

# Assessing the Gap: Analyzing Campus Transportation Infrastructure

*A Transportation Report Card Framework and Methodology*

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## Introduction

Transportation is always a topic of contention in cities. Whether it be the war on the car, the safety of cyclists, or a need for improved public transit, transportation affects everyone. Hence, any transportation project consists of several rounds of public engagement and stakeholder meetings to ensure the public's voice is heard. However, these projects are typically chosen before the general public is consulted; citizens' opinions are often not considered when examining existing conditions and deciding what solutions are most needed.

This holds true for post-secondary institutions as well; effective campus mobility benefits everyone who is part of the post-secondary community and thus everyone should be involved in its formulation. However, students and staff are often not consulted to see what improvements need to be completed to improve mobility. To make matters worse, unlike elected city leaders, many of the decision makers at post secondary institutions are not chosen by the students and hence their decisions are even less influenced by the public. They may hire industry experts to assess existing conditions and make recommendations, but students are often left out of this process. Students need a channel to voice their concerns so that projects can be better guided to address mobility on campus. This project aims to do just that.

This project's objective is to deliver an audit framework for assessing existing transportation infrastructure on post-secondary campuses on two different fronts - student perspectives and industry expert standards. The framework prescribes an analysis to be completed by measuring various transportation modes against standardized key performance indicators. Firstly, a student focused perspective; transportation modes within campus are analyzed by students via a survey to produce a transportation report card. A similar report card is produced based on the existing transportation infrastructure in and around campus via industry standards. These two reports can then be used to examine the gaps between existing infrastructure and user experiences to understand where there may be actual issues that need to be addressed compared to perceived problems that can be solved through better communication.

As an extension once this gap analysis is completed, an outline has been provided on how to further evaluate and recommend solutions to the gaps that are found. Project documentation like campus master plans can be assessed to ensure that these gaps are being addressed. Recommendations can then be made to help provide better guidance not only for future projects, but also for more effective communication of transportation modes available across

campus. These recommendations should help address both students' concerns that have been highlighted as well as existing infrastructure that has been indicated as requiring improvement.

Ultimately, the aim for this auditing methodology is to provide post-secondary institutions a method to assess mobility gaps within post-secondary campuses through a student-oriented perspective. The details below outline the framework and methodology to complete this gap analysis for any post-secondary institution across Canada.

## Report Card Framework

The ultimate goal of this project is to assess all transportation modes across campus using key performance indicators (KPIs) that can apply to all modes. Hence, the report card chosen to effectively visualize the results was a matrix, with transportation modes representing each row and KPIs representing each column. A sample report card can be seen below.

**Assessing the Gap: Transportation Report**

Legend:

- Poor
- Moderate
- Great

Campus: \_\_\_\_\_

Student Level: \_\_\_\_\_

Primary Mode of Transportation: \_\_\_\_\_

	Physical Infrastructure	Accessibility & Inclusivity	Reliability & Utilization	Safety	Comfort & Enjoyment	Intermodal Connectivity
Active Transportation	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○
Walking	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○
Public Transit	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○
Driving	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○
Transportation Network Companies TNCs	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○

It is worth noting that all these transportation modes are being analyzed not generally but in the scope of a post-secondary campus. Hence, each mode will be assessed based on the KPIs directly on or around campus. For example, Uber may be ubiquitous throughout all of Toronto, but if there are not practical pickup spots near campus, this would reflect poorly on the TNC mode. A breakdown of each mode and KPI is outlined below.

## Transportation Modes

**Active Transportation:** includes all modes of transportation (other than walking) that are active. This for the most part deals with bicycles, but also includes e-scooters, rollerblades, etc.

**Walking:** deals with all walking (both accessible and not) in and around campus.

**Public Transit:** involves all street cars, subway lines, and buses that run either through or adjacent to campus.

**Driving:** includes all private vehicle transportation in and around campus where the user is the driver.

**Transportation Network Companies (TNCs):** Also referred to as mobility service providers (MSP) this mode represents all rides from companies that match users with drivers including taxis, Ubers, and Lyft.

## Key Performance Indicators

**Physical Infrastructure:** This refers to the built form of an amenity, which could be subdivided into the categories of aesthetic appeal and functionality. While it is difficult to achieve a proper balance between both categories, the goal here is to ensure that transportation features incorporate both aspects into their physical infrastructure. Aesthetic appeal is more difficult to criticize as this feature requires certain subjectivity. Functionality on the other hand is more easily measured as ergonomics are relatively universal. More generally, the category is meant to assess existing infrastructure such as the number of bike racks, parking spots, bus stops, etc.

