

A Safe System Collaboration Support Toolkit: Using Systems Thinking Tools to Inform Safe System and Vision Zero Planning and Action

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16. Abstract A Safe System approach requires sustained and strong collaboration among multiple agencies, organizations, and individuals that influence and shape transportation systems. Systems thinking tools provide practical and structured tools for creating and sustaining these types of collaborations, helping partners shape transportation safety-related goals, plans, and actions in a shared manner. In this project, we tailored and supported use of five systems thinking tools (the 5 Rs Framework, Goal and Action Alignment Mapping, System Support Mapping, Balance of Petals Diagramming, and Causal Loop Diagramming) across a variety of transportation-related coalitions and partnerships to help them meet systems-based strategic planning and collaboration goals. We provide descriptions, case studies, how-to guides, and evaluation feedback on all five tools. Through this work, we found that the tools and resources presented in this toolkit can help support Safe System coalitions and partnerships, Vision Zero task forces, and other transportation-related partnerships in developing new partnerships, expanding thinking on points of intervention, conducting systems-based strategic planning, critically examining equity in their work, and establishing coalitions that strategically consider both the benefits and asks of specific partners.			
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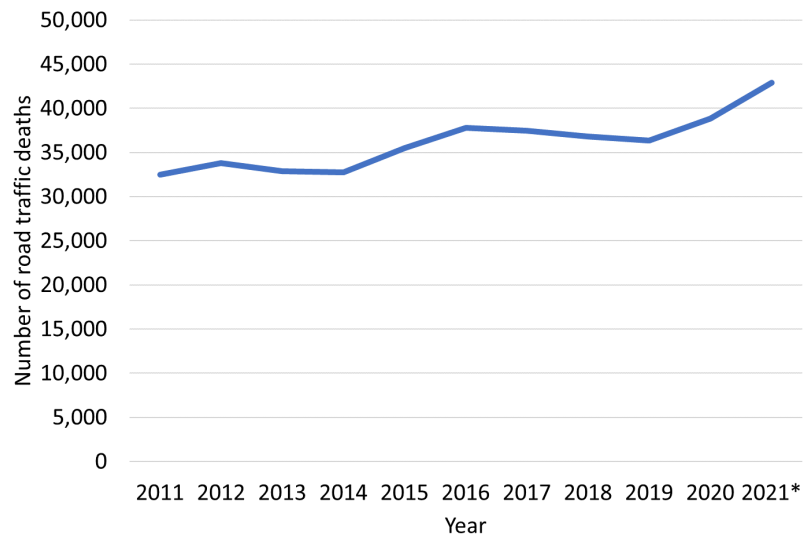
Introduction and Motivation for the Toolkit

Transportation-related injury and death in the United States is a persistent and growing public health problem. The effect of crashes on the U.S. population cannot be overstated. The number of individuals killed in crashes in 2021 exceeded 40,000, reaching a 16-year high (Figure 1), and nonfatal crash-related injuries exceeded 2.8 million in 2020 alone (CDC, 2022; NHTSA, 2022).

A recent analysis by the Centers for Disease Control and Prevention (CDC) indicated that road traffic death rates in the United States are higher than most other high-income nations, with the United States having the highest population-based death rate of 28 other major high-income nations (Yellman & Sauber-Schatz, 2022). Moreover, while the United States saw an increase in crash death rates between 2015 and 2019, nearly all other high-income nations observed decreases, with an average decrease of 10.5%.

Recognizing the enormous consequences and upward trends in crashes, injuries, and deaths produced by our transportation system, many transportation safety professionals in the United States have sought new road safety and injury prevention strategies, namely through the Safe System approach.

Figure 1. Road traffic deaths in the United States, 2011-2020



Who Is the Audience for This Toolkit?

This toolkit was designed for planners, engineers, public health professionals, communications specialists, first responders, advocacy groups, and other transportation-related practitioners interested in tools to support a holistic, systems-based approach to their transportation safety work, often through a Safe System approach. A systems-based approach starts with transforming the conversations and collaborations happening on the ground to ensure we are designing action mindful of the complexity we are working within and leveraging the unique assets of different partners who can intervene on diverse parts of a system.

This toolkit was designed for road safety practitioners interested in tools to support a holistic, systems-based approach to their transportation safety work.

