Fellows at Purple Line tunnel

Prioritizing Transportation CIP Projects 2019

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MCDOT

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EXECUTIVE SUMMARY

Background

The Montgomery County Department of Transportation (MCDOT) currently has 132 Capital Improvements Program (CIP) eligible projects and hundreds of other minor projects. The Office of Management and Budget (OMB) estimates the current CIP projects' total value at $6.75 billion. Due to the large value and number of projects, MCDOT requested that I develop a method capable of prioritizing stand-alone CIP projects as well as county wide level of effort projects. It is important that any such prioritization method be rational, meaning clear and logical such that it can be repeated, and defensible, meaning the methodology can withstand public scrutiny. For years, MCDOT staff have prioritized projects well and without inappropriate bias. The prioritization method is meant to enhance the effectiveness of achieving Montgomery County's stated goals, increase consistency in decision making, and allow for greater transparency.

Recommendation

A point system with weighting best meets the needs set out by this project. Such a method is rational and defensible, can handle the large number of projects to be prioritized, and includes the ability to increase efficiency while also promoting equity. Nearly all the 12 prioritization systems reviewed indicated that prioritization input data should be as high-quality and objective as possible in order to keep debate at a high level. Doing so would encourage, for example, debating the weighting of safety verses commute times rather than the sources of the data. A point system with weighting allows for the underlying data to be objective while simultaneously including the political priorities of elected officials.

In order to create a high-quality prioritization tool, the county should improve input data by creating datasets designed for this tool and invest in model inputs such as traffic analysis. The acquisition of a full-time project data specialist would resolve most of the remaining barriers to a high-quality prioritization tool for MCDOT.

Colton Keddington
Summer Fellow
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NOTES

About the Fellow

Colton Keddington is a current Master of Public Policy student at the University of Maryland. Before returning to school for his MPP Colton worked full-time as a data analyst. He has a passion for policy research and evidence-based policy. At school, Colton works as a research assistant supporting academic research regarding state and local tax policy.

Acknowledgements

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Overview

MCDOT requested that I research project prioritization methods, recommend an appropriate prioritization method for MCDOT, and begin drafting the recommended method into a useable tool. This report details that process by explaining selected prioritization methods, analyzing their strengths and weaknesses, and providing recommendations for the development of a prioritization tool.

Abbreviations

MCDOT – Montgomery County Department of Transportation

MDOT – Maryland Department of Transportation

CIP – Capital Improvement Program

OMB – Office of Management and Budget (Montgomery County)

HIN – High Incident Network

BiPPA – Bicycle Pedestrian Priority Area

Definitions

Rational – Clear steps and sequence such that it can be repeated in the future.

Defensible – Able to withstand intense public scrutiny with all details released.

Standardization – The mathematical process that forces a given distribution to average zero. Done by taking each number in the list and subtracting the mean of the list and then dividing by the standard deviation of the list.