**Accessibility & Inclusivity:** This refers to whether a service or amenity is designed to provide any interested party with the capacity to use said feature. The goal here is to minimize, if not totally eradicate, any feelings of exclusion or marginalization. This could include students with a disability or students who identify as part of a racial and/or ethnic minority. This category is meant to assess existing transportation infrastructure based on both physical infrastructural qualities (curb height for passenger drop off zones) and economic accessibility (is it cost-prohibitive for certain populations?).

**Reliability & Utilization:** This refers to transportation's dependability and the frequency of its usage. Only through understanding dependability are we able to understand usage, therefore the goal here is to comparatively measure the former against the latter. For example, reliability takes into consideration bus and subway train frequency, especially while paying attention to different parts of campus and at different times during the day. In comparison, utilization takes into consideration daily, weekly, monthly, and yearly subway train passengers.

**Safety:** This refers to the measures that were taken to ensure security while using this form of transportation, the grade that the operator was awarded, and the individual user's sense of security while using a particular form of transportation. The goal here is to ensure that the user, whether individually or as a group, is provided security. For example, safety will take into

consideration streetlight coverage at night, the availability of “eyes on the street”, and the certification(s) granted to local transit providers among others.

**Comfort & Enjoyment:** This refers to how pleasant a user experience is while utilizing a particular form of transportation. The goal here is to provide the user, whether individually or as a group, with an acceptable experience, but if possible striving for better. Certain key areas under consideration here include user leisure time, overall experience, and physical stimulation among others. (This area could also include aesthetic pleasure drawn from the form of transportation, currently under Physical Infrastructure.)

**Intermodal Connectivity:** This refers to the level of difficulty with which it takes to transfer from one method of transportation to an alternative method of transportation. The goal here is to see where stops in a person’s commute leads to inefficiency, personal discomfort, and excessive spending among others. Certain key areas under consideration here include integration across transportation networks, alternative methods of transportation should one or more portions of an individual’s commute become unavailable, and the overlap between different methods or providers of transportation that leads to inefficiency.

## Report Card Evaluation

The goal of the report card is to provide an effective visual that helps provide an easy to understand overview of the analysis that was completed. In this case, transportation modes are being analyzed so each square will be given one of the three colors of a traffic light to illustrate the results. The colors are as follows:

- **Green Light:** The transportation mode is meeting or exceeding the acceptable standards of the KPI.
- **Yellow Light:** The transportation mode is only partially meeting the standards of the KPI. Some improvements are required to meet acceptable levels.
- **Red Light:** The transportation mode is not meeting the standards of the KPI. Major improvements are needed to meet acceptable levels.

As mentioned above, the goal of this report card is to provide an overview of transportation conditions in and around campuses. Hence, these color indicators are not very technical. They are however decided upon based on various metrics for each KPI and transportation mode which is discussed in the Methodology Section.

# Methodology

The following section looks to outline the methodology to perform a successful analysis of transportation modes on and around post-secondary campuses. A brief overview of the steps outlined below are as follows:

- Separate report cards need to be created for both the student perspective based on survey data and industry standards based on field data
- These two report cards need to be compared and a gap analysis performed to understand the difference between perception and reality of transportation infrastructure on campus
- Once these gaps are analyzed, future projects and master plans for the campus need to be reviewed to see if these issues are being addressed
- Lastly, recommendations can be provided to inform post-secondary institutions on how they can better improve their campus mobility

This methodology has been designed such that it can be applied to any post-secondary institution. Although the scale of various metrics may need to be adjusted (access to public transit that is acceptable may be different for Toronto versus Guelph), the overall process can help any school improve their transportation infrastructure for students.

## Insight from Experts: Surveying Existing Conditions

Expert analysis on transportation infrastructure is very common for both cities and post-secondary institutions. These reports often come in the form of transportation or traffic impact studies. These reports typically review all existing conditions and provide recommendations based on projected future demands and standards. One of the major flaws with these reports however is that they are often quite long and can be confusing to the uninformed reader. To alleviate this issue, this methodology looks to create a report card that summarizes existing conditions in an easy to read, visually friendly manner.