What Is the Safe System Approach?

The Safe System approach is a transportation safety paradigm that places human safety above all else when designing a transportation system (Table 1) (Johansson, 2009; Mooren et al., 2011; Tingvall & Haworth, 1999). It starts from the understanding that humans are human (and errors occur) and that the systems we use, specifically the transportation system, should be designed with this in mind.

The Safe System approach requires redundancies and safeguards in the system so that people do not suffer serious injury or death on the transportation network when regular human errors occur. The Safe System approach includes placing safety at the forefront in the way we design streets, set speed limits, establish land use policy, design vehicles, and promote specific cultural norms that shape transportation behaviors, policies, and designs. Table 1 clarifies key characteristics and differences between a Safe System approach and the traditional approach to transportation safety that has historically been applied in the United States.

Table 1. A traditional approach versus Safe System approach to transportation safety*

Safety Issue	Traditional Approach	Safe System Approach
What is the inherent problem or target?	Crashes	Fatalities and serious injuries
What causes the problem?	Human behavior	Larger system of factors leading to the context and conditions in which the injury or fatality occurred
Who is responsible?	Individual road users	Agencies and organizations that create the system (e.g., policymakers, planners, engineers)
What is the underlying intervention approach?	Incremental, reactive treatment where crashes have occurred	Proactive, systemic approach to creating a safe road network and system
What is the safety goal?	An optimal reduction in fatalities and serious injuries based on previous trends	Zero fatalities and serious injuries is the only morally acceptable target

* Adapted from a figure created by the Towards Zero Foundation (<http://www.towardszerofoundation.org/thesafesystem/>)

Because a Safe System approach requires us to critically consider several factors that shape our transportation safety outcomes, implementation of a Safe System approach requires multiple stakeholders and agencies.

For example, city planners are critical to shaping land use policies that center transportation safety, which requires active collaboration with engineers as they design roadways, which requires active collaboration with policymakers as they approve speed limits and pass laws that promote safety, which requires active collaboration with public health practitioners as they bring critical injury data sources (e.g., health care data) to decision-making processes with all of these stakeholders to inform and evaluate action, and the list goes on.

Historically, the many stakeholders touching different pieces of the transportation system have worked in a siloed manner with little active collaboration across decision-making processes. The Safe System approach demands cooperation and collaboration, acknowledging that continued siloed work results in disjointed action that lacks the redundancies and layers of protection needed to create a system that protects us all from serious injury and death.

While there is general recognition of the need for considerably improved cooperation and collaboration across diverse agencies to implement the Safe System approach, authentic collaboration across agencies is hard and rarely sustained. Agencies and stakeholders have different priorities, different funding structures, and competing demands that make integrated work and partnership extremely challenging. Furthermore, there are few tools or resources in widespread use that help support and sustain this type of collaborative work.

What Is Systems Thinking and How Can It Support a Safe System Approach?

Luckily, there are several tools and strategies from the field of systems thinking specifically designed with these challenges in mind—to help support collaboration and coordinated action across several stakeholders to achieve system-wide change.

Systems thinking tools ultimately provide practical and structured exercises or frameworks for developing a shared understanding of factors interacting to produce an outcome (e.g., transportation-related fatalities and serious injuries) and the roles of diverse stakeholders within the system. As a shared understanding is developed, systems thinking tools are often then used to inspire and help explicitly identify opportunities for collective action and support collaborative planning.

Systems thinking tools can help address the challenge of operationalizing a Safe System approach and help ward off the potential for the Safe System approach to become another “in name only” program instead of fundamentally changing how transportation safety strategizing and planning is conducted and how action is implemented.

Systems Thinking:

Practical, structured inquiry, which taps into stakeholders’ unique perspectives and seeks to “see” wholes. Can promote a systemic understanding of problems, consistent with a Safe System approach.

What Are Some Specific Systems Thinking Tools and In What Ways Can They Help?

There are several systems thinking tools with specific advantages for understanding, planning, and implementing a Safe System approach. **Table 2** includes a list of several systems thinking tools that we believe hold potential for supporting Safe System work. Each tool description also includes an example of when a transportation-related stakeholder might use that tool.