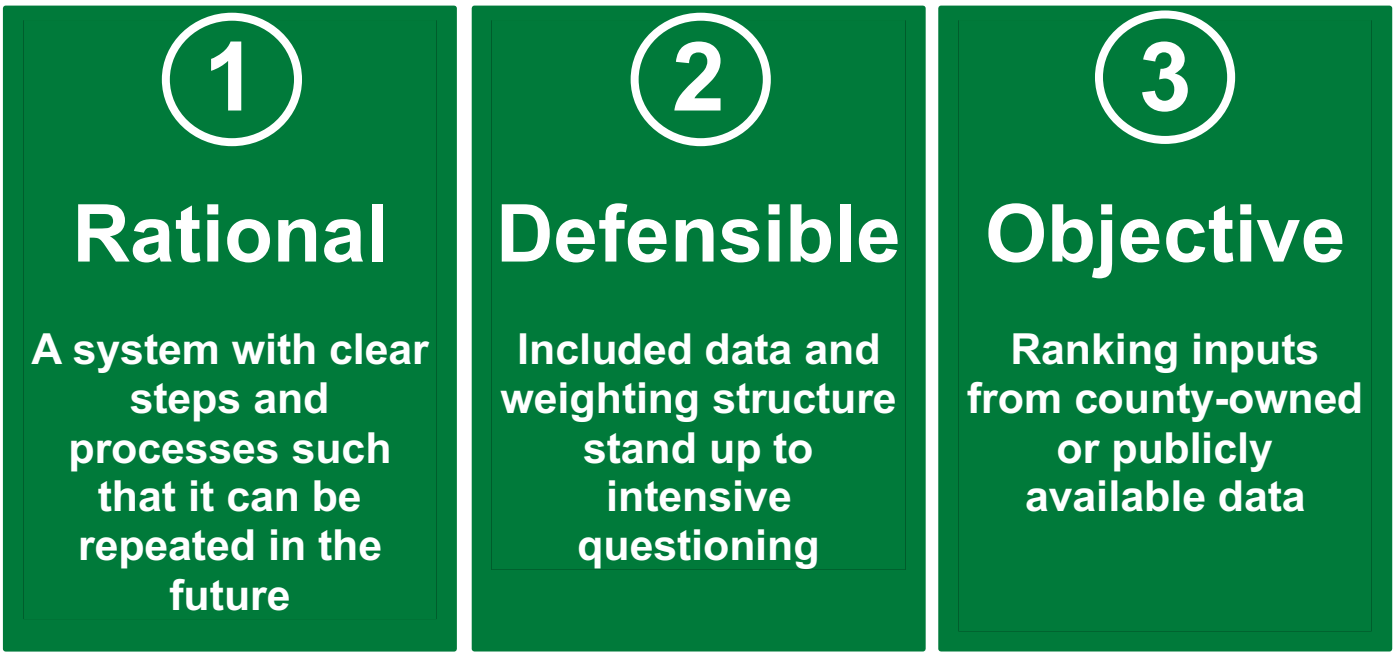
DIFFERENT METHODS OF PRIORITIZATION

Theoretical Framework

Regardless of the size of the entity, a good prioritization method should include some basic characteristics. The first characteristic is rational. Rational in terms of prioritization methods is defined by Turochy and Willis as “one with clear steps and a sequence”[1]. In other words, a rational method will include a system with clear steps and processes such that it can be repeated in the future. Being able to repeat or replicate a method is a desirable characteristic primarily because it allows stakeholders to understand how and why certain projects are prioritized over others.

A method that is only rational is not necessarily a good method because the steps may be politically or morally unacceptable. In addition to rational, a prioritization method should be defensible. Defensible in this context means that the included data and weighting structure can stand up to intense public scrutiny[2]. A method that is both rational and defensible is valid because it is logical and publicly acceptable.

While a prioritization method is valid if it is rational and defensible, it should also be as objective as possible. This is not to say a prioritization method could or even should be



[1] Turochy, R. E., and Willis, J. R. "Procedures for prioritizing proposed transportation improvements at the metropolitan level." Transportation Research Board 85th Annual Meeting, Washington, D.C.

[2] Id.

objective in its entirety. Specifically, the data inputs should be as objective as possible in order to keep the policy debate at a high level. Doing so would encourage, for example, debating the importance of safety verses commute time rather than the quality and accuracy of the raw input data. Objectivity thus removes unnecessary outside influence on the method while allowing for subjective political priorities to guide the priority rankings.

Rank Choice Prioritization

Rank choice prioritization is closely related to rank choice voting. The concept of rank choice voting is that a voter may indicate multiple candidates and the order of their candidate preferences. Some state legislature appropriation committees use the concept of rank choice voting or preferential voting in their prioritization processes. A hypothetical example is provided below.

Rank Choice Prioritization Example

Please rank your top 5 projects 1-5 with 1 being your highest priority, 2 being your next highest priority, and so forth.

Rank	Project Name
	Project 1
5	Project 2
	Project 3
	Project 4
2	Project 5
	Project 6
	Project 7
	Project 8
	Project 9
	Project 10
	Project 11
1	Project 12
	Project 13
	Project 14
3	Project 15
	Project 16
	Project 17
	Project 18
	Project 19
4	Project 20

In a rank choice prioritization method, each voting member of the committee would receive a list of all of the considered projects. Then, each voting member would rank their top few projects. The chairperson of the committee then collects the ranked lists. In some cases, the chairperson uses a formal rank choice voting scheme, and in some cases, the chairperson uses a more informal estimate of where the members generally ranked the projects. In either situation, the chairperson then presents a prioritized list to the committee which the committee may adjust further.