## Metric Overview

For each transportation and corresponding KPI, 2-4 metrics have been identified as key values that can be used for evaluation. For example, the section for Public Transit Mode and Reliability & Utilization KPI has 3 metrics identified: average excess waiting time (AEWT), number of operation days per year, and public transit capacity. Each of these metrics have the corresponding units they should be measured with noted (total minutes, number of days, and percentage respectively). The metrics for each section can be seen in the corresponding document.

## Metric Value Justification

These metrics were chosen such that the results can provide an accurate picture of the existing conditions of each transportation mode and KPI so that a grade (green, yellow, or red) can be

provided. It is worth noting that metrics have been quantified where possible, but many of them have qualitative results. For example, the amount of physical stimulation on a transportation mode (Comfort and Enjoyment KPI) is difficult to quantify, rather a statement is provided to summarize this metric. This is still acceptable as these qualitative metrics can provide insight on a section's grade. It is also worth emphasizing that although these metrics were chosen to be applicable to any post-secondary institution, campuses can have very diverse infrastructure and hence different metrics may apply. These metrics are by no means standard and can be adjusted on a per campus basis if they can help provide a more accurate analysis.

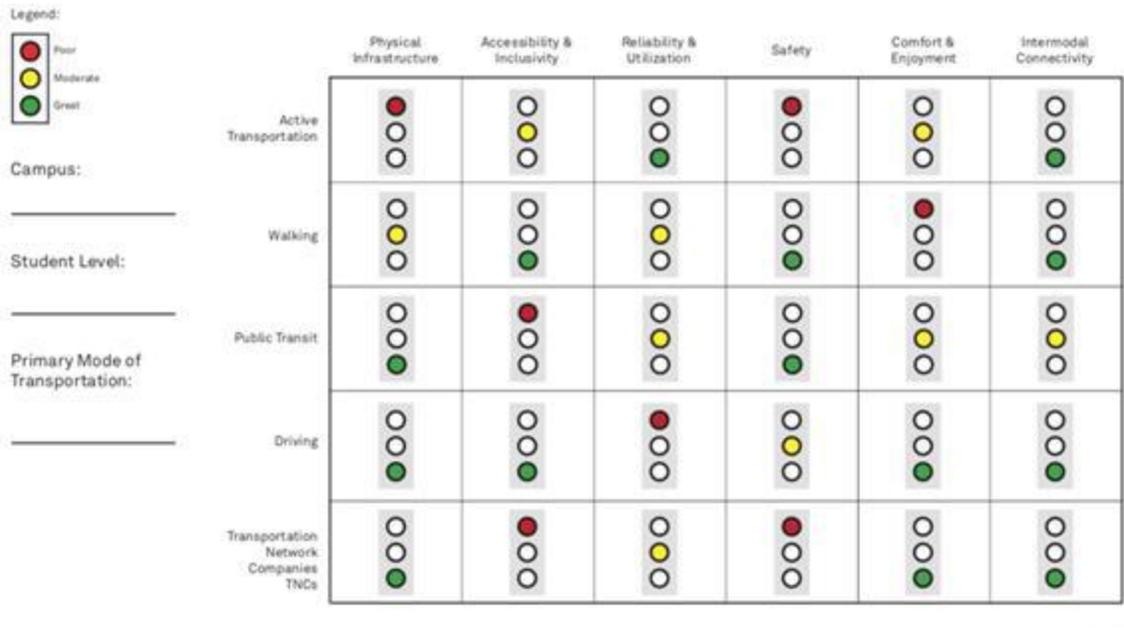
## Obtaining Metric Values

This analysis has identified the various metrics that need to be assessed, however a university still needs to find these values if they want to complete an analysis. Although it was noted that transportation studies don't necessarily present information in a user-friendly way, they do have a plethora of information that can help fill in many of the metrics in the existing conditions matrix. As many universities and colleges have completed these types of studies, they should be the first place to look to obtain metric values. Unfortunately, not all campuses have this information and some values would need to be calculated from field observations on an as needed basis. Institutions could take advantage of the fact they are performing this gap analysis and undergo a transportation study in tandem to obtain metrics applicable in both projects.