Following this brief overview, we follow with more specific descriptions of each tool with accompanying case studies of their use with real-world transportation safety partners. We also provide how-to handouts for each tool that can be used by transportation-related partners.

Our hope is that these materials will support tool uptake and use in a variety of settings—e.g., in internal agency strategic planning sessions, in transportation-related coalition task force meetings, in discussions between groups of agencies looking to strategically improve or brainstorm about their collaborative transportation work together, or as a communication/visualization tool with agency leadership or policymakers to advocate for Safe System-consistent action.

Table 2. Systems thinking tools for transportation safety collaboration, strategic planning, and/or research

Systems Tool	Goal	When Stakeholders Might Apply It
Causal Loop Diagramming	To depict our or others' perspectives about the interconnected factors and dynamics shaping problems of interest, and to use this shared understanding to design better actions.	A group of transportation safety stakeholders wants to understand the <u>different perspectives on and potential causes of a problematic transportation trend</u> , like, alcohol-impaired driving crash rates in their community, and also wants to strategically consider what actions they should pursue to address the problem.
The 5 Rs Framework	<p>To help a group brainstorm about the broad system around an area of work (often a system they are working within, such as a system of transportation-related partners, policies, and outcomes).</p> <p>To help a group define meaningful measures within the system, ensure they are engaging all relevant stakeholders, and help in designing action mindful of available resources/assets, rules (policies, norms, etc.), and key relationships. The 5 Rs Framework can help a group understand the system "as it is" or envision the system they want to create together.</p>	<p>A new coalition wants to understand the broad system of work around transportation safety in their community. They want to describe the current measures/metrics that the system is designed around, as well as the stakeholders, resources, policies, and key relationships determining how the system operates.</p> <p>They might also want to define, as a group, what they would like the system to look like—what the <u>most important results should be, what stakeholders should be involved, and which resources, rules, and relationships are needed to achieve the results</u> they collectively care most about.</p>
Goal and Action Alignment Mapping	<p>To align stakeholders (agencies, community groups, nonprofit partners, etc.) around some common agreed-upon goals.</p> <p>To make explicit how different stakeholders individually connect to the goals (i.e., how the goals of the initiative specifically link to the goals of their organization), what unique assets stakeholders can each contribute to the initiative, and what "win-wins" exist between stakeholders.</p>	A diverse group of potential partners is coming together to explore involvement in an initiative or program (e.g., a Vision Zero or Safe Routes to School initiative). They want to understand <u>why their organization should be involved</u> (what are the benefits?) or how to make the case to their organizational leadership, <u>what role their organization can play</u> (what can they contribute?), and which partners in the initiative they could potentially more closely partner with to achieve both initiative goals and their specific organizational goals.
System Support Mapping	To conduct a structured assessment about individual responsibilities in a given area of work, what is needed to support the work, resources utilized (and how well	Several colleagues within an agency (e.g., a Department of Transportation) or across agencies (e.g., transportation safety colleagues working within a task force) want to specifically examine how to more effectively support one another in their work together.

