG 4, no sub-sections of SDG 9 directly align with ADOT's transportation-related approach to fostering innovation and building infrastructure that is resilient. It can be claimed that resiliency within transportation systems and infrastructure cannot be achieved without improvements aligning with every facet of the infrastructure. These facets include the physical properties of the infrastructure, in the structures and lighting components, but should also include aspects that are often overlooked for resiliency, including pedestrian safety. Our infrastructure cannot truly be resilient unless the issue of pedestrian safety is addressed and reevaluated. As a result of this notion, ADOT directly addresses SDG 9 within its 2017 PSAP because its pedestrian-focused improvements, whether they be infrastructure-based or education-based, add to the resiliency of future infrastructure. Resilience of infrastructure is proportional to the life cycle of the infrastructure, and ADOT is improving the life cycle of Arizona's transportation-related infrastructure in a unique manner.

An SDG that ADOT's 2017 PSAP directly addresses is SDG 11, which states, "Make cities and human settlements inclusive, safe, resilient and sustainable". SDG 11.2 plays directly into improving pedestrian safety, as it discusses, "provid[ing] access to safe, affordable, accessible

and sustainable transport systems for all, improving road safety". The fact that ADOT addressed past PSAP recommendations, evaluating what their status is, and established new recommendations regarding pedestrian safety directly aligns with improving road safety. Additionally, sustainability can be tied into pedestrian safety improvements, as providing a safer experience for pedestrians will in turn encourage pedestrian activity and reduce vehicle-related emissions.

Recommendations

Sustainability Report

Through the use of the SDG Impact Assessment Tool, 14 goals were established as having correlations with the ADOT 2020 Sustainability Report (SR). The impact analysis employed by the tool separates the goals into three categories: direct positive, indirect positive, and no impact. The tool also has the ability to identify negative impacts, but this was not applied to this analysis. It was determined that the SDGs 3, 6, 7, 8, and 11 are the direct positives, while seven of the remaining goals held an indirect positive impact. The rest of the SDGs were found to have no impact. Given the indirect and no-impact results, this allows streamlining recommendations to be made for the improvement of ADOT's 2020 SR.

As one of ADOT's main project-level goals in the 2020 SR pertains to energy efficiency, as is related to the further adoption of LED lighting and solar energy, it is largely correlated with SDG 7. Developing technology in LEDs has allowed it to surpass HPS performance. As mentioned previously, ADOT is looking to further implement the use of LEDs as opposed to HPS luminaires due to the carbon emission savings and overall service life benefits. Specifically, the latest LED lamps can emit 130-150 Lumen per Watt which is around 1.5 times more efficient than conventionally used HPS lamps. The LED lamps can also be configured to various light distribution patterns that allow for the light to be efficiently distributed to reduce energy waste. Given that LED lamps also majorly outweigh the service life of HPS lamps by a factor of ten, that would reduce electronic waste which is a current

major issue in the modern age. The implementation of new technologies is promptly analyzed by ADOT using LCA and LCCA principles, which is significant to making a shift from the HPS to LED lamps as the initial costs and maintenance costs would need to be considered alongside environmental benefits. The use of the aforementioned analysis tools alongside the Federal Highway Administration (FHWA) INVEST criteria serve as parameters to ensure the shared goal towards targets 7.1 (affordable, reliable, and modern energy services) and 7.3 (improvement in energy efficiency). On a similar note, an opportunity is presented to factor energy efficiency into transportation infrastructure which would allow SDG 9 to become a direct positive correlation instead of indirect positive. Some recommendations on this would be standardizing the use of solar street lighting in the design process, and applying thermal coating to more pavements in dense urban areas. Implementation of these would contribute towards Target 9.4 (increased resource-use efficiency). From a business perspective, these would not seem desirable due to higher initial costs, but application of LCA, LCCA, and INVEST would prove the value of these implementations.

Along ADOT's SR, topics related to SDG number 8 of economic growth and employment, while not directly stated in any of plan, are addressed implicitly. The reasoning behind this is that, regardless of the project's desired outcome, it requires labor in order to be implemented. With that said, considering the economical multiplying effect of construction works for infrastructure improvement, it is recommended that ADOT estimate and consider the labor effects within its sustainability plans, mostly along the lines of SDG 8. This way, the department can better communicate the organization's awareness in terms of human labor, as well as draw eventual improvements for better work conditions.

Although not specifically outlined in the 2020 ADOT's SR, Arizona has become a hub for Autonomous Vehicle (AV) testing and commercial deployment, as companies such as Waymo, Cruise, and May Mobility operate in the state in 2023. With that in mind, there are new implications for vehicle emissions and safety of civilians. ADOT began its journey with

AV technology in 2015, which indicates a direct positive correlation to SDG Target 9.5, which pertains to encouraging innovation and research. Autonomous and connected technology is novel to the transportation industry and brings benefits such as safer mobility. Most companies are developing electric and hybrid AVs, which tend to reduce carbon emissions and greatly align with sustainability initiatives. Not only this, but AVs provide more transportation options for those individuals that have limited mobility. This technology also reduces human error that contributes to life-threatening vehicle collisions. As a whole, it is recommended that AV technology as an innovation should be continuously supported as it ensures safe and accessible transport systems for all with regards to SDG Target 11.2 (accessibility to safe, affordable, accessible, and sustainable transport systems).

Active Transportation Program

By employing the SDG impact assessment tool to analyze the correlation between ADOT's 2017 PSAP and the SDGs, we identify five goals that exhibit direct association. SDGs 1, 3, 4, 9 and 11 are directly related to the PSAP while many of the other seventeen have less relevance. These relevancies and irrelevances indicate room for growth in ADOT's PSAP.

Considering that poverty intersects with nearly every global objective, ADOT implicitly tackles poverty in various areas of the PSAP. While ADOT's plan does not directly address poverty, it makes two recommendations concerning the enhancement of education and infrastructure. While these two considerations indeed focus on enhancing education and infrastructure in low-income areas, it is imperative for the PSAP to address the root cause of the problem. For instance, a few fundamental causes of homelessness include limited housing availability or financial barriers, mental illness, substance abuse, and traumatic events. Recognizing these interconnected issues leads to the conclusion that the state must provide a support system for individuals facing behavioral or financial issues. Though this is an issue that cannot inherently be solved by ADOT itself, it is important that resources are actively being promoted. With that in mind, the team recommends the development of programs for substance abuse recovery, housing availability, employment opportunities,

and mental health resources for the homeless at all buses and bus stops. This promotion should be integrated with the traffic law education system that the PSAP promotes. Addressing homelessness and poverty can contribute to the improvement of various aspects of the remaining SDGs.

The SDG 3 is directly addressed in the 2017 PSAP. The goal's broad objective states "Ensure healthy lives and promote well-being for all at all ages." Because the PSAPaims to reduce the frequency of all pedestrian crashes by 25% by the year 2025, it is directly ensuring healthy lives and well-being for all individuals. Although SDG 3 is directly addressed by the primary objective of the 2017 PSAP, it will still demonstrate some improvement due to the incorporation of substance abuse recovery programs, housing availability, employment opportunities, and mental health resources for the homeless promoted in low-income areas. As previously stated, improving root causes of poverty and homelessness can positively impact all other SDGs even if they are already addressed by the 2017 PSAP.

Within the PSAP, the consideration of SDG 9 is evident. SDG 9 emphasizes the imperative to "Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation." While no specific sub-section of the 2017 PSAP precisely aligns with SDG 9's innovation strategy, it is essential to underscore the multifaceted nature of resilience, encompassing more educational frameworks and physical infrastructure. In addressing resilience in physical structures, ADOT can extend its innovation endeavors to enhance the durability of transportation-related components. This involves the implementation of resilient infrastructure features such as reinforced and weather resistant materials, particularly in critical elements like bus stops and pedestrian crossing areas. In this sense, the team recommends that ADOT integrate key elements like automated traffic monitoring, dynamic signage, pedestrian friendly infrastructure, and emergency communication systems into all bus stops and pedestrian crossings. Integrating sensors and cameras to monitor real-time traffic conditions, along with dynamic signage will ensure a safe and timely passage for pedestrians. Additionally, installing emergency contact boxes at all bus

stops and pedestrian crossings will facilitate immediate assistance during emergencies, and mitigate injuries and fatalities.

The analysis of ADOT's 2017 PSAP using the SDG impact assessment tool mostly identified direct associations with the following five SDGs: 1, 3, 4, 9, and 11. While the PSAP addresses poverty indirectly through recommendations on education and infrastructure, there is room for growth in tackling the root causes of homelessness. To contribute to the achievement of SDG 1 and several others, it is recommended to incorporate proactive promotion of substance abuse recovery programs, housing availability, employment opportunities, and mental health resources at all bus stops and on all buses. The PSAP's direct alignment with SDG 3, ensuring healthy lives and well-being, is commendable, and incorporating additional resources will enhance its impact. Recommendations for SDG 4 and SDG 1 also involve an augmentation of educational programs, emphasizing accessibility and inclusivity for poor communities. Addressing SGD 9's call for resilient infrastructure, the proposal integrated innovative elements like automated traffic monitoring, dynamic signage, and emergency communication systems at bus stops and pedestrian crossings. This holistic approach positions ADOT for a more inclusive and sustainable impact on pedestrian safety.

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Team 2 - Complete Transportation and Border Master Plan

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Overview

Complete Transportation Guidebook

The Complete Transportation Guidebook (CTG) is a comprehensive reference tool designed to ease the integration of sustainable practices into ADOT's transportation planning, scoping, and design. ADOT hopes to shape existing transportation infrastructure to enhance the quality of life in communities throughout the valley. The CTG is a resource for strategies and techniques to be implemented into the life cycle of ADOT projects. Complete Transportation aims to help the ADOT "work smarter, not harder." when it comes to designing the world of transportation. Transportation is not just as simple as moving vehicles, it is about moving people to connect markets and goods. Thus, a natural complete transportation system will work together with nature to align nature with the built environment.

The CTG presents a variety of tools and strategies to improve sustainability throughout Arizona's transportation network. The guidebook focuses on transportation practices such as complete streets, context-sensitive design, land use integration, and green infrastructure as methods for sustainability. The guidebook also highlights a few important questions. What is complete transportation? Why should there be investment in it? How does one plan/design/build complete transportation solutions? When should complete transportation concepts be applied? These questions drive the future implementation of sustainability practices within Arizona transportation.

In essence, complete transportation seeks to increase the health and happiness of the community, reduce the impact on the environment, and allow for growth and accessibility in the local and state economy. By balancing and perfecting these three factors,

communities will have safe and accessible transportation. Taking these principles into consideration, transport systems can be more compatible with the natural environment and reduce pollution emissions, as well as improve the economy on a local and state level

Within its content, CTG named several challenges that Arizona would have while trying to adopt and set up complete transportation. Among them, it is possible to mention the three main ones: funding challenges, evolving travel preferences, and population growth. Nonetheless, aspects like inflation, rapid population growth, and shifting modes of transportation could stall the early application of complete transportation strategies in future project development.

When it comes to benefits of complete transportation, its early adoption tends to promote reduced household transportation costs, increased road safety, efficient land use integration, positive environmental impacts, and increased community health. An example project of a real-world complete transport project is the SR 179 improvements in Sedona Arizona, which integrated complete transportation principles and shows the importance of partnerships and community involvement in project development.

The CTG also encourages early application of complete transportation strategies in project development and outlines seven critical core strategies throughout the project. These strategies are understanding context, establishing, and cultivating partnerships, defining wide-ranging measures of success, proving a full spectrum of project needs and goals, considering a full set of alternatives, planning for all users and modes of travel, and exercising available flexibility in design. The CTG is a valuable resource for ADOT, and community stakeholders involved in Arizona transportation planning and development. Moreover, the CTG is an excellent resource to emphasize and promote both the importance of complete transportation and the strategies involved with the incorporation of sustainable, efficient, and community-driven transportation solutions.

Arizona-Sonora Border Master Plan

Over a decade, there has been an increased amount of travel at the international border between the State of Arizona and the Mexican state of Sonora. The increased travel primarily occurs through nine land ports of entry (LPOE) between the two countries. There has been a rise in the flow of both people and goods through these LPOEs, and this trend is expected to increase as the population and economy along the border flourishes. Over 23 million people crossed the Arizona-Sonora border in 2010, either by foot or in personal and/or commercial vehicles such as buses and freight carriers. The Arizona-Mexico Commission reported approximately $55 million in bi-national trade and $7.3 million in tourism expenditures daily through the nine existing LPOEs.

Developing the capacity and operational capabilities of the LPOEs along with the supporting transportation infrastructure is imperative in alleviating traffic congestion, reducing delays, increasing safety and security, encouraging international trade, and developing a better standard of life for border residents. The Arizona-Sonora Border Master Plan (BMP) is an all-inclusive bi-national scenario designed to coordinate the planning and development of improved traffic operation projects for each of the LPOEs and increase the efficiency of the multi-modal transportation infrastructure with improved accessibility at each port of entry. This BMP is a collaborative venture employing the Arizona Department of Transportation (ADOT), the Federal Highway Administration (FHWA), Secretaría de Comunicaciones y Transportes (SCT), and the State of Sonora, Mexico's government.

The Arizona-Sonora BMP serves as a guideline for better development of efficiency and effectiveness for transportation facilities advocating the demanding social and economic cooperation along the international border. Primary goals consist of development and implementation for finding, prioritizing, and supporting LPOE and related transportation projects. Besides, there is the need for ensuring international stakeholders' involvement during the planning process and ongoing open dialogue among stakeholders to promote coordination for planning and development of the current and future projects.

ADOT, in collaboration with other stakeholders, analyzed long-term transportation infrastructure requirements in Arizona through the Building a Quality Arizona (BQAZ) procedure, resulting in the 2010 Statewide Transportation Framework Study and a sequential Long-Range Transportation Plan (LRTP) better known as What Moves You Arizona. However, it was without regard to the significance of transportation infrastructure improvements for the border region and the many LPOEs. Hence, the Arizona-Sonora BMP was drafted as the agenda for the US/Mexico Joint Working Committee on Transportation Planning with direct involvement from the FHWA and funding from the Coordinated Border Infrastructure (CBI) Program. The FHWA's involvement resembles that of other BMP strategies through the Surface Transportation Environment and Planning Cooperative Research Program (STEP) for other regions in California, New Mexico, and Texas.

Dividing the Arizona-Sonora BMP into three hierarchical areas for evaluation and analyzing transportation system requirements along the international border: Focus Area, Area of Influence, and Regional Area of Influence. The focus Area encompasses approximately 10 miles north and south of the 389-mile Arizona-Sonora international border. With expansions for three major metropolitan areas: Yuma/San Luis, Nogales/Nogales, and Douglas/Agua Prieta. The Area of Influence acknowledges the impact of social and economic development affecting transportation facilities north and south of the border, with emphasis on key corridors. The Regional Area of Influence expands beyond borders requiring coordination with neighboring states' BMPs, such as the California-Baja California BMP (2008) and the New Mexico/Chihuahua BMP.

In conclusion, the considerable increase in travel at the international border between Arizona and Sonora, Mexico over the past decade has shown the obligation of addressing the resulting challenges. With more than 23 million people crossing the border in 2010 and millions of dollars in bi-national trade and commerce, it is indisputable that improvements to the capacity and operational efficiency of LPOEs and supporting transportation infrastructure are vital. The Arizona-Sonora Border Master Plan (BMP) benchmarks a comprehensive bi-national approach to overcoming these challenges, with collaborative

efforts from ADOT, the FHWA, the Secretaría de Comunicaciones y Transportes (SCT), and the State of Sonora, Mexico's government. The BMP summarizes key goals, stakeholder involvement, and a commitment to public outreach and ongoing dialogue to promote coordination and development of current and future projects. This imperative plan considers the social and economic collaborations along the international border. Focusing on improving transportation facilities and accessibility. Through its three hierarchical areas, the BMP concentrates on the transportation needs of the region and the importance of coordinating with neighboring states for a more efficient and prosperous future.

Requirements

Detailed description and discussion of the SDG Impact Assessment Tool Step 2 requirements.

Complete Transportation Guidebook

The ADOT CTGaims to supply direction on how to design transportation systems that better serve the needs of people and communities through the use of, multimodal, contextual, sustainable, and complete design. These considerations, when implemented in transportation projects and systems, contribute to improve Arizona's environmental impact, improve the health of Arizona's communities, improve safety in transportation systems, better integrate transportation systems with homes and businesses, and reduce costs for individuals, businesses, and governments. With this in mind, it is clear that the CTG could have wide-ranging effects on ADOT's future projects, as well as projects outside ADOT if other governing agencies decide to adopt policies inspired by the CTG.

While the CTG has a life cycle of its own, it is more important to consider its impacts on the life cycle of the projects that follow its implementation. Considering the design of the CTG can help ADOT transportation systems provide an easier and more enjoyable user

experience, it is expected that individuals who use the systems can be more satisfied with the systems and use them for longer periods of time. The CTG will also reduce the environmental impacts of future ADOT products, allowing for projects to last longer while producing a smaller impact on the environment. The life cycle of projects will be most significantly affected by the CTG's goals to improve the relationship between transportation infrastructure and existing land uses. That is, if transportation can be designed to positively interact with existing land use and adapt to changes in transportation use and land use, then the life cycle of projects can be improved. A better implementation of multi-modal transportation, as outlined by the CTG, would allow for significantly more adaptability in ADOT's transportation systems, which would also lead to longer life cycles for ADOT's projects. Additionally, The CTG will have impacts on the future maintenance of all ADOT projects.

By considering the application of CTG's principles into every ADOT project, the CTG could be visible in every part of ADOT's transportation systems. As a consequence, the guidelines laid out must be carefully considered in the CTG, to avoid eventual negative consequences if the CTG encourages misguided design. On the other hand, it also means that guidelines in the CTG that have positive effects will generate large beneficial outcomes for all of ADOT's transportation systems, as well as people, businesses, and the environments connected to those systems. With that in mind, CTG will need to be consistently and rigidly implemented in all ADOT projects to ensure that its impact is maximized. The scale of implementation associated with the CTG is variable. It could be applied to the construction of a single new bus stop, a large roundabout in a city center, or the design of a large multi-modal corridor. Moreover, its scale goes beyond pure construction projects as it will be used for transportation planning, and it may be used for education on the methods and goals of complete transportation.

The geographical scope of the CTG covers the entire state of Arizona, given that the CTG is administered in every ADOT project. The sum area of effect of the CTG may also be greater than just the area of ADOT projects as the CTG will have secondary effects on the

transportation systems of counties and cities within Arizona as well. In addition, the geographical scope is not limited to the state of Arizona, as secondary effects like emissions can spread outside the state, bringing the CTG considerably to larger scales. In all practicality, it is best to analyze aspects of the CTG that may have both broader impacts and more local ones.

ADOT's CTG implementation is a long-term process. Transportation construction projects, can take a few years or decades to be completed, so the accomplishment of CTG's goals can take decades. Some of the CTG's goals are more immediate than others. For instance, goals related to negative environmental impacts reduction may be more urgent, and the CTG allows for freedom to prioritize certain objectives over others. While the CTG has some flexibility, it will take a long time for systems to be brought up to the standards presented in the CTG, and for policymakers to fully adopt the goals and suggestions of the CTG.

The CTG can influence ADOT systems to meet our changing and growing needs and a more sustainability-oriented transportation infrastructure. Specifically, the CTG helps to make systems more efficient and adaptable to changing needs of the future in terms of lessening environmental impacts, and improving people's lives. This idea is to reach the goals by adapting how ADOT develops projects, adding more consistency, interconnectedness, and thoughtfulness to the design process. All things considered, the CTG should end up positively affecting the people, systems, natural environments, and built environments surrounding it. Given these goals and the methods, it is clear that the CTG has a strong relationship with the SDGs, which will be more minutely presented along this report.

Arizona-Sonora Border Master Plan

The Arizona-Sonora BMP, completed back in 2013, introduced a new roadway expansion that helps reduce traffic delays, promote international trade between the two countries, and increase security across the border for both pedestrian and vehicle crossing along the roadways. With the increasing number of traffic volumes for vehicles flowing in and out of the state border each year, the number of goods also increases. These values are crucial

for cities along the border, as they increase population and goods along the towns, which grows and builds the community around the borders. The main focus of implementation in the Arizona-Sonora BMP is to have better roadway efficiency and effectiveness along the state border. In order for that to happen, social interactions along the border, the economic side of the project with costs and effectiveness, and the critical interactions are highlighted terms for improvement on this plan.. Along these lines, some BMP goals are to develop a plan for LPOE by promoting it with other transportation services, create a scope of the idea to promote stakeholders (thus being citizens) to partake in the LPOE with improving infrastructure all along the state border, create more knowledge of LPOE's and spread the news along both sides of the border to promote more stakeholders, and to coordinate with other stakeholders on future projects that are focused solely on LPOEs. From these goals, there needs to be assumptions made for each one of them, which are the first step from the SDG Impact Assessment Tool that are introduced.

Scale of implementation is found in the SDG guidelines. For the Arizona-Sonora BMP, an Implementation Monitoring Committee considered and used for the nine LPOE's along the state border. Having this committee is absolutely crucial to assessing each of the state borders and to deciding if new infrastructure or design needs to take place. This helps decide what problems might need reporting. This committee is more of a guided type of resource to where every piece of information about certain types of material or objects is written and kept into a report to become well organized. Each state border should have a committee member, to where they all come together to address which LPOE is in the most need of improvement and the reason based on the notes taken down.

The geographical scope of the Arizona-Sonora Master Plan is written as two distinct types of studies. The first being the "Focus Area" and the second being the "Area of Influence" For the focus area aspect, this scope narrows down the earlier transportation design projects and the rewards credited to those projects. It is especially important to scope out what the cities are proposing to design and the awards being issued to these projects. The awards that are issued to the cities and ADOT are also awarded based on the project scope of each

project. For the earlier projects, the project scope categories were ability, pavement preservation, transportation enhancement and fencing. Graphs shown in these scopes with the number of scopes awarded in the earlier projects and the total cost of the scopes. Taking this into account, the Arizona-Sonora Master plan's focus area will be through the ability of how many vehicles and pedestrians are able to cross the border while supporting the traffic flow to a steady state. With the expansion of traffic lanes for each LPOE along the border, also highlighted is an area of a main point in the economic standpoint too.

The area of influence is proportional to the focus area by only narrowing the highways and roadways south (the I-8 and I-10) and west towards the New Mexico state line. By ranging down the location of earlier projects, it helps show the distribution of awards given based on freeways. Awards from the projects are also given economically for each scope, showing which scopes are more valued under the specific area of influence. For the Arizona-Sonora Master Plan, the scope that was given the highest rewards is the ability. Presented with all of the awards from the project, shown that the project had completed in 2013. Having a timeline of 3 years for the project to be completed, the project was divided into combined project scores. Keeping in mind the earlier projects that used the model of the scores, it helps show the Arizona-Sonora project the importance of specific areas. This creates an improvement on the timeline, as the execution of the LPOE's builds off better infrastructure and life-cycle durations of each project for the LPOE's.

Findings

Complete Transportation Guide

The Arizona Department of Transportation's CTG is a reference tool for integrating sustainable practices into all ADOT transportation planning processes. The SDG subsections which are considered to be relevant to the ADOT CTG are listed below; how the SDG listed is connected to the CTG is explored within each listed subsection.

1.4 Equal Rights to Ownership, Basic Services, Technology, and Economic Resources

The CTG directly prioritizes enhanced mobility choices, safety, and economic opportunities for all users.

1.5 Build Resilience to Environmental, economic, and Social Disasters

The CTG highlights its goal to support public priorities such as community and the environment.

3.6 Reduce Road Injuries and Deaths

The CTG outlines how a less car-focused and more pedestrian/cyclist-aware transportation network will lead to reduced conflicts between modes of transportation and less injury and death.

7.3 Double the improvement in energy efficiency

The CTG's plan to diversify Arizona's transportation infrastructure will lead to an increase in the use of more energy-efficient modes of travel, such as walking, cycling, buses, trains, etc. all of which are more energy-efficient per person than car-based travel.

8.1 Sustainable Economic Growth

The CTG's plan has a direct impact on the local and state economic growth but needs to be addressed further in more detail.

8.2 Diversify, innovate, and upgrade for economic productivity

The CTG emphasizes that an improved transportation system will help communities as it will create greater access to services, jobs, and walkable destinations.

8.3 Promote policies to support job creation and growing enterprises

The CTG's plan shows that an abundance of transportation options leads to lower household transportation costs. These lower transportation costs free up resources to meet other daily needs.

8.4 Improve resource efficiency in consumption and production

The CTG states that roadway expansion can be a viable option. Complete transportation would improve the efficiency of the existing system and integrate more responsible land use. More responsible land use would foster an increase in resource efficiency.

9.1 Develop sustainable, resilient, and inclusive infrastructures

A more modally diverse and well-integrated transportation system that relies on clean energy or no outside energy, dependent on the mode of transportation, will inherently be more sustainable, resilient, and inclusive, given that a system of this description would be more efficient, more expansible, and more accessible.

9.4 Upgrade all industries and infrastructures for sustainability

The CTG will lead to a more energy-efficient transportation network that burns less fossil fuels and has a lower environmental impact for every mile traveled by any given individual. The adoption of clean energy by systems implemented according to the CTG will need to be explored further.

11.2 Affordable and sustainable transport systems

The CTG's plan to diversify Arizona's transportation systems and provide better access to essential services will reduce the cost of transportation for everyone, creating a direct positive impact on the affordability of transportation systems.

11.3 Inclusive and Sustainable Urbanization

Inclusive and Sustainable Urbanization requires that transportation systems be widely and easily accessible, in space and monetarily, diverse enough to survive catastrophic failures in transportation systems, and well-integrated into urban environments. The CTG will have a direct positive impact on the inclusivity and sustainability of urbanization in Arizona.

11.6 Reduce the environmental impact of cities

The CTG outlines how the reduction of motor vehicles and the growth of walking and cycling will lead to a reduction of emissions produced by Arizona's transportation systems, leading to the reduction of Arizona's environmental impact on the world.

11.7 Provide access to safe and inclusive green and public spaces

While the CTG does not directly contribute to the growth, construction, or design of safe and inclusive green and public spaces, it is demonstrable that a more accessible and more efficient transportation network will give individuals more access to green and public spaces.

11.A Strong national and regional development planning

The CTG outlines how its complete transportation approach leverages partnerships to other solutions. These partnerships increase the public's trust in ADOT and its agency partners in the planning and development process.

12.2 Sustainable management and use of natural resources

The CTG inherently addresses the need for sustainable management when it comes to the overall scope of transportation. Sustainable management will only come into play when natural resources are conserved in the natural environment.

Arizona-Sonora Master Plan

TheArizona-Sonora BMP is a guideline for the development of transportation facilities along the Arizona-Mexico international border. The SDG subsections which are considered to be relevant to the ADOT BMP are listed below; how the SDG listed is connected to the BMP is explored with each listed subsection.

3.6 Reduce road injuries and deaths

The BMP outlines a dedicated pedestrian/cycle path which will reduce vehicular/pedestrian injuries. As well as improving the transportation infrastructure at the border to improve efficiency during crossings for commerce and tourism.

6.5 Expand water and sanitation support to developing countries

The BMP intends to improve the supplied water as well as restrooms at the new facilities. These improvements will assist in supporting the employees as well as the travelers.

7.1 Universal access to modern energy

As with the water and sanitation, the BMP will supply power and data to the new facilities. Providing power and data this will assist the staff's ability to process in a timely and efficient manner.

8.1 Sustainable economic growth

With the improvement of the infrastructure and facilities, this will promote a more efficient and economical means of transporting goods. This may also present greater development in economic growth for the freight industry.

8.4 Improve resource efficiency in consumption and production

This program would promote Mexican companies to import better machinery and raw supplies. This production would then allow these companies to re-export the product without an incurred import cost.

8.A Increase aid for trade support

The increase in efficiency and flexibility for crossing through the border either by truck or train will further aid in trade support. The ability to increase the processing capacity will be heavily dependent on the improvement to the transportation infrastructure.

9.1 Develop sustainable, resilient and inclusive infrastructures

Implementation and development of sustainable programs and policies awarded this project with a certification from the Border Environmental Cooperation Commission (BECC) as well as funding from the North American Development Bank (NADBank).

9.A Facilitate sustainable infrastructure development for developing countries

Improvements, expansion, and modernization have all aided in the development of sustainable infrastructure. By increasing the efficiency of the time it takes to pass through the order this will then reduce vehicle idle times while queued for security measures.

12.2 Sustainable management and use of natural resources

Measures are taken into account for the potential disruption of the natural environment. With an approximative effect on the air quality, parks, and/or wildlife areas.

Recommendations

Complete Transportation Guidebook

The goal of the CTG to implement broader, more interconnected, and more modern transportation systems has a significant positive impact on many of the SDGs. Still, there are some SDGs that are relevant to the CTG and are not sufficiently addressed by the CTG.

Goal 1 of the SDGs seeks to ensure that worldwide poverty and its effects are reduced. The CTG could better address this SDG with some modifications. The CTG's planned implementation of better walking and cycling will provide better access to essential services and everyday needs for poorer and underserved Arizona residents. In its current state, these problems are only addressed indirectly, but the CTG should more directly outline how systems should be designed with accommodation in mind. The CTG currently includes some language about how senior citizens, those with disabilities, and children would benefit from changes brought forth by the CTG. In order to provide a better understanding of how underprivileged people can be better served by complete transportation, the CTG

could describe how systems should be designed to minimize the cost of transportation for individual users, with monetary and time costs in mind.

The CTG does an excellent job of highlighting future plans and goals. However, the CTG lacks when it comes to addressing the entire cost of implementing its vision of better transportation. These costs should be more transparent, along with how these projects will be funded from the state and local levels. The CTG addresses how costs would be reduced throughout households. However, it does not fully explore how the full implementation would benefit the economy at the state and local levels. Improved mobility and decreased costs generated by the implementation of the CTG would increase the spending of people who participate in the Arizona economy, which would produce economic benefits for governments and businesses. This is left unaddressed by the CTG, so it would be beneficial for the document to explore these ideas, granting readers a better understanding of the driving forces underlying the CTG.

Many of the issues discussed in the SDG including community health, the needs of impoverished people, access to safe green and public spaces, etc. are heavily impacted by both transportation and urban planning. Hence, the CTG could include more guidance on the integration of these aspects of planning if the CTG is going to last.

The CTG discusses how all modes of transportation must be thoroughly considered when transportation infrastructure is being designed and constructed, however, it is also important to consider, for example, how pedestrian transportation corridors should be implemented alongside pedestrian-focused and safe public spaces. Thus, the CTG should also include information about how complete transportation should be implemented alongside urban and suburban planning in order to create communities that provide for maximized access and mobility of a place's citizens.

The CTG explores how a greater focus on multi-modal transportation infrastructure would lead to a reduction in the use of private motor vehicles, which would reduce the environmental impact of fossil fuel usage. It is recommended that the ADOT CTG include

more information about how electric vehicles such as electric buses, tram cars, etc. can be combined with renewable energy. This would allow the scope of the CTG to cover the sustainability of ADOT's overall transportation systems.

In conclusion, the CTG for Arizona stands out as a well-crafted and comprehensive document that addresses the current transportation challenges in the state of Arizona. The CTG is filled with strategic recommendations with a clear presentation that contributes to a thorough understanding of the existing transportation landscape in the state. In order to improve the effectiveness of the document, a few changes could be made, specifically in articulating the future goals the document outlines for Arizona. The document could better engage all readers and stakeholders by providing a more visionary and detailed roadmap. This change would foster a shared understanding of Arizona's overall transportation aspirations. The CTG does serve a solid foundation overall, however, the adjustments mentioned above would significantly improve its capacity to guide Arizona into a more efficient and sustainable transportation era.

Arizona-Sonora Master Plan

From using the SDG assessment tool for the Arizona-Sonora Border Master Plan, we can identify which goals were set as direct impact and indirect impact. For the BMP, there were half of the goals that have a direct positive impact on the project. While the other half of the goals did not have as much relevance on the BMP. The five goals that were highlighted as relevant embrace the following targets: 3.6, 6.5, 7.1, 8.1, 8.4, 8.A, 9.1, 9.A, and 12.2. These goals are directly and indirectly related to the BMP document, while the rest of the goals were excluded from the document and did not seem to be relevant enough in the BMP.