MCDOT should not use rank choice prioritization due to the lack of rationality and practical issues associated with rank choice prioritization. Rank choice prioritization fails to meet the need of rationality due to the unscientific nature of individual preference. It would be extremely difficult if not impossible to replicate the method by which the committee reached its final priority rankings. The public, along with future committees, could only guess at which members ranked projects high or low and the level of coordination between committee members on project rankings.

Furthermore, rank choice prioritization is impractical for MCDOT and the transportation CIP project list. The CIP currently has 132 projects in need of prioritization ranging from sidewalk projects to large scale public transit projects such as the Purple Line. Additionally, some of the 132 projects are county-wide level of effort projects that incorporate over 100 sub-projects. The large number of projects along with the vast diversity in project characteristics indicate that it is not reasonable to attempt prioritization by hand.

Point System Prioritization

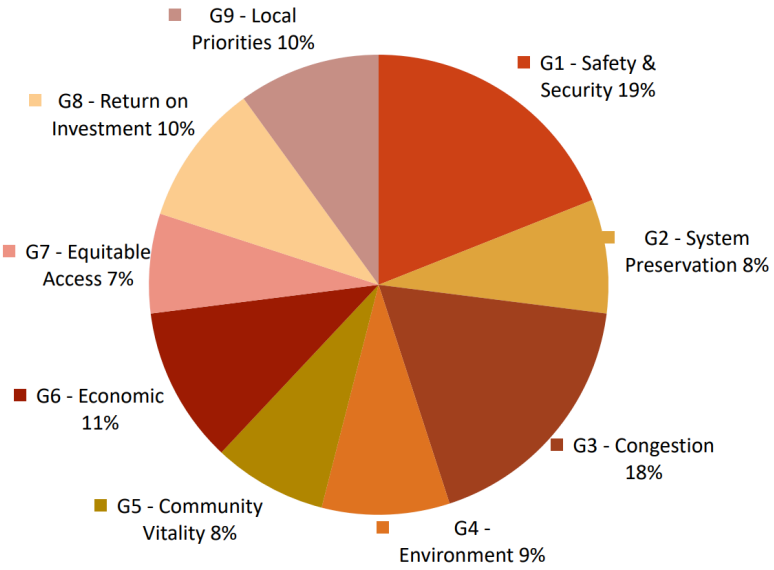
Point system prioritization is a system where each project scores points based on its characteristics. The project with the most points is considered to be the highest priority. This general system is used by many transportation departments including the Maryland Department of Transportation (MDOT), Vermont Department of Transportation, and Illinois Department of Transportation among others.

Point systems differ largely from entity to entity in order to meet the unique needs and policy priorities of the entity. As an example, Vermont[3] assigns points to projects based on the type

[3] "Background info emphasis areas and project prioritization." Transportation Program FY 2014 | Agency of Transportation. https://vtrans.vermont.gov/about/capital-programs/2014

of project. Road projects have a point system, bridge projects have a point system, intersection design projects have a point system, etc. Alternately, Maryland uses a single point system that includes all types of projects. Maryland also employs a weighting system where it formally prioritizes certain outcomes over others[4]. Again, Vermont's method differs in that it does not overtly state which of the priority outcomes are most important.

Maryland Shows Policy Priority Order Through Weighting[5]



The comparison of Vermont and Maryland briefly illustrates that point system prioritization may come in differing forms. Despite the differences, it is largely true that the measured characteristics relate to or directly derive from political priorities. Point system prioritization is not necessarily designed to remove subjective values. Maryland's weighting formula clearly shows subjective policy values driving the prioritization process.

MCDOT should use a point system to prioritize its CIP projects because it meets the rational, defensible, and objective needs while promoting the policy priorities of the county. A point system fulfills the definition of rational by having set definitions and point values given to projects when they meet the set definitions. Given the definitions and point values, the process will be replicable and therefore rational.

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[4] "Chapter 30 - MDOT Project Prioritization Program." Department of Transportation. May 07, 2019. http://www.mdot.maryland.gov/newMDOT/Planning/Chapter_30_Score/Index.html.

[5] Id page 15

While a point system does not inherently ensure defensibility, it is highly likely that MCDOT's point system will be. The structure of the department and the oversight provided by the County Council should safeguard against the point system being politically infeasible.

A point system meets the rational, defensible, and objective needs while promoting the policy priorities of the county.