	they work), and prioritized wishes for how to be better supported.	They want to better understand the roles across the agency/task force/collaboration, where there are needed resources (or untapped resources), and <u>how to better support one another to most effectively achieve well-defined goals for the future.</u>
Balance of Petals Diagram	<p>To brainstorm and document what, specifically, is needed from stakeholders to support an initiative as well as what about the initiative brings value to each stakeholder.</p> <p>To spur assessment of the balance of need/benefit among all partners in an initiative to ward off partner burnout.</p> <p>To support similar conversations (in a somewhat abbreviated version) as those you might have when using Goal and Action Alignment Mapping.</p>	<p>A diverse group of potential transportation-related partners is coming together to explore (or revive thinking on) involvement in an initiative or program (e.g., a Vision Zero or Safe Routes to School initiative). <u>Similar to Goal and Action Alignment Mapping</u>, they could use this to quickly understand why their organization might contribute to the initiative and what benefits they might derive from involvement. The diagram allows them to <u>quickly look at the balance of “gets” (benefits from being involved in the initiative) and “gives” (what they can uniquely contribute to the initiative) across partners</u> to ensure relationships in the initiative are well balanced and that the initiative is therefore set up for sustainable involvement of partners.</p>
AcciMap*	<p>To illuminate the system of interconnected events, conditions, and decisions that result in an outcome (e.g., crash) or cluster/trend of outcomes (e.g., crashes).</p> <p>To support a Safe System view of crash causation.</p>	<p>A road safety coalition is concerned about the increase in nighttime pedestrian injuries that they have observed. They pull data and bring experts from a variety of domains (e.g., engineering, enforcement, public health, social work) to construct <u>a holistic map of the mechanisms that are likely contributing to these crashes.</u> The map prompts them to consider proximal conditions leading to the crashes, as well as how those conditions are created by larger processes and policies (e.g., infrastructure placement, organizational resources).</p>
Simulation Modeling (e.g., System Dynamics, Agent-Based Modeling)*	<p>To build a quantitative decision support tool representing the system under study.</p> <p>To test the model’s consistency with data helps us critically examine our hypotheses about the system.</p> <p>To offer a virtual world in which to test and simulate impacts of different programs or policies.</p>	<p>A local Department of Transportation is interested in exploring potential policies and programs that could help reduce cyclist injuries in their city. They pull together a range of experts to lay out the potential mechanisms leading to these crashes, and the increase in crashes they have observed over time. They then pull data and collaborate with a systems modeler to develop a simulation model that portrays these mechanisms. Using this model, they <u>test out different changes (i.e., policy and program changes to the model) to learn about potential impacts of actions they might take.</u></p>

* Not included in this toolkit but covered through other projects conducted by the Collaborative Sciences Center for Road Safety.

Case Studies and How-to Handouts of Systems Thinking Tools for Safe System Collaboration, Planning, and Implementation

In Appendices A-J, we highlight five different systems thinking tools that we utilized with a variety of transportation safety partners in California, North Carolina, and Pennsylvania. We present case studies on each of the five tools (Appendices A, C, E, G, and I) to give a clearer sense of what each tool can help with, and the types of insights derived from tool use. Following each case study, we include a how-to handout (Appendices B, D, F, H, and J) that walks through the steps needed to apply the tool in a meeting, workshop, or strategic planning session.

The case studies and how-to handouts include the following tools:

- The 5 Rs Framework (Appendix A: case study; Appendix B: how-to handout)
- Goal and Action Alignment Mapping (Appendix C: case study; Appendix D: how-to handout)
- System Support Mapping (Appendix E: case study; Appendix F: how-to handout)
- Balance of Petals Diagramming (Appendix G: case study; Appendix H: how-to handout)
- Causal Loop Diagramming (Appendix I: case study; Appendix J: how-to handout)

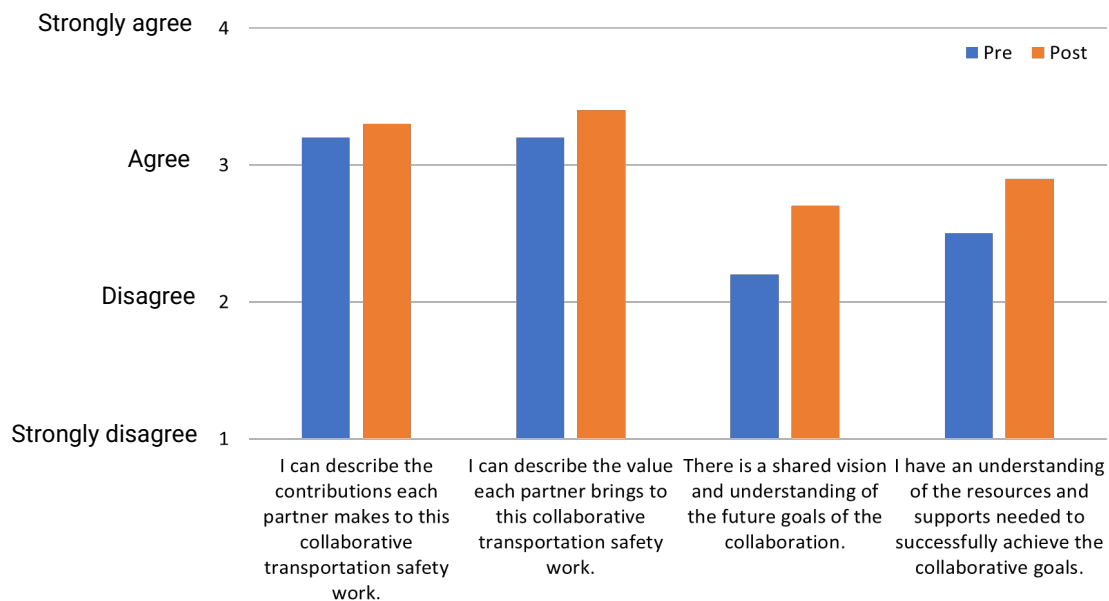
The remaining sections of this toolkit provide feedback and evaluation data, as well as recommendations on software that can be used to facilitate discussions using these tools in a virtual setting. Because this project was conducted during the COVID-19 pandemic, all of these case studies were conducted in a virtual setting, which included various pros and cons, including the advantage of potentially involving a wider range of people in the discussions but the challenge of maintaining sustained attention and active collaboration among all meeting members. All of these tools can and have been used in in-person settings as well, which we recommend, if possible.