The first target that has a direct positive impact is reducing road injuries and death (3.6). In the BMP, safety is one of the most important topics that is focused when dealing with this goal. ADOT directly provides both pedestrian and vehicular safety as well as providing state funding sources to ensure this goal is achieved. These sources will provide roadway

maintenance and enforcement of vehicle safety. Knowing that the root cause of this goal is found by traffic delays, this solution can help enhance both pedestrian and vehicular safety, which then advances efficiency in the transportation infrastructure. Although the goal is directed, a recommendation that would expand this goal is visualizing the safety numbers of both vehicular and pedestrian safety on a number scale. It would ensure an image that allows the public eye to be alongside this proposed BMP.

Another direct positive impact goal from the BMP is addressing the development of the infrastructure (9.1) and implying that the infrastructure for the LPOE's are sustainable throughout the developing countries (9.A). The Arizona-Sonora BMP's main goal is to provide a transportation infrastructure that improves both efficiency and effectiveness for all LPOE's. Creating the new infrastructure through the BMP while also creating a fast, efficient, roadway to enhance less traffic delays are relevant in this project. However, some recommendations that could be used include implementing traffic signals, pedestrian walkways, etc. Providing pedestrian and vehicular safety is important from the BMP, so being on the conservative side of safety would always be important.

The last direct positive impact on BMP is associated with the LPOEs is the sustaining management of the natural environment. An important topic when considering any new infrastructure design is the environmental aspect of it, as well as the possible effects the BMP will have towards air quality, parks and natural wildlife. In the BMP, air quality, parks, and wildlife are evaluated and categorized by a point scale. This highlights what key sources are being interrupted during the new infrastructure development and in what ways the BMP is disrupting the natural environment. A recommendation to help with this goal is to reevaluate each aspect of the natural environment and maintain an alternate solution to ensure that no wildlife is harmed while building the new infrastructure.

Expanding water and sanitation support (6.5) to developing countries is one of the indirect positive impacts that is implied in the BMP. This idea has an indirect impact, as the main

focus of the expansion of the LPOE's and the transportation infrastructure, leads to a focus on providing sanitation support towards the public due to the increasing traffic volume. To help expand this goal, finding ways to sustain stormwater or conserving water from sanitation support areas can lead to less economic costs yearly in water. Creating more ways to conserve water leads to increasing spending in other departments within the BMP.

Similarly to expanding water and sanitation support, supplying power and data as well as sustainable economic growth (7.1 & 8.1) to new facilities is also an indirect positive impact that is implied in the BMP. One way to better promote this goal is to enhance the public eye about the new infrastructure of the BMP through articles, television, school systems, etc. Directly promoting the LPOEs can lead to higher traffic volumes, which leads to higher population growth and, consequently, to better efficiency in the transportation industry for goods and services. Thus, it helps to grow the freight industry for future companies and the economy. Having sustainable energy sources and promoting the public eye can lead to infrastructure improvements and expand BMP's scope and positive impact.

Similarly to targets 7.1 and 8.1, improving resource efficiency in consumption and production (8.4) and increasing aid for trade support (8.A) are indirect impacts from the BMP. Considering that the project will promote the public view of the BMP to increase traffic flow, there will also be an addition to the BMP's goals to increase efficiency in roadways.

In conclusion, the BMP sets many goals for the border of Arizona and Sonora. The document holds a lot of information that is directed to improving the future goals of the project by clearly stating the steps to further enhance these needs. ADOT provides tons of graphic information that can help the audience visualize what problems are occurring and what new solutions can be made from this. However, there are some ways in which the BMP can increase the impact on certain goals that were missed or had an indirect impact.

All of these efforts can lead to the next steps of future innovation in infrastructure and traffic engineering.

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Team 3 - Operationalizing Sustainability and Aviation

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Overview

This section summarizes the main ideas exposed within two relevant Arizona Department of Transportation's (ADOT) documents regarding the topics of Operationalizing Sustainable Transportation and Aviation System Plan. To do that, the group made use of two main sources, which are the Operationalizing Sustainable Transportation section in ADOT's 2nd Sustainable Transportation Program Final Report, and ADOT's State Aviation System Plan (SASP) Update Report.

Operationalizing Sustainable Transportation

The maintenance and operation of a strong, financially advantageous transportation network depends critically on more effective resource planning and prioritization, as acknowledged by ADOT. ADOT uses methods for continuous improvement in an effort to invest resources wisely and to get the best return possible. The importance of a well-balanced use of economic, social, and environmental resources is at the center of the three main tenets of sustainability. Theoretically, this will enable the achievement of all project demands and objectives while ensuring appropriate budget utilization. With that in mind, ADOT is strategically investing in a sustainable transportation program, integrating it into core activities like planning, design, and construction. Accordingly, over the past few years, they have moved from implementation to operationalization, scoring a platinum rating in some sustainability evaluations. ADOT links sustainability with NEPA (National Environmental Policy Act). This program reflects their commitment to evolving established processes.

Since 2011, ADOT has participated in the INVEST implementation program and the FHWA Sustainable Highways Program. These platforms were utilized to evaluate and improve sustainable practices. They implemented the INVEST module for Operations and

Maintenance in 2015. It has always been a challenge to integrate a sustainable transportation program across the entire state, but despite this complexity, ADOT presented its initial sustainability experience in 2015. This showed significant progress in understanding and implementing sustainability in transportation systems. The implementation of sustainability measures by ADOT has been facilitated by the engagement of executive management and an organized strategy that adheres to the values of compromise and deliberate decision-making. ADOT's Sustainable Transportation Program achieved success through the efforts of key champions, possessing skills in global sustainability, resource management, project delivery, and consensus building. These individuals were crucial in reaching milestones such as Universe of Variables and Executive Management, with their absence potentially jeopardizing the program's existence. The Universe of Variables milestone involved reviewing widely accepted sustainability rating systems and conducting internal engineering and technical outreach. This process ensured a collaborative effort, breaking down silos within ADOT and incorporating diverse expertise. The Milestones Framework, outlining the program's development, emphasizes the importance of champions, recognizing existing actions, and documents prior to its framing.

ADOT's Sustainable Transportation Program thrives on strong executive management partnerships and outreach. Some notable achievements include the context-sensitive solutions (CSS)-driven rehabilitation of State Route 179, helping improve safety, reliability, and community engagement. Collaboration with FHWA, especially through the INVEST program, has propelled ADOT into a national leadership role. Their involvement as a pilot agency and contributions to INVEST enhancements highlight a commitment to advancing sustainability in transportation projects. Internal activities, such as SEO briefings, the Design Excellence Award Program, and collaboration with Local Public Agencies, MPOs, and COGs, showcase ADOT's dedication to fostering a sustainability culture. Participation in national conferences, university collaborations, and the release of the First Annual Sustainability Report have elevated ADOT's profile as a sustainable transportation leader. Beyond achieving the initial thirteen milestones, ADOT continues to operationalize the program

through the development of Operational Focus Areas (OFAs). These OFAs align with agency goals, FHWA initiatives, and broader sustainability principles. Looking forward, ADOT explores sustainability policies, resilience initiatives, and strategies to address climate-related challenges. Their sustained efforts reflect a comprehensive approach to integrating sustainability into transportation planning, design, construction, and operations.

Aviation System Plan

The State Aviation System Plan (SASP) Update for Arizona embarked on a mission to assess the current condition of the aviation system in the state, outline future requirements, and formulate priority recommendations to guarantee that Arizona's airports can continuously adapt to the ever-evolving needs of the public. This strategic plan was steered by a diverse Project Advisory Committee (PAC) encompassing a spectrum of stakeholders, including representatives from Arizona airports, the ADOT, the Federal Aviation Administration (FAA), aviation enthusiasts, businesses, military entities, Tribal communities, and local- and regional-level planning organizations. As it is possible to see, inclusivity was a core principle, and three public outreach workshops were held to gather input and engage the community.

The aviation history of Arizona, from its early flights to its current role as an economic powerhouse, vividly demonstrates its role in the state's growth and prosperity. Arizona boasts a total of 67 publicly owned, public-use airports that support flight instruction, uphold safety and security, fuel the tourism industry, and provide a foundation for the aerospace and defense sectors. Recognizing the profound importance of the aviation system, ADOT took the initiative to commission the 2018 SASP Update to evaluate its capacity to meet current and future demands. The SASP Update set forth a vision and established key goals for the system, including areas like safety and security (to maintain safety and security with applicable standards), fiscal responsibility (cost-effective investment strategies) and economic support (promote Arizona’s growth and development).

The report also introduces indicators for aviation activity, focusing on enplanements, operations, and the number of based aircraft. Furthermore, the SASP Update implemented

a system performance assessment by introducing performance measures and system indicators. These metrics established a foundation for evaluating the system's capabilities to meet both existing and future demands. In this sense, the SASP Update provides future performance targets for each one of the performance measures and system indicators, which are classified within the goals of safety and security, fiscal responsibility and economic support. In total, there are 16 performance measures and 10 system indicators.

For instance, within the safety and security goal, enhancement encompassed the safeguarding of land use, which has as a target measure of reaching 100% of airports with surrounding municipalities with zoning control in the airport environments. Other performance measures such as capability of supporting medical operations, as well as existence of clear approaches to primary runway ends are also considered.

In the fiscal responsibility goal, the report highlights the preservation of runway pavement, encompassing performance measures associated with a Pavement Condition Index (PCI). The target for that is to make 97% of the airports with a primary runway PCI of 70 or higher up to 2036 as opposed to 64% in 2018. Other metrics are also worth mentioning, like the percentage of population within 30 minutes of an all-weather runway (target of 93%), and the percentage of airports with a primary taxiway PCI of 70 or greater (target of 97% as opposed to 55% in 2018).

In terms of economic support, an important performance measure is the percentage of airports with availability of continuous 24/7 fuel services, which has the target of reaching 76% by 2036, as opposed to 63% in 2018. For each one of the goals, the SASP Update brings key action improvements that are ADOT’s focus to achieve the proposed targets. For example, to foster economic growth, there is the consideration of addressing policy hurdles that eventually limit funding opportunities for revenue-generation projects.

Furthermore, the report’s summary of needs pinpointed a requirement for nearly $8.7 billion in funding to address anticipated demands through 2037. This budget includes $3.4 billion earmarked for maintaining the current infrastructure and an additional $5.3 billion allocated

to expand capacity in case of heightened future demands. Plan implementation and policy recommendations are also outlined, apart from the focus on continuous improvement of data and development of relevant studies. In conclusion, the SASP Update in Arizona sets the stage for an all-encompassing framework to develop and enhance the state's aviation system. The plan highlights the necessity of collaboration, ongoing data monitoring, and a capacity for adaptability to meet the evolving needs of Arizona's aviation sector.

Requirements

This section aims to provide the group understanding of the aspects related to the Step 2 of the SDG Impact Assessment Tool in terms of the topics summarized so far.

Operationalizing Sustainable Transportation

To realize the objective of ADOT's operationalization of sustainable transportation, several key requirements must be addressed. First, comprehensive planning and policy development are essential, as well as setting clear sustainability goals. Secondly, investment in modern technology and data-driven solutions is crucial for optimizing transportation systems, reducing emissions, and enhancing efficiency. ADOT should also prioritize public engagement and education to encourage sustainable commuting choices and raise awareness about environmental impacts. Additionally, fostering collaboration with local municipalities, private sector stakeholders, and regional partners is necessary to develop integrated, multimodal transportation networks that prioritize sustainability. Finally, ongoing monitoring and assessment of sustainability performance will help ADOT make informed decisions and continually improve its sustainable transportation efforts.

ADOT additionally has dependencies in this objective. ADOT uses methodologies from the Federal Highway Administration (FHWA) and has derived its Sustainable Transportation Program from tools created by other agencies. These externally sourced systems constitute dependencies for realizing the object.

The ADOT sustainable transportation plan assumes that ADOT is confined to key focus areas laid out in the Arizona ADOT Sustainable Transportation Program. These areas include solar lighting, alternative pavement types, freight mobility, use of EDC initiatives, accelerated construction techniques, post construction BMP installation, integration of modeling techniques for mitigating environmental damage, consideration of alternate materials (to pursue end-of-life and reuse plans), and stakeholder involvement. These assumptions aim to decrease greenhouse gas emissions, improve transportation quality, and reduce the environmental impact of transportation. The plan pertains to the UN SDGs, primarily SDG 11 (Sustainable Cities and Communities) by fostering accessible, efficient, and eco-friendly transportation within urban areas. Furthermore, it aligns with SDG 13 (Climate Action) by reducing carbon emissions and mitigating climate change's adverse effects, ultimately promoting a more sustainable and environmentally responsible transportation system.

ADOT's sustainable transportation program incorporates a life-cycle perspective, considering the entire lifespan of transportation systems and infrastructure. This approach encompasses planning, design, construction, maintenance, and eventual decommissioning or replacement. It evaluates the environmental, social, and economic impacts at every stage. By doing so, the program aims to reduce long-term environmental and social costs, enhance resilience, and maximize infrastructure longevity. This perspective also promotes sustainable materials and construction techniques, which align with UN SDG 9 (Industry, Innovation, and Infrastructure) and SDG 11 (Sustainable Cities and Communities), as it contributes to the development of more efficient, resilient, and environmentally responsible transportation networks.

The operationalization’s focus is statewide, concerning all of ADOT’s coverage in the state of Arizona. The program extends to the ten areas of focus laid out in the previous section. This list of OFAs provides a scope of the issues considered by the program while the institute of ADOT considers the scope of the application of the program. It is additionally worth acknowledging that according to the ADOT Sustainable Transportation Program key focus areas, some geographical areas may be prioritized over others as some areas may require

more servicing than others to achieve the goals of sustainability. In the same vein, some OFAs from the program's key focus areas may have more scale of implementation than others.

The geographical scope of ADOT's sustainable transportation program consists of the state of Arizona, encompassing its diverse landscapes and communities. This includes urban areas like Phoenix and Tucson, as well as rural regions. ADOT's sustainable transportation initiatives also aim to address the specific needs and challenges of these different geographical areas. Overall, the program aims to create a comprehensive, state-wide framework for sustainable transportation that aligns with local conditions, contributing to improved mobility and environmental outcomes within Arizona.

The ADOT Sustainable Transportation Program does not provide a strict timeline for achieving its objectives. However, some context can provide approximate deadlines and timelines. The program initialized in 2014 with ADOT's national conference and webinar participation. In 2016 the Sustainable Transportation Program put out a revised consideration list in line with INVEST 1.2 which laid out the focus areas previously enumerated in the report.

For a future timeline of events, the primary deadlines come from the UN SDGs which the ADOT Sustainable Transportation Program intends to abide by. The majority of the UN Sustainable Development Goals are modeled around a timeline extending to 2030, making many of the program's goals into a 15 year timeline. The long-term nature of sustainability planning necessitates strategic planning, ongoing project implementation, and continuous monitoring and evaluation.

Aviation System Plan

There are necessary requirements to put the State Aviation System Plan (SASP) in place in order to serve the needs of locals, visitors, and companies into the foreseeable future. In summary, there are three SASP goals: Safety and Security, Fiscal Responsibility, and

Economic Support. To achieve them, all airports should adhere to certain regulations, especially those pertaining to safety and security, and, depending on the classification of the airports, different targets are assigned to them. With that in mind, SASP breaks down each goal in different measurable targets, which also have a time frame to be accomplished.

Given the magnitude of the State Aviation System, several institutions take part in decision-making processes and have important leverages to make the achievement of targets possible. So, some dependencies of this plan include collaboration with ADOT, Project Advisory Committee (PAC), Federal Aviation Administration (FAA); aviation enthusiasts; businesses; military members; Tribal communities; and local- and regional-level planning organizations. Thus, ADOT is required to manage eventual existing constraints when it comes to aviation operation and improvement imposed by general plans of local governments, like Runway Protection Zones (RPZs). For instance, within the safety and security goals, one of the important metrics is related to complying with zoning control in surrounding municipalities of airport environments. Moreover, the means utilized by ADOT to make SASP a reality should necessarily consider meeting the existing and future demands for aviation in Arizona.

Additionally, due to the number of measurable targets proposed by SASP, it is important that ADOT keep regular assessments of the improvements as time goes by. Also, financial needs must be considered. Through 2037, around $8.7 billion will be required to meet the projected future demands on the Arizona aviation sector.

Assumptions for this plan can be seen in terms of the possible limitations for this assessment. There are different actions within the plan where each airport in Arizona is assigned a label. Those labels include: Commercial Service-International, CS-National, Reliever, General Aviation-Community, GA-Rural, and GA-Basic. These classifications come from criteria defined by ADOT, and assessing all the different categories of airports could lead to extensive results. So, for means of simplification to run the assessment, it is considered the pursuit of the targets of Commercial Service-International and Commercial

Service National airports in Arizona. Because these airports are associated with the most ambitious targets and carry the main operations within the state, it seems reasonable to assume them as a good representation of the picture of aviation sustainability in Arizona, in the scope of SASP.

Also, it is considered that improvements over aviation infrastructure, mostly improvements of airports, will be done over the next years and decades with the same construction patterns observed nowadays. Accordingly, aspects such as availability of fuel services are assessed through the consideration of the current most used fuels, not envisioning a transition to biofuels or other more sustainable propelling technologies, for example, since there is no information in this regard along the SASP report. Moreover, since there is a prospect of increasing demand for commercial flights within Arizona, also as a result of population increase in the urban areas in the state, the assessment considers eventual amplifications of positive or negative impact of aviation operations within the time frame of the plan. For instance, ADOT sees that over the next 20 years, Arizona's aviation industries will improve, as the population is expected to grow statewide along with the Gross Regional Product (GRP) by nearly 60 percent. The increasing demand for aviation services, there should be long-term benefits, that are also considered in the assessment.

When it comes to life-cycle perspectives, it is seen under the goal of Fiscal Responsibility, an indicator listed, as mentioned prior, was PCI. One of the biggest capital investments an airport makes is maintaining the pavement, which is essential to the efficient and safe operation of aircraft. Airport pavements are rated using PCI, which allows for the planning and execution of maintenance and repairs at the right points in the pavement's lifecycle. This was designed to incorporate the performance and maintenance of pavements along their whole life cycles.

Due to the scale of the plan, the implementation of the Aviation System Plan is statewide, encompassing all Arizona aviation systems (67 public-use airports). This will enable the aviation system to cater to the demands of residents, tourists, and companies. The long-term

strategic plan for Arizona's aviation system is contained in the SASP Update. As a result, PAC and the ADOT Aeronautics Group also have a vision statement that highlights the necessity for airports to be progressive, adaptable, and representative of Arizona's varied constituents, which is an important consideration for the assessment. System goals were then created with this vision as its foundation in order to give the framework for assessing the system's overall effectiveness, highlighting its accomplishments, and pointing out areas that needed improvement.

The Aviation plan includes help and guidance from ADOT, the PAC, and the FAA. Because the FAA is involved, the geographical scope can be indirectly expanded. As mentioned prior, the 67 publicly owned, publicly used airports that make up the Arizona aviation system are the mainstays of the state's aviation industry today. These airports support statewide safety, security, and resilience; enable Arizona to be among the top states in the nation for flying training; and serve as the backbone of the state's tourist sector, which is the state's main source of income. Moreover, Arizona's airports sustain over 1,200 aerospace and defense businesses based in the state and play critical roles in the country's armed forces.

The Aviation System Plan then sets planning directions for a 20-year horizon, starting in 2018. Another focus of the Aviation System Plan was to assess the capability of the current system in meeting the future aviation demands through 2036. Through 2036, the capacity of the current airport system to accommodate present and future aviation demands was thoroughly evaluated by this integrated planning effort. Another time frame to consider is the timeline of future aviation demands. The baseline being 2016 and the forecasts of 2026 and 2036 of Commercial Service and General Aviation.

Findings

Operationalizing Sustainable Transportation

This section exposes the findings obtained from the use of the SDG Impact Assessment Tool to assess ADOT's Operationalizing Sustainable Transportation. Figure 1 shows a summary board with the results per SDG, which are further described below.

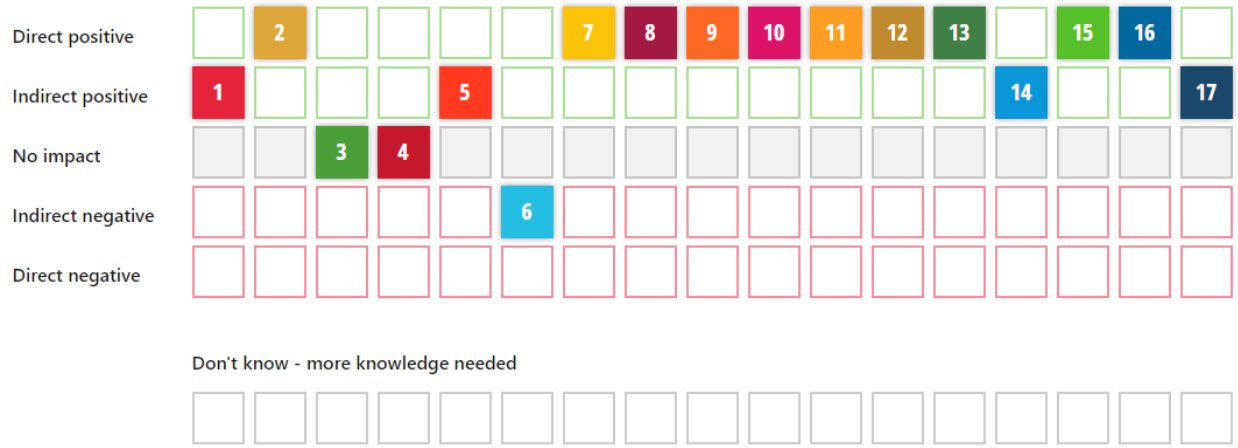

Figure 3.1 - Results board from the SDG Impact Assessment Tool - Operationalizing Sustainable Transportation

1. No Poverty

Operationalizing sustainable transportation can increase the transport of food and water to more resource-scarce areas, which can promote a more healthy and thriving population. In this way, the Sustainable Development Goal (SDG) of No Poverty can eventually become **positively indirectly impacted** by the operationalization of sustainable transportation. ADOT's commitment to sustainable transportation indirectly supports this SDG by promoting economic development, balanced resource utilization and community involvement. Through effective resource planning, job creation, and community engagement. ADOT's initiatives contribute to long-term strategies aligned with poverty alleviation efforts.

2. Zero Hunger

Operationalizing sustainable transportation will expedite and increase the ability to transport food resources to hungry and food-insecure areas, which will **positively directly impact** the Sustainable Development Goal (SDG) of Zero Hunger. As mentioned earlier in

the previous SDG, operationalizing sustainable transportation will help the community create jobs, increase utilization and sustainable resources, and increase community engagement. By advocating for sustainable practices and policies, ADOT contributes to broader initiatives that can positively impact agricultural policies, improving food production and distribution systems on a national scale.

3. Good Health and Well-Being

Operationalizing sustainable transportation will not have significant impacts on any of the premature deaths that fall under this category. While ADOT's work in transportation can help reduce premature deaths due to traffic accidents or construction-related deaths, these are minimally connected to diseases, substances, or chemicals. This program will have **no impact** on this SDG. It is essential to note that the primary focus is on sustainability in transportation, and the health-related impacts are not explicitly related. There are certain projects mentioned that might involve more community involvement, projects like the context-sensitive solutions-driven rehabilitation of State Route 179, that emphasize on community engagement. However, while this may contribute to community well-being, it does not explicitly discuss health outcomes such as improvements in healthcare accessibility or reductions in disease or even death. ADOT's sustainable transportation goals may indirectly contribute to community well-being and economic development, but it does not provide explicit details on how these efforts directly impact health outcomes.

4. Quality Education

While the program primarily focuses on environmental and sustainability goals, it doesn't directly address quality education. Potential indirect positive impacts on education could arise through improved community health and awareness. However, the program does not have information on educational initiatives, suggesting a limited direct impact on quality education. Any influence on education would likely be indirect and would depend on the broader societal and environmental effects of the transportation initiatives. For the sake of this assessment, it is considered that this SDG is **not impacted**.

5. Gender Equality

Operationalizing sustainable transportation and gender equality aligns with broader societal goals of inclusivity, social responsibility, and well-being, thereby **indirectly positively** supporting the objectives of the transportation program. The engagement of key champions with skills in global sustainability, and consensus building indicates a commitment to diverse expertise. This inclusivity can contribute to breaking down gender-related barriers in traditionally male-dominated fields, promoting gender equality in the workforce. The focus on community engagement, as exemplified by projects like the context-sensitive solutions-driven rehabilitation of State Route 179, can empower local communities. Engaging women in the decision making processes related to transportation projects can lead to more gender-inclusive outcomes, addressing gender disparities in community development. And lastly, the commitment to skills development and job creation, particularly through the engagement of key champions, can provide opportunities for women in fields traditionally underrepresented by females. This aligns with SDG 5 by promoting equal opportunities for women in the workforce.

6. Clean Water and Sanitation

There are potential negative indirect impacts related to construction activities and resource utilization that should be carefully managed to ensure alignment with the goal of clean water and sanitation. Therefore, the overall impact is likely to have **indirect negative** effects, emphasizing the importance of sustainable and environmentally responsible practices in transportation planning and implementation. Transportation projects that involve heavy construction can contribute to soil erosion, sedimentation, and runoff, potentially leading to water pollution and impacting water quality in nearby rivers or streams. Particularly in water-sensitive areas that can potentially alter natural drainage patterns. This alteration can potentially lead to increased runoff, affecting the quantity and quality of water in the surrounding environment. Although there can be beneficial aspects to why having a more

sustainable transportation system may impact a healthier environment in the future, the process of it requires heavy construction to do so.

7. Affordable and Clean Energy

Operationalizing sustainable transportation is constituted by efforts to improve sustainability and use of clean energy, and thus research in this field will have a **direct positive** impact on clean energy technologies. ADOT's commitment to operationalizing sustainable transportation includes promotion of clean energy sources and energy efficiency in the transportation sector, contributing to a more sustainable and environmentally friendly energy footprint. The participation in programs like INVEST and the FHWA Sustainable Highways Program indicates a heavy commitment to evaluating and improving sustainable practices as well. These programs often emphasize energy efficiency and cleaner technologies in transportation, directly contributing to SDG 7 objectives. The development of Operational Focus Areas aligned with broader sustainability principles suggests a strategic approach to integrating clean and affordable energy practices within the organization. This aligns with SDG 7's emphasis on increasing the share of renewable energy in the global energy mix.

8. Decent Work and Economic Growth

The work done on operationalizing sustainable transportation can have massive improvements to decent work and economic growth as transit as a whole, including the associated technologies in the field, is greatly improved. So this case **directly positively** impacts the SDG. ADOT's emphasis on creating a financially advantageous transportation network suggests a commitment to fostering economic growth. This growth can lead to job creation, providing employment opportunities that contribute directly to the SDG 8 objective of promoting sustained, inclusive, and sustainable economic growth. The participation in programs such as INVEST and the FHWA Sustainable Highways Program indicates a commitment to evaluating and improving sustainable practices.

9. Industry, Innovation and Infrastructure

Operationalizing sustainable transportation involves broadening the use of public transit options which will improve the disparity in transportation access between wealthier and poorer individuals. So this will **positively directly** impact industry, innovation and infrastructure. Participation in programs like INVEST and the FHWA Sustainable Highways Program signifies engagement with initiatives focused on sustainable practices. Such programs often encourage the adoption of innovative technologies and practices, which are crucial for achieving SDG 9.

10. Reduced Inequalities

Operationalizing sustainable transportation involves broadening the use of public transit options which will improve the disparity in transportation access between wealthier and poorer individuals, **positively directly** impacting the SDG. According to the report, one of the key program focus areas is related to the introduction of multimodal pathways, bike or pedestrian connections or safety measures. In this sense, it is known that fostering proper infrastructure for active mobility generally democratizes the accessibility to areas within cities with more jobs, education, and leisure activities, as a consequence of the urban space becoming less dependent on the use of automobiles. This initiative, for example, is clearly a way of addressing targets 10-1 (reduce income inequalities), 10-2 (promote universal social, economic and political inclusion), and 10-3 (ensure equal opportunities and end discrimination).

11. Sustainable Cities and Communities

Operationalizing sustainable transportation is **directly positive** and relevant to improving affordable and sustainable transport systems. This is one of the number one intentions of creating this program. For instance, targets 11-2 (affordable and sustainable transport systems), and 11-6 (reduce the environmental impact of cities) are addressed by the focus area of creating multimodal pathways, bike or pedestrian connections or safety measures,

through the 'Complete Transportation Guidebook - 2016 New'. Moreover, target 11-5 (reduce the adverse effects of natural disasters) is directly related to one of ADOT's Sustainable Transportation long term subprograms, which is named ADOT Resilience Pilot Program. This latter program entails the provision of transportation systems that could be compromised from the effects of heat extremes, dust storms, wildfires, flooding, and other negative impacts of climate change.

12. Responsible Production and Consumption

Measures taken to further sustainable transportation necessarily involve curbing consumption of finite natural resources and thus **directly positively** impact the SDG of Responsible Production and Consumption. Through the use of the Operations and Maintenance module within INVEST, ADOT is able to address factors such as electrical energy efficiency and use, vehicle fuel efficiency, as well as reduce reuse and recycle. The mentioned factors are directly aligned with some of the existing targets within SDG 12, such as targets 12-2 (sustainable management and use of natural resources), 12-5 (substantially reduce waste generation), and 12-6 (encourage companies to adopt sustainable practices and sustainability reporting).

13. Climate Action

Considering the main objective of this SDG, which is taking urgent action to combat climate change and its impacts, it relates to ADOT's Operationalizing Sustainable Transportation report in terms of modernizing existing infrastructure with the aim to adapt to a changing climate. As previously mentioned, ADOT's Resilience Pilot Program, which embraces the provision of safe, efficient transportation, and is under the umbrella of the Sustainable Transportation subprogram, focuses on climate adaptation for the statewide transportation system in Arizona and is related to target 13-1 (strengthen resilience and adaptive capacity to climate related disasters).

Additionally, the Internal Sustainability Plan within INVEST's Operations and Maintenance Module requires ADOT to consider employee engagement and training in order to give awareness of weather vulnerability. Another worth mentioning aspect is the use of ADOT's extensive knowledge regarding vulnerability assessments, due to the variable climate and weather in Arizona, to further investigate ways to approach climate change into planning and ongoing activities, which is also exposed along ADOT's Operationalizing Sustainable Transportation report. These aspects are also in line with targets 13-2 and 13-3, that embrace the integration of climate change measures into policies and planning, plus knowledge and capacity building to meet climate change. Along these lines, it is possible to state that ADOT's efforts are impacting SDG 13 in a **direct positive** way.

14. Life Below Water

ADOT's sustainable transportation program may **indirectly positively** contribute to SDG 14. Sustainable transportation practices, including eco-friendly infrastructure and reduced emissions, which are addressed within the INVEST methodology, can indirectly contribute to preventing and reducing marine pollution. For instance, through setting goals for maximizing fuel economy, replacing older vehicles for the fleet to become more efficient, fostering reuse of materials and setting energy reduction goals (in 2016 the agency achieved a 24% reduction from a 2002 baseline), some targets within SDG 14 are positively impacted. The extreme dependence on fossil fuels in the transportation sector is intertwined with several negative externalities that harm life below water and are caused by extraction of oil, production and consumption of fuels to be used in transportation. In this sense, targets 14-1 (reducing marine pollution) and 14-3 (reducing ocean acidification) could be achieved, in part, through lessening the extensive use of fossil fuels.

15. Life on Land

The program **directly** contributes **positively** to some aspects of SDG 15, such as the conservation of terrestrial ecosystems and prevention of invasive species. It is widely known that the construction of roads entails the need of dealing with environmental constraints

concerning wildlife, eventual deforestation and effects over natural habitats. Since the beginning of ADOT's Sustainable Transportation Program, one of the key program focuses was the integration of modeling techniques to determine the least damaging design to surrounding environments. This sort of consideration goes directly in line with target 15-5 from SDG 15 (protect biodiversity and natural habitats).

16. Peace, Justice, and Strong Institutions

Although ADOT does not directly go deep into topics of peace and justice, the program recognizes its responsibility in terms of the importance of governance, accountability, visibility, and rigorous process check and balance exercise, which is related to developing effective, accountable and transparent institutions (target 16-6). In this sense, the integration of plans for sustainability, and the continuous capacity building for the professionals of the agency could have a **direct positive** contribution to strengthen institutions involved in transportation decision-making in Arizona.

17. Partnerships for the Goals

The transportation program may **indirectly** contribute **positively** to some aspects of SDG 17, such as enhancing partnerships and data availability. ADOT's emphasis on collaboration with local municipalities, private sector stakeholders, and regional partners align with SDG 17's goal of enhancing the Global Partnership for Sustainable Development. The ongoing monitoring and assessment of sustainability performance in the transportation program may indirectly contribute to the goal of enhancing the availability of reliable data, indirectly and positively impact SDG 17.