A point system has the ability to be objective and promote subjective policy priorities. The objectiveness of the system comes from the data inputs. The data inputs can and should be defined in such a way that it is objective. An example could be: is a project within a half-mile of a Metro stop? This input is objective because a project either does or does not meet the definition of this input. However, a subjective policy preference could be highlighted by making projects within a half-mile of a Metro stop earn five points rather than just one. Doing so would suggest that connecting to Metro is especially important in meeting the county's priority outcomes.

The availability and cost of input data limits point system prioritization. Only projects with data for all of the defined inputs can be prioritized. Therefore, new projects with little or no data inputs cannot go through the prioritization process. High-quality data inputs, such as traffic analysis, can be expensive or time consuming to produce. The cost, either in time or money, grows larger with the number of projects possibly making some or many high-quality data inputs infeasible.

MCDOT SPECIFIC METHOD

Input Data

MCDOT has a uniquely critical role in the county because of the vast impact transportation has on the county. MCDOT projects have the potential to affect each of County Executive Marc Elrich's seven priority outcomes[6]. Those seven priority outcomes are:

1. Easier Commutes
2. A Growing Economy
3. A Greener County
4. A More Affordable and Welcoming County
5. Safe Neighborhoods
6. Thriving Youth and Families
7. Effective, Sustainable Government

The priority outcomes of easier commutes, greener county, and safe neighborhoods stand out as the most overtly transportation-oriented priority outcomes. However, after conducting some brief interviews with county staff[7], it was clear that transportation projects could be used as a tool to promote a growing economy, a more equitable county, and access for youth. Because transportation CIP projects can affect each of the Executive's priority outcomes, data inputs for each outcome should be considered.

The proceeding page lists data Montgomery County already possesses or has access to that could be used to award points to transportation CIP projects. The potential data inputs are categorized by priority outcome and sometimes appear in more than one outcome as some project characteristics promote more than one priority.

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[6] "MontgomeryCountyMD.GOV." Office of the County Executive - Montgomery County, MD. https://montgomerycountymd.gov/exec/.

[7] "Dr. Glenn Orlin." Interview by C. Keddington. June 13, 2019 & "Gene Smith." Interview by C. Keddington. June 14, 2019.

Potential Data Inputs

Easier Commutes

- Project type: road
- Project type: bicycle
- Project type: public transit
- Project type: pedestrian
- Creates new route
- Within 0.5 miles of Purple Line
- Within 0.5 miles of BRT
- Within 0.5 miles of MARC
- Within 0.5 miles of Metro
- SSP zone
- On state road

A Growing Economy

- Project type: Freight
- In area with high density of residents
- In area with high density of jobs

A Greener County

- Project type: bicycle
- Project type: public transit
- Project type: pedestrian
- Bicycle master plan

A More Affordable and Welcoming County

- Equity emphasis areas
- In area with high density of low-income residents
- In area with high density of low-income jobs
- Geographic equity (council district)

Safe Neighborhoods

- State of good repair
- Collision reduction
- High Incident Network (HIN)
- Lowers bicycle stress level
- Bicycle Pedestrian Priority Area (BiPPA)

Thriving Youth and Families

- Within 0.5 miles of K-12 school

Effective, Sustainable Government

- In state priority letter
- Prior construction funding
- Scale of project / cost

Standardization

The previous page clearly demonstrates that the priority outcomes that are classically associated with MCDOT projects – easier commutes, safe neighborhoods, and a greener county – have, on average, more potential data inputs. Using a simple point system would result in a higher priority for projects that excel in these classic transportation goals purely due the number of data inputs in these priority outcome categories. A solution that allows policy makers to more directly control how much each category influences the final rankings is standardization.

Standardization is when a list of numbers is transformed into the normal distribution[8]. Standardizing is helpful because it takes a list of numbers and forces the new list of numbers to average zero and have a standard deviation of one. Each new number signifies how far above or below average its value is compared to the other numbers in that list in terms of standard deviation. Applying standardization to each priority outcome category separately would make each priority outcome equal on average. The scores would depict how a project performs compared to other projects in that priority outcome category regardless of how many or few data inputs are in that category.