## Metric Values to Report Card Grades

Now that all metric values have been obtained, the final step in the existing conditions report card is to evaluate each matrix square and provide a grade. These grades are going to vary greatly depending on the campus being analyzed and hence benchmarks have not been included for each metric. For example, affordability of a campus or public transit options in a big city can be much different than a smaller city. This does not mean all bigger cities have better transportation modes, different benchmarks may need to be used to help gauge the different standards across all campuses. This is where transportation studies can also help identify the benchmarks for the various grade levels. Once these grade levels have been clearly identified, each square can be given a grade and a final report card for existing conditions can be produced. A sample of a completed report card can be seen below

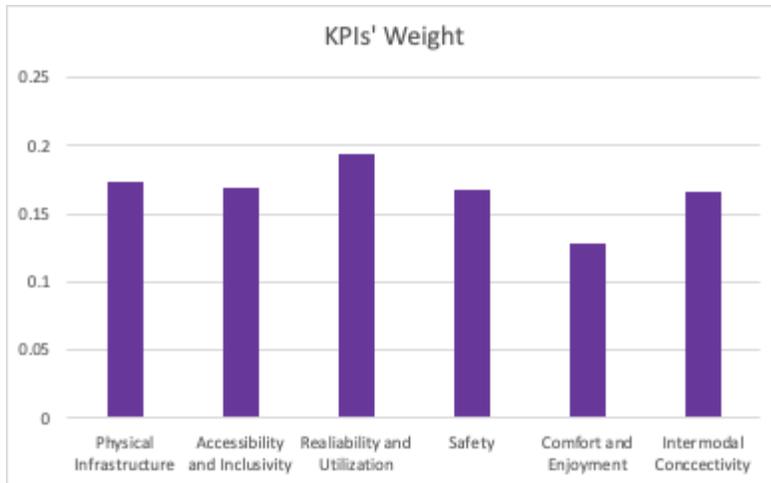
# Assessing the Gap: Transportation Report



## Walking in Someone Else's Shoes: A Student Perspective

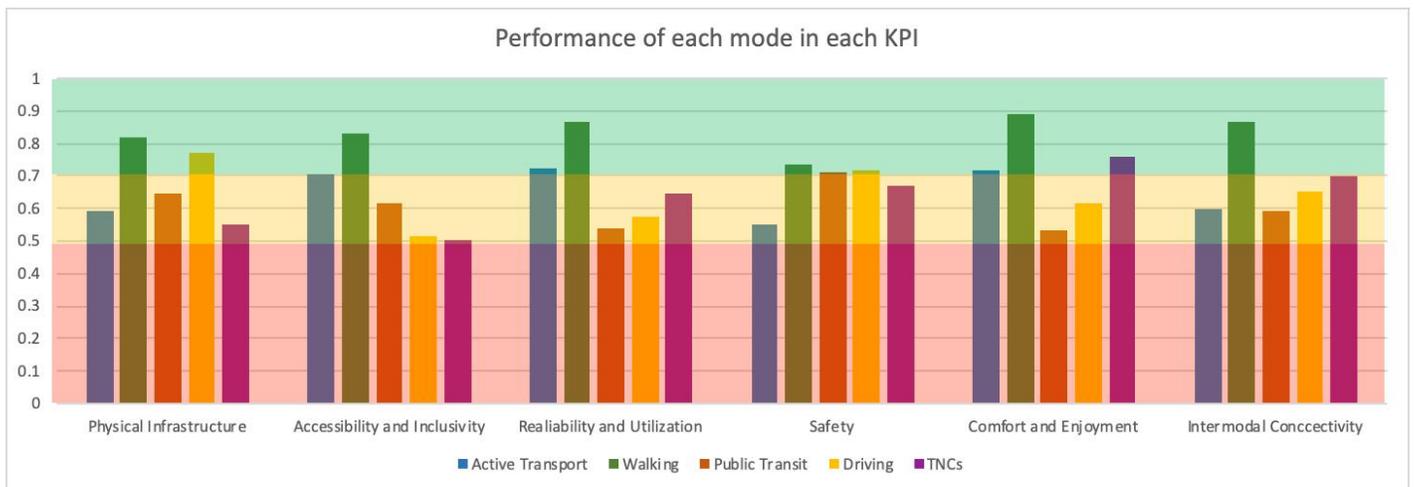
Similar to the industry standard report card, a student perspective report card needs to be created. To obtain an accurate picture of student perspectives on campus, a survey is recommended as a source of data collection. A sample survey based on multi-criteria decision making ideology has been created that can be used to fill out each of the report card's matrix indices. Multi-criteria decision-making methods have been utilized extensively for the task of choosing the "best" option from available alternatives by policymakers and planners. However, in this study, this survey enables students to rate the importance of the various KPIs and then comment on each transportation mode performance in reference to each KPI. The survey analysis tool can then calculate the grades for the entire report card, i.e., which modes are providing the best and the worst means of transport from the students' point of view. It is worth noting that although this gap analysis is student focused, faculty and staff can also partake in these surveys as they use the campus in a similar capacity to students.