Aviation System Plan

This section exposes the findings obtained from the use of the SDG Impact Assessment Tool to assess ADOT's Aviation System Plan. Figure 2 shows a summary board with the results per SDG, which are further described below.

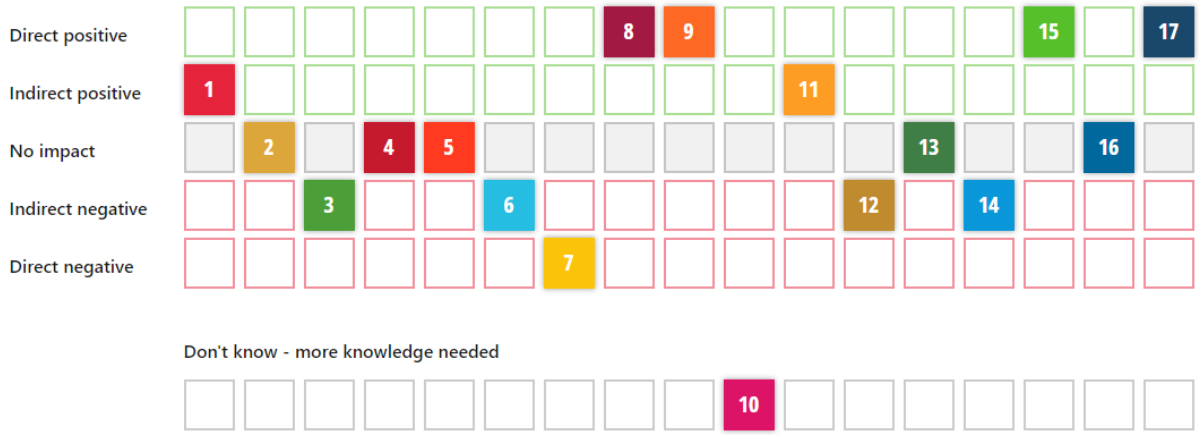

Figure 3.2 - Results board from the SDG Impact Assessment Tool - Aviation System Plan

1. No Poverty

ADOT's SASP is clearly concerned with economic growth generated from aviation operations. The report mentions fiscal responsibility and economic support performance measures that address topics such as 'population living within a 30-minute drive time of each airport', and 'dollars of direct and indirect impact in the state from aviation'. So, it is possible to relate that ADOT already has measurable metrics to assess the statewide accessibility of the aviation infrastructure to different populations, as well as the economic benefits of aviation operations in Arizona. Even though the SASP does not provide explicit metrics to define how economic growth is going to be distributed along different populations, it could be possible to assume that it has **indirect positive** effects on SDG 1. Moreover, the concern ADOT also has on accessibility of airport infrastructure is also an indicator of offering equal accessibility to a wider range of people.

2. Zero Hunger

This SDG focuses on ending hunger, plus accomplishing food security and proper nutrition, besides promoting sustainable agriculture. Because of the focus of this goal, the targets that are presented do not relate to the SASP's scope. So, it is considered that ADOT's SASP has **no impact over** SDG 2 (Zero Hunger).

3. Good Health and Well-Being

Based on the SASP report, ADOT's considerations over health and well-being could be considered as indirect. Even though there are concrete performance measures of improving airports' capability of supporting medical operations, and 'adoption of zoning to make land use in airport environments compatible with airport operations', there is no direct goal and respective indicator that directly addresses the impacts of aviation operations on good health and well-being. Indirectly, it is widely known that extraction of oil, followed by production and consumption of fossil fuels are related to human health impacts due to air pollution, eventual contamination of water bodies. Besides, noises generated by aircrafts can also impact human well-being and impact land use regulations, which is addressed by SASP through recognizing that applicable laws should be followed.

Nonetheless, when a comparison is drawn between SASP's objectives and SDG 3 targets, target 3.9 is the one that bridges the two ends the most. With that being said, plus considering that SASP intends to foster more aviation activity and does not explicitly provide metrics to pursue fueling decarbonization, it can be stated that the Aviation System Plan in Arizona will tend to have **indirect negative** impacts on good health and well-being.

4. Quality Education

This SDG focuses on ensuring inclusive and equitable quality education, plus promoting lifelong learning opportunities for all. Because of the focus of this goal, the targets that are presented do not relate to the SASP's scope. For this reason, it is considered that ADOT's SASP has **no impact over** SDG 4 (Quality Education).

5. Gender Equality

This SDG focuses on achieving gender equality, and empowering all women and girls. Because of the focus of this goal, the targets that are presented, such as 'elimination of forced marriages' and 'promoting empowerment of women through technology', do not relate to the SASP's scope. For this reason, it is considered that ADOT's SASP has **no impact over** SDG 5 (Gender Equality).

6. Clean Water and Sanitation

The scope of this SDG focuses on the provision of universal access of water and sanitation, which could be considered out of the SASP's scope. However, when a life-cycle mindset is considered along the aviation operations in Arizona and, principally, the prospects presented in the SASP report, it is possible to assume an **indirect negative** impact of Arizona's Aviation Plan on SDG 6.

There is no mention in the SASP report about ADOT's intentions for decarbonizing aviation operations in Arizona. So, the use of fossil fuels in the aviation industry can be associated with indirect impacts related to clean water provision. Then, target 6-3 could be eventually negatively impacted by extraction, production and consumption of fossil fuels. Accordingly, in order to support the State economically, there is an aim of offering 24/7 fuel to have more operational safety and to attract aircraft operators who need quick access to on-demand fuel. Although one of ADOT's system indicators for fiscal responsibility is the number of airports with utilities (electricity, telephone, water, sewer, and gas), it does not cover the targets nor the scale of implementation required by SDG 6.

7. Affordable and Clean Energy

This SDG centers around energy that is reliable, efficient and affordable for many. However, this goal is not fulfilled because of harmful sources of energy that are continuously being used. Reducing the use of fossil fuels is one of the main issues that are not addressed by

ADOT within the SASP report, therefore this SDG's impact is considered a **direct negative.** Keeping methods of non-renewable energy sources will have an impact on the environment, through not just CO_2 emissions, but also by releasing nitrogen oxides, which has about twice as much warming potential than CO_2. Thus, this scenario does not foster a transition to cleaner means to provide energy to aircrafts as recommended by this SDG.

8. Decent Work and Economic Growth

SDG 8's aim is to promote economic growth while maintaining sustainability and being inclusive. This goal is evident and there is a **direct positive** impact within the SASP, ADOT mentions ways they plan to reach their goal of economic support and growth. For instance, the plan of effectively meeting the future aviation demands in Arizona, as well as providing a better airport infrastructure through keeping minimum standards of pavement condition and more availability of fuel, tends to promote job creation as well as entrepreneurship through develop oriented policies (target 8-3). This also aligns with the broader goal of promoting policies for decent job creation. Additionally, there is a focus on sustainable tourism, driven by aviation activities (target 8-9). Considering that ADOT's SASP is aligned to Arizona's trends of economic growth, which is deeply related to tourism activities, it is possible to say that it creates a proper condition for the promotion of beneficial and sustainable tourism, creating jobs and promoting local culture and products.

9. Industry, Innovation and Infrastructure

Considering ADOT's desire to use SASP to foster economic growth in Arizona, it can be said that SASP generally has a direct relation with SDG 9, even though some targets within this SDG are out of ADOT's scope of work. Along SASP's report, there are several performance measures and system indicators that resonate with safe airport operation and development, which concerns satisfying proper land use regulations, good pavement conditions, reliable and constant fuel availability, and development of emergency plans (the latter does not have a future performance target associated with it). Moreover, there is the concern with integration of airport infrastructure to local and regional growth plans, as well as to local

transportation plans. Along these lines, based on ADOT's objectives within SASP, the mentioned improvements would principally contribute to fostering resilient infrastructure (target 9-1), plus increasing access to financial services and markets (target 9-3) . With that in mind, it can be stated that ADOT's SASP has a **positive direct** impact on SDG 9 (Industry, Innovation and Infrastructure).

10. Reduced Inequalities

This SDG basically centers around targets related to ensuring equal opportunities and adopting social policies that promote equality, which are not directly addressed by ADOT's SASP. Nonetheless, considering the multiple jobs that are generated within the aviation sector in Arizona, it might impact SDG 10. Since the SASP report does not explicitly cover how ADOT approaches topics such as reducing income inequalities (target 10-1), and social and economic inclusion (target 10-2), it is not possible to define which is the character of the relation of ADOT's SASP with SDG 10. Thus, **more knowledge is needed** to classify the impacts.

11. Sustainable Cities and Communities

ADOT's potential influence on SDG 11 is acknowledged through some of the targets within this SDG. The SASP report is concerned with meeting local zoning regulations related to aviation activity. It is known that activities of this nature have the potential to harm local communities with high noise levels. Also, SASP recognizes the importance of meeting local, regional, and federal requirements in terms of airport noise compatibility and to provide an additional level of safety for people and property on the ground. With this in mind, even though there is not specific measures for sustainable urbanization, indirectly it could be considered that ADOT's SASP is indirectly related to targets 11-1 (safe and affordable housing), due to the concern of meeting regulations of housing near airports and 11-A (strong national and regional development planning), because of SASP's integration to Ariozona's trends of economic growth and local development plans. Thus, this goal is that there is an **indirect positive impact**.

12. Responsible Production and Consumption

While ADOT expresses dedication to enhancing aviation operations' efficiency, the specific methods for achieving this in sustainable ways remain unspecified. Objectives pertaining to decarbonization and the sustainable utilization of resources are notably absent from the discourse. Moreover, ADOT is prone to promote a higher availability of fuel for aircrafts in the airports of the state, as stated in the performance measure offering 24 hours a day, seven days a week fuel, plus providing more facilities to support jet aircrafts. Combining the trend of more flights occurring within Arizona with the non consideration of transitioning aviation operations to a low-carbon future, this means there is an **indirect negative** impact on the goal.

13. Climate Action

SDG 13 highlights the importance in taking the initiative to confront climate change. It is deemed that the decision-making regarding Climate Action falls beyond the domain of ADOT hence there is **no impact** on this goal. ADOT does not touch upon ways that this goal is affected.

14. Life Below Water

SDG 14 focuses on sustainability in areas like the ocean, sea life and water quality. The created plan discusses modifications to airports and their operations. Some safety measures specifically outlined about the airports are presented but they are not sustainable ones. The extraction, production, and consumption of fossil fuels are intricately linked to water resource pollution and adverse effects on marine life. These zones being impacted, means targets like 14-1 to 14-5 are not reached and undesirable repercussions. The absence of a well-defined strategy to diminish fossil fuel usage raises concerns about ADOT's **indirect negative impact** on SDG 14.

15. Life on Land

SDG 15 promotes conservation and reverse degradation of land to help prevent the loss of biodiversities. The construction of airports is associated with adverse effects such as wildlife displacement and alterations to the natural environment. Nevertheless, SASP primarily collaborates with established airports to enhance their operations. Partnerships enable the achievement of significant outcomes and facilitate more substantial positive transformations. Additionally, ADOT explicitly advocates for the adoption of Wildlife Hazard Assessment/Management Plans by more airports in one of its performance measures for safety and security, which is related to target 15-5 (protect biodiversity and natural habitats) of SDG 15. As this consideration aligns with SASP, it can be characterized as a **direct positive impact.**

16. Peace, Justice, and Strong Institutions

SDG 16 advocates peace, justice, and inclusive institutions for sustainable development. Though broadly speaking, ADOT's jurisdiction does not cover most of the targets outlined. Thus, there is **no impact** visible from the Aviation Plan. However, it is important to note that target 16-6 is briefly touched upon. This would relate to one of ADOT's main goals within the aviation sector, fiscal responsibility. The incorporation of budgets helps illustrate how it is spent and would potentially allow economic growth.

17. Partnerships for the Goals

SDG 17 accentuates the significance of cooperation with others for support and expansion. In the SASP report it is evident that ADOT sees the benefits of working with others. As well as taking the initiative to reach out to other institutions to collaborate and have economic support. Partnerships that seem to be important and are mentioned in the report are PAC and FAA. Partnerships with organizations like those fall under target 17-6, where all are working towards a common goal of innovation and information sharing. In the report, ADOT described that the PAC is essential for guidance and contributions specific to Arizona, and

some recommendations were jointly worked on by both ADOT, ADO and multiple other stakeholders (target 17-17). Given all these factors it is apparent that there is a **direct positive** impact on SDG17.

Recommendations

This section is centered around possible actions that ADOT could take to improve its reach along the 'Operationalizing Sustainable Transportation' and 'Aviation System Plan' programs. It is important to notice that some recommendations might impact a diverse range of SDGs, and that is why this section is subdivided into the actions that could have the most positive impact over the SDGs that the mentioned programs relate with.

Operationalizing Sustainable Transportation

The Arizona Department of Transportation (ADOT) plays a crucial role in shaping the transportation landscape of the state. To effectively pursue their goal of operationalizing sustainable transportation and aligning with the Sustainable Development Goals (SDGs), ADOT should consider the following recommendations:

1. Integrate Sustainability into Planning Processes:

ADOT could embed sustainability principles into its planning processes from the outset. This includes incorporating environmental, social, and economic considerations into transportation project evaluations. The integration of sustainability should be evident in the early stages of project development to ensure that sustainable options are thoroughly examined and prioritized. Even though there are extensive efforts to make sustainability a reality in operational and maintenance activities, the report does not provide as much details on how ADOT is performing within INVEST's scoring of System Planning for States, and Regions, and Project Development. Thus, it is advisable to assess these aspects to better understand the best future practices for ADOT to incorporate sustainability into planning and project development, which could have a more significant impact than having isolated initiatives in these realms. Moreover, particular attention should be paid to the development

of a comprehensive Environmental Compliance Tracking System (ECTS), which could substantially positively impact ADOT's score through the INVEST methodology along the operation and maintenance module. With this recommendation, it is believed that ADOT's impact would be improved for **almost every SDG** that has a relation to the scope of the Operationalizing Sustainable Transportation initiative.

2. Develop a Comprehensive Sustainability Policy:

ADOT should develop a robust sustainability policy that outlines clear objectives, targets, and performance indicators aligned with the SDGs. As mentioned, mainly in terms of addressing sustainability in the planning and project management stages of transportation infrastructure, the ADOT report encompasses initiatives that are not so oriented by measurable indicators as the operations and maintenance stages are. That is, it was identified the lack of metrics that could comprehensively guide ADOT's actions throughout the systemic process of providing sustainable and resilient transportation infrastructure (**SDG 9 and 13**). Once it is created, it is advisable for this policy to be communicated across the different levels of stakeholders, emphasizing the importance of sustainability in all facets of transportation planning and development. Then, this communication effort positively impacts resilience building (**SDG 9**), addressing climate action (**SDG 13**) and strengthening institutions (**SDG 16**). It is also worth mentioning that developing and implementing sustainability policies include exploring sustainability policies and strategies to address climate-related challenges, which can directly impact agricultural resilience and food security for all citizens (**SDG 2**).

3. Prioritize Active and Public Transportation:

To reduce carbon emissions and promote healthier living, ADOT should prioritize investments in active transportation modes such as walking and cycling, as well as public transportation. By enhancing public transit infrastructure and integrating it seamlessly with other modes, ADOT can reduce dependence on private vehicles and contribute to sustainable urban development. As seen along the existing operational focus areas within

the report, there is a lack of initiatives that directly embrace active and public transportation, except for the Complete Transportation Guidebook. Hence, a better integration of a set of initiatives that comprehensively address more sustainable means of transportation, as well as diagnosing the main existing barriers to support them, could be strongly beneficial for **SDGs 3, 9, 10 and 11**.

4. Invest in Alternative and Renewable Energy:

By incorporating more sustainable aspects into activities like planning, and project management, ADOT is likely to prioritize energy-efficient technologies and practices. This can involve the adoption in a larger scale of clean energy solutions, such as electric vehicles, renewable energy sources for transportation infrastructure, and energy-efficient design considerations (**SDG 7**). For instance, investments along alternative and renewable energy, can contribute to reducing greenhouse gas emissions. Additionally, the integration of renewable energy sources for transportation facilities, such as solar-powered rest areas, could further align with sustainable goals. These actions also are aligned to achieving more sustainable and resilient infrastructure (**SDG 9**) and sustainable cities and communities (**SDG 11**).

5. Promote Smart and Connected Infrastructure:

Leveraging technology for smart and connected transportation systems can improve efficiency and reduce environmental impact. Intelligent traffic management systems, real-time data analytics, and smart infrastructure can optimize traffic flow, minimize congestion, and enhance overall transportation sustainability. This sort of measure is not so present within ADOT's report on operationalizing sustainable transportation, but its incorporation into comprehensive sustainability plans could definitely have positive impacts on **SDG 9**.

6. Embrace Sustainable Design Standards:

Implementing sustainable design standards for transportation infrastructure can significantly contribute to achieving environmental goals. Using eco-friendly materials,

incorporating green spaces, and adopting low-impact development techniques can minimize the environmental footprint of transportation projects. This action could also be part of a comprehensive sustainability plan for planning and project management, by the deployment of the INVEST scoring methodology to assess how ADOT is currently addressing sustainability within design and planning stages of transportation projects. By doing that, it could be considered that **every related SDG** could be positively impacted.

7. Continuous Monitoring and Evaluation:

ADOT should establish a robust monitoring and evaluation system to track the progress of sustainability initiatives. Regular assessments of the environmental, social, and economic impact of transportation projects will enable ADOT to make data-driven decisions, adapt strategies, and continuously improve its sustainability performance. This is also an existing feature within the INVEST methodology, but that was only totally used to assess operational and maintenance activities within ADOT. The implementation of actions like this could strongly have positive impacts on **almost every SDG**, directly and indirectly.

8. Collaboration with Stakeholders:

Collaborate with various stakeholders, including other government agencies, non-profit organizations, and the private sector, to leverage resources and expertise. Building partnerships can enhance the collective impact of sustainable transportation initiatives and foster innovation in the field. ADOT has been very committed to dialogue with several different institutions, and applying this approach for the development of a comprehensive sustainability framework to be implemented mostly in the planning and managerial scales, also including community members, could be very beneficial to **almost every SDG**. Because of the systemic effect that this cross-scale action has, it could be defined as the basis requirement for every sustainable planning conception.

Aviation System Plan

ADOT could take into account the following suggestions in order to successfully further pursue their Aviation System Plan and harmonize with the Sustainable Development Goals (SDGs):

1. Incorporation of Renewable Energy Methods:

The use of fossil fuels by ADOT for aviation operations raises environmental issues. Reducing carbon emissions and supporting clean energy goals could be achieved by converting to sustainable aviation fuels or integrating renewable energy sources like solar or wind power for airport infrastructure. **SDG 7** highlights any concerns for environmental impacts with the discussion of Affordable and Clean Energy. This also impacts **SDG 3** human health in the present and in the future. A recommendation would be to incorporate clean fuels and advocating for policies that incentivize the use of cleaner energy sources.

2. Further Discussion of More Sustainability Topics:

ADOT can engage in in-depth discussions focusing on conducting thorough environmental impact assessments for aviation operations. Emphasis can be placed on the critical need for strong mitigation strategies, encompassing concerns such as noise pollution, air quality, and habitat preservation. Based on the findings, the SASP has an indirect negative impact on **SDG 12**, so promoting conversations can change this. As mentioned previously, the SASP has a direct negative impact on **SDG 7**. This can also improve the use of affordable and clean energy. Overall, more communication and involvement would benefit the SASP.

3. Community Engagement:

Encouragement of open dialogue and involvement with nearby communities impacted by airport operations can be helpful. ADOT can seek input, respond to issues, and include interested parties in decision-making procedures to guarantee inclusivity and meet community needs. Although the SASP may not directly address sustainable urbanization or transport systems, involving the community on local and regional levels can bring a positive impact to **SDG 11**. The engagement can involve collaboration with those communities to

ensure aviation plans align with community needs and development objectives (sustainability). Educating the people around the areas affected by the SASP for land-use regulation is beneficial. This discussion between both parties will ensure compatibility with both aviation and local needs.

4. Human Health Impacts

There are no clear indicators in the Aviation plan to address the effects of aviation on human health. Incorporating strategies to reduce aviation-related air and noise pollution would be in line with **SDG 3** objectives and enhance public health. The plan lacks explicit indicators to address aviation's impacts on human health. Incorporating measures to remove the overall pollution would help. As mentioned prior, the targets shown along this SDG are deeply connected to ensuring healthy lives and promoting well-being (reducing illnesses and death from hazardous chemicals and pollution). The Health Impact Assessment (HIA) can be used to conduct an analysis on the direct and indirect effects of aviation operations on public health. The assessment covers factors like noise pollution and air quality.

5. Poverty Awareness

It is encouraged that ADOT emphasizes the economic growth brought about by aviation operations. However, more explicit metrics that specify how economic growth is distributed among various low-income groups might enhance the aviation plan and its ability to eradicate poverty. While future aviation jobs have the potential to positively impact **SDG 10**, ADOT doesn't directly discuss income inequality.

6. Water Resource Impact

ADOT should try to incorporate programs for fuel decarbonization or adoption of sustainable practices to limit negative impacts on water resources, given that aircraft reliance on fossil fuels has an indirect impact on water quality. Aircrafts are reliant on fossil fuel consumption. ADOT could aim to include initiatives for fuel decarbonization or adoption of sustainable practices to limit the adversity in **SDG 6**. As time progresses, companies are

experimenting with potential aviation fuels as a substitute for fossil fuels. Involvement with this can be seen as a good step in futuring sustainability practice.

7. Economic Growth and Environmental Responsibility

ADOT can foster discussions to balance aviation's environmental responsibilities with economic prosperity, emphasizing how sustainable economic development in aviation can mitigate negative environmental effects through policy implementation aligned with sustainable development goals. The topic of furthering economic prosperity aligns directly with **SDG 8**. Although an increase of activity could result in more jobs, **SDG 1**, it is not certain whether or not the SASP will increase economic prosperity outside of its bubble.

8. Partnerships and Collaborations

Highlighting the significance of establishing alliances and working together with government agencies, academic institutions, and business stakeholders to advance aviation sustainability initiatives can help. It's encouraged that talks with the goal of exchanging best practices and utilizing group knowledge to hasten the transition to environmentally friendly aviation practices. **SDG 17** highlights that being involved in a community could aid in achievement of aviation goals.

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Team 4 - Asset Management and Tribal

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Overview

Asset Management - Infrastructure Resilience - Overview

The very essence of a state's economy and society relies on a well-functioning transportation system, and in a vast and diverse state such as Arizona, this significance is heightened. Recognizing the critical need for a durable and adaptable transportation network, the ADOT introduced its ambitious Resilience Program in 2023. This comprehensive initiative is strategically crafted to confront the immediate issues confronting Arizona's transportation infrastructure.

At the core of ADOT's Resilience Program, infrastructure enhancement assumes a central role in strengthening Arizona's transportation network. With a specific emphasis on the enhancement and upkeep of essential assets, such as roadways and bridges, this program strives to prolong life and enhance the resilience of the state's critical infrastructure. By tackling structural weaknesses and maintaining these assets consistently, the Resilience Program strives to enhance the dependability of Arizona's transportation system, facilitating the smooth movement of goods and people while providing protection against unforeseen challenges. This investment in infrastructure not only fosters the state's economic growth but also underscores ADOT's dedication to ensuring the long-term sustainability of Arizona's transportation infrastructure. Temperature plays a central role in ADOT's resilience strategy, significantly influencing robustness and security. Arizona's climate, marked by drastic temperature fluctuations, ranging from scorching summers to freezing winters, presents substantial challenges to the state's vital assets. To address these challenges, the resilience plan incorporates a range of measures. It includes the utilization

of heat-resistant pavement materials and construction techniques aimed at mitigating the softening and potential damage of asphalt surfaces in high-temperature conditions. Furthermore, the plan takes into account thermal expansion and contraction, ensuring the capacity of bridge structures and roadways to endure temperature-induced movements without compromising their structural integrity. ADOT's plan encompasses adapting to the impacts of climate change, emphasizing the revision of design standards and preparedness for future temperature extremes. Winter readiness is an additional facet, covering activities such as snow removal, de-icing, and maintenance to guarantee road safety during cold spells. The plan addresses safety concerns associated with extreme heat, safeguarding both travelers and the functionality of transportation systems like traffic signals and electronic signage in severe heat conditions.

This places significant emphasis on bolstering the resilience in response to natural disasters as well. This commitment reflects the department's dedication to ensuring the durability and flexibility of the transportation system when confronted with environmental adversities. Recognizing Arizona's susceptibility to natural calamities like floods, wildfires, and extreme weather conditions, the Resilience Program adopts a proactive approach to reinforce transportation infrastructure. This includes the strategic implementation of resilient construction practices, aimed at improving the system's capacity to withstand these perils, reduce disruptions during emergency situations, and expedite recovery efforts. These measures, integrated into the program, not only prioritize commuter safety but also prioritize the uninterrupted flow of crucial goods and services essential to the state's economy, even when facing nature's most formidable challenges.

ADOT's commitment to fostering a more environmentally conscious transportation system in Arizona is evident. This forward-thinking element of the program is geared toward reducing the environmental impact of the state's transportation infrastructure. It encompasses various initiatives, including the expansion of electric vehicle charging infrastructure and the integration of sustainable road design principles. Through the

promotion of cleaner, eco-friendly transportation methods, ADOT aims to curtail greenhouse gas emissions and minimize the environmental footprint associated with transportation activities in the state. The Resilience Program's dedication to environmental sustainability not only aligns with global initiatives to combat climate change but also highlights the department's awareness of its pivotal role in safeguarding Arizona's natural resources for the benefit of future generations. Public engagement holds a central place in this 2023 plan recognizing that the input and feedback of the public, as well as various stakeholders, are invaluable in shaping the program's priorities and project selection. Through initiatives such as public meetings, surveys, and consultations, the Resilience Program seeks to create a meaningful dialogue with the community. This approach not only ensures that the transportation system aligns with the needs and expectations of the people it serves but also fosters a sense of ownership and shared responsibility among residents. By actively involving the public in the decision-making process, ADOT strengthens its connection with the community, making the Resilience Program a collective effort, responsive to the diverse needs and aspirations of Arizona's citizens.

With a deliberate emphasis on infrastructure, safety, sustainability, and resilience, the program seeks to guarantee the strength and preparedness of Arizona's transportation system for the forthcoming challenges. The equitable distribution of investments, notable project features, and a dedication to involving the public all collectively underscore the program's importance in fortifying a prosperous and resilient future for the state. In a global landscape where transportation serves as the backbone of both society and the economy, ADOT's Resilience Program 2023 represents a vital stride in safeguarding Arizona's future and preserving its competitive advantage.

Tribal Transportation - Overview

The purpose of ADOT’s Tribal Transportation Planning is to provide safe and adequate public transportation and public road access to and within Indian Reservations. Tribal Transportation plays a pivotal role in ensuring mobility and preserving the cultural

heritage within Native American communities. Moreover, Tribal Transportation is governed by the complex relationship of federal, state, and tribal regulations. The Tribal Transportation Program (TTP) provides funding for the administration, planning, construction and maintenance of roadways in Indian Country. Its main goal is to extend beyond infrastructure development. Tribal Transportation has a commitment to cultural preservation, enhanced connectivity, and sustainability. Moreover, it has integrated Tribal cultural values into transportation planning by recognizing the significance of roads and transit systems. Enhanced connectivity facilitates safe and efficient travel within Tribal lands and between reservations and neighboring communities, fostering economic and social ties. Tribal Transportation embraces sustainable and environmentally conscious transportation practices, minimizing negative impacts on tribal lands and ecosystems. With these goals in mind, Tribal Transportation has facilitated many accomplishments.

Tribal Transportation has achieved many notable milestones including infrastructure developments, safety enhancements and technological integration. Their accomplishments come from the partnerships that Tribal Transportation has developed. The tribes that are partnered with Tribal Transportation are the Hopi Tribe, Navajo Nation, and San Carlos Apache Tribe. These Tribal partnerships have provided significant opportunities from Federal Highway Administration and ADOT to earn the trust essential to establishing excellent long term working relationships. From these relationships came many improvements and opportunities for program enhancements. For example, there have been significant investments in Tribal Transportation that have led to the improving access to tribal communities and promoting economic development by improvement on road and bridge construction. There is an implementation of safety measures to achieve these safety enhancements. Certain applications such as improved road signage and traffic management, has contributed to a reduction in accidents and enhanced overall road safety. Technological integration is implemented with the adoption of advanced technologies that have improved traffic flow and provided real-time information to travelers. These Tribal

Transportation achievements lead to many communities wanting Tribal Transportation to be a part of their communities.

Tribal Transportation has requirements in order to have funds. For example, funds are available for communities to use for the year they are authorized, plus three additional fiscal years. Funds are also allocated among the Tribes using a statutory formula based on tribal population, road mileage and average tribal shares. Some eligible uses for these funds are for updating Long Range Transportation Plans, planning and designing roads, bridges, and transit facilities, or updating the National Tribal Transportation Facility Inventory. There are also different reallocations of TTP funds that Tribes can use. For example, Tribes are able to request their planning funds to be transferred into construction funds for use on any eligible and approved National Tribal Transportation Facility Inventory projects. Tribes may also identify transportation planning as a priority and request a certain percentage of their TTP program construction funds for transportation planning. If there are any unused planning funds, they may be reallocated for after construction after consultation with the Tribe. These requirements and information are placed by the relationship between federal and state regulations along with Tribal concerns.

The success of Tribal Transportation is shown through the strong collaborations. These collaborations with TTP include federal partnerships, state coordination, tribal-to-tribal collaboration, and private sector engagement. The federal collaboration, specifically Federal Highway Administration and the Bureau of Indian Affairs are essential for securing funding, technical expertise, and compliance with federal regulations. On the state level, the cooperation with the Arizona Department of Transportation facilitates coordination on regional transportation planning and ensures tribal priorities are considered at the state level. Tribal Transportation really encourages collaboration between Tribes. Inter-Tribal partnerships enable the sharing of best practices, resources, and knowledge, fostering a sense of solidarity and collective progress. Tribal Transportation also encouraged Tribes to collaborate with private sectors in the state. Collaborating with private entities, including

engineering firms and construction companies, brings expertise and resources to tribal transportation projects. These partnerships encourage the conjoining of different communities and the chance at sustainability.

ADOT's Tribal Transportation Planning's emphasis on cultural preservation, community engagement, and sustainable practices ensures that transportation initiatives align with the values and aspirations of Tribal nations. Tribal Transportation encourages sustainability and efficiency of transportation through multiple Tribes and communities. As partnerships evolve and accomplishments accumulate, Tribal transportation will remain a cornerstone for fostering resilience, connectivity, and the preservation of rich cultural legacies within Arizona's Native American communities.

Requirements

Detailed description and discussion of the SDG Impact Assessment Tool Step 2 requirements.

Asset Management - Infrastructure Resilience - Requirements

Requirements

ADOT is currently looking for ways to improve the resilience of its infrastructure, throughout its entire life cycle, to deal with extreme natural weather events as well as a changing climate. The main objective is to develop a life cycle management database that considers the role that these extreme weather and climate events will have on ADOT's transportation assets. Other goals of the pilot included having life cycle plans that reduce

the total cost of the infrastructure over its entire lifetime in use, monitoring entry points and potential risk they may have, demonstrating how these risk mitigation techniques might impact life cycle planning, and documenting the techniques used to help with knowledge transfer.

Scope

The scope of ADOT's Resilience Program is to build upon current ADOT resilience efforts and assess what weather and climate events are the highest threats to transportation infrastructure in Arizona as this is the focus of the report.

These events are:

- Intense precipitation
- Wildfires
- Wildfire induced flooding
- System flooding
- Drought-related dust storms
- Rockfalls
- Slope failures
- Increasing surface temperatures

Assumptions

One assumption that the report makes is that temperatures will continue to rise in the state of Arizona. It is anticipated that temperatures will rise from anywhere from 2^{O}F to 16^{O}F by 2100 depending on the amount of emissions produced until then. Considering the extreme heat in Arizona, it can lead to pavement deformation, increased dust storms, and increased wildfires; it would be imperative to keep this assumption in mind while planning and building future infrastructure. Another assumption is that precipitation in the state is expected to remain at a consistent level, but in such a way that resulted in fewer, higher

intensity rainfall events. This change in rain could have the potential to overwhelm the current pump drainage system in the state.

Geographic Scope and Scale of Implementation

The geographic scope is transportation infrastructure in the state of Arizona that is managed by ADOT. This program is also being done in partnership with the United States Geological Survey (USGS) as their knowledge of soil was important for determining the most flood hazardous zones. The data will be implemented at the district level to ensure that the best results can be achieved to manage risks from weather and climate.