Standardization is done by taking each number in a list and subtracting the mean of the list and then dividing by the standard deviation of the list. The formula is provided below.

$$Z = \frac{x - \mu}{\sigma}$$

Policy makers gain greater control over the final rankings through standardization because after the process is complete, meaning all of the categories are on average equivalent, policy makers can simply increase or decrease the power of a particular category through weighting (rather than by the sheer number if data inputs available). Weighting should be used because it ensures that the highest priority areas are influencing the prioritization rankings the most.

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[8] Stock, James H., and Mark W. Watson. 2007. *Introduction to Econometrics*. Boston: Pearson/Addison Wesley. Page 36.

Weighting

Weighting refers to the power a particular category possesses in determining the final ranking of a project. As stated previously, MDOT uses weighting in its point system to prioritize its policy goals. Like MDOT, MCDOT could use weighting to prioritize specific priority outcomes over others. It is important to note that not setting weights is a weighting decision within itself. If policy makers choose not to explicitly weight the priority outcomes, the priority outcomes will be inherently weighted equally assuming that the previously recommended standardization occurs.

MDOT provides a good example of how weighting should work. The weights are expressed in terms of percentage. Each priority outcome category receives a percentage with all of the categories' percentages summing to 100 percent. The sum should not be higher nor lower than 100 percent. As certain categories receive higher weights, other categories must go down in weight. The weighting process largely determines which projects rise as top priorities and which fall to the bottom. Specific weighting schemes should be the subject of discussion and debate by policy makers.

On the following page, two tables illustrate how different weighting schemes could result in different priority rankings. In the first table, the weights are set evenly whereas the second table heavily weights safe neighborhoods and a greener community. The level of the weights serves as a quantified signal of the relevant importance of each priority outcome. The tables represent hypothetical projects, points, and weighting; they are not recommendations.

Example of Weighting Scheme: All Equal

	A Greener County	Easier Commute	Effective, Sustainable Government	Safe Neighborhoods	Thriving Youth and Families	Growing Economy	Affordable Welcoming County	TOTAL Weighted points	Rank
Weight	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%		
Project A	3.29	3.33	5	3.13	4.16	4.08	5.34	4.05	3
Project B	5.05	4.44	5	6.90	5.21	5.19	4.26	5.15	2
Project C	5.92	5.91	5	5.64	6.27	6.30	5.34	5.77	1

Example of Weighing Scheme: Differing Weights

	A Greener County	Easier Commute	Effective, Sustainable Government	Safe Neighborhoods	Thriving Youth and Families	Growing Economy	Affordable Welcoming County	TOTAL Weighted points	Rank
Weight	20.0%	10.0%	5.0%	50.00%	5.0%	5.0%	5.0%		
Project A	3.29	3.33	5	3.13	4.16	4.08	5.34	3.48	3
Project B	5.05	4.44	5	6.9	5.21	5.19	4.26	5.88	1
Project C	5.92	5.91	5	5.64	6.27	6.3	5.34	5.74	2

OTHER POTENTIAL USES

While the goal of this report is to recommend a method for prioritizing transportation CIP projects, the same method could apply elsewhere in MCDOT. Specifically, a point system with weighting could prioritize projects within county wide level of effort projects. One example includes the Sidewalk Program Minor Projects. MCDOT maintains a list of all sidewalk requests in this program. The number of projects in this single county wide level of effort project exceeds the average person's ability to properly evaluate. The same point system with weighting, even with the exact same inputs, could be used within this project to determine which sidewalks should be designed and constructed first. Other MCDOT parent projects that could use the recommended prioritization method include:

- Resurfacing
- Facility Planning
- Bikeway Program Minor Projects
- Bridge Design
- Bridge Renovation
- Bus Stop Improvements
- Pedestrian Safety Program
- Ride On Bus Fleet

A point system with weighting could prioritize any list of potential transportation projects as long as the data inputs are comprehensive enough for all project types.