In analyzing the data, the first step is to determine the weight of each KPI. As shown in Figure 1, reliability and utilization are the most important KPI that people asked for.

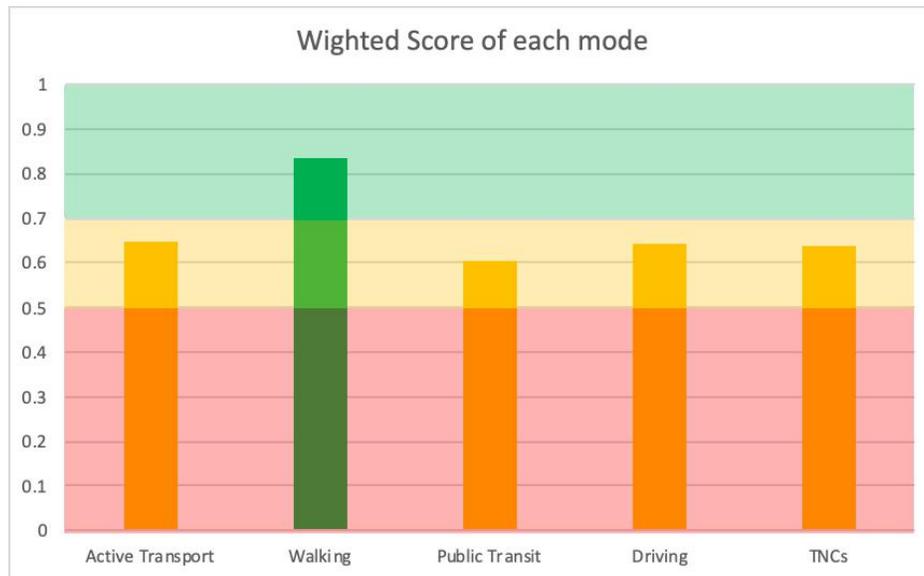


**Figure 1: Key Performance Indicator Weights**

The second step is to determine the performance of each mode in each KPI, shown in Figure 2. Figure 2 is divided into three sections. If a mode performance for a KPI is in the green section, such as mode Walking for KPI Intermodal Connectivity, it means that performance is acceptable in this KPI. On the other hand, for instance, public transit performance in reliability and utilization KPI is in the yellow section meaning that performance needs some improvement with respect to this KPI. Lastly, each mode's grade is calculated based on each KPI weight and its associated performance, shown in Figure 3.



**Figure 2: Mode Performance Across KPIs**



**Figure 3: Weighted Score of each mode**

The survey that has been created can also produce several other results that can be beneficial to a university. As mentioned above, the survey has been created based on MCDM method. There are however different methods that can be applied using this data. The method should be chosen based on the objective definition. In this study specifically, the rank of each transportation mode based on various KPIs was investigated from students' perspectives. Another promising method for this kind of opinion-based analysis is the *Analytical Hierarchy Process* (AHP) which was introduced by Thomas Saaty in 1980 for prioritizing different alternatives for complex decision-making process. AHP is "a theory of measurement through pairwise comparisons and relies on the judgments of experts to derive priority scales" (Saaty, 2008, p. 83). In this survey, students are considered the experts. Based on the analysis, public transit is the mode which is dominated in all the KPIs by the other modes, meaning that this mode has the worst performance from students' point of view. This may have been expected, but the question now is how the institutions can help to improve this mode.

Although this survey provides an effective method to complete the report card it is by no means the only method. Survey questions can be altered to or additional questions added to address certain issues or get more insight depending on the campus being analyzed. There may also be existing survey information that can help shape the grading on the report card. For example, Transform TO completed an online survey to understand how students commute to and from campus. This information could be very valuable in understanding student perspectives of mobility on campus. Regardless of the method used, the final report card can then be compared to the equivalent industry expert report card and a gap analysis completed.

## Reality Versus Perspective: Comparison and Gap Analysis

Now that the two report cards have been produced - one for existing conditions and one based on student perspectives - they can be compared. It is important to emphasize that although the

same transportation modes and KPIs are being analyzed, the methods used to calculate a final “grade” for each report card are quite different and should not be compared. What can be compared are the final grades themselves as they use the same red, yellow, green ranking system.