Time Frame

The time frame is for the life cycle of transportation infrastructure in Arizona, which often goes on for multiple decades. For bridges, which were determined to be the highest and most critical risk asset class; there would be a life cycle of 75 to 100 years.

SDGs

The SDGs more likely to be included within the assessment are SDGs 3, 8, 9, 11, 12, 13, and 15. These SDGs are Good Health and Well-Being; Decent Work and Economic Growth; Industry Innovation, and Infrastructure, Sustainable Cities and Communities; Responsible Production and Consumption; Climate Action; and Life on Land, respectively.

Good Health and Well-Being is applicable because one of its goals is to reduce the amount of car accidents and road injuries. By creating a more resilient infrastructure that can last in more difficult situations, there will naturally be less roadway accidents. Decent Work and Economic Growth is applicable as by making Arizona's transportation structure more resilient, it is ensured that the state can keep up its economic growth in a sustainable manner in the long term. The overall goal of the report is to find methods that improve the resilience of ADOT's infrastructure, which is also a subgoal of Industry, Innovation, and Infrastructure. Sustainable Cities and Communities can be included as a goal because resilient infrastructure is naturally more affordable and sustainable for communities than

infrastructure that falls apart in extreme weather events that become more and more the norm. Responsible Production and Consumption may not seem like it should be one of SDGs involved for the pilot, but the roadway infrastructure also includes the vegetation next to the road which is an important part of the natural environment. The vegetation also has the added goal of restoring land devastated by floods and droughts, making them less susceptible to those events in the future, filling out one of the targets of Life on Land to restore degraded land. As the transportation infrastructure is directly affected by climate, it follows that Climate Action would be needed as any ability to reduce climate change would reduce the amount of resiliency that is required.

Tribal Transportation - Requirements

Tribal Transportation in Arizona started with ADOT's consultation Policy, which was initially adopted on September 1, 2006, and updated on a regular basis, and takes into consideration statutes from different agencies or dependencies as these are the U.S. Department of Transportation, U.S. Department of Interior and Tribal Governments. These statutes work for ADOT to require that Tribes are consulted in any decisions affecting their historic and cultural legacy, applying for any of the Tribes that reside in Arizona or with aboriginal or ancestral interest in the State. This Tribal consultation policy for the ADOT provides a basis for a mutual understanding and appropriate partnerships and agreements with Tribes, communities and Native nations to address both State and Tribal transportation issues. ADOT's Geographical Scope in Tribal transportation falls under the common goal of providing efficient transportation systems for the safety and welfare of the traveling public for both State and Tribal government of the 22 federally recognized Indian Tribes, Communities and Native Nations that reside in the state of Arizona, with tribal land that corresponds to the 28% (encompassing approximately 27,736,000 acres) of the State of Arizona land base, through where 1,273 out of the 6,785 centerline miles of the State Highway System traverse this Tribal Land. And the 14 Tribal airports and Seven Tribal Public transit system situated within these Tribal communities, all throughout the state of Arizona.

In order to do this, ADOT gets to a stakeholder and public outreach, where stakeholders are the community members who are directly or indirectly impacted by the potential improvements as it is schools' representatives, emergency services, hospitals and business owners. The reason this outreach is so important is because it helps Tribal leaders to understand the transportation needs of the community, helps to build public support of transportation projects, and by being a federal requirement. In the process of stakeholder and public outreach, ADOT presents identified issues and needs to stakeholders, refine improvement needs based on stakeholder input, present identified issues and needs to the public, and refine improvement needs based on public input.

In Arizona Tribal Transportation Planning, the main purposes and needs of Tribal communities are safety, looking to make an improvement in this rubric for all modes, reducing the number of injuries and fatal crashes; Infrastructure preservation, with the objective to improve infrastructure reliability, by knowing the impact of this project in the regional transportation network; Mobility and accessibility, trying to provide different transportation options to Tribal communities with more choices for a community member without an automobile; Economic Development, by supporting economic growth and giving more opportunities for development, tourism or recreation; community support, with the objective of reflect the community's vision in the project; and Enhance the environment, by looking to preserve the natural environment, protecting Tribal lands and its ecosystems.

What the Arizona Department of Transportation manages regarding the time frame of Tribal Transportation Planning and Projects are the different planning horizon time periods, which are used to match the state's transportation planning horizon, such as short-term (5 years) or long-term (20 years) projects. Within a life cycle perspective, ADOT uses the Long-Range Transportation Planning Process, which consist of a process with different steps, as follows:

- Visioning: Evaluate current transportation issues and needs, determine what type of enhancements they would like and establishing goals and objectives;

- Analysis of current conditions: Review of previous studies, reports and plans, which provides insight into identified transportation issues and potential improvements. Review land use and socioeconomic conditions, which helps to understand the areas' current development and demographic patterns by reviewing existing land use, population, physical and cultural environmental constraints and employment conditions. Evaluate Roadway system conditions, by an inventory of roadway characteristics such as number of lanes, surface type condition, speed limits, traffic control, crash data analysis and traffic conditions. Evaluating multimodal transportation systems, by reviewing and inventorying pedestrian, bicycle, trail and transit facilities. Moreover, listing existing transportation issues and needs, this being made based on the inventory and analysis on the existing conditions, identifying transportation system deficiencies and issues, serving as the foundation for developing improvement recommendations;
- Analysis of future conditions: forecast future socioeconomic conditions, utilizing population growth estimates to determine future population and employment for short (5 years), medium (10 years), and long term (20 years) timeframes. Additionally, utilizing development plans to identify where and when in the future development will occur. Then, forecasting future traffic conditions, consisting of analyzing the impacts of future traffic conditions on the transportation system if no improvements are made and identifying intersections and corridors that become congested due to development. Lastly, summarizing future deficiencies and needs, by analyzing all possible deficiencies or issues that might occur for each horizon year if no roadway improvements are made.

ADOT works for Tribal communities' transportation issues and needs. For instance, ADOT's Tribal Transportation scale of implementation is not only on transportation system, but also looks for the needs of Tribal communities in many aspects like safety, looking to make an improvement in this rubric for all modes, reducing the number of injuries and fatal crashes; Infrastructure preservation, with the objective to improve infrastructure reliability,

by knowing the impact of this project in the regional transportation network; Mobility and accessibility, trying to provide different transportation options to Tribal communities with more choices for a community member without an automobile; Economic Development, by supporting economic growth and giving more opportunities for development, tourism or recreation; Community support, with the objective of reflecting the community's vision in the project; and Enhancing the environment, by looking to preserve the natural environment, protecting Tribal lands and its ecosystems.

Along these goals, it is possible to see a big interaction with some of the SDG's, being some of these in a directly form, as it is in Good health and well-being (SDG 3), through the improvement of safety and reducing injuries and fatal crashes on roads; Decent work and economic growth (SDG 8), by targeting on sustainable economic growth and development for tribal communities; Industry, Innovation and Infrastructure (SDG 9), on the sustainable, resilient and inclusive development of infrastructures by focusing on quality and reliability of tribal transportation infrastructure; and looking for Sustainable Communities (SDG 11), with affordable and sustainable transport system that provides access to safe and accessible transport systems for all improving road conditions and public transport; and Partnership for the goals (SDG 17), by mobilizing resources (funding) on tribal communities for the develop of transportation infrastructure in Tribal lands.

Apart from these directly related SDGs, ADOT's Tribal Transportation Planning has an indirect influence over other goals like No poverty (SDG 1), by making it possible for more remote tribal communities to ensure mobilization of resources from a variety of sources; Zero Hunger (SDG 2), by investing in rural infrastructure and sustainable food production maintaining Tribal communities ecosystems; and Quality Education (SDG 4), by giving access to remote Tribal Communities with transportation hindrances to superior education.

Findings

Asset Management - Infrastructure Resilience - Findings

Essentially, the goal for asset management is to increase asset resilience against extreme weather events through the creation of new plans. This will be done by making asset management more cognizant of the changes that the environment and weather of Arizona is going through because of climate change and other causes. The SDGs that are most impacted by asset management include SDGs 9, 11, and 13, as these SDGs deal directly with ADOT's infrastructure. SDGs 3, 8, 12, and 15 can still be affected by asset management, but in more indirect ways.

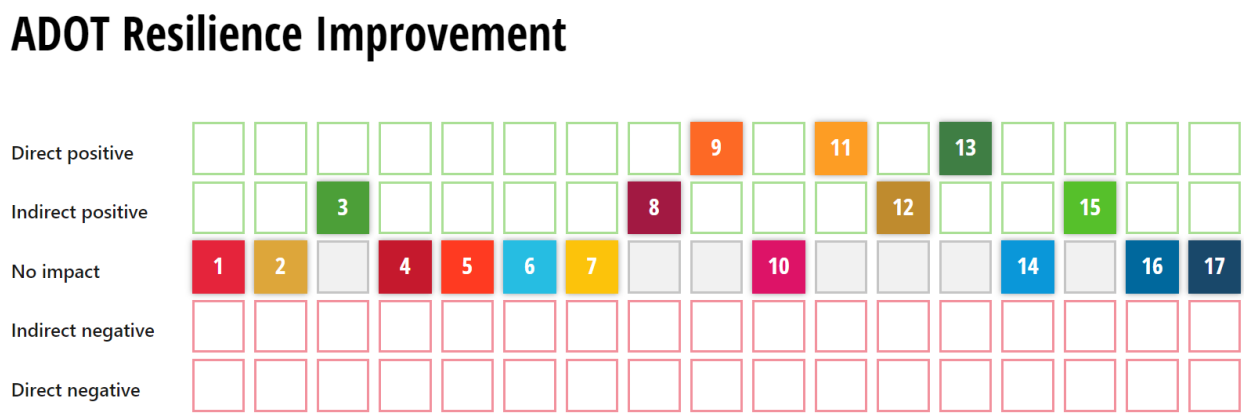

Figure 4.1 - Asset Management Results

Direct Sustainability Goals of Asset Management

SDG 9: Industry, Innovation, and Infrastructure

The goal of SDG 9: *Industry, Innovation, and Infrastructure* is to "build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation". Target 9-1: *Develop sustainable, resilient and inclusive infrastructures* is about creating resilient infrastructure that supports financial growth and human well being in an equitable fashion. Considering that the goal of the report is to find ways to improve Arizona's infrastructure resilience against extreme weather events, ADOT's asset management directly affects this SDG.

SDG 11: Sustainable Cities and Communities

The goal of SDG 11: *Sustainable Cities and Communities* is to "make cities and human settlements inclusive, safe, resilient and sustainable". Two of this SDG's targets, Target 11-2: *Affordable and sustainable transport systems* and Target 11-7: *Reduce the adverse effects of natural disasters* directly relate to ADOT's plan for enacting resilient infrastructure. If infrastructure is made more resilient, the negative impacts of extreme weather events will naturally go down. One part of Target 11-2 is improving road safety and a road that has been worn down by weather will be more unsafe than one that was designed to be resilient against such weather events.

SDG 13: Climate Action

The goal of SDG 13: *Climate Action* is to "Take urgent action to combat climate change and its impacts". Increasing infrastructure resilience in response to extreme weather events directly matches the SDG 13's Target 13-1: *Strengthen resilience and adaptive capacity to climate related disasters*.

Indirect Sustainability Goals of Asset Management

SDG 3: Good Health and Well-Being

The goal of SDG 3: *Good Health and Well-Being* is to "ensure healthy lives and promote well-being for all at all ages". This means promoting healthy lifestyles, enacting preventative measures, and providing good quality healthcare for everybody. One of the targets of this SDG is Target 3-6: *Reducing Road Injuries and Deaths*. Asset management indirectly affects this target as a byproduct of improved asset management would be less accidents on the road caused by failing or dilapidated infrastructure under ADOT control.

SDG 8: Decent Work and Economic Growth

The goal of SDG 8: *Decent Work and Economic Growth* is to "promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all". This means providing economic growth without causing harm to the environment or labor. One part of this is Target 8-1: *Sustainable economic growth.* This target

is specifically about how economic growth needs to be sustainable given a region's circumstances. Naturally, if the resilience of ADOT's infrastructure is increased, the result would be less infrastructure failures which could be harmful to Arizona's economic growth. Thus improving ADOT's infrastructure can indirectly improve Arizona's economic outlook over the long term.

SDG 12: Responsible Production and Consumption

The goal of SDG 12: *Responsible Production and Consumption* is to "ensure sustainable consumption and production patterns". ADOT's asset management plays into SDG target 12-2, *Sustainable management and use of natural resources,* as the roadside vegetation is managed by ADOT and is part of the natural ecosystem of Arizona. Thus ADOT's asset management and infrastructure does indirectly play a part in managing Arizona's natural resources.

SDG 15: Life on Land

The goal of SDG 15: *Life on Land* is to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss". Similar to SDG 12, SDG 15 is indirectly affected by the roadside vegetation managed by ADOT. As stated in the ADOT report " The main goals of roadside vegetation management are maintaining traffic safety, preserving highway infrastructure, and maintaining a resilient native roadside plant community". The roadside vegetation management is a part of ADOT's plan to halt land degradation and promote native biodiversity in Arizona.

Tribal Transportation - Findings

The United Nations includes in the 2030 Agenda for Sustainable Development 17 Sustainable Development Goals (SDGs) with 169 targets. These targets represent the framework with which any activity or project can be evaluated towards truly Sustainable Development.

In the first section of this report, the overview, a general description of what ADOT wants to achieve in the objective of Tribal Transportation was provided. Moreover, the requirements section looked to frame the scope of the assessment, describing specific circumstances of the object that can be relevant when discussing the impacts of the SDGs by the detailed description of its time frame, geographical scope, scale of implementation, life-cycle perspectives, assumptions for the assessment, and requirements and dependencies for realizing the objective. With the overview and requirements, we have enough information to sort whether an SDG is relevant for the object of Tribal Transportation or not. In this sense, where the results found that the following SDGs are relevant to the scope of ADOT's Tribal Transportation Planning: SDG 1, No Poverty; SDG 2: Zero Hunger; SDG 3: Good Health and Well-Being; SDG 4: Quality Education; SDG 8: Decent Work and Economic Growth; SDG 9: Industry, Innovation and Infrastructure; SDG 11: Sustainable Cities and Communities. Once we are aware of the SDGs with which ADOT's Tribal Transport Planning has relevance the most, we can assess its impact on each one of these SDGs, since one SDG can be more relevant than another, and the way they are impacted is not the same. To do this, we must understand what targets each SDG has and how Tribal Transportation relates to them, categorizing each relevant SDG as having a direct or indirect positive impact. In doing so, we are going to describe the definition of each Goal and provide arguments that help understand why its impact was considered that way.

Sustainable Development Goals Directly Impacted by Tribal Transportation

SDG 3: Good Health and Well-Being - Ensure healthy lives and promote well-being for all at all ages.

This SDG is considered directly impacted by ADOT on Tribal Transportation when we look at its targets and find target 3-6, Reduce Road injuries and deaths. As explained previously in this report, ADOT addresses its efforts in Tribal Transportation to the improvements of transportation systems, where they evaluate the actual conditions and how much a new project for transportation infrastructure is going to improve -among other criteria- the safety of the road. This is done by evaluating the actual safety conditions to improve safety for all modes by determining if the project aids in reducing the number of injuries and fatal crashes. Moreover, ADOT assists Tribal Governments with minor transportation projects regarding safety improvements such as adding roadway shoulder/safety edge, sidewalks, road diets, adding/replacing signs and lighting, and bicycle/pedestrian improvements whenever these are needed to improve Transportation safety having a direct impact on the target mentioned before (3-6).

SDG 8: Decent Work and Economic Growth - Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.

In this goal, we can find different targets where Tribal Transportation has a direct impact. Sustainable Economic Growth (8-1), as ADOT evaluates if a new project on a Tribal Community will have an impact on economic development, either by improving the actual conditions and enhancing opportunities for development, tourism, and recreation, or by having an impact on the promotion of beneficial and sustainable tourism (8-9). Moreover, it promotes policies to support job creation and growing enterprises (8-3), since ADOT considers stakeholder (i.e., business owners, Tribal leaders) positions to understand the needs, issues, and concerns of community members and with this improve economic conditions by creating jobs and helping small enterprises in their growth.

SDG 9: Industry, Innovation, and Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

This goal can be considered directly impacted by its target to Develop sustainable, resilient, and inclusive infrastructure (9-1), by understanding ADOT efforts to Improve Tribal Transportation infrastructure and support economic development, with which it also increases access to financial services and markets (9-3).

SDG 11: Sustainable Cities and Communities - Make cities and human settlements inclusive, safe, resilient, and sustainable.

In this SDG, we can understand by a variety of targets why it is considered that ADOT has a direct impact on it. The Arizona Department of Transportation considers all multimodal Transportation Systems in Tribal Transportation, from minor mobility improvements as adding bus stops or bus pull-outs, to ADA requirements, to bicycle and pedestrian mobility options such as sidewalks/shared-use path, with having an impact on affordable and sustainable transportation systems (11-2), inclusive and sustainable urbanization (11-3) and strong regional development planning (11-A) supporting positive economic, social and environmental links between urban, peri-urban and rural areas. Furthermore, ADOT's Tribal Transportation has an impact in an important target as it is protecting the world's cultural and natural heritage by strengthening efforts to protect, preserve and improve tribal communities' transportation infrastructure conditions.

Sustainable Development Goals Indirectly Impacted by Tribal Transportation

SDG 1: No Poverty - End poverty in all its forms.

This SDG aims to end poverty in all its forms by aiming to eradicate extreme poverty (1-1), reduce poverty by at least 50% (1-2), and provide equal access to ownerships, basic

services, technology, and economic resources (1-4). Because of these targets, it is believed that ADOT has an indirect impact on this goal through their tribal transportation projects where they look for economic development and improvement opportunities for the transportation infrastructure, not only focusing on road conditions but also services like water and/or power.

SDG 2: Zero Hunger - End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

In projects where ADOT looks to improve multimodal transportation infrastructure such as adding sidewalks or bicycle lanes, the Arizona Department of Transportation has achieved the goal of providing enough connectivity for pedestrians to reach commercial areas while also ensuring their safety. This has an indirect impact on universal access to safe and nutritious food (2-1), allowing people that are unable to drive to a commercial area to get groceries while having safe and easy access to it. Moreover, it has an impact on rural infrastructure (2-A) by providing services such as water and power to tribal communities where agriculture can be developed.

SDG 4: Quality Education - Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Equal access to quality pre-primary education (4-2) is one of the targets of this goal, which is indirectly impacted by Tribal Transportation as one of the Tribal Communities issues is the decrease of student school attendance. This has been due to a lack of infrastructure available to facilitate travel from a remote location (Tribal community locations) to schools, making travel expensive and causing schools to lose funding due to students' absence. As mentioned before ADOT's projects have the goal of improving multimodal transportation systems in terms of safety and road condition, community to safe walking and bicycle routes,

and affordable transit systems, indirectly impacting access to education by making it possible for students to get to school in a cheap and safe manner.

Recommendations

Asset Management - Infrastructure Resilience - Recommendations

At the moment, the Infrastructure resilience program directly affects SDGs 9, 11, and 13, as well as indirectly affecting 3, 8, 12, and 15, a total of 7 out of the 17 total goals. While this is by no means an outstanding coverage, it is certainly more than adequate when considering the primary focus of the project is on the longevity of infrastructure in a land-locked state that is primarily desert. Such an environment makes it incredibly difficult for certain goals to be influenced, Goal 14's focus around the conservation of marine resources coming to mind. That said, this unique environment also provides the potential for certain objectives to be fulfilled more effectively, such as Goal 15's focus on terrestrial ecosystems and combating desertification.

The Recommendations section will focus around what ADOT may be able to change, add to, or improve the preexisting Infrastructure resilience project in order to further the effects it will have with regards to these SDGs.

- SDG 6: Ensure availability and sustainable management of water and sanitation for all
- SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Recommendations for Sustainable Development Goals

SDG 6: Ensure availability and sustainable management of water and sanitation for all

One of the most important aspects of the Infrastructure Resilience Program with regards to hazardous weather conditions was to do with flood susceptibility and control. As the population of Arizona grows and the availability of water in the local environment

decreases with changes to the local climate, it may prove worthwhile to consider implementing infrastructure centered around reclaiming flood and rainwater as opposed to diverting it. This does not necessarily mean that all of said water must be contained, if such a task was easy it is likely that flooding would not be as much of an issue in the first place, but retaining some portion of the water for use at a later, more desperate date or using it to recharge groundwater reserves would satisfy the objectives of increasing sustainable water use (6.4) and implementing integrated water resources management (6.5).

One less considered impact of floods and large scale rain events is the effects they have on local waterways. The large amount of rapidly moving water is much more capable of picking up pollutants - be they chemical or debris - and moving it all into a nearby waterway in a relatively short period of time. This can be disastrous for the ecosystem of said waterways, and with the anticipation of increased flood frequency the problem is liable to get worse. Considering this, it may be worthwhile to implement strategies similar to those used in western Washington to prevent stormwater runoff from adversely affecting the multitude of waterway ecosystems in the Puget Sound region. One example of such a practice is the implementation of roadside stormwater retention basins in lieu of catch basins that arrest some quantity of water running off of the road and providing a method for it to recharge local aquifers. For parking lots, a much larger impermeable surface, a larger pond may be used instead. Additionally, increasing the permeability of the pavement through porous asphalt may allow more water to penetrate down to the subgrade of the road, allowing the roadways to provide a slight buffer to flooding as opposed to the current amplifying effect it has. However, given the current problems associated with resilience in the face of higher temperatures, porous pavement materials may not be an ideal solution.

SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Arizona's position as a desert state presents a few unique opportunities to effect change on the environment, namely the combatting of desertification. Desertification can occur when local flora with roots vital to keeping the local soil from eroding are removed, allowing the soil to be disturbed and eroded much faster. As a result of lower quality soil in the region, it may prove difficult for the flora that once performed the duty of holding the soil to return, exacerbating the issue further. One event known to kickstart desertification instances is the wildfire, particularly high intensity ones that burn even that which is underground. These types of wildfires are expected to grow in intensity and frequency as evidenced in the report. While the complete prevention of such fires is impossible, it should be possible to limit their frequency, intensity, and impact through proper management of susceptible areas. For example, the removal of long dead plant material that would act as fuel for fires near roadways could make Arizona's road network something of an artificial barrier against the spread of wildfires, presenting a stretch of land the width of a road without any easily blown around combustible material the fire can use to spread. In addition to preventative measures, some level of redress for the local environment may be achieved by way of manually replanting portions of the affected area instead of waiting for natural recovery to kick in. This could potentially retard the effects of erosion on the soil post fire enough to stop the landscape from becoming truly barren.

Tribal Transportation - Recommendations

By the findings section, we can assess ADOT work on making Tribal Transportation Planning more sustainable by identifying the impacted SDGs. As a result of this, it was found that ADOT has achieved an impact -either directly or indirectly- on 7 SDGs. Yet, ADOT has gaps for 10 of these SDGs where it was assessed they have no impact on this planning. Therefore, in this section of the report we are going to share recommendations for the Arizona Department of Transportation looking to have an impact on the SDGs left as no impact on. To begin with this section, the SDG assessment tool was used to graphically illustrate and understand what strategies to use, by identifying what SDGs have no impact.

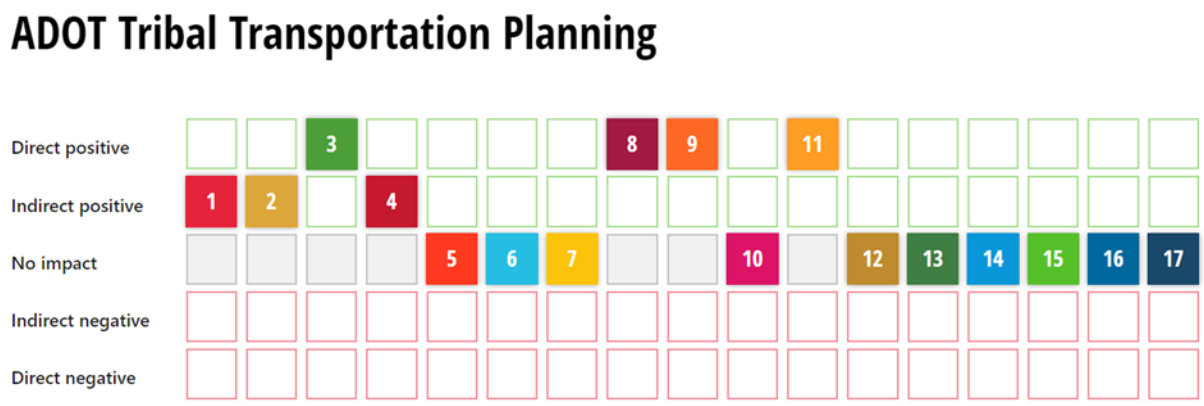

Figure 4.2 - Tribal Transportation Planning Results

The recommendations in this report for ADOT Tribal Transportation Planning focus on having an impact on the SDGs that were assessed as not relevant for these projects rather than only strengthening those that have already been impacted. As mentioned before, the SDG impact assessment was made in a more conservative way with the purpose of making clear and describing how is that ADOT is having its impact, whether directly or indirectly, and to create a strategy for those SDGs where there is still a gap where progress could be made towards sustainable development. As we can see in the image 1.1, we have 10 out of 17 SDGs considered as not impacted by Tribal Transportation, being the following: SDG 5: Gender Equality, SDG 6: Clean Water and Sanitation, SDG 7: Affordable and Clean Energy, SDG 10:

Reduced Inequalities, SDG 12: Responsible Production and Consumption, SDG 13: Climate Action, SDG 14: Life Below Water, SDG 15: Life on land, SDG 16: Peace, Justice and Strong Institutions, SDG 17: Partnerships for the Goals. Anyhow, not all these SDGs can be impacted by Tribal Transportation, but the following strategies are going to focus on those that can be somehow achieved by this planning.

Recommendations for Sustainable Development Goals

SDG 6: Clean Water and Sanitation, Ensure availability and sustainable management of water and sanitation for all.

Particularly in this SDG, we can find targets where ADOT can have a direct impact on. For instance, improve water quality, wastewater treatment and safe reuse (6-3) and support local engagement in water and sanitation management (6-B). This last target focuses on supporting and strengthen the participation of local communities in improving water and sanitation management, being this a focus where the Arizona Department of Transportation can support Tribal communities with resources as campaigns and giving knowledge on how to manage water, implementing integrated water resources management (6-5) and help communities, where applicable, to protect and restore water-related ecosystems (6-6), on communities located on mountain areas, forests, wetlands and rivers. As a matter of fact, ADOT has made progress on one of these targets, safe and affordable drinking water (6-1) by improving water infrastructure in communities where this has been an issue.

SDG 7: affordable and clean energy, Ensure access to affordable, reliable, sustainable and modern energy for all.

As it was explained in the findings section of this report, ADOT does have an indirect impact on energy infrastructure, as it does in water, whenever this is an issue for a Tribal community, improving power infrastructure. However, the Arizona Department of Transportation has a gap when it comes to this goal where different targets could be aimed at. For example, look to a more direct impact by giving Universal access to modern energy

(7-1) to Tribal communities, where it can ensure universal access to affordable, reliable and modern energy services. Moreover, this service could be provided by renewable energy by increasing the percentage of renewable energy (7-2), the improvement in energy efficiency (7-3) and promoting access to clean energy (7-A).

SDG 15: Life on Land, Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

This SDG looks for the protection of ecosystems in some of its targets, where ADOT could help Tribal Communities to integrate ecosystem and biodiversity in Tribal Government Planning (15-9), by supporting them in acknowledging the value of their ecosystems and biodiversity and having an impact into conserve and restore terrestrial and freshwater ecosystems (15-1), by ensuring the conservation, restoration and sustainable use of their territories. Furthermore, this helps to ensure conservation of mountain ecosystems (15-4), protect biodiversity and natural habits (15-5).

SDG 17: Partnerships for the Goals, Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Regarding this Goal, it can be considered that ADOT has made progress with Tribe communities Transportation Partnerships where we can find Hopi Tribe Transportation Partnership, Navajo Nation Partnership and SCAT/WMAT Transportation Partnership. On the other hand, we can also find that there is a gap for the Arizona Department of Transportation in regarding Tribes Partnerships considering that, as mentioned before in this report, there are 22 federally recognized Tribe communities in the state of Arizona. With this information, it is possible to see that ADOT can address efforts towards increasing the number of partnerships, encouraging effective partnerships (17-17).

As a result of having a direct impact on the previous SDGs, ADOT can achieve an indirect impact in some other goals, for example: SDG 10: Reduce Inequalities within and

among countries. Where ADOT can reduce income inequalities (10-1) Tribal communities see themselves affected and encourage development assistance and investment in least developed regions (10-A). Moreover, SDG 12: Responsible Production and Consumption is indirectly impacted as well, by helping these communities in sustainable management and use of natural resources (12-2). SDG 13: Climate Action, whereby having an impact on the protection of the ecosystems as mentioned before on SDG 15, they can build knowledge and capacity to meet climate change (13-3) in Tribal communities. Lastly, the impact of conserving freshwater ecosystems indirectly impacts SDG 14: Life Below Water, protecting and restoring ecosystems (14-2), and reducing water pollution (14-1).

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Team 5 - Freight Plan and Complete Transportation

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Overview

Freight Plan

The ADOT freight plan's primary purpose is to ensure the freight network remains strong while supporting a safe, efficient and reliable system for moving goods in and through Arizona. It also guides decision making and investments related to the transportation networks, and details the importance of freight to Arizona's economy. Freight is reliant on the efficiency of the transportation network, and is in a transformative state as technology alters system demands. ADOT outlines specific goals for success that prioritize safety and adaptation while ensuring economic, social, and environmental responsibility is adhered to.

Arizona's freight network is multifaceted, consisting of highway, rail, pipeline, and air cargo assets. This local and global reach creates complexity that requires careful consideration before any change. Manufacturing has been a driving element of an increased economic dependency on the freight network as major tech, telecom, and military manufacturing companies are moving into the valley and changing demands. Changes must also take international demands into consideration as a state situated between seaports in California and ports of entry from Mexico.

The strategic direction is a focus of ADOT's freight priorities and is portrayed through a vision statement, goals, objectives and performance measures. ADOT's vision statement focuses on working towards national goals while supporting state's economic development, all of which is guided by state and national priorities. For measuring the progress of these goals, measurable performance aspects were developed and detailed on how a goal will be achieved.

Draft goals were based on state and national freight standards and were presented to a Freight Advisory Committee (FAC) for feedback and editing. Stewardship is included in the updated plan to align with ADOT's sustainable transportation program, specifying that the goals cover all freight modes and intermodal activities. The finalized goals are safety, competitiveness, stewardship and system management and mobility.

Safety objectives reflect ADOT's progress towards maintaining a safe and secure freight transportation system. These objectives include reducing the number and severity of freight related crashes and injuries, coordinating with relevant organizations to implement ADOT's Cross Border Plan for safe movement at the international border, identify and address infrastructure and cargo vulnerabilities to environmental and human interference.

System management and mobility objectives reflect how ADOT makes progress towards having a resilient and future-oriented transportation system that enables efficient multimodal freight. These objectives focus on strengthening local-scale partnerships, accepting and adapting to technological updates, maintaining base level operations and addressing climate vulnerabilities in the system.

Competitiveness objectives reflect ADOT's progress towards utilizing strategic policies, investments, partnerships and infrastructure to benefit from economic activities. These objectives focus on building economic opportunities, building supply chain partnerships, sharing data, and developing strategies and policy to improve Arizona's economic preparedness and competitiveness.

Stewardship objectives involve how ADOT makes progress towards economic, social and environmental stewardship. These objectives focus on governance transparency, ecologica--based decisions, increased use of green infrastructure, and an emphasis on social equity based on the ADOT Public Involvement Plan.

Building off these objectives, the plan identifies key elements that will challenge these goals. Some of these strengths are inherent due to the geographic location of Arizona, and some

are a result of careful planning. Similarly, there are a number of weaknesses within the system that are outside the control of ADOT.

To prioritize which areas need focus, ADOT uses this framework to analyze each project, and will allocate funding as necessary. This results in a “financially constrained” investment plan that can be pursued with federal funding. Future benchmarks are outlined that will guide plan efficacy analysis and direction into the future, ensuring success in continued management and growth of Arizona’s freight network.