LIMITATIONS AND NEXT STEPS

Improve Input Data

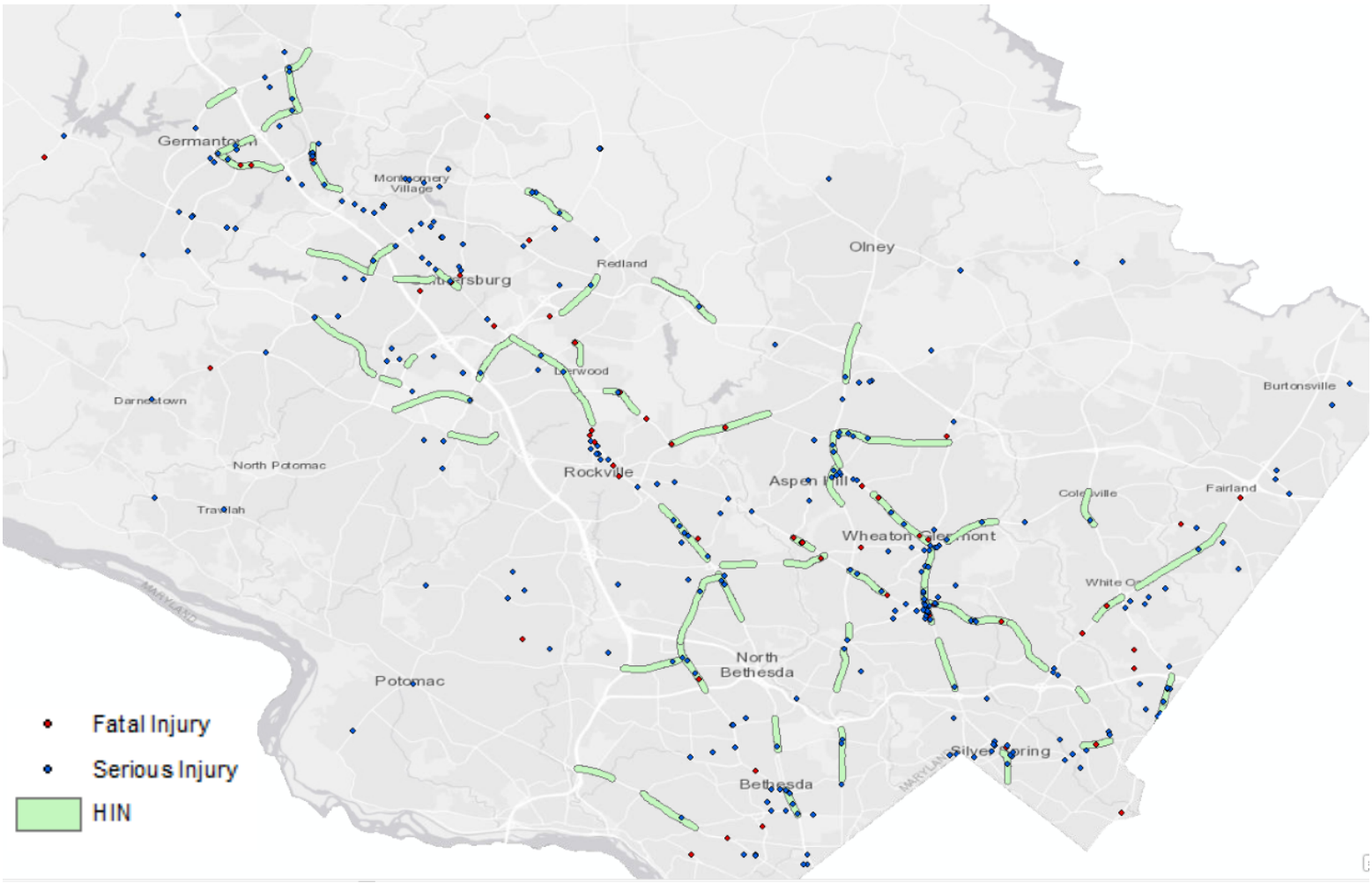
The most apparent limitation to MCDOT's ability to implement the point system with weighting is input data. Montgomery County possesses a large amount of useful data that allowed for the creation of a prototype tool. However, it is clear that many of the data inputs are instruments or substitutes for what should actually be measured. Mode-specific safety provides a simple example.

Vision Zero stands as Montgomery County's commitment to zero traffic fatalities. The County has a large amount of data regarding automobile crashes involving other cars, bicycles, and pedestrians. The efforts of Vision Zero provided the County with areas known as High Incident Networks (HIN). In essence, the County marked the areas with high rates of car crashes. HIN is an excellent measure that can assist in data informed policy. Unfortunately, it does not suffice for a high-quality point system.