Feedback and Evaluation on Tool Use

To evaluate and collect feedback on systems thinking tool use within a transportation safety and Safe System context, we asked questions specific to the systems thinking tools used and aims of each workshop. For most case study workshops, feedback was collected pre-and post-workshop; however, for a few workshops we were only able to collect feedback following the workshop. The figures below summarize results from these surveys.

Workshops using Balance of Petals and System Support Mapping Tools (see Appendices E and G for case studies)

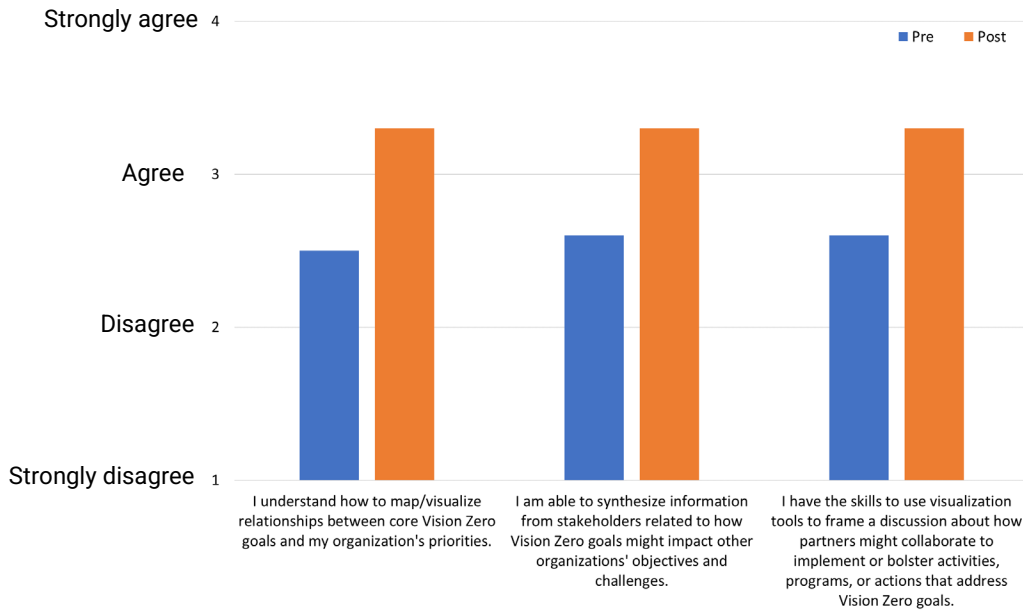
Mean scores pre- and post-workshop for Balance of Petals and System Support Mapping (N=10 people)



In this workshop, we used both the Balance of Petals and Systems Support Mapping tools. We asked participants several questions pre- and post-workshop using a four-point Likert scale (1: strongly disagree to 4: strongly agree). We found that these tools helped slightly increase participants' average ability to describe partner contributions and value added to their collaborative initiative. Larger increases pre- and post-tool use were observed for feeling like there was a shared vision and an understanding of the resources and tangible supports needed to achieve collaborative goals.

Workshops using Goal and Action Alignment Mapping (see Appendix C for case study). Note: this tool was used in two separate workshops with separate groups, and we include evaluation feedback below for both.