Complete Transportation Guidebook

The complete transportation guidebook is an Arizona Department of Transportation (ADOT) publication that explains the concept of “complete transportation,” why this approach is useful, and how ADOT can strategically utilize it in infrastructure development and management. Complete transportation is an approach to transportation management that emphasizes effective and efficient performance of the transportation system, while also positively impacting the “triple-bottom-line goals” of social quality of life, economic competitiveness, and natural environment preservation. Despite massive efforts and progress within ADOT, there are many challenges that arise through the process. These include adequate funding reliability, population changes, and evolving travel preferences. However, through the challenges come benefits such as lower household transportation costs and land use and transit planning integration, improving road safety, addressing environmental impacts, and promoting healthy communities by encouraging physical activity and active transportation opportunities..

To create a comprehensive and complete transportation system, ADOT follows seven strategies that consider the needs of all users like community goals, safety, and mobility. ADOT's project development phases are interconnected decision-making cycles. The planning and scoping phases offer various solutions, impacting transportation investment choices beyond individual projects, including regional strategies and network solutions. The

first strategy involves understanding the project's context, considering the physical environment, road usage, community goals, and economic priorities. Forming partnerships is the second strategy, enabling flexibility, cost-sharing, improved communication, and public support through each stage. ADOT's strategies continue by defining measures of success that encompass broader project goals. Further collaboration with project partners defines goals and generates alternative solutions. The final strategy focuses on creating a plan for all users and modes of travel, promoting various travel choices and safe access. Integrating complete transportation into ADOT's project development and design processes ensures context-aware solutions for all roadway users. These strategies guide ADOT towards developing an efficient and complete transportation system.

Understanding a transportation project's context involves considering various factors like land use, demographics, economic activities, and environmental assets. Multiple tools, including land use plans, economic development plans, and community meetings, aid in assessing the project's context. This understanding is crucial for Arizona's rapid growth, as it enables ADOT to design facilities that support the triple-bottom-line goals. Proper implementation of this plan leads to community support, improved livability, partnership opportunities, and tailored mobility solutions.

Complete transportation should be incorporated early into the project's planning and scoping to correctly evaluate and construct solutions. Planning can vary from statewide to mode specific plans and is important to identify a plan's needs as well as build trust in the project's development. Scoping includes the input of the project's environmental impact, stakeholders needs, and the project concept and cost. Complete transportation design elements for activity centers in multiple different areas can be broken down into four different categories: traveled roadway realm, pedestrian realm, intersections, and transit. By prioritizing elements like design speed, vehicle size, multimodal use, and more, safety and efficacy of transit assets can be effectively designed to serve all users. Activity centers can be designed according to whether it's located in urban, suburban, or rural areas.

In the end, there is no one size fits all solution for designing transportation assets. The various area types, design elements, goals, and constraints must be considered through the design decision making process, and the complete transportation guidebook allows for flexibility in needs and contexts. The plan also provides a framework to improve the design and management of transportation infrastructure on longer time scales, creating social management sustainability through various users and asset managers. The guidebook, if implemented correctly, provides a matrix and metrics of action that ADOT can utilize in various cross-scale situations to improve the movement and living of people statewide.

Requirements

Detailed description and discussion of the SDG Impact Assessment Tool Step 2 requirements.

Freight Plan Assessment Scope

When beginning to analyze the Arizona Freight Plan in terms of the SDGs, there are several assumptions and perspectives that must be considered before an adequate and thorough analysis can be done. First, there is a general acknowledgement that financial capital remains a large inhibitor of any large-scale infrastructure or asset transformations, updates, and changes. The freight plan addresses financial constraints in chapter six, and utilizing their framework to understand financial priorities will allow a parallel analysis in terms of SDG analysis. Further, sources of funding may often have directed guidelines as to what those funds may be used for, and how rapidly. Simply put, having money is difficult in the first place, and having it in general doesn't mean it is always free to use. Regardless, financial capital is required of all improvements made in the physical asset realm, and oftentimes in the internal restructuring or consulting realm.

Another assumption to be made throughout our assessment of the SDGs is that ADOT and asset managing authorities manage only the assets related to the movement of freight and storage of those assets, but do not control that actual freight itself. Therefore, there cannot be any direct preference given to certain goods or cargo that may aid in achieving the SDGs. However, there will be consideration given to the partnerships or initiatives that may exist across institutional, state, or national boundaries that may incentivize certain goods to utilize Arizona's freight network at higher rates.

Life-cycle perspectives in analyzing the freight network must, to some degree, be constrained or outlined clearly, to allow for clarity in the final analysis. Our analysis will take a macroscale approach in most cases, analyzing how management and development of the freight network as a whole will be connected to the SDGs. Taking a closer look at subsystems will include breaking the freight network into its various modes, such as rail, truck, air, and pipeline, as each will have different implications in this analysis. Further, life-cycle assessment will be difficult within certain contexts of the freight plan, as analyzing the life cycle of governance of a network, with the assumption that the network is intended to grow and adapt to further increases in demand and use patterns, may yield incorrect conclusions about the efficiency or effectiveness of the network itself. As a result, material life-cycle assessment, while pertinent to the assets used within the freight networks, will not be a main focus of analysis. Instead, the life-cycle will be considered with the aforementioned understanding that the network will continue to grow.

The freight plan itself follows this format for the most part, but specifies some scenarios for improvement, largely outside the scope necessary for this analysis. As mentioned, there will be room for exploration into the partnerships that may further these goals, and local DOT and community organizations will be useful for further analysis at cross-scale boundaries at these smaller scales.

Geographically, ADOT remains focused largely on how actions within the State of Arizona may individually hit any of the 17 SDGs. Time wise, policy and implementation moves slow,

especially when approaching the state, federal or international level. As a result, certain timelines may be largely disregarded in the initial analysis as a "snapshot" analysis perspective is adopted. This will allow the analysis to touch on various avenues for improvement, and provide room for further in-depth analysis into topics or areas that are considered most feasible or desirable by policymakers. It is worth noting, however, that the SDGs were established in 2015 with a 15 year target to achieve substantial growth by 2030. This creates some issues with achieving these goals and keeping a continued focus on striving for improvement in the freight network. For analysis, we will assume that the 2030 benchmark will not be the boundary of improvement, but will instead emphasize the necessity to focus on these topics in a timely manner.

The freight plan does outline some variations in region versus statewide approaches, touching the unique needs of highly urban corridors or rural areas. Analysis can be made in both areas, as both will need unique understandings of the needs of freight, and the impact each area may have on achieving the sustainable development goals. Considering these assumptions and unique specifications will allow for a more thorough analysis of the freight plan in the context of the SDGs.

Increasing access to data and analytics of freight transportation in Arizona is going to be key to meeting the objectives. IHS Markits Transearch Database is a tool used to monitor freight moving through the state. It has been an essential tool in gathering, forecasting, and understanding freight movements while developing the AZ Freight plan. By continuing to monitor the progress and changes to demand through this tool, agencies will have a better understanding of the impacts being made and where continuing work needs to be done.

Complete Transportation Guidebook Assessment Scope

ADOT's Complete Transportation Guidebook outlines a development framework to utilize transportation infrastructure for more than just moving goods, but also to revitalize and protect the social and ecological systems within which that transportation infrastructure exists. Other goals include improving road safety, reducing traffic congestion, and

enhancing public transportation. As a result, understanding the interconnectedness of the social, ecological and technological systems is crucial for making any sort of analysis of the efficacy of the transportation guidebook, especially when comparing to the SDGs. Both the complete transportation guidebook and the SDGs depend on cooperation of cross-scale institutions to manage the transformation of the system. Further, all initiatives are dependent on policy guidance and funding to aid in implementation of the plan statewide. The complete transportation guidebook is unique in that the underlying goals of the report itself could be considered parallel, in many ways, to the sustainable development goals. In an effort to focus our analysis in a more useful way, we will operate with certain assumptions about the system, as well as certain limitations and boundaries in our scope of analysis.

First, as with most public agencies like ADOT, an assumption must be made that financial capital and fiscal freedom may be very limited, and impede certain “ideal scenario” goals. Recommendations and analyses may, as a result, emphasize a governance or policy approach as opposed to a “hard infrastructure” approach. Internal changes to the system of governance can be slow, but may be more attainable in the short term than increased or redirected funding options. Further, another assumption that can be made is that the complete transportation approach inherently addresses and emphasizes the social and environmental welfare of our communities. Without these factors, complete transportation is a misnomer, so less emphasis may be placed on local initiatives in this regard, as it is assumed to be a goal of the report already. There are risks and uncertainties that need to be assessed and accounted for future planning. Construction delays and increased pricing could prevent a project from being completed in the desired time frame. With the rise in autonomous vehicles, traffic patterns have the potential to change.

The entire life cycle of the project will consist of planning, construction, maintenance, operation, and decommissioning or upgrading. During the planning phase there will be lots of engagement in issues such as permitting for environmental issues, meetings about land use and studies done for design. During construction, there will be environmental impacts

including increased pollution from noise and construction equipment. The local communities will be impacted by the increased traffic, noise, even detours. The positive of construction is that there will be an increase in jobs for the area. During operation, cars will have greater accessibility to their destination. There may be an increase in pollution due to vehicle emissions. In the future, at the end of its life cycle, the used materials will need to be disposed of. Reconstruction will lead to delays in traffic for the surrounding communities and there will be an additional cost to start the reconstruction or remediation.

The guidebook itself adopts a time frame assumption of up to thirty years for the development process and as a result, considerations will be made within that timeframe as well. However, it is worth noting that the SDGs were adopted with the hope that they would be achieved by 2030. The passage also elaborates on the critical need for early incorporation of the "complete transportation" approach into project planning and scoping. It illustrates that when complete transportation is not included at the beginning, it can lead to future issues such as increased congestion and the relocation of buildings and roads. This emphasis on early integration underlines the importance of considering long-term impacts and the need for proactive planning that extends well into the future. To avoid discrediting progress for the sake of timeliness, the analysis will adopt the complete transportation guidebook timeframe for development, as it outlines the framework for action as such. This extended temporal perspective is crucial to recognizing the dynamic nature of geographical settings and the need to adapt transportation solutions to evolving conditions over time. It highlights the importance of a persistent commitment to sustainable transportation development that accounts for geographic changes, such as population growth or shifts in land use, that may occur over several decades.

Geographically, the complete transportation guidebook looks at various scales including local, regional, and statewide. Understanding how ADOT is approaching each of these scales will be crucial in understanding the impact of these scales on the sustainable development goals. It acknowledges the diverse range of geographical settings within

Arizona's transportation environments, including urban, suburban, rural, and special use areas. This acknowledgment highlights the importance of tailoring transportation solutions to the specific needs and expectations of each region, underlining a commitment to addressing the unique mobility and infrastructure demands of different areas. The passage further advocates for the application of the "complete transportation" concept across these varied geographical settings, with the goal of attaining complete transportation objectives in all these contexts. This exhibits a commitment to adapting transportation planning and design to local conditions, accounting for factors such as population density, economic activities, and demographics.

Findings

Complete Transportation Guidebook Findings

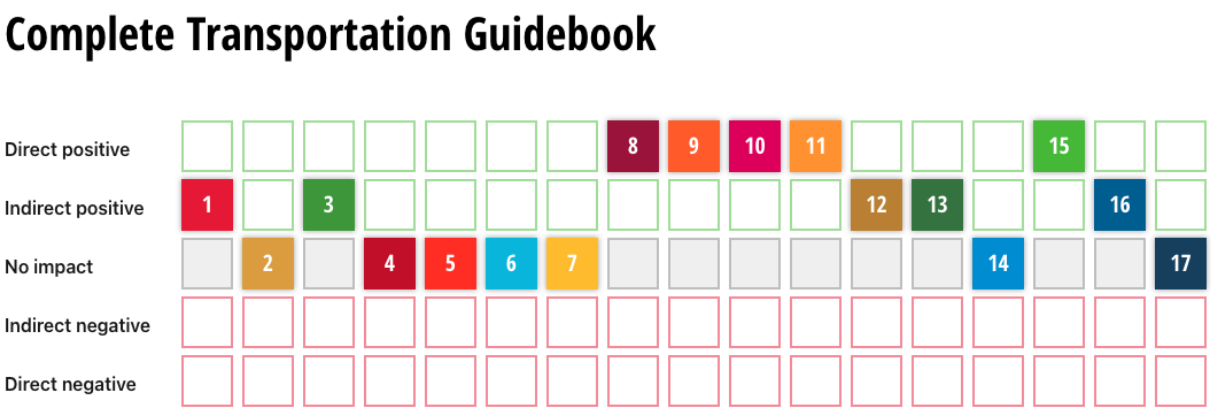

Figure 5.1. CTG results from SDG Assessment Tool[4]

The ADOT Complete Transportation Guidebook (CTG)[1] inherently aligns with many of the UN SDGs[5], and further analysis highlights areas of near perfect alignment, as well as areas for further growth with ADOT initiatives. Initial analysis identifies some key SDGs that are directly supported by the complete transportation Guidebook, including SDGs 8, 9, 10, 11, and 15.

Starting with direct positive alignment, we can see that one of the goals of the CTG is economic competitiveness within communities as a result of transportation systems. This directly supports SDG 8: Decent Work and Economic Growth. By emphasizing local and state-wide economies, there will be increased demand on transportation infrastructure. Subsequently, this will demand the need for further complete transportation infrastructure, which further incentivizes communities to utilize the infrastructure. This cycle supports economic development across all communities. By focusing on the ecological health of the communities through the transportation infrastructure, target 8.4 can be achieved by finding novel pathways to allow for economic growth coupled with ecological protection through roadway degradation prevention and air quality improvements with reduced automobile pollution.

Complete transportation will also improve tourism opportunities and experiences, which will further bolster local economies and provide employment opportunities community wide. Finally, rural communities would be served as well by increased access to urban areas and resources, which spreads opportunities and benefits to well outside urban areas. These initiatives also aid in achieving SDG 9, which emphasizes utilization of sustainable infrastructure to widen equitable financial and social opportunities.

SDG 9 is further achieved through applying the complete transportation framework when analyzing infrastructure updates that may change the layout and land use patterns of transportation infrastructure. This also incorporates enhanced scientific approaches to transportation and urban planning practices, utilizing modern understandings of communities and transportation infrastructure as complex social-ecological-technological systems. These approaches again act as proof of concept for large scale transportation and community management that can be emulated nation and worldwide.

This joint focus of transportation infrastructure as a mode for moving goods as well as a tool for revitalizing and protecting social and ecological systems achieves SDG 10 in many ways, as well. By focusing on inclusive economic growth, the bottom 40% of the population

wealth wise can be provided pathways for transportation and employment, widening their opportunities for economic success. Inclusivity in transportation infrastructure can also work to reduce gender inequality where, due to safety concerns, women and children may not be able to use infrastructure during certain times of day or even at all. By reducing automobile pollution, particularly in underserved communities with less green development, equitable health opportunities will be increased across the state. These efforts also aid in achieving SDG 15 by preserving natural resources through the infrastructure development life-cycle and implementation.

All of the aforementioned efforts aid in the achievement of sustainable communities, which aligns with nearly every SDG 11 target. Efforts to reduce pollution (11.2, 11.6), increase walkability and public transportation (11.2, 11.3, 11.7), reduce car dependency (11.2, 11.6, 11A, 11B), and foster ecological and economic protection and advancement (11.1-11.4) all aids in a sustainable community. These targets are all achievable and expected from utilizing the complete transportation guidebook framework, especially when utilizing the framework early in the project development cycle.

There are also a number of areas where the complete transportation guidebook may indirectly support the achievement of the UN SDGs, namely goals 1, 3, 12, 13, and 16. Through efforts to increase economic competitiveness through transportation infrastructure and planning, community economies can be bolstered and assist in mobilizing resources to decrease poverty across the state (SDG 1.2, 1.3, 1A). SDG 1.5 can also be realized as a result of building walkable and transit-oriented communities. The CTG also may increase the access to healthier communities and access to health resources, which may help achieve SDG 3. Especially SDG 3.6, reducing road injuries and deaths.

SDG 12 can be at least partially realized through current CTG by considering material use and operational emissions in project developments, as well as creating infrastructure that allows for sustainable lifestyles by community members. SDG 13 can somewhat be achieved similarly, where sustainable infrastructure and resilient planning can be utilized to

mitigate the effects of climate change on communities, by incorporating green infrastructure for flood mitigation, reducing urban heat island effects, and increasing natural shading to block sunlight (13.1, 13.2).

Finally, SDG 16 has some potential of achievement not only within Arizona, but also globally as ADOT could outline best implementation practices of complete transportation in climate sensitive communities, like the Phoenix Valley, that can serve as a framework for climate adaptation in vulnerable communities globally. This also may allow for increased community buy-in and increased transparency in the ADOT planning process, which again can be emulated in other nations and communities where co-management and governance will be necessary to adapt to the future.

Freight Plan Findings

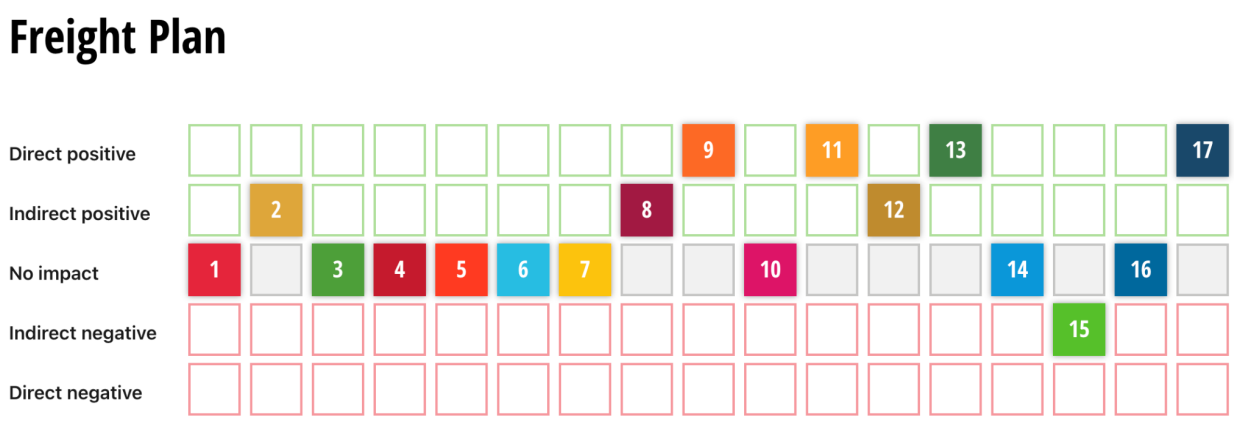

Figure 5.2. Freight Plan results from SDG Assessment Tool[4]

The capacity for impacting the UN SDGs through the ADOT State Freight Plan[2] has some limited capacity but still presents areas of SDG achievement, as well as areas for great improvement. Initial analysis highlights the ADOT Freight Plan positively impacting SDG 2, 8, 9, 11, 12, 13, and 17, both directly and indirectly. Conversely, there are some highlighted negative impacts when considering SDG 15: Life on Land.

Positive impacts on the SDGs via the Freight Plan lie mostly in the infrastructure and resource movement realms of SDG 2, 9, 11, and 12. Due to limitations of ADOT when it

comes to controlling the actual type of goods moving across the freight network, the Freight Plan mostly expands the opportunities of SDG achievement, rather than immediate realization of SDG achievement. For SDG 2: Zero Hunger, the Freight Plan may increase the capacity to spread food resources in a more efficient and timely manner to underserved communities within the state and immediate surrounding communities, including Mexico. This helps to achieve targets 2.3, 2A, 2B, and 2C.

Similarly, by following sustainability initiatives in the Freight Plan by focusing on more sustainable modes of freight movement and sustainable infrastructure developments, SDG targets 9.1, 9,2, 9.4, and 9.5 can be more easily achieved. The same initiatives will aid in reaching similar targets 11.2 and 11.3. Specifically, Freight Plan objectives 2.5 and 3.4 highlight efforts within ADOT to mitigate and adapt to natural disasters. This directly addresses 11.5 and 11B, as well as SDG 13.1. Due to the capacity for positive impacts on the SDGs, whether indirect or direct, ADOT has the ability to model the way of financing infrastructure and governance practices in cooperation with partner institutions throughout the state and surrounding states or countries. This will assist in achieving SDG 17, specifically mobilizing domestic resources (17.1), sharing knowledge of best practices (17.6), and bolstering global economies through trade (17.11, 17.13, 17.17). This is especially prudent when considering that 13.6% of freight tonnage in Arizona is a result of international trade, as outlined in the Freight Plan. Furthermore, bolstered rail capacity connecting to ports in California and Mexico would increase the capacity for north-south and international trade, achieving SDG 17.9

When considering harm to the SDGs, consideration must be made again into the capacity for ADOT to make positive changes in certain sectors or approaches. For SDG 15: Life on Land, there will be certain challenges and obstacles to mitigating harm to these sub-targets, as the very development of freight infrastructure will have some level of habitat destruction. This leaves room for exploration and growth into solutions that can greatly shift the harmful impacts of freight infrastructure.

Recommendations

Complete Transportation Guidebook Recommendations

As outlined above, the present and potential synergies between the ADOT CTG and the UN SDGs are abundant, given the intent of the CTG to emphasize economic strength, natural resource protection, and social quality of life. While this is effective at shaping the communities to be more aligned with the SDGs, there is still room for improvement when expanding the scope of ADOT planning and development with the complete transportation framework. For example, more effort can be made on prioritizing sustainable procurement of resources to transportation infrastructure, which would strengthen the ADOT compliance with SDG 12. This approach could also be implemented more easily across scale and urban-rural boundaries, allowing for more expedient success in SDG achievement. This should also be considered a part of complete transportation, as the ecological impact of development projects does not only exist where the development itself happens.

Further, SDG 12 emphasizes sustainable tourism, which would be aided further by sustainable communities within Arizona. For example, many communities in Arizona that are tourist heavy are also incredibly car dependent and lack walkability or public transportation options. This can be seen in places like Scottsdale, Flagstaff, and Sedona. With main, high speed or heavily trafficked thoroughfares in the downtown sections of these communities, the ability to navigate the community is limited to largely car dependent modes and sustainable lifestyles are not as achievable. By emphasizing walkability, green infrastructure, and public transportation options in these communities, SDG 12 can be more easily achieved.

Due to overlap in SDG sub-targets, multiple objectives could be hit with intentional and careful planning and incorporation of the CTG. For example, not only do the above mentioned examples promote sustainable lifestyles and tourism, but they also increase the health of the land and ecosystem by reducing car dependency and increasing green spaces

and natural infrastructure. This further strengthens SDG 3, 6, and 13. SDG 13 can be achieved by emphasizing the importance of pollution reduction to communities, with the intent on reducing air pollution from automobiles within urban areas. SDG 6 can further be strengthened by realizing the importance of natural permeable surfaces to allow for water runoff and ecosystem services in terms of natural water cycle sanitation. SDG 13 can be achieved by emphasizing not only immediate land use impacts on the environment, but the long-term impacts of using transportation infrastructure on the communities in which it is built. Incorporating this awareness into a risk and damage assessment through the planning process can preserve these SDG achievements.

While initial analysis may separate much of the urban development initiatives that may aid in SDG achievement, ADOT must acknowledge the power that transportation infrastructure itself has on the fabric of urban areas itself. The CTG proposes a framework for analyzing transportation projects, but developing this framework to a wider urban planning lens could increase sustainable partnerships in accordance with SDG 17, such as with city and regional planning offices, urban planning consultants, and locally led community representative groups. This will allow ADOT and community partners alike to hit a wider set of goals and initiatives that serve the organizations and communities.

Freight Plan Recommendations

First steps for change should be when addressing SDG 15, as it has a negative relationship with freight in itself. While there are struggles with entirely preventing ecological harm, there is existing capacity for ADOT to expand its focus when planning to start to address these sub-targets. By starting with targets 15.9 and 15A, increased financial and planning resources will be allocated to ecosystem and biodiversity protection. This means increasing emphasis on the stewardship guidelines from section 4.5.4 of the freight plan. By increasing easements and reconstruction efforts of habitats surrounding infrastructure developments, targets 15.1-15.5 can begin to be realized in the state, though there will still be limitations on total achievement of these targets. To widen a road or build a railway or

runway is to inherently harm the natural ecosystem in some capacity, whether through habitat destruction, heat island effect increases, or even air quality degradation from the use of that infrastructure. Regardless, emphasis can be placed on the planning process similar to the incorporation of the complete transportation approach in building efficient and effective transportation infrastructure.

To increase the efficacy of some of the indirectly positive targets, there are a few actions that ADOT can focus on that considers the budget and personnel reality in the organization. Despite lack of control over the goods that flow through ADOT infrastructure, ADOT can encourage or even enforce some level of reporting from primary corporate users of the infrastructure as to how the corporation can utilize ADOT infrastructure to achieve the SDGs more effectively. This reporting alone achieves target 12.6. To aid in achieving 12.5 and 12.7, ADOT can emphasize sustainable procurement practices to reduce development waste and reduce the harmful ecological impacts over the life cycle of their developments. Further, by incorporating inspiration from similar organizations like New York City DOT, striving to emulate programs like the NYC Clean Trucks program[3] to further achieve SDGs 3 and 6. Finally, to ensure maximization of positive progress within freight planning, regular assessment and revision of Arizona freight networks will be necessary. ADOT should incorporate regular SDG reviews and analyses of sustainable development initiatives to keep the state freight network strong, efficient and sustainable into the future.

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Team 6 - Carbon Reduction and State Rail Plan

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Overview

Report 1: Carbon Reduction Program

The Clean Transportation Emissions Reduction Program (CRP) is aimed at funding projects that reduce carbon dioxide emissions from on-road highway sources. To receive CRP funding, ADOT is required to develop a Carbon Reduction Strategy (CRS), which is presented in this report. Arizona is set to receive $114 million over five years through the CRP, with 65% of these funds allocated to urbanized areas. Beneficiaries of the CRP

allocation include the eight Municipal Planning Organizations (MPOs), including Central Yavapai, Lake Havasu, Maricopa, MetroPlan Flagstaff, Pima, Sierra Vista, Sun Corridor, and Yuma. These MPOs have prioritized their regional CRP projects through local processes, ensuring effective fund utilization. The CRS represents a comprehensive approach to reducing transportation emissions inline with the Federal Infrastructure Investment and Jobs Act of 2022.

ADOT has developed the CRS by exploring the objectives in Arizona's Statewide Long-Range Transportation Plan (LRTP) in order to identify where efforts already exist to support the reduction of carbon emissions. Federal requirements state that the CRS must be updated every four years, and ADOT's intent is to integrate future CRS updates into Arizona's future LRTP in 2028. ADOT has developed this strategy in consultation with the MPOs and Arizona tribes. The MPOs are planning and evaluating options for projects to utilize CRP funds based on unique local needs.

In Arizona, 46.3% of the total carbon dioxide emissions come from the transportation sector. ADOT aims to reduce emissions by 1) reducing vehicular fuel consumption, 2) reducing vehicle miles traveled, and 3) reducing emissions from construction and maintenance projects. This includes projects to improve vehicle fuel efficiency, mitigate congestion, promote electric vehicles, and improve access to transit and active transportation options. ADOT also suggests a reduction in freight emissions because freight creates more emissions than passenger transportation. All plans must account for projected state population growth.

ADOT defined five categories of transportations projects and strategies which can support the carbon reduction plan in Arizona. These include the 1) Statewide Truck Parking Plan, 2) the Transportation Alternative Program, 3) the Electric Vehicle Infrastructure Deployment Plan, 4) a Pavement Management System, and 5) Infrastructure-based intelligent transportation systems capital improvements.

The 2050 LTRP vision, goals, and objectives support the reduction of on-road carbon emissions in Arizona. Seven policies, each with different objectives, are the foundation for its vision. These policies are to 1) preserve and maintain the system, 2) enhance safety and security, 3) improve mobility, reliability, and accessibility, 4) have environmental and health stewardship, 5) support equitable access to the State Highway System, 6) strengthen partnerships, and 7) support economic vitality.

ADOT is implementing performance measures and targets to assess progress in achieving its environmental objectives, particularly in reducing on-road mobile source emissions. ADOT's current estimation of emissions reduction is facilitated through its air quality performance measure, quantifying the benefits of air quality derived from investments supported by the Congestion Mitigation and Air Quality federal program. ADOT is committed to further enhancing its environmental efforts, with plans to introduce additional embodied carbon tracking and performance measures.

Achieving the CRS goals poses significant challenges. Arizona's projected population growth, limited transportation funds, and substantial freight activity present formidable obstacles. In response to these challenges, ADOT seeks to strengthen partnerships with stakeholders including Metropolitan Planning Organizations (MPOs), the logistics industry, and transit agencies. ADOT aims to bring about meaningful carbon reductions through a comprehensive efficient and multimodal transportation network , contributing to the broader national goal of a net-zero transportation future.

Report 2: State Rail Plan

The ADOT State Rail Plan Update report details the current state of the rail network infrastructure and use in Arizona, projected future demands and associated infrastructure needs, and project management and investment mechanisms to support these demands.

This includes detailing progress and plans to improve the passenger and freight rail networks, amplify the economic benefits of rail within Arizona, outline rail investment mechanisms to maintain the system and accomplish new goals, and coordinate rail planning with ADOT's broader vision for the Arizona transportation system.

Arizona has a large network of railroads including two Class I (long-haul) lines and nine Class III (short-haul) lines, consisting of nearly 2,000 miles of track. Each Class I railroad runs east-west across the state, with the BNSF line passing through Flagstaff and Kingman (with a branch to Phoenix), and the Union Pacific line passing through Tucson and south of Phoenix in Maricopa. The Class III lines are dispersed throughout the state and connect to the Class I lines. Most lines carry primarily freight of varying types, from mining products in Arizona to shipments of diverse goods to and from Mexico and the ports of Los Angeles and Long Beach, which comprises a large portion of Union Pacific's nationwide traffic. Growth in freight traffic across the state has motivated ongoing plans to expand the freight rail network. Passenger rail, by comparison, has much lower demand. Two Amtrak lines operate along Arizona's Class I lines, but infrequent service times and lack of direct service to Phoenix limit ridership. Currently, early plans to implement passenger rail between Phoenix and Tucson have been developed, and the feasibility of commuter rail in Maricopa county is being evaluated.

Improving on the current lack of passenger rail options is a focus for ADOT. ADOT surveys have shown widespread public interest in passenger rail with speed, route location, and frequency among the current barriers to increased ridership. In line with both metropolitan and statewide needs, ADOT is prioritizing expansion of passenger rail for three key purposes, including 1) travel between other major southwest cities (like Los Angeles and Las Vegas), 2) travel along the Tucson-Phoenix Corridor, and 3) commuter travel within the Phoenix metropolitan area. ADOT is participating in multiple collaborative planning efforts to complete these goals. The Southwest Multi-State Rail Plan (MSRP) includes stakeholders from Arizona, California, and Nevada. The MSRP has projected significant growth in trips along major city-to-city corridors in the region, finding that large portions of urban

populations could be effectively serviced with passenger rail that is comparable to air travel times in some cases. The Tucson-Phoenix passenger rail corridor is similarly expected to see growing demand, primarily from commuters. Options for Phoenix commuter rail are currently being evaluated for ridership, travel times, and cost. In both the Tucson-Phoenix and intercity Phoenix cases, ADOT recognizes the need for passenger rail to lessen demand on the region's strained freeway network. Implementing passenger rail is a key strategy to reduce peak hour traffic congestion and commute times.

ADOT is focusing on a variety of freight rail issues as well. ADOT recognizes a significant difficulty for prospective shippers to access major lines due to imposed infrastructure requirements designed to maintain flow by the railroad companies. It is recommended to increase use of industrial parks to share these access costs, and transload facilities that connect to lines via trucks. ADOT has also identified several areas in need of improved line connectivity, especially in the Phoenix area. Both construction of new lines and reactivation of unused rail lines have been proposed to better connect Phoenix to the nationwide network. To improve commerce from Mexico, expansion of the Nogales border crossing rail infrastructure is also proposed. Arizona's shortline railroad are in varying condition and face unique arid climate risks, so funding to improve these connecting lines are crucial. Finally, several urban rail crossings are in need of safety improvements to prevent future automobile collisions and deaths.

In line with ADOT's 2045 vision for an efficient multimodal transportation system, extensive rail investment projects are being completed. These projects improve freight and passenger rail capacity, mitigate automobile congestion, improve multimodal safety, lessen transportation emissions, and facilitate economic and job growth in Arizona. These goals require a collaborative effort with stakeholders including neighboring states and Mexico, city governments, planning agencies, and local citizens. ADOT envisions significant increases in rail investment as a core component of the state's development strategy in the coming decades.

Requirements

Carbon Reduction Plan

The purpose of the CRS is to provide a vision and objectives to decrease carbon dioxide emissions due to transportation in Arizona. The completion of the CRS will allow Arizona to receive $114 million over five years in funding from the CRP. ADOT has developed the strategies in the CRS by further examining the 2050 LRTP which describes the current efforts made to reduce the emission of carbon dioxide across Arizona's transportation infrastructure and where additional resources could be utilized.