## Understanding the Gaps

There are three main scenarios that can occur between any two squares on opposing report cards. Each scenario is identified and explained below.

**Identical Colours:** This result is straightforward - the student perspective aligns with the actual existing conditions. If both squares are green no improvement is needed, but if both are either yellow or red both the current state of the transportation mode and student opinions indicate that improvements need to be made.

**Existing Conditions Grade Higher than Student Perspective Grade:** This result can be caused by two different discrepancies. The first is the difference between perception and reality due to lack of communication. For example, students may think there are no places to securely lock bikes on campus but in reality there are, the institution is just not effectively informing people on their locations. Oftentimes better communication or promotion of the respective issue by the university or college can help remedy this discrepancy. It is also worth noting however that the transportation infrastructure may still need improving, it may just not be as bad as people perceive it to be. The other type of discrepancy can be caused by inaccurate assessments of existing condition standards. For example, an area might meet sufficient lighting levels and have close access to emergency blue lights, but students still feel unsafe walking at night. These issues can be more difficult to fix, but not impossible. Getting feedback from students can help understand the core issues better and help lead to more concrete solutions.

**Student Grade Higher than Existing Conditions Grade:** This last result is uncommon, but still requires action. Students may feel that a certain aspect of a transportation mode is sufficient but based on the actual conditions it is not. This may lower the priority but does not eliminate the need for infrastructure improvement. It is only a matter of time before student perceptions catch up to reality and at that point the problems will need to be addressed. It is always better to be proactive than reactive.

## Completing the Analysis

Using the various scenarios described above, each square in the matrix can be commented on to provide an idea of the type of recommendations that will need to be made. For example, two red squares for Active Transportation - Safety would imply that recommendations to improve cycling safety are needed. This analysis will provide context when assessing future plans for a campus and ultimately making recommendations on how to address both actual and perceived issues with mobility on campus.

## Looking to the Future: Master Plan Evaluation

Before any recommendations are made on how a campus can improve its transportation issues, an evaluation should be done to see if the institution already has plans in place. This includes reviewing campus master plans, building projects, and any relevant transportation projects happening on campus. These types of documents should provide insight on whether the issues and gaps found from the report cards are already being addressed. For example, if the report card noted that there was a lack of TNC friendly drop off and pick up locations but the master plan outlines that several of these will be installed in the next few years, a final recommendation does not need to suggest installing more TNC locations on campus. Ultimately, this evaluation can help produce more accurate recommendations for issues that the institution has overlooked or ignored, not ones they are already working to solve.

Note that the documentation analyzed doesn't necessarily have to be produced by the institution. Municipalities and transit agencies will have information or even formal plans for the transportation infrastructure that runs around and through campus. These projects could address the problems that have been noted by the gap analysis so they should not be overlooked.

## Aligning Goals: Results and Recommendations

The purpose of this final section is to summarize the issues found and put together a final list of recommendations. The various problems found and corresponding solutions will vary greatly depending on the campus and hence specifics will not be discussed here. However, it is important to emphasize that not all problems necessarily need transportation infrastructure upgrade recommendations. For example, a campus might not be prioritizing driving on campus and hence will not look to improve private vehicle infrastructure. Also, many issues could be driven by poor communication; solutions could take the form of better signage or messaging of the infrastructure available to students on campus. Of course some recommendations will be infrastructure related, but that is by no means the sole purpose of this gap analysis.

Regardless of the results, it is recommended that this information be made publicly available to help shape future conversations about mobility on campus. Transparency and honesty will help spur change and show students that their institutions are always working to better the campuses they operate.

## Conclusion

The framework and methodology outlined above can help institutions have a better understanding of their transportation needs in and around campus. By comparing industry standards to student perspectives, the gap between perceived and actual deficiencies can be highlighted in a straightforward way. Assessing future projects and plans can ensure that an institution is moving in the right direction towards solving transportation related issues on campus. Lastly, recommendations can be made to improve campus conditions to better align with both student ideals and what is expected in the industry.

To conclude, it should be emphasized again that this methodology is not set in stone. Institutions can take this process and shape it to best suit their campus needs. Ultimately, the goal of this framework is to provide post-secondary institutions with an often overlooked perspective of transportation on campus. This process can help colleges and universities design campuses to best suit the people that use them most.

# References

Saaty, Thomas L. "Decision making with the analytic hierarchy process." *International journal of services sciences* 1, no. 1 (2008): 83-98.



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