Mean scores pre-and post-workshop for Goal and Action Alignment (N=45 people)



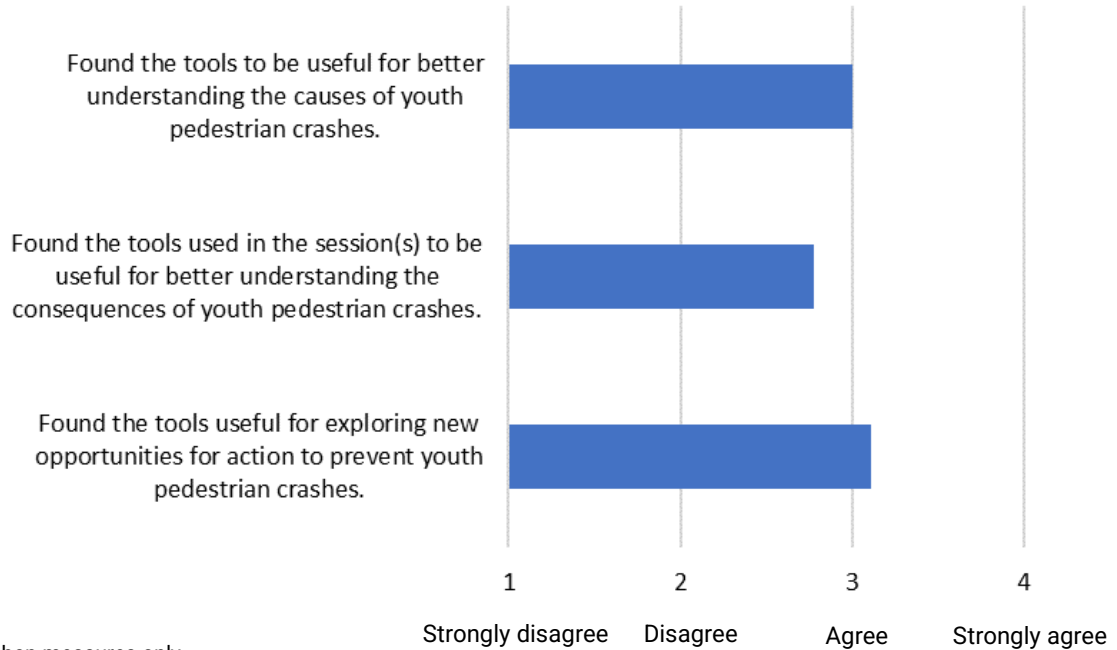
Mean scores pre-and post-workshop for Goal and Action Alignment (N=38 people)



Goal and action alignment mapping was used in two workshops, once with collaborative Safe Routes to School (SRTS) coalitions and partnerships, and once with a large countywide Towards Zero Task Force. Across both case studies, participants' understanding of how to visualize and map relationships between shared goals and organization-specific priorities and challenges increased, as did participants' confidence in feeling more equipped to use systems tools to frame brainstorming discussions around developing and implementing collaborative activities, programs, or actions.

Causal Loop Diagramming workshops (see Appendix I for case study)

Mean scores post-workshop for Causal Loop Diagramming* (n=9 people)