Requirements/Dependencies

The CRS is subject to requirements imposed by the federal government such as an updated CRP every 4 years and an allocation of 65% of the 5 years funds to urbanized areas in accordance with their relative share of the state population. It is also government organizations such as the federal government, Arizona's Metropolitan Planning Organization, the Environmental Protection Agency, and Arizona's Tribes that determine the funding, timeline, and data acquisition for the program.

Assumptions made for the assessment

In the context of the SDG assessment there have been several key factors to the ADOT CRP that have been assumed. The first assumptions that have been made include the steady and constant increase in the Arizona state population, employment rate, and temperature. These assumptions are based on the accuracy of this data, and that this will remain constant so that the plan will align with these predictions. ADOT also strongly assumes that there will be an increase in the use of electric vehicles, and that this use will outweigh that of the use of standard combustion vehicles. The use of freight is also assumed to decrease

using other modes of the transportation of goods. These assumptions are backed by the future changes in the Arizona state transportation infrastructure.

Life-Cycle Perspectives

Regarding the life-cycle perspective in the case of the SDGs there are several phases to this project. These phases include the material extraction, production, manufacturing, construction, use, and end-of-life. In the beginning production and construction of vehicles, materials, roadways, and other items connected to the creation of the transportation system in Arizona. This production and manufacturing phase also encompasses the transportation of these materials through freight and other means. The use phase encompasses the majority of the CRP. This phase is where the highest change will take place. In this phase there will be changes to reduce the VMT, tailpipe emissions, the type of vehicles in use, and the transportation of goods. As ADOT plans to reduce emissions and change all of these sections this portion of the life-cycle is the largest. With the end-of-life in mind regarding this plan we can assume that this will fall outside of the current ADOT timeline because there will always be emissions, and there will constantly be updates to the plan. ADOT currently has reductions planned to 2050.

Scale of Implementation

For the purpose of the SDG assessment, it is important to understand the scale of implementation of the project, and to which extent it will affect transportation systems in their current state. From the Statewide Truck Parking Plan to Pavement Management Systems, ADOT has defined specific categories of transportations projects and strategies which can support the carbon reduction plan. These strategies have different scale of implementation as some constitute minor rehabilitations while others demand considerable investments such as the Electric Vehicle Infrastructure Deployment Plan. To execute such vision and objectives, an effective collaboration between the various governing bodies in Arizona is primordial. As such, cooperation among the state's MPOs is

the best approach to reach the numerous environmental targets set by the CRS and to attain net-zero greenhouse gas emissions by 2050.

Geographical Scope

The scope of the CRS and its accompanying policies and objectives is limited to the state of Arizona, and to its various counties and cities from major urban areas such as Phoenix to small rural communities. This scope pertains to all roadways, infrastructure, policies, cities, and counties within the state. As the state continues to grow, so will the transportation system and infrastructure, and therefore the increased need for emission reductions. While this is the case the plan will constantly encompass the entire state, and need to be continuously updated to fit the needs and requirements set in place. Furthermore, connecting population centers with various transportation modes in Arizona, which contains a wide variety of landscapes and terrain, is in ADOT's purview. As such, it will strive to do so in the most efficient and sustainable manner possible, and will thus aim to implement the CRS objectives into its transportation system and infrastructure while maintaining operational roadways.

Time frame

There is no definite time frame for the specific policies or goals set by the CRS to achieve the net-zero greenhouse gas emissions by 2050. However, since the CRP is updated every 4 years, the CRS is regularly amended to fit the new requirements set by the EPA or the federal government. Furthermore, the vision of the program being to make transportation across the state more sustainable and carbon-free in the long-term, it is to ADOT's interest to implement changes rapidly to further collect funding for the required investments. In line with this plan, our SDG Assessment will focus on 2050 as a goal for carbon neutrality with 10-year milestones for increasing levels of progress in 2030 and 2040. To acknowledge that many carbon reduction projects will not be finished by 2050, the SDG assessment will continue to 2070 to more completely evaluate ADOT's strategies.

Requirements and Dependencies

Currently, Arizona does not fund rail services as all existing intercity passenger rail services are funded by ticket revenues and federal funding. Federal grant funding for this plan would come from many sources such as the Highway-Rail Crossings Program (Secon 130), TIGER Grant Program, and FAST Act FRA Programs. This project will require an environmental impact assessment, following regulations set by EPA ADEQ.

To get federal funding the project has been designed to meet the requirements of each of the grants. These include the Federal Passenger Rail Investment and Improvement Act (PRIIA) of 2008, the Federal Railroad Administration (FRA) in 2013, and the Federal Highway Administration's Congestion Mitigation and Air Quality (CMAQ).

Federal government funding has a range of possibilities, potentially leading to larger loans that could ultimately impact the public through taxation. Contractors responsible for project construction may confront changes in material prices and, depending on the pace of construction, potentially encounter increased vehicle rental costs. Additionally, environmental engineers will be contracted to conduct environmental impact assessments, ensuring compliance with EPA regulations. Furthermore, ADOT will need to garner support from the communities directly and indirectly affected by the project's construction.

Assumptions made for the assessment

In the context of the SDG assessment, many key assumptions are made. Firstly, it is assumed that the goods transported via Arizona railroads, which are handled by private companies, do not contribute to SDG impacts for ADOT. Additionally, it is assumed that the End-of-Life phase of the railroad tracks falls outside the timeline scope established for the SDG assessment.

Furthermore, it is assumed that all currently operational railroads will remain in service within the defined timeline scope. To project future scenarios, we will rely on population growth patterns as presented in Table 2-33 and Table 2-34, with the assumption that this growth remains accurate up to the year 2070. Moreover, we will also assume the accuracy of the current climate projections from the Draft 5th National Climate Assessment.

Life-Cycle Perspectives

In the context of a life cycle perspective, we begin by assuming that the goods transported via Arizona railroads are not directly linked to SDG impacts for ADOT. The life cycle of this project encompasses various phases, including Extraction, Production/Manufacturing/Construction, Use, and Post-Use/Disposal/End-of-Life.

Of these phases, the Use phase stands out as the primary contributor to the SDG assessment. During this stage, the upgraded railway system is expected to facilitate quicker passenger car arrivals at stations. Taking a passenger train is generally more fuel efficient than cars on highway travel and train travel is much safer than highway travel. However, it is important to note that the increased volume of trains resulting from the project may lead to higher energy consumption for operation. Additionally, the introduction of new stations could place added demands on the power grid, necessitating increased power generation to sustain these stations.

The construction phase will involve the construction and repair of railways within the project's scope, while the maintenance of freight and passenger rail infrastructure is expected to remain consistent with previous levels. Importantly, we assume that the End-of-Life phase falls outside the current timeline scope.

Scale of Implementation

The Arizona State Rail Plan (SRP) serves as a guiding framework for rail development, aiming to strategically incorporate rail infrastructure into budgetary considerations. It fosters a collaborative environment that encourages coordination with local governments

to ensure a unified approach to advancing rail transportation in the state. It addresses not only passenger rail services, but also vital investments required to meet the burgeoning demands in the realm of rail transportation. Arizona's railroads are categorized into three distinct classes based on their annual revenue generation: Class I, Class II, and Class III. These varied classes play essential roles in shaping the state's rail landscape, contributing to both the economy and the efficient transportation of goods. The shift to rail transport can reduce reliance on freight trucks, easing traffic congestion and enhancing safety. The SRP has the potential to reduce fuel consumption and emissions, aligning with sustainability goals and addressing transportation, safety, and environmental concerns. Our SDG assessment covers each of these components within ADOT's plan.

Geographical Scope

In Arizona, eight operating rail territories span approximately 691 miles in the southern region, representing a valuable asset for ADOT. The rail network serves as a crucial conduit for transporting goods into the state, including imports from neighboring states like California and across the Mexican border. This intricate rail system connects Arizona to national and international trade networks, contributing to economic vitality. Our SDG assessment considers each of these components, comprising the entirety of rail shipments and activity that travels through or entirely within Arizona. Portions of rail operations that occur outside the state are not considered.

Time Frame

In the context of long-term projects, well-defined benchmarks and timelines are crucial for guiding and assessing progress. ADOT has included a milestone for 2045 within its strategic framework, forming part of a broader timeline spanning 2024 to 2070. This breakdown allows for the systematic pursuit of various SDGs. Arizona's rail network plays a vital role in safe, efficient, and sustainable travel, boosting economic opportunities. This multimodal system underpins Arizona's inclusive economy, attracting diverse industries. By recognizing the varying complexities of SDGs and adjusting milestone timelines accordingly, ADOT aims

to adapt and achieve SDGs. These benchmarks within ADOT's strategic planning serve as concrete progress indicators, aligning with the long-term vision of a greener, more sustainable transportation system.

Findings

Carbon Reduction Strategy Findings

The Impact Assessment for the ADOT Carbon Reduction Strategy (CRS) revealed immense potential to address the majority of the SDGs. With current projects, updates to existing plans, or implementation of previously envisioned plans, ADOT can achieve direct positive or indirect positive impacts for 12 of the 17 SDGs. Figure 1 shows the impact type of CRS for each SDG. The SDGs with direct positive impacts are SDGs 3 (Good Health and Well-Being), 7 (Affordable Clean Energy), 9 (Industry, Innovation, and Infrastructure), 12 (Responsible Production and Consumption), and 13 (Climate Action). The SDGs with indirect positive impacts are SDGs 1 (No Poverty), 8 (Decent Work and Economic Growth), 10 (Reduced Inequalities), 11 (Sustainable Cities and Communities), 14 (Life Below Water), 15 (Life on Land), and 17 (Partnerships for the Goals).

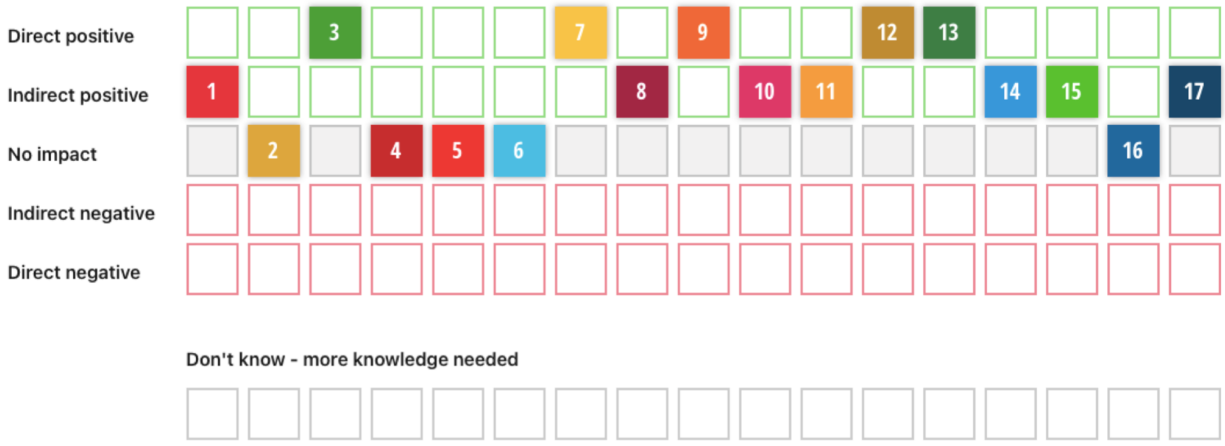

Figure 6.1. Results of the SDG Impact Assessment for the ADOT Carbon Reduction Strategy.

For each positive SDG, there are many strategies ADOT can implement that can make progress on multiple SDGs at once. As such, these strategies are recommended repeatedly across the report in the context of each relevant SDG. The most common strategies include expanding access and geographic coverage, alternative modes to driving, improving efficiency in construction and maintenance, providing redundancy in the transportation system to improve resilience, and improving collaborations with diverse stakeholders. Alternative modes can include public transit (such as commuter and passenger rail between and within cities) or active modes (walking and biking). Construction and maintenance improvements can involve more efficient resource use from reusing materials, using more efficient methods, or choosing projects that have lower resource and land use demands. Resilience is a crucial focus to ensure that Arizona residents are shielded from the economic and health impacts of climate-related disasters that could arise when transportation networks fail. And collaboration between ADOT and local and regional agencies, like city governments and planning agencies, will be necessary to achieve each SDG. This is because ADOT does not have complete control over planning, designing, implementing, and monitoring less carbon-intensive strategies, so working with other stakeholders to consider the indirect impacts of this work is crucial.

The SDGs for which the CRS has no (or negligible) impact are SDGs 2 (Zero Hunger), 4 (Quality Education), 5 (Gender Equality), 6 (Clean Water and Sanitation), and 16 (Peace, Justice, and Strong Institutions). These were selected based on descriptions provided for each SDG target. For each SDG here, the targets indicated a focus on developing nations (SDGs, 2, 4, 5, and 6), policies that fall outside the scope of transportation (SDGs 2, 4, 5, 6, 16), or actions that direct global international policy (SDG 16). Based on the large number of recommendations we provide, it is advised that ADOT focus on those categories which can have the largest immediate benefits.

1.1 No Poverty (SDG 1)

For SDG 1, it can be seen that by reducing the carbon emissions and vehicle miles traveled (VMT) that the plan will reduce poverty. This can be seen by target five in this SDG by the creation of roadway resilience targeted towards natural disasters. It will also be seen to create equal rights to ownership, basic services, technology and economic resources from the expansion of infrastructure. Investments that support efficient transit operations and higher transit ridership (ADOT Carbon Reduction Strategy. 2023, p. 57). This shows that improving equality is within the scope of the plan. With these targets of this SDG working together it shall create more transportation accessibility and mobilization of resources, and policies to end poverty. While the CRS does not directly discuss this SDG, it can be seen as an indirect positive outcome of the changes in place for the reduction of carbon.

1.2 Good health and Well-Being (SDG 3)

The goal for SDG 3 is to improve the good health and well-being of the population. ADOT's Carbon Reduction Strategy is centered around this SDG providing a direct positive impact from this plan. By implementing the carbon reduction plan the air quality in Arizona will increase causing overall better health.

Some of the SDG goals using the tool can be seen to align as a direct positive impact due to the carbon reduction plan. Due to the increased roadway infrastructure a decrease in road injuries will be seen alongside the decrease in VMT. ADOT can be seen taking initiative in the safety of roadways by implementing roadway alterations (ADOT Carbon Reduction Strategy. 2023, p. 56). A decrease in the deaths in youth will be seen as well as this group is the most susceptible to air pollution. Similarly a decrease in illness can be seen from the decreased pollution and creation of hazardous chemicals. These can be seen with ADOTs goal of net-zero emissions.

1.3 Affordable and Clean Energy (SDG 7)

SDG 7 focuses on the use of affordable and clean energy. ADOTs Carbon Reduction Strategy can be seen to align with this SDG in several aspects that provide a direct positive impact from the plan. The reduction of carbon can be seen to create a more clean form of energy. With the carbon reduction plan aiming at reducing VMT, selecting alternate fuel types, and altering the infrastructure of the transportation system in Arizona. ADOT shows that this is currently in the works throughout chapter 5 in the ADOT CRS within Table 5-3: *Electric Vehicles, Alternative Fuels, and Energy Efficiency (ADOT Carbon Reduction Strategy*. 2023, p. 57). Several things can be seen to be affected by this regarding energy. A heightened want for electric vehicles (EVs) will be seen taking place. This will cause the need for the expansion of the electric grid to handle the added EVs. Increasing the need for EVs will cause an increase in the need for research and technology to invest in alternate means of EV battery production, and energy productions. These changes will also in turn cause the increase in technology for the energy services in underdeveloped tribal territories in Arizona.

1.4 Decent Work and Economic Growth (SDG 8)

The strive for innovation addressed in the Carbon Reduction Strategy has an indirect positive impact on SDG 8. ADOT's goal of having more sustainable infrastructure and transportation modes aims at having an economic growth driven by sustainable innovations and production. Within Table 5-2: Transportation Alternatives (ADOT Carbon Reduction Strategy. 2023, p. 56) it can be seen that ADOT has thought about ways of creating alternate modes or substitutions. The CRS further aims to diversify economic productivity and to forward technological improvements through a sustainable perspective. An improvement of resource efficiency in both production and consumption is pushed forward by ADOT. In accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, ADOT aims to decouple economic growth from environmental degradation by promoting sustainable innovation in pavement design and

construction. The CRS furthur touches on sustainable tourism by creating local jobs and carbon-free transportation modes like the bicycle or transit.

1.5 Industry, Innovation and Infrastructure (SDG 9)

The targets listed in SDG 9 in tandem with the Carbon Reduction Strategy can be projected to yield a direct positive impact. The strategy can be seen to target several points of SDG 9 industry, Innovation and Infrastructure. The improvement of the infrastructure to reduce VMT is seen to create a more sustainable and resilient transportation system throughout Arizona as a whole. ADOT is seen to show that this is in effect throughout chapter 5 in the CRS as they discuss several different aspects. They discuss the ADOT Sustainable Pavement Program, Sustainable Construction, Technology Solutions, and more (ADOT Carbon Reduction Strategy. 2023, p. 58). In regards to the infrastructure it can be seen that this is within ADOTs scope and can be enhanced. Increasing EV charging infrastructure will promote inclusive and sustainable industrialization to combat carbon emissions with the population growth of the state. The plan will presumably alter the industries to accept more clean technologies. With the alterations of the infrastructure the roadway systems will need to become more sustainable to reduce the emissions from maintenance vehicles, and or alter the technologies of said maintenance vehicles.

1.6 Reduced inequalities (SDG 10)

Among ADOT's Carbon Reduction Strategy an emphasis is made on the social, economical, and political inclusion of people living in Arizona, which relates to SDG 10. Encouraging and promoting the inclusion of all regardless of sex, race, ethnicity, or religion is a prerogative that ADOT has undertaken with the CRS and its equity considerations. This idea can be seen in the beginning stages within CRS chapter 3. Lower-income communities having less access to more expensive alternative fuels that are more sustainable is an issue that ADOT

attempts to address by promoting different transportation modes such as bicycle and transit. It is an important axis of the strive for net-zero carbon and as such equity must be considered during the project selection process.

1.7 Sustainable Cities and Communities (SDG 11)

SDG 11 target is addressed in the Carbon Reduction Strategy as it aims to provide affordable and sustainable transport systems. The access to safe, accessible, and affordable sustainable transport systems is an important aspect of the CRS and its target to reach zero-carbon. Expending public transport to reach secluded areas or lower-income communities is in ADOT's vision to sustainability urbanize Arizona. Reducing the environmental impact of cities by having more carbon efficient means of transportation as well as paying attention to municipal and other waste management systems is paramount. The CRS further addresses the need to implement policies aimed at disaster resilience in infrastructures and adaptation to climate change. Providing people with different origins, religions, or social backgrounds equality with innovative sustainable solutions to reach the zero-carbon target is a part of ADOT's vision for a sustainable future.

1.8 Responsible Production and Consumption (SDG 12)

The Carbon Reduction Strategy addresses multiple targets listed in SDG 12 as its implementation strategy will create a sustainable management of resources. The tracking of each construction material or fuel source, combined with the sustainable practices that ADOT wishes to adopt, will create the bedrock to a responsible carbon emission monitoring of production. The CRS discusses "strategies that support improved freight movement (without increasing single occupancy vehicle capacity). Projects that help freight vehicles reduce emissions and save fuel, including electric charging and alternative fueling facilities" (ADOT Carbon Reduction Strategy. 2023, p. 58). This provides insight that ADOT is capable

of these adjustments, and is already taking this into consideration. Additionally, ADOT pursues an optic of technological improvement to address its sustainable vision, which directly reduces the waste generation caused by vehicle parts such as tires, automotive fluids, and various other polluting items.

1.9 Climate Action (SDG 13)

The targets listed in SDG 13 are addressed in the Carbon Reduction Strategy in a direct positive manner as climate change is an important consideration of the plan. Among its objectives, the CRS aims to integrate the changing climate factors into the design and construction of sustainable and carbon free infrastructures. ADOT recognizes “Changing climate can impact the transportation network through more frequent wildfires, flooding, dust storms, and other natural events. These events will require increased focus on resiliency to ensure that transportation options remain available, safe, and efficient.” (ADOT Carbon Reduction Strategy. 2023, p. 48). This will have a positive impact on the awareness and knowledge that carbon reductions are essential to sustainable systems and that implementing them as soon as possible is for the best interest of both Arizona and the planet. It is further understood in the CRS that building more resilient infrastructure to increasing temperatures, floods, and other natural events is a necessity for the citizens and visitors of Arizona.

1.10 Life Below Water (SDG 14)

The Carbon Reduction Strategy addresses SDG 14 by reducing emissions that contribute to ocean acidification (Target 14-3). With the reduction of carbon a protection and restoration of the natural underwater ecosystems can be seen to take place. The plan can also support small-scale fisheries in Arizona (Targets 14-7 and 14-B) if more sustainable transportation

options are provided to the state's major lakes. With this in mind the CRS provides an indirect positive impact on the targets listed in this SDG.

1.11 Life on Land (SDG 16)

With SDG 15 in mind this can be seen as a potential indirect positive change in place within the carbon reduction plan. Having the infrastructure changed to reduce VMT and carbon can have a massive positive impact on life on land if integrated properly. This will allow for the restoration of degraded land, and a healthier ecosystem in Arizona. The reduction in carbon enhancing life on land isn't the only aspect in play, but in terms of the restructure of the infrastructure to reduce VMT. The restructure to reduce VMT if done properly will allow certain areas of Arizona to have healthy ecosystems. The reduction in carbon will cause the temperature to decrease allowing for more life to thrive. All of this must be taken into account when restructuring and moving roadways.

1.12 Partnership for the Goals (SDG 17)

SDG 17 seems to be an indirect positive based on the information obtained from the CRS. This is because throughout the process of the plan ADOT intends to communicate and accept the opinions of the MPOs, Cities, Counties, and Tribal Nations. The targets of this SDG can be seen as an indirect outcome of this plan. By having continuous communication and collaboration ADOT will be mobilizing financial resources for the Tribes, This will in turn create a long lasting partnership between the tribal nations and ADOT. In turn creating the opportunity for these nations to become more developed utilizing the technologies and infrastructures that this plan brings.

State Rail Plan Findings

The Impact Assessment for the ADOT State Rail Plan revealed immense potential to address the majority of the SDGs. With current projects, updates to existing plans, or implementation of previously envisioned plans, ADOT can achieve direct positive or indirect positive impacts for 10 of the 17 SDGs. Figure 2 shows the impact type of the State Rail Plan for each SDG. The SDGs with direct positive impacts are SDGs 8 (Decent Work and Economic Growth), 9 (Industry, Innovation, and Infrastructure), 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production), 15 (Life on Land), and 17 (Partnerships for the Goals). The SDGs with indirect positive impacts are SDGs 1 (No Poverty), 3 (Good Health and Well-Being). 10 (Reduced Inequalities), and 13 (Climate Action).

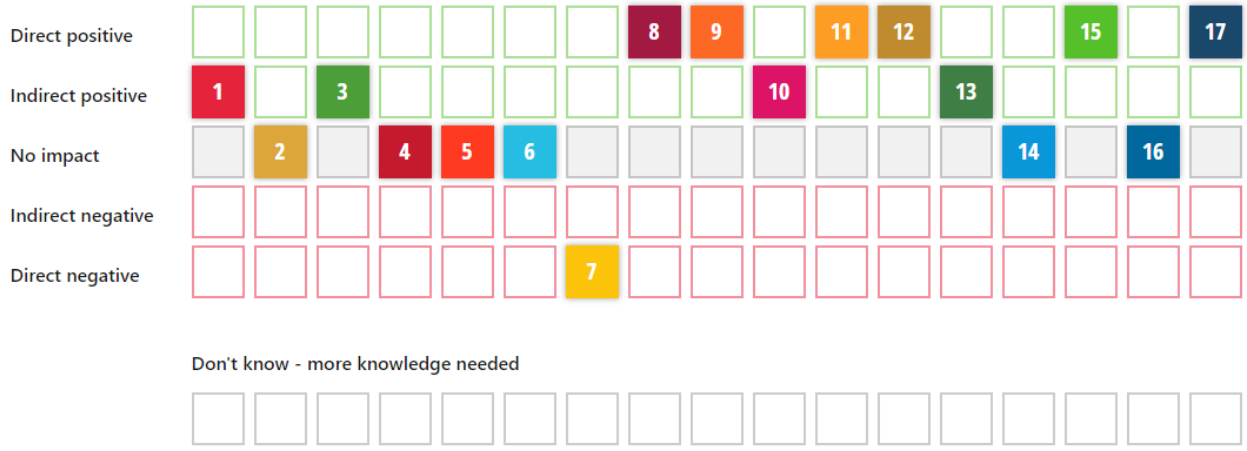

Figure 6.2. Results of the SDG Impact Assessment for the ADOT State Rail Plan.

For each positive SDG, there are many strategies ADOT can implement that can make progress on multiple SDGs at once. As such, these strategies are recommended repeatedly across the report in the context of each relevant SDG. The most common strategies include expanding both intercity and intracity passenger rail, expanding capacity and easing access to the freight rail network, and improving collaboration with other stakeholders. Passenger rail benefits primarily result from increased affordable transportation options, reduction in automobile use (and associated congestion, pollutants, and both personal and infrastructure costs), and more efficient land use. Freight improvements can help industries shift shipping loads from high-emission trucks to more efficient rail. And collaboration

between ADOT and local and regional agencies, like city governments and planning agencies, will be necessary to achieve each SDG. This is because ADOT does not have complete control over planning and designing the rail system, so working with other stakeholders to consider the indirect impacts of this work is crucial.

The SDGs for which the State Rail Plan has no (or negligible) impact are SDG 2 (Zero Hunger), 4 (Quality Education), 5 (Gender Equality), 6 (Clean Water and Sanitation), 14 (Life Below Water), and 16 (Peace, Justice, and Strong Institutions). These were selected based on descriptions provided for each SDG target. For each SDG here, the targets indicated a focus on developing nations (SDGs, 2, 4, 5, and 6), policies that fall outside the scope of transportation (SDGs 2, 4, 5, 6, 14, 16), or actions that direct global international policy (SDG 16). Based on the large number of recommendations we provide, it is advised that ADOT focus on those categories which can have the largest immediate benefits.

2.1 SDG 1 – No Poverty

ADOT's goal for SDG 1 is no poverty. Proper expansion of the rail system can facilitate the swift transportation of goods on a large scale which could lower product costs. Furthermore, the refurbishment and extension of the rail network will enhance passenger transport, providing cost-effective travel options to key destinations across the broader Arizona region. The SDG impact potential is considered to be indirect positive as ADOT does not directly lower transportation and shipping costs, but can use rail to provide lower-cost options that residents can choose, thus alleviating financial stresses of transportation.

The objectives outlined in ADOT's report align with the SDG objectives of building resilience among impoverished and vulnerable populations (Target 1-5), as well as ensuring substantial resource mobilization from diverse channels (Target 1-A). The achievement of these goals is gauged through indicators such as the reduction of direct economic losses

from disasters in relation to global GDP and the proportion of government expenditure allocated to essential services.

2.2 SDG 3 – Good Health and Well-Being

Proper implementation of ADOT's State Rail Plan can achieve direct positive benefits to SDG 3, addressing Targets 3-6 ("Reduce road injuries and deaths") and 3-9 ("Reduce illnesses and death from hazardous chemicals and pollution"). The majority of travel in the state of Arizona is conducted using personal vehicles, most of which are internal combustion engine vehicles (ICEVs). ICEVs produce large amounts of air pollutants including greenhouse gasses (CO2) and local air pollutants (NOx, SOx, and particulates). The former contributes to climate change which exacerbates extreme weather events such as heatwaves, which can cause heat stroke and deaths. The latter contribute to local respiratory issues among urban residents. Motor vehicle crashes also frequently cause deaths, signifying a need to provide safer options of travel. Through the State Rail Plan, ADOT can address each of these issues by expanding passenger rail services both within and between major urban areas.

2.3 SDG 8 – Decent Work and Economic Growth

For SDG 8, the impact of the expansion and modernization of the State Rail Plan extends far beyond the confines of ADOT. With this plan, ADOT can address Targets 8-1 ("Sustainable economic growth"), 8-2 ("Diversify, innovate and upgrade for economic productivity"), 8-3 ("Promote policies to support job creation and growing enterprises"), 8-4 ("Improve resource efficiency in consumption and production"), and 8-9 ("Promote beneficial and sustainable tourism"). ADOT's State Rail Plan can have both direct and indirect positive impacts for each of these targets. This is due to both the jobs directly created by ADOT to improve the state rail infrastructure, and the boost that this

infrastructure could then provide to other industries that use rail to obtain materials, ship products, or travel. With a transportation plan that makes rail a central economic resource for both goods and passengers, ADOT can facilitate economic growth around this energy and space-efficient transportation mode.

This ambitious initiative is poised to become a catalyst for not only revitalizing the rail infrastructure but also for fostering economic growth and community development. The creation of numerous job opportunities is a noteworthy aspect, with employment prospects not only in the construction phase but also in the ongoing operation and maintenance of the enhanced rail system.

As progress is made on the State Rail Plan, the infusion of new jobs can significantly bolster local economies. From skilled construction workers to dedicated operators and maintenance personnel, the ripple effect of employment will touch various facets of the community. The prospect of an updated train infrastructure holds promises of improved transit into cities, amplifying accessibility and potentially enhancing tourism, particularly around major stations such as the bustling City of Phoenix. This can help support the local businesses and economies.

2.4 SDG 9 – Industry, Innovation, and Infrastructure

The integration of SDG 9 into ADOT's agenda is projected to yield direct and positive impacts. With this plan, ADOT can address Targets 9-1 (“Develop sustainable, resilient and inclusive infrastructures”) and 9-4 (“Upgrade all industries and infrastructures for sustainability”). This potential for improvement lies in the enhancement of the rail plan, a move that promises to mitigate environmental impact when compared to traditional road construction. The smaller environmental footprint of rail construction, in terms of materials used, presents a sustainable alternative to roadways. The anticipated need for

maintenance of railways, as opposed to roads, further contributes to the environmental sustainability of such infrastructure developments as a direct positive.

As highlighted in "The Future of Rail," the rail sector stands out as one of the most energy-efficient modes of transport for both passengers and freight. The statistic that rail represents only 2% of total transport energy demand while carrying 8% of the world's passengers and 7% of global freight transport underscores its efficiency (IEA, 2019). This efficiency is a crucial element that contributes not only to environmental sustainability but also to the economic viability of transportation systems. The energy efficiency of rail transport positions it as a key player in achieving ADOT's sustainability goals and the broader SDGs. The positive impacts extend to the surrounding communities. Improved rail systems not only enhance transportation efficiency but also pave the way for the development of new industries. The more efficient modes of transportation facilitate the movement of goods and people, fostering economic activities that contribute to community growth and resilience.

2.5 SDG 10 – Reduce Inequalities

With equitable improvements to accessibility of the rail network, ADOT can reduce inequalities in an indirect positive manner. This aligns with components of Targets 10-1 (“Reduce income inequalities”), 10-2 (“Promote universal social, economic and political inclusion”), and 10-3 (“Ensure equal opportunities and end discrimination”). These inequalities can be primarily addressed through strategic passenger rail improvements. The benefits are considered to be indirect because the rail system has the potential to connect residents with more economic opportunities. Simply using the rail system alone will not directly address inequality, but the opportunities provided as a result of improved mobility are what ultimately produce the desired benefits. This can be accomplished by providing easily accessible, affordable rail with wide geographic coverage and fast travel times. For residents that cannot drive due to physical or financial reasons, or struggle to

find jobs with living wages that do not require long commutes, passenger rail can be a reprieve from the monetary and time costs of car-dependent transportation.

A liberal interpretation of ADOT's abilities indicates that the State Rail Plan could also indirectly address Target 10-7 ("Responsible and well-managed migration policies"). There is an opportunity to address this with rail travel across the Arizona-Mexico border, but complications surrounding federal migration and border protection policies may make this infeasible in practice. Regardless, $7.2 billion dollars in goods travels through the Nogales border crossing (Arizona State Rail Plan, 2022, p. 2-68) and 1,406,877 people travel using vehicles and 445,674 people walked between Arizona and Mexico in June 2023 (The University of Arizona, Border Crossings) due to work, family connections, and recreation, so the potential should be investigated.