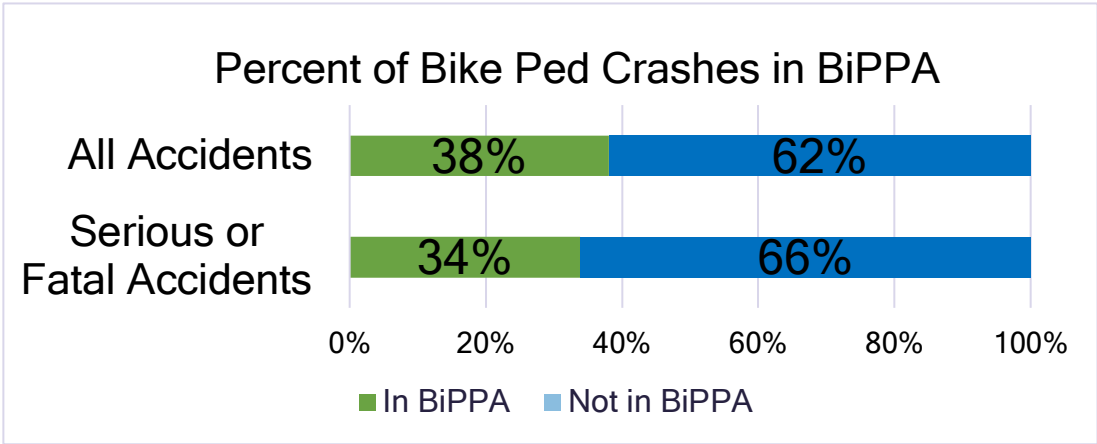
It does not suffice because of the obvious and large difference between a car crashing with another car and a car crashing with a pedestrian or bicyclist. HINs are calculated using all types of crashes and produce an overall sense of dangerous areas. However, intersections that are dangerous for pedestrians are not necessarily dangerous for cars. (See next page.) Mode-specific HINs would provide better input data because transportation projects are mode-specific. Building safer intersections for pedestrians makes little sense if that road is a HIN due to a high concentration of automobile crashes. Mode-specific HINs would provide a point system greater ability to reward transportation projects that improve the specific safety needs of each street throughout the County.

HIN and Bicycle/Pedestrian Crashes

Only 36% of the serious or fatal accidents are accounted in an HIN[9]. Mode-specific measures would better account for bicycle or pedestrian crashes. See next page