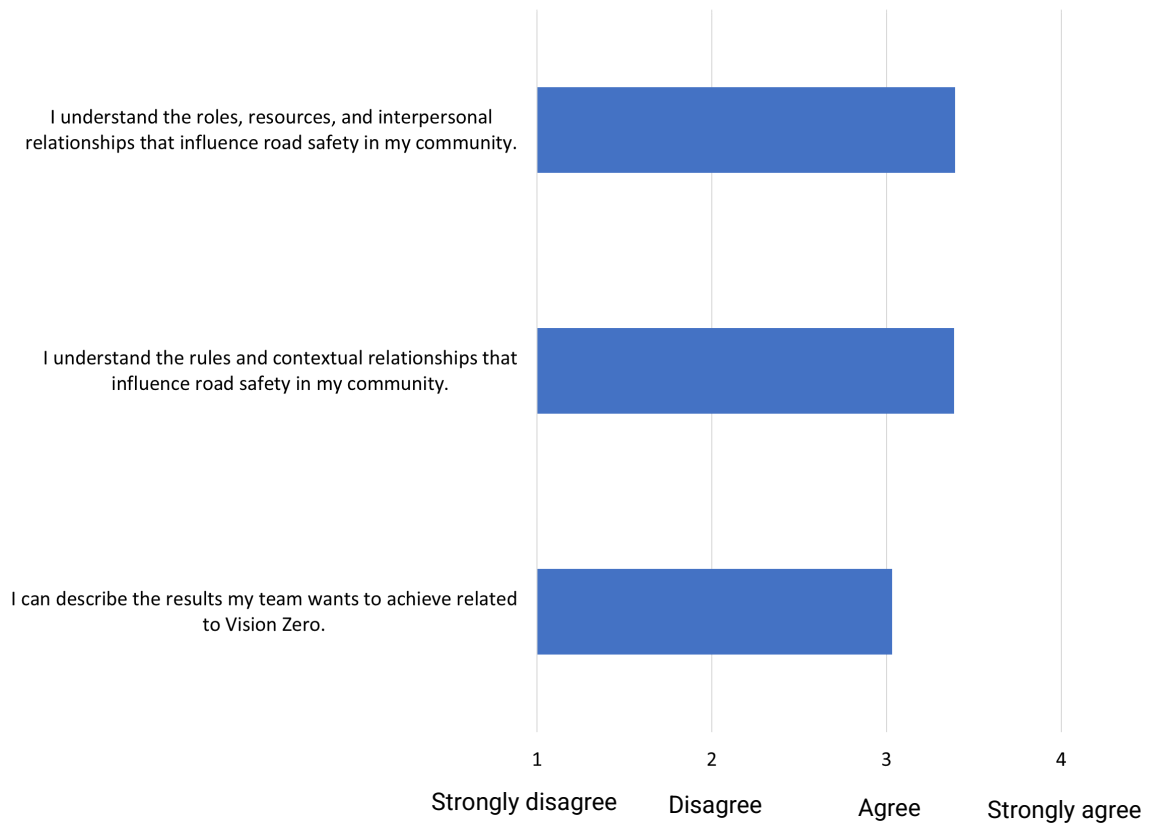


* Post-workshop measures only

For the last two case studies (Causal Loop Diagramming and the 5 Rs Framework), data were only collected post-workshop. For the Causal Loop Diagramming workshop (Appendix I case study), we observed that, on average, participants agreed that the tool was useful for helping to understand the causes of a persistent transportation safety problem (i.e., youth pedestrian crashes) and for exploring opportunities for action to prevent these crashes. A lower proportion found the tool useful for understanding the consequences of crashes, which was expected, given that most of the discussion was focused on upstream mechanisms generating crashes.

5 Rs Framework (see Appendix A case study)

Mean scores post-workshop for 5 Rs Framework* (N=31 people)



* Post-workshop measures only

Finally, post-workshop data on the 5 Rs framework (see case study in Appendix A) revealed that, on average, the tool helped participants understand each “R” shaping their transportation systems. Specifically, participants reported that they understood the roles, resources, rules, and relationships influencing road safety in their community. Additionally, feedback indicated that participants felt that they could describe the ultimate results that their team collaboratively wanted to achieve.

In addition to gathering feedback by asking participants to rate their agreement with skill development or understanding on a four-point Likert scale, we also provided an opportunity for all workshop attendees to describe what they found useful and what they felt needed improvement about the workshops and systems thinking tools used. We provide key feedback below across the systems thinking tools to inform the thinking and planning of others who may want to utilize these tools:

What participants found to be most useful about the workshops or tools used:

- “Talking through the 5 Rs with my team and getting specific about what our goals may need to look like in the future moving forward. Helping us gain clarity on the direction that we’re going in.”
- “It was really helpful to see how others who do the same work as I do have different thoughts on our goals, resources, etc. I think it’ll help our conversations moving forward on what matters most to us and how we approach the work.”
- “Making connections and seeing how different partners can work together.”
- “Focusing on partners that can give us greater leverage/impact.”