2.6 SDG 11 – Sustainable Cities and Communities

In SDG 11, sustainable cities and communities, the pursuit of creating sustainable cities and communities, a fundamental goal for governments and organizations is ensuring universal access to basic needs. As Arizona continues to expand in size, this poses a problem for ADOT. As mentioned in the State Rail Plan Report, economic development opportunities may be available along the BNSF Ennis Subdivision in the Phoenix area (Arizona State Rail Plan, 2022, p. 4-10). This already has a direct positive impact on the current SDGs, but improving it will ensure its commitment to sustainable development. It focuses on the Target 11-2 from SDG 11 as a main encompassment of providing access to safe, affordable, accessible and sustainable transportation for everyone. This can play a pivotal role by expanding railways within cities. This strategy holds the promise of reducing dependence on individual cars as the primary mode of everyday transit. It will not only contribute to the economic benefits, but also to a substantial decrease in environmental impact and a direct positive overall.

The envisioned increase in railways offers a multifaceted solution to urban challenges. Beyond its potential economic advantages, such as job creation and enhanced transportation efficiency, it directly addresses issues related to traffic congestion and its associated costs. Households stand to save nearly $10,000 by reducing their reliance on private cars and embracing public transit (Rail Passenger Association, 2020). This financial savings is coupled with a qualitative improvement in daily life, with the average commuter gaining back 54 hours per year that would otherwise be spent stuck in traffic (2020). This goes on to demonstrate that improving on the rail plan can help control the traffic that currently will continue to grow in the Phoenix metropolitan area.

2.7 SDG 12 - Responsible Consumption and Production

The SDG 12, responsible consumption, and production, aligns seamlessly with ADOT's plan, offering a direct positive impact through envisioned improvements in the railway infrastructure (Arizona State Rail Plan, 2022, p.2-63). The move to enhance railways not only facilitates efficient transportation of various goods but also addresses a critical safety concern. Shifting the transportation of hazardous materials from large trucks to railways reduces the risk of accidents and limits public exposure to these materials, thereby enhancing overall safety and risk mitigation.

The benefits of updating the rail plan extend beyond safety considerations to unlock new opportunities for affordable access to various destinations. Arup emphasizes that rail infrastructure development can drive better land planning, fostering a balanced approach that considers the impact on the surrounding environment (2020). This can be exemplified through the creation of biodiverse rail verges, showcasing how rail systems actively support, rather than degrade, the natural habitat. Such measures contribute to environmental conservation and promote healthier living environments for communities.

2.8 SDG 13 - Climate Action

The goal of SDG 13 is to take urgent actions to combat climate change and its impacts. The rail plan may help reach SDG 13-1, with the implementation of the plan facilitating a rise in passenger transport within the rail system. This shift is expected to decrease the number of individuals opting for personal cars on the road, subsequently resulting in a reduction in carbon emissions attributable to decreased driving. Additionally, this transition contributes to mitigating congestion on roadways, promoting a more sustainable and eco-friendly mode of transportation. The reduction in carbon emissions between a passenger train and an average car was determined by Ritchie and Roser (2023), showing that "national rail emits around 35 grams per kilometer. The average petrol car emits 170 grams."

If ADOT expands rail services sufficiently, the decrease in the number of vehicles on the road could alleviate traffic congestion, leading to reduced idle times. This helps achieve Target 13-2 ("Integrate climate change measures into policies and planning") by enabling vehicles to reach optimal speeds, contributing to a decrease in emissions. According to Palmer (2015), "in an ordinary trip with minimal traffic, you're likely to emit around 0.7 pounds of carbon dioxide per mile traveled. If your average speed drops to 15 miles per hour, that emissions amount rises to 1.2 pounds." This upgraded railway system facilitates the efficient transportation of both people and goods to and from disaster-stricken areas. The swift and organized movement of essential resources, including emergency supplies, medical aid, and relief personnel, becomes more accessible, ensuring a more effective response during critical times. Importantly, this streamlined transportation process significantly contributes to minimizing the number of casualties that typically occur in the aftermath of climate change-induced disasters. The improved railway acts as a lifeline, enabling rapid and well-coordinated interventions, thereby enhancing overall disaster resilience and response capabilities within the affected areas.

2.9 SDG 15 - Life on Land

The goal of SDG 15 is to protect, restore, and promote sustainable use of terrestrial ecosystems. Relevant targets include ensuring the conservation of terrestrial ecosystems (15-1), conservation of mountain ecosystems (15-4), and integrating ecosystem values into local planning (15-9).

The railway plays a pivotal role in achieving the conservation of terrestrial ecosystems, primarily because railways occupy less space compared to roadways. This spatial efficiency extends to the construction and maintenance phases, where railways require fewer resources and entail less frequent maintenance compared to their roadway counterparts. Moreover, the reduction of cars on the road, as previously highlighted, not only minimizes congestion but also mitigates the necessity to expand roadway infrastructure. This, in turn, contributes to the preservation of ecosystems by minimizing the physical footprint associated with transportation networks and fostering a more sustainable and ecologically friendly approach. It effectively aligns with the goal of conserving Arizona's mountain ecosystems, which attract large numbers of tourists year-round, primarily in vehicles. Like the previously mentioned goal, the railway facilitates lower-impact travel through the mountainous terrain in Arizona. Furthermore, this initiative results in a decrease in the number of trucks required to transport goods up the mountains, leading to a notable reduction in carbon emissions and less wear and tear on roadways.

2.10 SDG 17 - Partnership for the Goals

The SDG 17, partnership for the goals, a direct positive impact on ADOT stands as a beacon for direct positive transformation. A crucial avenue for this transformation lies in the improvement of the rail plan, which not only enhances inter-city relationships but also has the potential to foster broader connections at the state and international levels. Arizona,

strategically located, shares its borders with California and Mexico, making these regions significant players in the state's economic landscape. Upgrading the railways not only facilitates smoother trade between states but also strengthens ties with Mexico, a critical trading partner. This can address Target 17-14 (“Enhance Policy Coherence for Sustainable Development”), as ADOT can help position rail as a central passenger and freight infrastructure to reduce transportation emissions from trips that extend beyond state borders.

California and Mexico play a pivotal role in the region's economic stability. By improving the existing railways, ADOT can contribute to global macroeconomic stability (Target 17-13) by enhancing the efficiency of cross-border trade. The impact of a railway upgrade extends beyond the immediate economic implications, influencing the growth trajectory of the Phoenix Metropolitan area. It directly relates with Target 17-11 as well as increasing the exports of neighboring countries. The ability to ship more goods efficiently contributes to the economic vitality of the region, positioning it as a hub for trade and commerce.

Recommendations

Carbon Reduction Strategy Recommendations

3.1 No Poverty (SDG 1)

For SDG 1 “ no poverty” to have a greater direct positive impact due to the plan it can be recommended to implement more policies aimed at these targets in tandem with the policies that the carbon reduction plan will bring. To start ADOT should communicate with others the importance of the accessibility for alternative means of fuel. ADOT can also provide more alternative systems for transportation in order to provide more equal opportunities for those that are less fortunate, and still reduce carbon. One such

implementation could be a light rail expansion within the Phoenix area. Throughout this plan's lifespan ADOT should allow the equal sharing of technology and resources from the expansion of the infrastructure. Within this SDG we see a target similar to others 1-5 “build resilience to environmental, economic , and social disasters”, and within chapter 7 ADOT touches on this idea. It can be recommended on how the changing of the infrastructure will help to build resilience for disasters that are environmental, economic, and social. ADOT can also take charge throughout this plan to mobilize the proper resources and implement the proper policies to achieve target 1-A. This can be done with the expansion of charging station accessibility as it is not yet a statewide standard, as seen in Zullo’s piece (Zullo et al.).The technologies associated with this expansion would become more available for the average consumer. This would allow a seamless integration of the changes necessary while creating a sustainable method for the plan.

3.2 Good health and Well-Being (SDG 3)

For ADOT to excel with this SDG it is recommended that when making these changes to infrastructure, and vehicular policies, that the health of the population is held paramount. It is also suggested that when speaking with organizations that ADOT emphasizes the statistics for emissions, and illnesses caused by emissions. This will help to show the necessity of this carbon reduction plan. For ADOT to expand upon the SDG targets several recommendations can be made. For the reduction of road injuries and death ADOT can begin by collaborating with governing bodies to generate better planning and organization of the land use policies in place. This collaboration can also create the opportunity to provide more alternative modes of transportation, and improve safety for pedestrians, cyclists, and automotive users. With improved land use policies in place, items such as protected bike lanes and car free zones can be integrated more effectively. Having a better land use plan will allow for a more effective road maintenance system to allow for less automotive accidents based on the roadway conditions.

ADOT can also have a direct positive relationship to the SDG target “reduce illnesses and death from hazardous chemicals and pollution” in a few similar ways to those stated above. It may suit ADOT to provide alternate modes of transportation so that the production and maintenance of roadways and vehicles is reduced. As well the emissions from combustion vehicles, pollution from tiers, and the emissions from concrete production would decrease if done properly.

3.3 Affordable and Clean Energy (SDG 7)

It is recommended for ADOT target SDG 7-1 “Universal access to modern energy” by collaborating the expansion of the power grid capacity, and this is not stated in the plan. ADOT cannot directly expand the grid, but the collaboration must occur in order to effectively alter the infrastructure and reduce carbon emissions of combustion automobiles. This extensive collaboration should be stated in the plan to handle the new capacity of EVs, and potentially use of EVs as micro-grids in underdeveloped locations within Arizona. ADOT should initiate these changes during the expansion of the infrastructure so that the collaborators can successfully expand the grid and fuel sources to handle the new capacity. With these changes there will be more research done for clean energy sources. This additional research can be seen to target 7-B “expand and upgrade energy services for developing countries”. With the additional expanse and communication throughout Arizona, ADOT can indirectly promote the upgrade of the energy services in underdeveloped areas throughout Arizona. This would improve the fuel efficiency and energy efficiency of vehicles as they will not have to slow down for roadway hazards as much. This will also assist in the achievement of target 3-6 with a reduction in roadway injuries and death. ADOT must keep these targets in mind and back these strategies to ensure higher success with this plan.

3.4 Decent Work and Economic Growth (SDG 8)

It is recommended that ADOT provides alternative ways for the economy to grow sustainably by designing and building pavement structures adapted to the ongoing climate change. Having infrastructures built with a degree of resilience to environmental disasters such as floods or extreme temperatures would make them last longer and thus more sustainable. An important aspect of SDG 8 is diversifying and upgrading economic productivity, and as such it is recommended that ADOT further diversifies modes of transportation throughout Arizona. It is understood that a principal objective of the CRS is to “pursue transportation asset and operational improvements that will expand access to economic opportunities, jobs, and core services” (ADOT Carbon Reduction Strategy. 2023, p. 68). This would reduce the overall carbon emissions and promote economic growth by allowing people without cars to access the economic center more easily. Having connected economic centers and allowing people to access them while generating the least amount of carbon emissions or waste is a prime target that ADOT should keep pursuing.

3.5 Industry, Innovation and Infrastructure (SDG 9)

It can be recommended that ADOT develop sustainable, resilient and inclusive infrastructures, and this can be achieved by protecting humans and the infrastructure from extreme climate impacts. This can be done by utilizing less concrete, more green space, better drainage systems for monsoons, and effective consultation with the required parties. ADOT must accept these required technology upgrades and work with industries to retrofit the infrastructure and create more sustainability within the system. This cooperation with industries will allow for the reduction in fossil fuel consumption and begin to allow for greater reuse of materials. ADOT states how they currently allow 15 to 25 percent of some new pavements to be created using reclaimed materials (ADOT). Reusing materials will provide decreased carbon emissions for production and maintenance. This cooperation can also be seen to support another target to “enhance research and upgrade

industrial technologies", and this can drastically reduce carbon emissions. With the proper cooperation with others new automotive technologies can be achieved to reduce emissions. While ADOT has stated the communication with the Tribes, Counties, and Cities it is recommended to add stakeholders to that list to create a smoother integration and creation of new technologies required for ADOTs plan to reduce carbon by 2050.

3.6 Reduced inequalities (SDG 10)

In order to address SDG 10, it is recommended that ADOT further promotes universal social, economic, and political inclusion by providing additional transportation modes. For example, additional access can be provided to disabled people to various transportation modes through the implementation of ramps in buses or trains. Promoting an equitable transportation system that "takes into consideration the needs of vulnerable, historically disadvantaged, or underserved communities across the State" (ADOT Carbon Reduction Strategy, 2023, p. 61) is a priority. As such, deploying sustainable infrastructure in low-income areas to improve their access to economical centers would be beneficial for the state as it will increase economic opportunities for those communities. It is essential that ADOT considers existing inequalities in access to transportation modes and addresses them by planning sustainable developments in infrastructure.

3.7 Sustainable Cities and Communities (SDG 11)

It is recommended that ADOT expands affordable and sustainable transport systems in order to reach all of the targets of SDG 11. Expanding bicycle rental infrastructure for example would allow a carbon-free and affordable means of transportation for people traveling short or medium distances. ADOT could further expand their various sustainable infrastructure by creating "strategies that reduce on-road emission from construction equipment and use materials that require less carbon emissions to produce" (ADOT

Carbon Reduction Strategy. 2023, p. 60), as stated in the Carbon Reduction Plan. This would reduce the environmental impact of building or renovating roads which would by extension make cities more sustainable. Expending various infrastructures throughout communities of various backgrounds could further SDG 11 targets and promote inclusivness across the state. Regulating resources consumption when building infrastructures and promoting innovations that will address the disasters associated with climate change should also be a foundation of ADOT's sustainability vision.

3.8 Responsible Production and Consumption (SDG 12)

Sustainability and responsibility goes hand in hand, and as such discouraging the use of fossil fuels and non-renewable resources is essential. Putting an emphasis on the importance of sourcing resources and communicating this information to the public through plans such as the CRS are exactly what ADOT should do. It could also be recommended that ADOT further supports the Tribal Nations technological and sustainable growth by developing sustainable means of production and consumption within the transportation sector. As stated in the CRS, both the State and Tribal governments have "the common goal of providing efficient transportation systems for the safety and welfare of the traveling public" (ADOT Carbon Reduction Strategy. 2023, p. 47). Working together to provide responsible production and consumption is how things will move forward towards a more sustainable approach to resource efficiency. Finally, it is recommended that tools monitoring sustainable tourism are introduced in order to track VMT and provide alternative modes of transportation like rail.

3.9 Climate Action (SDG 13)

In order for ADOT to effectively excel in this SDG category it is recommended to focus on strengthening resilience and adaptive capacity to climate related disasters. This target can

somewhat be recognized by ADOT in chapter five of the CRS. However, it can be recommended that ADOT expands on the strategies to create redundancy and resilience within the transportation systems. These strategies include alternate routes, alternative modes of transportation, rail systems, structural fixes, and more. If one roadway fails it would be a good idea to have an alternate roadway or several that are able to maintain a similar capacity. Similarly, if there are more accessible modes of transportation to make up for this failure then commuters would be able to use the adaptable system and get to their destination with little added hassle. An increase in structural redundancies such as storm drains and or bridge designs would allow the system to still function properly given one of these scenarios. For Target 13-2, ("Integrate climate change measures into policies and planning"), because obtaining funding for adaptation projects will be crucial, ADOT should also take charge in the sharing of knowledge regarding carbon emissions in order to strengthen awareness regarding the topic. ADOT can start by ensuring all of their own employees are well versed in the topic so that they can begin to spread the information to others outside the organization. With the awareness of this project being spread this will allow for the integration of all changes listed to be smoother and more easily accepted.

3.10 Life Below Water (SDG 14)

In order to achieve the targets in SDG 14, it is recommended that ADOT expands its road networks to give fishers and tourists access to various maritime resources. The promoted access to nature relates to ADOT's goal to "strive for cleaner, more efficient, and sustainable energy sources for transportation operations and facilities" (ADOT Carbon Reduction Strategy. 2023, p. 66) as it would make people more aware of the importance of safeguarding the environment. Spreading awareness of climate change and its various impacts of nature should also be in ADOT's purview as it directly impacts the sustainability of transportation means across the State. Although Arizona is not next to the ocean and may not have as many rivers or lakes as other states, it still has prominent water sources

such as Lake Pleasant or Lake Havasu. As such, by promoting the safe and sustainable passage to those areas of the State, ADOT contributes to its safeguard as it sensitizes the public on climate related issues. It is thus recommended that ADOT increase its investments in sustainable infrastructures that support marine life and small-scale fishers as it constitutes one of the principle natural habitats that humans strive to safeguard. All other strategies recommended to reduce carbon emissions will also help mitigate ocean acidification.

3.11 Life on Land (SDG 15)

It is crucial that when restructuring ADOT consults with other environmental engineers to understand and further assess how a transportation project will impact the local ecosystem. In order for ADOT to achieve the targets in this SDG, they should promote the safeguarding of natural habitats. This directly impacts target 15-9, and this promotion should be done within the planning and development phases for the future infrastructure. Similarly to the planning, target 15-1 (“Conserve and restore terrestrial and freshwater ecosystems”) can be achieved as well. Using proper governmental planning and collaboration for the previously mentioned target, ADOT would be able to effectively hit this target by the proper reconstruction of the transportation system. It is essential that ADOT ”support transportation system accessibility to underprivileged populations without damaging community culture or neighborhood integrity” (ADOT Carbon Reduction Strategy. 2023, p. 67), which often includes protecting nearby ecosystems with cultural significance.

3.12 Partnership for the Goals (SDG 17)

Improving collaboration between ADOT, city governments and planning agencies, and community stakeholders will facilitate a more effective implementation of the SDG

strategies described throughout this report. With the entirety of Arizona's governmental sectors on board, the plan and technologies can be seamlessly integrated, advanced, and seen to promote carbon reduction. It is recommended that ADOT further "work with appropriate specialists/experts during project development, design, and construction to optimize safety, community health, and climate responsiveness" (ADOT Carbon Reduction Strategy. 2023, p. 68) in order to build partnerships and work toward common goals. Enhancing policy coherence through communication and collaboration for sustainability should be one of the targets in SDG 17 that ADOT prioritizes. It is paramount that policies move forward as fast as possible to mitigate the worst impacts of climate change. It is recommended that ADOT continues its ongoing efforts to build strong partnerships and that sustainability is placed at the forefront.

State Rail Plan Recommendations

4.1 SDG 1 – No Poverty

To thrive in this SDG, ADOT should prioritize enhancing the resilience of railways to ensure their adaptability in the face of disasters. This entails developing comprehensive plans for the swift clearing and repair of rail infrastructure in the aftermath of disasters. By establishing proactive strategies, ADOT can minimize downtime and swiftly restore rail connectivity to different destinations. Additionally, the implementation of contingency plans should include the deployment of standby trains capable of transporting crucial resources and people during and after natural disasters. This proactive approach not only underscores a commitment to disaster preparedness but also ensures that the railway network remains a reliable and resilient lifeline in times of crisis.

The 2030 SDG to build resilience could be met as the railways play a pivotal role in disaster relief efforts during and after natural calamities. According to the Association of American Railroads, railways serve as instrumental conduits for the rapid transport of essential supplies, encompassing vital resources like food, water, shelter, fuel, and materials essential for the reconstruction of affected regions. Impoverished groups are among the

most vulnerable during natural disasters, so maintenance of transportation services is crucial. Furthermore, the adaptability of rail networks extends to the efficient relocation of individuals directly affected by disasters, ensuring secure transport to safer locations. In essence, the strategic utilization of rail infrastructure emerges as fortifying resilience against natural disasters, facilitating the seamless movement of critical supplies and impacted populations alike.

Another milestone accomplished by the rail plan is the assurance of resource mobilization. The measurable indicator for the achievement of this goal lies in the allocation of a segment of government spending towards essential services. In the case of the rail plan, ADOT, in conjunction with other government grant funding, will play a pivotal role in enhancing infrastructure. This initiative not only improves the overall transportation network but also opens up avenues for greater opportunities for impoverished populations. The expansion and renovation of the passenger railway, outlined in ADOT's 2022 State Rail Plan, are anticipated to generate employment opportunities, providing jobs that contribute to economic upliftment (Arizona State Rail Plan, 2022, p. 5-2). Additionally, by facilitating accessible transportation, the rail plan enables individuals to travel for work who would otherwise face challenges due to a lack of means of transportation. With comprehensive coverage of the passenger rail both within and between cities, ADOT can provide a cheaper alternative to automobile transportation that reduces economic stress on impoverished communities.

4.2 SDG 3 – Good Health and Well-Being

SDG 3 can be advanced through the renovation and expansion of the railway, particularly in its capacity for enhanced passenger transport. This strategic initiative aims to alleviate the strain on roadways, which could contribute to a significant reduction in roadway deaths. The transition of passengers to trains, facilitated by the improved railway system, holds the promise of creating safer travel conditions, mostly because of the notable contrast to the inherent risks associated with roadway transportation. As stated by National Safety Council

Injury Facts, “Passenger vehicles are by far the most dangerous motorized transportation option compared. Over the last 10 years, the passenger vehicle death rate per 100,000,000 passenger miles was over 20 times higher than for buses, 17 times higher than for passenger trains, and 595 times higher than for scheduled airlines” (NSC Deaths by Transport Mode).

Hence, by promoting a shift toward the railways, the project aligns with SDG 3's overarching objective, not only by facilitating efficient and convenient passenger transport but also by mitigating the health risks associated with road travel. These health risks also include exposure to air pollutants from vehicles and lack of physical exercise due to increased commute times. Ultimately, expanding passenger rail would contribute to improved overall well-being and safety within the community.

In summary, ADOT should provide affordable passenger train travel options, thereby expanding access to this mode of transportation. Additionally, it is advisable to increase the frequency of passenger trains, providing commuters with more choices and options for their travels. As referenced in the State Rail Plan, Amtrak ridership has decreased between 2016 and 2018 (Arizona State Rail Plan, 2022, p. ES-17).

4.3 SDG 8 – Decent Work and Economic Growth

The renovation of the rail system is not just about movement of people, but also about the efficient transport of goods. The accelerated movement of goods can have a profound impact on the economy, fostering increased trade within the state and beyond its borders. The economic implications are substantial, and the improved transportation infrastructure can serve as a catalyst for regional economic development. This aligns with ADOT's broader goals of contributing to economic prosperity and sustainable growth. In line with the State Rail Plan, ADOT should invest in expanding its freight infrastructure to provide increased capacity and geographic coverage. In 2016, the total weight of all goods being imported and exported through the Arizona railway was 28,090 tons (Arizona State Rail Plan, 2022, p. ES-13). ADOT has recognized that companies across the state often find the requirements to

access rail prohibitive, including building connecting lines capable of reaching high speeds (Arizona State Rail Plan, 2022, p. 2-4). ADOT should investigate the feasibility to ease these burdens without significantly increasing cost, in order to promote the most indirect job growth possible.

Drawing from insights, the development of a multi-modal transportation system, including high-speed railways, plays a crucial role in addressing congestion costs in urban areas. It not only aids in urbanization, but also fosters regional integration and cross-regional travel. Considering this, ADOT's commitment to the enhancement of the passenger rail system aligns (Arizona State Rail Plan, 2022, p. ES 18-21), with a holistic approach to community development, offering the potential for urbanization, regional connectivity, and increased accessibility. The indirect impacts of this could include increased economic productivity as commute times decrease, better support for small businesses that are more easily accessible, and increased tourism income for cities with rail stops. To fully realize these benefits, ADOT must ensure that passenger rail is reliable, affordable, and accessible enough to outweigh the impacts of induced demand on freeways, which could result in a decrease in vehicle use.

Finally, the expansion of the rail network can have direct economic impacts by providing long-term jobs for construction companies and engineering contractors. The extensive needs for rail improvements to accomplish the SDGs will likely require decades of design, construction work, and continued maintenance for the lifetime of the infrastructure. This creates stable jobs for Arizona residents while providing infrastructure that has broader indirect sustainability benefits.

4.4 SDG 9 – Industry, Innovation, and Infrastructure

Renovating the railway infrastructure brings not only environmental benefits but also operational advantages. The potential for larger and more efficient shipments, coupled with shorter transit times, has the capacity to diminish reliance on truck transportation. This can help industries that rely heavily on shipping to reduce the carbon footprint of their

operations. The envisioned improvements in the rail system transcend mere logistical enhancements; they hold the potential to foster economic development. The positive correlation between efficient freight transport and economic prosperity is underscored by ADOT's pursuit of sustainable rail solutions. By making freight transport more cost-effective, smaller-scale industries stand to benefit, fostering healthy competition with larger counterparts. This aligns with the broader SDG objective of promoting inclusive and sustainable economic growth. The State Rail Plan mentions the need to make the freight rail network more accessible for use by industries, which could help achieve the full benefits of SDG 9.

Considering resilience and economic well-being, another key asset that rail expansion could provide is service redundancy. Many local and regional events can cause transportation infrastructure to fail—severe floods can destroy bridge crossings for roads and rail, heatwaves can pose health risks for travelers, and crashes can delay service and increase travel times. A key component of a resilient transportation network is the ability to adapt to changing conditions. This requires recognizing that infrastructure will fail and designing a system that can meet demand with shifting modes or routes. With expanded passenger and freight rail networks, especially in major Arizona cities, the resilience of the transportation system can be dramatically improved. ADOT should focus on making its rail networks accessible to both private industry and passengers. The report addresses these needs in Sections ADOT SRP, p. 2-39, and improvements are recommended to include consideration of enhancement to safety.

4.5 SDG 10 – Reduce Inequalities

Regarding passenger rail improvements, ADOT can best reduce inequalities by ensuring that rail is accessible to the most disadvantaged communities in Arizona. In line with sustainability goals, focusing first on the largest cities can benefit the most people with more efficient use of limited resources. ADOT should consider providing extensive geographic coverage across major cities so that as many trips as possible can be conducted

by rail. In Phoenix, for example, this can include a focus on connecting outer suburbs such as Chandler, Mesa, and Glendale. Currently, Valley Metro operates light rail routes through Mesa, Tempe, and Phoenix, with expansions currently under construction in northern Phoenix locations (Valley Metro.org, n.d.). However, acceleration of these improvements in line with the proposed 2018 MAG Commuter Rail Plan (ADOT SRP, p 1-25) should be pursued. A key challenge in implementing this system is the low-density development that characterizes most of the Phoenix region with an average of 63 people per square mile (Arizona population 2023, n.d.). Thus, the role of reducing inequalities through rail improvement is not entirely the responsibility of transportation organizations like ADOT or MAG. Instead, ADOT must collaborate with city governments to develop land-use policies and encourage in-fill development that makes large-scale transit viable. One of the goals of the rail plan outlined by ADOT is to foster collaboration between federal, State, regional and local public agencies to plan a seamless multimodal transportation system" (Arizona State Rail Plan, 2022, p. 5-3). Failure to do so will not produce meaningful reductions in income inequality or help travel-limited communities strengthen their social connections within their cities.

Another suggested course of action for ADOT involves exploring the possibility of establishing a dedicated passenger crossing for the railway at the Arizona-Mexico border. This initiative would significantly enhance the safety of crossings for migrants while concurrently alleviating congestion at the existing motorway crossing. The implementation of this passenger railway crossing would not only prioritize safety, but also foster the creation of new job opportunities. The development of essential infrastructure, including security checks akin to those for personal vehicles, would be integral to the successful implementation of this project, contributing to both improved safety measures and economic growth within the region. This is an incredibly challenging task, as border security and migration policies between the US and Mexico can be very restrictive. Such a project would require ADOT to work with federal agencies like US Customs and Border Protection, and the US DOT to navigate policy and funding challenges of new infrastructure for cross-

border travel. While this is a difficult task, the potential inequality improvements—especially for cities in Mexico that have economic and cultural connections to Arizona—could be immense. Easier daily travel between the two countries could spur economic growth and improve job opportunities.

4.6 SDG 11 – Sustainable Cities and Communities

Providing sustainable and affordable transit options between cities becomes crucial for fostering regional connectivity and cooperation. The prospect of an efficient and reliable rail system encourages cities to plan and organize around this mode of transportation, creating a more interconnected urban landscape. This facilitates not only efficient transit for individuals but also the streamlined movement of goods, further contributing to economic vitality. Each of these goals are mentioned in ADOT's SRP on page 5-2.

An indirect yet impactful consequence of an expanded rail system is its potential to increase housing availability within cities. As the rail infrastructure grows, it opens new areas for residential development, leading to an expansion of housing options. This, in effect, addresses housing affordability concerns and reduces the need for multiple vehicles in average family households. The integration of housing and transportation planning around the rail system creates more walkable and accessible urban environments, fostering a sense of community and reducing the overall environmental impact associated with extensive car usage. In essence, ADOT's strategic focus on expanding railways aligns seamlessly with the broader objective of creating sustainable and resilient cities. By reducing the reliance on individual cars, it not only improves the economic landscape and eases traffic congestion but also fosters environmental sustainability and community development.

4.7 SDG 12 - Responsible Consumption and Production

The impact on tourism emerges as a significant dimension of the positive effects stemming from enhanced railways. As outlined in ADOT's SRP report, this may "encourage proactive

smart growth land use planning for land adjacent to rail infrastructure that does not conflict with freight rail operations." (Arizona State Rail Plan, 2022, p. 5-3). The ability to monitor passenger patterns and congestion levels offers valuable insights for optimizing rail operations and strategically shaping tourism strategies. This data-driven approach contributes to gauging economic impacts and identifying areas for further development. As ADOT actively refines and implements its rail plan, the organization's pivotal role in contributing to a sustainable and interconnected world becomes increasingly apparent, reinforcing its commitment to transformative change.

4.8 SDG 13 - Climate Action

ADOT is recommended to set up measures for disaster relief utilizing the railway infrastructure, such as utilizing it to move essential goods and people during disasters. This goal is mentioned in the SRP report by ADOT: "Provide parallel or alternative transportation routes and services to facilitate emergency access, including evacuation" (Arizona State Rail Plan, 2022, p. 5-3). A more in-depth plan explaining what measures will be taken is required to directly impact this SDG.

4.9 SDG 15 - Life on Land

ADOT is to increase cargo train transport in mountainous regions as currently they are poor (Arizona State Rail Plan, 2022, p. 4-6), aiming to decrease the reliance on trucks for transporting goods. By doing so, not only can this strategy mitigate wear and tear on roadways, but it can also enhance travel times for smaller personal vehicles. This multifaceted approach not only optimizes the efficiency of cargo transportation but also contributes to the improvement of emissions through a reduction in road traffic. Additionally, ADOT should work with city governments planning organizations like MAG to implement a transit-oriented development strategy for the growth of Arizona cities. This will help limit future degradation of the Sonoran Desert as more people move to the state.

4.10 SDG 17 - Partnership for the Goals

Mexico is a significant economic partner for Arizona, and this can be leveraged to make progress on the SDGs. Enhancing the rail infrastructure from its current state opens avenues for expedited transportation, allowing a greater volume of items to reach their destination. This improvement not only benefits local industries, but also has the potential to strengthen collaboration with Mexico. Currently ADOT plans to "improve the efficiency of passenger and freight movements within the State, in partnership with private carriers" (Arizona State Rail Plan, 2022, p. 5-2). To better satisfy SDG 17, it is recommended to expand efficiency to surrounding states as well. As highlighted by the Association of American Railroads, U.S. freight railroads already offer the most efficient and affordable freight rail service globally, connecting businesses worldwide (2023). With the potential for an increase in the number of daily trains transporting materials, the cost-effectiveness of rail transport is likely to further improve. This incentivizes companies to shift away from traditional modes of transportation, such as semi trucks, in favor of rail transport, ultimately resulting in cost savings.

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Team 7 - LRTP and Rural Areas

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Overview

Long-Range Transportation Plan

Introduction

The ADOT presented the 2040 Final Long-Range Transportation Plan called “What Moves You Arizona 2040” in 2018. This document is comprised of the findings from trends and issues affecting Arizona transportation, polished and refined goals and milestones for ADOT, an evaluation of the current conditions of state highway system (SHS), an estimate

of funds required for maintenance and improvement of the SHS and non-highway modes, an analysis of expected revenues over the 25 years period of time from 2016 to 2040, and the Recommended Investor Choice (RIC) plan to allocate the revenues based on findings from collaborative efforts with stakeholders. In order to provide guidance for what ADOT will strive to achieve over this time frame, six major goals were established – Strengthen Partnerships, Preserve and Maintain the System, Make Effective Investment Decisions, Enhance Safety, Promote Fiscal Stewardship, and Improve Mobility, Reliability and Accessibility.

Stakeholder and Public Involvement

Throughout the plan development process, ADOT collaborated closely with Metropolitan Planning Organizations (MPOs) and Councils of Government (COGs) to integrate an engagement procedure which consisted of multiple outreach sessions, workshops, a dedicated website and social media involvement. Through an online survey conducted, ADOT was able to obtain stakeholders' perspective on budget allocation, and their spending suggestions were 45% on preservation & maintenance, 32% on expansion, 12% on safety, 6% on technology, and 5% on accessibility. This stakeholder input, along with current investment practices, led to ADOT's revisioned Recommended Investment Choice (RIC) of the WMYA 2040, which ultimately shows how ADOT intends to assign future resources. Over the whole state of Arizona, ADOT's RIC anticipates spending 47% of the expected revenue on expansion, 35% on preservation & maintenance, and 18% on modernization.