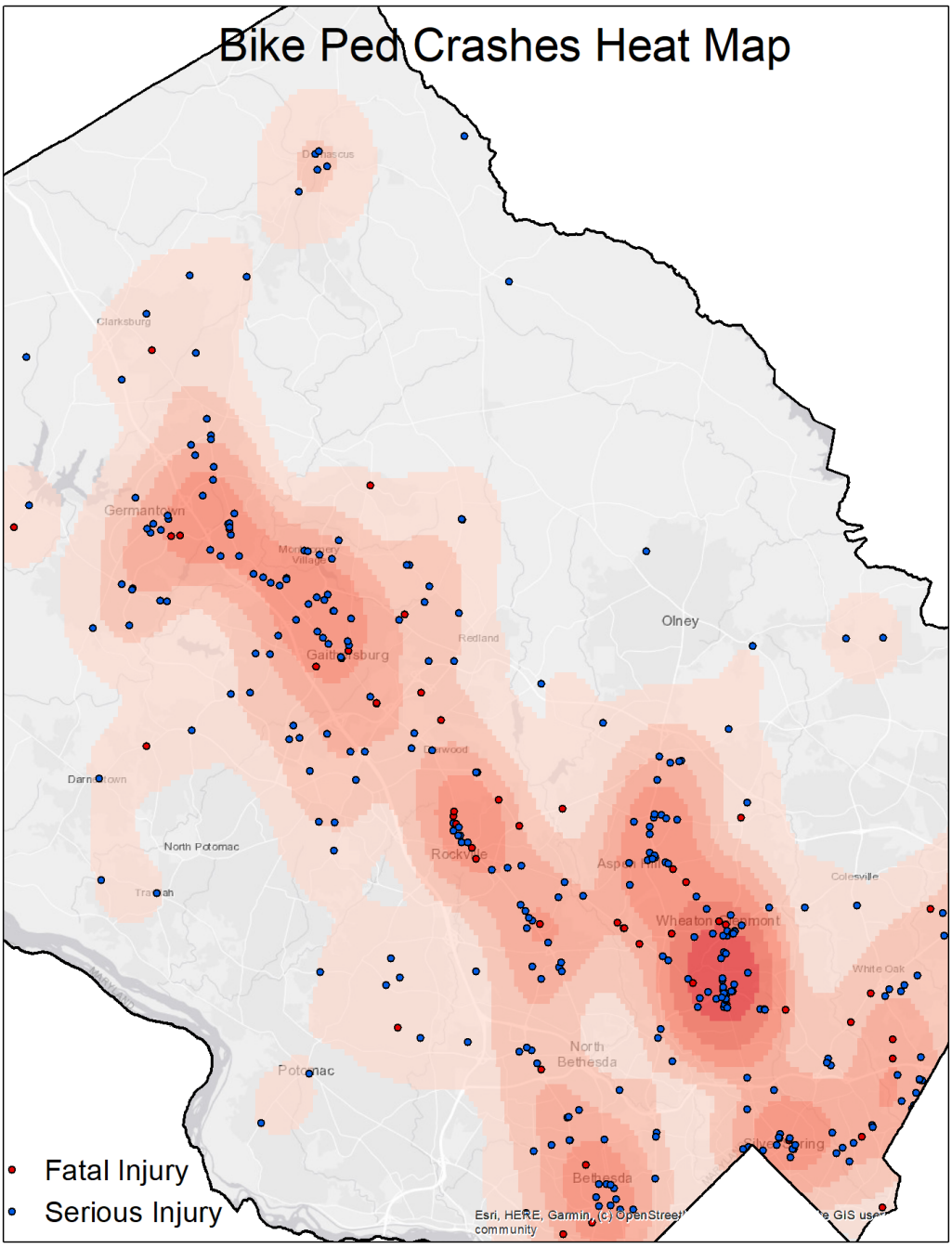


Similar issues exist with other measures such as the new Bicycle Pedestrian Priority Areas (BiPPA). Data should be arranged in new ways specifically to measure the desired inputs that match the priority outcomes of MCDOT and the County.



[9] Crash data open source at https://data.montgomerycountymd.gov/Public-Safety/Crash-Reporting-Incidents-Data/bhju-22kf

The following figure is an example of how current county-owned data could be leveraged into the creation of better input data. Bicycle and pedestrian crash point data transformed into raster data so that crash rates can be determined in a given area.



Input data could also be improved by including model inputs such as traffic analysis. Under the priority outcome “Easier Commutes” many of the inputs attempt to reward projects that connect to existing mass transit options. Logically, the easier it is to get to a mass transit option, the faster one could get from place to place. However, this is just an assumption. Traffic analysis that includes commute times would be a superior measure. Not only would traffic analysis more directly measure the desired variable of improved commute times, but it would also be able to provide more nuance. Traffic analysis could provide estimates for average time saved and total man hours saved per day whereas the current inputs are binary. The county should invest in better input data for each project and each priority outcome.

The county should invest in better input data for each project and each priority outcome.

Hire a Project Data Specialist

Many of the limitations currently prohibiting MCDOT from having a functioning high-quality prioritization method could be solved by hiring a single full-time individual with data skills. A transportation project data specialist should have similar skills to those of County Stat. In fact, the individual hired could be placed in County Stat rather than MCDOT, if needed. Specific responsibilities of a project data specialist should include:

- Create and maintain a CIP project list
- Automate data entry for each project
- Ensure data inputs measure desired characteristics
- Assign logical points to data inputs
- Standardized summed priority outcome points
- Create interactive weighting tool usable by policy makers

Presently, there is no updated shapefile with all of the CIP projects. A project data specialist would be able to create and maintain an up to date CIP project shapefile. Having such a shapefile would allow MCDOT to better understand where and what each of the projects to be prioritized are. Additionally, automation becomes much easier when all of the data is centralized into one file. Even if improved data inputs are provided, such as model inputs, many data inputs will still be geographically based. Having a single shapefile will allow a project data specialist to quickly and repeatedly assess which projects fall into geographies of interest. A project data specialist could then organize the input data into a form which policy makers could adjust through changes in weighting, and see the resulting rankings of projects. From that point, the weighting would be continually adjusted and debated until a final policy decision on weighting is reached thus determining the priority rankings of the transportation CIP projects.

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