Current Revenue & Expenditures

The resources available for Arizona's transportation systems come from three primary sources: the State Highway User Revenue Fund (HURF), county transportation excise tax, and the federal government. Together, Arizona is estimated to raise and receive a total of $31.1 billion inflation-adjusted dollars over the 25 year period. The fundings received from the local sources will be used for all of the four main sectors – Department

of Public Safety Highway Patrol, Counties, Cities, and Towns, State Highway Fund, and COGs & MPOs – while the federal funds would only be invested in the latter two. Primarily due to the extensive growth of the state and the travel demand, the estimated funding needed to operate, maintain, and improve Arizona's key transportation facilities and services over the 25 year plan period exceeds the estimated resources available by more than threefolds at $98.3 billion. This imbalance makes it all the more crucial for ADOT to carefully assess the investments to pursue.

Implementation Strategy

To successfully implement the plan within the 25 year time frame, ADOT will be taking initiatives in four areas: Resource Allocation, Performance Measurement, Target Setting, and Project Selection. The 2040 RIC highlights a significant shift in investment from expansion to preservation. Hence, ADOT envisions to materialize the expansion projects already programmed in the Fiscal Year (FY) 2018-2022 Five Year Program before carefully considering further expansion projects. To ensure that the plan is effective and is producing positive results and to monitor the implementation progress, ADOT will need to further strengthen its performance measures in the coming years. ADOT has also been striving to improve the alignment between Arizona's long-range transportation plan and the selection of projects through an initiative called Planning to Programming (P2P) link, and with the help of WMYA 2040 Plan the direction and goals become clearer.

PARA Program

Introduction

The Planning Assistance for Rural Areas (PARA) program, an initiative sponsored by the ADOT Multimodal Planning Division (MPD), addresses transportation challenges in non-metropolitan areas of Arizona. These challenges include escalating traffic demands, safety

concerns, and the need for sustainable multimodal transportation systems. Despite its success in addressing these challenges through over 100 studies, the program concluded at the end of FY 2018. This overview focuses on 5 exemplary studies conducted under the program, showcasing their impact and outcomes.

Eligibility and Funding

Targeted at supporting rural and tribal communities outside of Transportation Management Areas (TMAs) in Arizona, the PARA program was uniquely funded entirely by ADOT using Federal Statewide Planning and Research (SPR) funds. Projects under this program needed to align with at least one of the FAST Act National Performance Goals, allowing eligible entities to benefit without requiring a local funding match. Funding was restricted to planning and preliminary scoping activities, excluding design, construction, and staffing costs.

Roles and Responsibilities

In the PARA program, local public agencies collaborated closely with ADOT, contributing to study teams, developing public involvement materials, and providing local insights. ADOT's role encompassed project management, including scheduling, reviewing, approving deliverables, and handling consultant payments. The program aimed to enhance transportation infrastructure, improve safety, and stimulate economic growth in rural and tribal areas, with measurable outcomes in transportation improvements, reduced congestion, and enhanced multimodal transportation systems. The success of these projects is gauged by tangible outcomes like the execution of transportation improvement plans, reduced traffic congestion, and improved pedestrian, bicycle, and transit systems.

Pre-Scoping Projects

ADOT fully funded the Pre-Scoping process within the program, aimed at defining the scope, budget, and timeline for potential minor transportation-related improvements efficiently. The scope of work covered various planning activities across Arizona, including roadway and transit operations planning, public transit feasibility studies, and updates to general circulation plans. These projects, varying in focus from urban revitalization in Lake

Havasu City to long-range planning in the Ak-Chin Indian Community, addressed diverse regional transportation needs. In addition, projects eligible for funding are required to align with FAST Act National Performance Goals like safety, infrastructure condition, and congestion reduction.

Methodology and Approach

The methodologies employed in these studies include data collection, traffic analysis, public involvement, stakeholder consultations, and safety assessments. Innovative approaches, such as the focus on reducing single-occupancy vehicle usage in Sierra Vista and the incorporation of tribal community perspectives in the Ak-Chin study, showcase the adaptability and inclusiveness of the methodologies. These approaches ensure that the solutions are not only data-driven but also community-centric.

Community Partnerships

The PARA program emphasizes community partnerships, utilizing local surveys to gather insights on issues and preferred solutions from residents, thus promoting collaborative planning across multiple jurisdictions and within specific neighborhoods. Private consultants, however, are excluded from developing project applications to avoid conflicts of interest. Each report concludes with ADOT and local planners' recommendations, typically involving phased infrastructure improvements or new transit systems, aiding communities in understanding and addressing their challenges. The reports or final presentations also provide contact details for the local and ADOT Project Managers and any consultants involved, ensuring accessible communication channels for community involvement.

Requirements

Long-Range Transportation Plan

Realizing the Object

The purpose of the long-range transportation strategy, presented by ADOT, called "What Moves You Arizona 2040" is to layout the observed trends and issues revolving

around the state's transportation systems, the current functionality status of these systems, the estimated costs to maintain and improve the existing infrastructure, the anticipated revenue to be collected and how it will be allocated over a span of 25 years from 2016 to 2040. ADOT also established six major goals they aim to achieve within this time period – Strengthen Partnerships; Preserve and Maintain the System; Make Effective Investment Decisions; Enhance Safety; Promote Fiscal Stewardship; Improve Mobility, Reliability, and Accessibility.

Assumptions

The assumptions to be made with regards to the WMYA 2040 plan lie mainly in the financial sector. Due to the lack of data accessible and for the sake of easier analysis of the implementation of the strategies mentioned in the WMYA 2040 and their effectiveness, it will be assumed that the revenues anticipated will actually be collected and received over the time span, and the costs will remain similar without much deviation from the estimated value. It could also be helpful to note that the population of Arizona is projected to increase by around 4 million by 2050. This could affect the state's per capita income, commuting patterns, land use allocation, employment, and the scale of additional infrastructure required as both expansion and improvement.

Life-cycle perspectives

According to ADOT's 2016 Transportation in Arizona Report, the data from Federal Highway Administration in 2011 showed that 86% of Arizona's rural interstate and 86% of urban interstate were in good condition. However, these percentages are decreasing every year due to ADOT dedicating approximately $220 million annually, which is an amount barely adequate to maintain current conditions. A similar trend was observed for the bridges across the state. For these reasons, it is important for ADOT to carefully review the Return On Investment (ROI) and cost-benefit analyses of each of their transportation assets that requires work done in the future. It is evident that even though new infrastructure is needed often to accommodate the increasing population and business in the state, it is also important to maintain the existing infrastructure and transportation systems that have

been serving the community. This could also motivate ADOT and the stakeholders to strive for better materials/engineering methods that would result in improved sustainability and longevity of the transportation systems, without compromising their service utility. A transparent view of a project's purpose, needs, service utility, and life-cycle can help ADOT make important investment decisions in sustainable infrastructure.

Scale of Implementation

The Long-Range Transportation Plan is designed to include the transportation system and infrastructure as a whole for the state of Arizona and its 15 counties. The WYMA 2040 plan involves a wide variety of stakeholders including, but not limited to, the federal government, the state government, metropolitan planning organizations, councils of government from different counties, and Arizona residents. The transportation systems mentioned in WYMA 2040 includes 18,488 miles of State Highway, 27 transit systems, 2,853 miles of bike facilities, 2,000 miles of freight railroad, 8 international ports of entry, 7,826 bridges, and 69 public use airports. For all the infrastructure mentioned previously, ADOT and the related stakeholders must analyze the existing conditions and determine if any work is required and the type of work – modernization, expansion, or preservation and maintenance – that would best benefit the system being analyzed. In addition, ADOT will need to determine the importance and urgency of all the assets that require attention and how to fund the projects selected.

Geographical Scope

The scope of the WYMA 2040 Long-Range Transportation Plan spans over the entirety of the state of Arizona and the counties within, covering a total of 113,998 square miles. This includes both urban and rural areas categorized under three main bodies of government – the Maricopa Association of Governments (MAG), the Pima Association of Governments (PAG), and Greater Arizona. However, we expect most of the projects from ADOT within the time frame of this plan from 2016-2040 to be in urban areas where the highest volume of traffic, passengers, and users of the systems are usually observed, such

as the Interstate Highways and State Routes and the bus and rail lines in the Metro Phoenix region.

Time frame

The WYMA 2040 Long-Range Transportation Plan covers a time period of 25 years starting in 2016 and ending in 2040. Within this time frame, ADOT has planned to update the Recommended Investor Choice guide every 5 years to consider any potential dramatic changes in terms of economy, population, climate, and technology. This 25 year time frame is just for what ADOT currently has intended to assess and work on its transportation systems. The usefulness and effects of the projects done within this time frame ought to be assessed for a longer period of time throughout their complete cradle-to-grave cycle.

PARA Program

Realizing the Object

The purpose of the PARA studies is to provide preliminary planning services for multimodal transportation plans to improve safety, reduce congestion, improve environmental sustainability and economic vitality. These services include but are not limited to the planning of bike lanes, mass transit services, identifying roads for repair prioritization, and safety improvements for all users. Things like planning for HomeOwners Associations and recreational paths are thus excluded as they serve either private groups or do not enhance the transit options for a community. To obtain PARA services, the onus is on local governments to submit applications to ADOT requesting their use in a competitive bidding process. However, once these services are approved, funding of the project is through Federal Statewide and Planning Research (SPR) funds, meaning the only thing both ADOT and local transit authorities have to fund is personnel costs.

Project responsibility is then divided between ADOT and the local transit authority, with the former being responsible for overall project management and funding while the latter being responsible for obtaining and providing relevant information about local conditions and managing community involvement. Once approved, studies first identify the

proposed study area, determining key features like community demographics, transportation characteristics within the community, and transportation deficiencies both real and perceived by the community. This section is the most comprehensive as it serves as the justification for recommended improvements. Once this has been completed, recommendations are then made for a phase-by-phase improvement process in the community based on expected funding source, the amount of time it will take to receive funding, and the priority the improvement has to the community.

Assumptions and Limitations

The primary limitation of this study is that the PARA program is currently suspended, thus there are no recent studies which would provide insights into how ADOT would currently perform these activities. Given that some of the reports are over a decade old, it is possible that many initial assumptions and recommendations may be considered by current ADOT standards to be outmoded. We are thus assuming that should the PARA program be restarted it would be providing planning services and recommendations in the same manner as evaluated during the identified time frame.

Furthermore, ADOT's PARA program only provides preliminary planning assistance for rural communities and is thus not responsible for the final design and implementation of their recommendations. While it is not strictly necessary to know the ultimate outcome of these recommendations, they lie outside the scope of PARA's work, it would be useful for determining how communities view the recommendations made by ADOT and whether they are actually followed. Finally, given the large number of PARA studies conducted (over 100 as of November 2023), it is simply not practical to assess every single report given the limited time available. Thus, we are relying on a sample of five reports to make an overall assessment on PARA, which, while selected to be as geographically and demographically broad as possible, may result in the missing of some broader trends.

Life-Cycle Perspectives

Given PARA's focus on advising and preliminary planning, the program is able to have a significant impact on the life-cycle of rural infrastructure and transportation by setting early expectations and requirements for project durability, economic viability, and

sustainability, even with limited information on how the ultimate implementation will take place. Planning and recommendations for PARA reports cover a wide time frame from short-term (less than five years) to long-term (15 or more years), providing for phased improvements to meet budgetary restraints and changing traffic volumes. Key to our assessment will be determining how ADOT identifies and recommends solving current and predicted transportation issues in the community, including whether ADOT gives consideration to the total economic, social, and environmental life cycle impact of the project from initial conception to eventual replacement. However, given that the deadline placed for achieving SDGs is 2030, in some cases the timeframe for ultimate completion of all recommended improvements and thus achievement of SDGs will be after this date.

Scale of Implementation, Geographical Boundaries, and Time Frame

According to ADOT, these PARA studies cover all areas within the state of Arizona outside Transportation Management Areas (Phoenix and Tucson urbanized boundaries), including all tribal territories, encompassing nearly 83% of the state's land area. The five focus studies are for the communities of Ak-Chin Indian Community (2016), Sierra Vista (2011), Payson (2011), Chinle-Many Farms and St. Michaels-Window Rock-Fort Defiance (2012), and Lake Havasu City (2012). The window for infrastructure improvements planned up to 20 years beyond the day of publishing. These places have been selected as they broadly represent the geographical, economic, and cultural diversity of the state, including tribal and tourism-driven communities, making it suitable to see how adaptable the program is across a wide range of environments and groups.

Findings

Long-Range Transportation Plan

The What Moves You Arizona (WYMA) 2040 long-range transportation plan by Arizona Department of Transportation consists of six main objectives: Improve Mobility, Reliability, and Accessibility; Preserve and Maintain the System; Enhance Safety; Strengthen Partnerships; Promote Fiscal Stewardship; Make Effective Investment Decisions. In this

section, each of these main goals of the WYMA 2040 plan will be analyzed through “Step 2.3 : Sort the SDGs” and “Step 2.4 : Assess your impact” of the SDGs Impact Assessment Tool.

As the nature of the WYMA 2040 is a heavily transportation based strategy, it has been assumed that the most relevant SDGs would be associated with infrastructure and cities. Initially, the 17 SDGs have been sorted into three categories based on their perceived relevance to the long-range transportation plan as per Step 2.3 – Relevant, Not Relevant, and Unsure.

The SDGs deemed relevant include:

- Goal 3 : Good Health and Well-Being
- Goal 8 : Decent Work and Economic Growth
- Goal 9 : Industry, Innovation and Infrastructure
- Goal 10 : Reduced Inequalities
- Goal 11 : Sustainable Cities and Communities
- Goal 12 : Responsible Consumption and Production
- Goal 16 : Peace, Justice and Strong Institutions
- Goal 17 : Partnerships for the Goals

The SDGs deemed not relevant include:

- Goal 1 : No Poverty
- Goal 2 : Zero Hunger
- Goal 4 : Quality Education
- Goal 5 :Gender Equality
- Goal 6 : Clean Water and Sanitation
- Goal 7 : Affordable and Clean Energy
- Goal 14 : Life Below Water
- Goal 15 : Life on Land

The SDGs placed under unsure include:

- Goal 13 : Climate Action

The next step in using the SDG impact assessment is actually to evaluate in detail each of the six main goals mentioned in WYMA 2040 and comprehend which SDGs it is related to, as well as what the indicators of this relation are specifically.

Goal 1 : Improve Mobility, Reliability, and Accessibility

The first goal of WYMA 2040 is to Improve Mobility, Reliability and Accessibility. According to ADOT's Goals and Objectives: Draft Working Paper #2, published in 2016, ADOT aims to "implement critical/cost-effective investments to improve access to multimodal transportation and optimize mobility and reliability for passengers and freight". The objectives under this goal include making improvements to the existing transportation systems to better promote recreation and tourism and accommodate a wider range of users in terms of transportation preference, age and disability status, addressing congestion of not just roadways, but also freight systems and public transportation services, and also optimizing the capacity and performance of these systems with the help of technology. The improvements intend to promote economic growth through recreation and tourism, plus accommodating a wider demographic have a direct positive impact on SDG 11 (Target 11.2) and SDG 9 (Target 9.1). Moreover, this goal has an indirect positive impact on SDG 8 (Target 8.2), and an indirect positive impact on SDG 10 (Target 10.2) through more chances of employment due to less physical and economical barriers. This goal has a direct impact on SDG 11 (Target 11.2) because it talks about providing safe access to transit for everyone which is closely related to goal 1f. Also, the goal is an indirect positive impact to SDG Target 8.2 due to the innovation being pronounced with the SDG, which relates to the overall goal of improving mobility throughout the state.

Goal 2 : Strengthen Partnerships

The second goal of the WMYA 2040 is to Strengthen Partnerships. ADOT will actively "develop and nurture partnerships that support coordination, integration and preservation

of [their] investment". The main purpose of the objectives is to continue improving ADOT's coordination with MPOs, COGs, NGOs, local agencies, state and federal agencies, and local tribes by streamlining and making administrative processes transparent. The streamlined and transparent partnerships and administration ADOT anticipates to achieve have a direct positive impact on SDGs 16 and 17 (Targets 16.6 and 17.17). SDG 16's Target 16.5 and SDG 13 require more information on the types of organizations ADOT has partnered with would be required to determine its relevance to this LRTP goal. The SDG which can be an indirect positive impact of this goal is SDG 16 (Target 16.5), which basically states the desire to reduce corruption and bribery in all forms. This can be indirect and positive, since strengthening partnerships can reduce the chances of bribery from taking place.

Goal 3 : Preserve and Maintain the System

The third goal of WMYA 2040 is Preserve and Maintain the State Transportation System. According to ADOT's Goals and Objectives: Draft Working Paper #2, published in 2016, ADOT focuses on making sure the infrastructure system is being well preserved in order for it to last as long as possible. The objective under this goal is to meet or exceed the percentage of State Highway System pavement conditions and off-system bridges, in good condition of repair. Another objective is to advocate for repairs and improvements within the transportation infrastructure throughout the whole state. One more objective is to maintain a condition of well-repaired when it comes to any state highway infrastructure assets like rest areas, and ports of entry. The objectives of this LRTP goal has an indirect positive impact on SDG 16 (Targets 16.b and 16.1). Furthermore, it has a direct positive impact on SDG 12 (Target 12.7). This is because the target discusses following national policies and priorities which is what this goal intends to do statewide.

Goal 4 : Make Effective Investment Decisions

The fourth goal of WMYA 2040 is to make effective investment decisions. This goal demonstrates the idea of better linking the planning and programming processes through performance-based decision-making. The objectives under this goal include optimization of

return on investment, cost-effective transportation solutions, and maximizing the leverage of ADOT funds. The idea of putting funds in the right place directly positively impacts SDG 16 (Target 16.7). This goal directly impacts SDG 16 because it promotes decision-making in all levels which is what the goal is set out to do. The direct impact comes from making effective investment decisions by all and the SDG relates to fair decision-making processes. Goal 4 also gives an indirect positive impact on SDG 12 (Target 12.6) because it talks about encouraging companies to gain sustainability practices. As this goal desires for better link planning and programming, it results in better decision-making, which will then result in more effective sustainability practices.

Goal 5: Enhance Safety

The fifth goal of WMYA 2040 is enhancing safety. This goal demonstrates the continuous improvement of all transportation system modes, as well as pursues multiple objectives, including the reduction of the number of highway fatalities, serious injuries, non-motorized fatalities, non-motorized serious injuries, and improving evacuation plans. Its main purpose is to advocate for safety measures regarding any injury, independently of its nature. The idea of decreasing the total number of fatalities is a direct positive impact to SDG 16 (Target 16.1), because it talks about reducing all forms of violence and death rates, which is what Goal 5 intends to do.

The goal also indirectly positively relates to SDG 11 (Target 11.5), which states the desire to significantly reduce the number of deaths and the number of people affected by the global gross domestic product caused by disaster. Since goal 5 tries to reduce the number of fatalities by improving transportation modes, it is positively related to what SDG 11 (Target 11.5) represents. A positive direct impact of this goal is SDG 3 (Target 3.6) which explains the desire to halve the number of global deaths caused by traffic incidents. This relates to this goal because goal 5 is concerned about reducing fatalities on the road throughout the entire state.

Goal 6: Promote Fiscal Stewardship

The sixth goal of WMYA 2040 is to promote fiscal stewardship. This goal ensures responsible management of public resources and implementation of funding strategies to solidify long-term balanced investment in transportation systems throughout Arizona. This will be achieved by delivering high quality projects on time and within budget, least environmental impact possible while performing effective communication, as well as use of data and technology to make better decisions for projects and improvements. This LRTP goal impacts directly positively SDG 9 (Target 9.1) because ADOT's objective to deliver high quality projects lines up exactly with the target. The objectives to achieve this LRTP goal also have the potential to leave a positive impact on target 9.4 of SDG 9, due to better use of data and technology between all the teams working on a project, innovative systems or upgrades to the existing ones that are more efficient and sustainable could arise.

The Sustainable Development Goals established by the United Nations and how they are relevant to the goals established in What Moves You Arizona 2040 by Arizona Department of Transportation are summarized in the figure below.

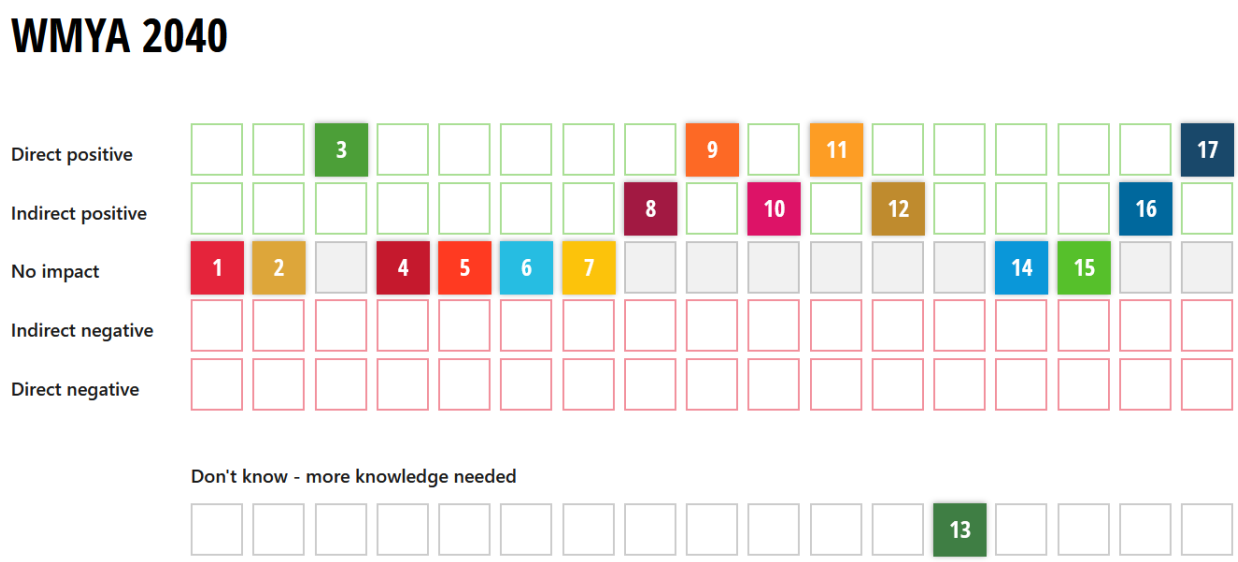

Figure 7.1. Assessment Results for WMYA 2040 Plan

PARA Program

Based on the analysis using the SDG Impact Assessment Tool, the findings for the PARA program study reveal significant insights:

Ak-Chin Indian Community (2016): This study directly supports SDG 11 (Sustainable Cities and Communities) through its focus on sustainable urban planning and infrastructure. It also indirectly contributes to SDG 13 (Climate Action) by promoting the use of sustainable transportation modes.

Sierra Vista (2011): The emphasis on reducing single-occupancy vehicle trips aligns with SDG 11 and SDG 13 by enhancing urban mobility and reducing greenhouse gas emissions. Indirectly, it supports SDG 3 (Good Health and Well-being) by encouraging active transportation modes like walking and cycling.

Payson (2011): The study's focus on addressing traffic congestion and improving road safety directly contributes to SDG 11. Additionally, it indirectly supports SDG 9 (Industry, Innovation, and Infrastructure) by proposing innovative transportation solutions.

Chinle-Many Farms and St. Michaels-Window Rock-Fort Defiance (2012): This study's approach to long-range transportation planning in tribal communities directly addresses SDG 11. It also indirectly contributes to SDG 10 (Reduced Inequalities) by focusing on transportation equity.

Lake Havasu City (2012): The urban revitalization efforts and improvement of public transit systems in this study align with SDG 11. Indirectly, this study contributes to SDG 8 (Decent Work and Economic Growth) by potentially enhancing access to job opportunities.

ADOT has previously identified SDGs 2, 3, 7, 9, 11, 13, and 17 as most likely to be impacted by the activities they perform. Of these SDG goals and those identified in the assessed studies, the following indicators were determined to be most relevant (either directly or indirectly) based on their relation to rural infrastructure. These indicators were further placed into five broad goals which will be the primary focus of our assessment.

Table 7.1: SDG Targets Relevant to PARA

SDG	Direct or Indirect Impact	SDG Target	Goal 1: Infrastructure Construction and Access	Goal 2: Community and Stakeholder Involvement	Goal 3: Disaster and Climate Resilience	Goal 4: Environmental Impact Minimization	Goal 5: Public Health and Safety
2	Direct	2.3	x				
		2.a	x				
3	Indirect	3.6					x
		3.9					x
9	Direct	9.1	x		x	x	
		9.4	x			x	
11	Direct	11.2	x				x
		11.6				x	
		11.a	x				
13	Indirect	13.1			x		x
		13.2			x		
		13.3			x		x
17	Indirect	17.17		x			

These goals and their associated targets will be individually assessed for each published report to determine if ADOT is meeting these goals (and thus achieving the applicable SDGs) through the program.

Table 7.2: Goals Met by Study Area

Goal	Payson (2011)	Sierra Vista (2011)	Lake Havasu City (2012)	Chinle-Many Farms and St. Michaels-Window Rock-Fort Defiance (2012)	Ak-Chin Indian Community (2016)
Goal 1	Yes	Yes	Yes	Yes	Yes
Goal 2	No	Yes	Yes	Yes	No
Goal 3	No	No	No	No	No
Goal 4	No	No	No	No	No
Goal 5	Yes	Yes	Yes	Yes	Yes

Goal 1: Infrastructure Construction and Access

In all viewed instances of the PARA Program, infrastructure construction and access is the essence of each report. Not only are infrastructure improvement recommendations made for all forms of transportation, but things like demographic and socioeconomic factors are taken into account when considering which improvements to make and how soon to make them. A highlight of the reports is the Navajo Reservation (Chinle-Many) study, which not only proposed a full phased program to implement infrastructure improvements based on priority and budget constraints, but also considered how making the improvements might temporarily restrict transportation access for vulnerable groups. Thus, SDG 2, 9 and 11 are directly positively impacted.

Goal 2: Community and Stakeholder Involvement

Community involvement is mixed. In some cases (Lake Havasu City and Sierra Vista), public meetings and a comment period allow residents to list issues that they feel personally impact them. However, this was not consistent from report to report, potentially constraining transportation authorities by limiting their perspective to issues which they feel are important to address rather than community-wide concerns. Overall, SDG 17 is indirectly positively impacted.

Goal 3: Disaster and Climate Resilience

Disaster and climate resilience is not mentioned in any of the observed studies. While admittedly such planning often falls to the scope of local emergency services, it is disappointing to see a lack of discussion in both categories especially since resilient transportation systems are essential to dealing with a crisis. In none of the observed instances were the effects of a changing climate or even disaster resilience considered. SDGs are thus not impacted by this goal.

Goal 4: Environmental Impact Minimization

Environmental impact is another area in which the reports are sorely lacking, and potentially even having a negative direct impact. Given that these are pre-scoping services, this phase of the project is the ideal time to set standards for identifying and minimizing environmental impacts. In some of the reports a passing mention of environmental concerns are made, however these merely point out some of the general environmental challenges in the areas rather than one's specific to transportation or ways to fix them.

Goal 5: Public Health and Safety

Concurrent with the infrastructure improvements is the (indirect) improvement in safety for all road users. Measures such as dedicated bike lanes in Sierra Vista and Lake Havasu directly improve public safety by separating non-vehicular road users. If there was one area that could be improved in this category, it would be increased discussion of vehicle emissions and how that impacts adjacent communities, particularly with Payson study as reducing congestion also reduces emissions, however this would likely be an indirect impact. SDGs 3, 11, and 13 are indirectly positively impacted.

Recommendations

Long-Range Transportation Plan

The commitment of the ADOT and their *What Moves You Arizona* (WMYA) 2040 Long-Range Transportation Plan towards the achievement of the SDGs underscore a dedication to comprehensive and responsible practices. The assessment results provided in *Findings* reveal a collective emphasis on critical aspects such as infrastructure development, sustainability, natural resource protection, the cultivation of partnerships, and the overall well-being of communities. While acknowledging the positive actions ADOT is currently taking to progress towards these goals, the assessment also highlights areas for improvement.

1. Establishing Constant and Variable Goals over the 25 years.

Notably, the impact of ADOT and WMYA on SDGs varies over a 5-year span, considering that WMYA undergoes revision every 5 years to align with evolving visions, missions, and goals. This periodic reassessment ensures flexibility but also implies potential changes in resource allocation and overall impact over the 25-year plan duration. Recognizing the importance of understanding the transportation system's standing, investment, and future revenues, it is imperative to address areas demanding a sustained, long-term commitment. ADOT should prioritize evaluating the enduring effects of resource allocation over the 25-year plan, emphasizing not only resources but also policy adjustments to ensure the successful realization of SDG's 9, 11, and 13, which are particularly sensitive to the diligence and commitment applied to their objectives.

2. Further Implementation of SDG 15 : Life on Land

As mentioned in the findings of the report, the current WMYA 2040 Long-Range Transportation Plan has no impact that can be related to the SDG 15. However, there can be an impact made by including it into the basis of the transportation plan. SDG 15 is crucial because it is about the importance of promoting, protecting, and restoring sustainable use of terrestrial ecosystems. When it comes to building roads, bridges, any form of transportation, or infrastructure, it almost always involves disturbing the ecosystem in some way shape or form. That said, it is recommended special attention to this SDG along the WMYA.

3. Directly Impact SDG 13 : Climate Action

In the assessment, SDG 13 was categorized as needing more information for a comprehensive evaluation. While the WMYA 2040 does not explicitly have a focus on Climate Change, it is essential to recognize the interconnectedness between transportation systems and the environment and climate. Considering the reciprocal relationship between climate change and infrastructure, it is advisable for ADOT to allocate greater investment in addressing this issue and incorporating it as a key metric in the 25-year plan.

In summary, ADOT's WMYA 2040 Long-Range Transportation Plan reflects a strong commitment to UN SDGs through infrastructure, sustainability, and community well-being. While commendable, periodic revisions necessitate sustained alignment with SDGs 9, 11, and 13 over the 25-year plan. Prioritizing long-term effects, integrating SDG 15 (Life on Land) for ecosystem preservation, and increasing focus on SDG 13 (Climate Action) within the plan are crucial for ADOT to fortify its impact on sustainability and ensure a resilient transportation future for Arizona.

PARA Program

Overall, we find PARA in its former incarnation to be marginally on track to help ADOT achieve the UN SDGs by 2030. However, in its current status as an inactive program, ADOT is unlikely to meet its desired SDGs via the PARA program within the desired time frame. Based on our findings, four main recommendations are made by our group to improve these circumstances.

1. Reactivate and Enhance the PARA Program

Reactivating PARA is essential for progress in SDGs, particularly in transportation accessibility for disadvantaged groups (SDG 10 - Reduced Inequalities). This should include a comprehensive approach to environmental impact mitigation and climate change resilience, contributing to SDGs 9 (Industry, Innovation, and Infrastructure), 11 (Sustainable Cities and Communities), and 13 (Climate Action).

2. Integrate Environmental Sustainability and Innovation

Emphasize eco-friendly transportation solutions like electric public transit, bike-sharing programs, and infrastructure for electric vehicles to address SDG 13 directly. Invest in smart transportation technologies to enhance efficiency, safety, and resilience, aligning with SDG 9 and reinforcing climate action strategies.

3. Promote Inclusivity, Health, and Community Engagement

Ensure transportation plans are inclusive, catering to all community members, including those with disabilities, thereby directly supporting SDG 10. Encourage active transportation options like cycling and walking paths to improve community health (SDG 3). Mandate comprehensive community involvement in all PARA projects to foster collaborative planning and partnerships (SDG 17), setting a standard for effective engagement as seen in the Chinle-Many Farms study.

4. Align Transportation Projects with Economic and Social Goals

Integrate transportation initiatives with local economic development strategies, potentially improving access to employment opportunities and stimulating local economies (SDG 8). This approach should also consider the social implications of transportation projects, ensuring equitable access and benefits for all community members.

By focusing on these recommendations, the PARA Program is able to achieve its desired impacts on the SDGs and ensure a better, more sustainable state for the people of Arizona. ADOT can effectively expand its impact across multiple SDGs, ensuring a more integrated and comprehensive approach to sustainable development in transportation planning and implementation.

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