- “Learning how to better connect with current partners and expand mindset to look for ways to connect with atypical potential partners.”
- “Learning the new tools available to network and get each organization moving towards the same goals.”
- “Learning how to manage the goal mapping exercise so we can engage with potential, non-traditional SRTS partners and demonstrate to them the value of the SRTS program in achieving their own goals.”
- “We have struggled for years to expand our SRTS coalition beyond our usual partners and now we have a method and tool for doing so.”
- “Having a visual to guide discussion.”
- “Being able to collaborate and have a discussion with others outside my engineering role.”
- “Helped me realize there are wide differences of opinion of what our problems are and how to resolve them.”
- “I think mapping tools are always helpful especially as all the work and perspectives from today gets rolled up into a larger systems map.”

Suggestions for improvement:

- Needed more time or help with the online software used for the workshops.
- Teamwork and strategic planning can be challenging in virtual settings (feels like a slower rate of progress).
- Shorter, but more meetings.
- Have the sessions on consecutive days instead of a week's gap.
- Needed more time for discussions.
- Ask folks to start early if they need an orientation to the technology. Or maybe send a Miro tutorial link before the meeting so folks can focus more on content and less on technical aspects of Miro.
- One-pager with discussion questions/prompts would be really nice!
- Bring in a guest speaker, especially someone who has been bold in this space.

Overall, workshop participants appreciated the opportunity to think more deeply and strategically about complex transportation safety challenges. They used the tools to develop new partnerships, expand thinking on points of intervention, conduct systems-based strategic planning, critically examine equity in their work, and establish coalitions that strategically considered both the benefits and asks of specific partners.

Due to the COVID-19 pandemic, all workshops were conducted virtually. Most comments regarding improvement related to this aspect of the workshops— e.g., that it was challenging to get up to speed on collaborative software tools or to have enough time for all of the conversations that participants wanted to have. While virtual workshops may allow workshop leaders to more easily convene diverse voices and partners, there are important benefits to in-person sessions, and individuals looking to use these tools in their transportation safety work should critically consider these pros and cons.

Software for Facilitating Virtual Systems Thinking

Tool Exercises and Discussions

If an individual or group decides to use one or more of these tools in an in-person setting, most tools would simply require access to a white board or flip chart paper in order to allow participants to collaboratively capture their thoughts and diagram/map.

If an individual or group decides to conduct a workshop or use a tool together online, there are several tools that can support these processes. Below, we list several of the platforms that we have used. Many of the case studies covered in this toolkit include screen shots from these types of online platforms.

Software tools for conducting System Support Mapping, 5 Rs Diagramming, Goal and Action Alignment Mapping, and Balance of Petals Diagramming:

- Google Jamboard: <https://jamboard.google.com/>. Free tool. Multiple people can contribute to a map or diagram at once.
- Miro: <https://miro.com>. Free version. Multiple people can contribute to a map or diagram at once. Provides more virtual white board space than Jamboard.
- Mural: www.mural.com. Similar to Miro in many ways. Free version. Multiple people can contribute to a map or diagram at once. Provides more virtual white board space than Jamboard.

Tools for creating Causal Loop Diagrams:

- Kumu: <https://kumu.io/>. Free version available. Helpful for constructing visually appealing maps and presentations to help walk through maps.
- Insight Maker: <https://insightmaker.com/>. Free. Easy-to-use tool for creating causal loop diagrams.
- Mental Modeler: <https://www.mentalmodeler.com/> Free version available. Easy to quickly understand notation.
- Stella: <http://www.iseesystems.com/>. Free version with limited functionality available.
- Vensim: <http://www.vensim.com/>. Free version available.

Systems Thinking Resources for More Information

In addition to the software resources described above (with related examples and guidance materials on their websites), several tools and other resources are available to explore systems thinking core concepts more broadly. Resources include:

- The Systems Thinker (<https://thesystemsthinker.com/>): Provides several useful articles, additional how-to guides, and videos related to systems thinking more broadly and causal loop diagramming.
- US AID 5 Rs Framework Toolkit (<https://usalearninglab.org/resources/5rs-framework-program-cycle>): provides the foundation for the 5 Rs Tool described in this document.
- System Support Mapping (<https://pubmed.ncbi.nlm.nih.gov/30807460/>): a publication demonstrating its use with another set of professionals.
- Causal Loop Diagramming exercises and workshops (<https://en.wikibooks.org/wiki/Scriptapedia>): provides exercises or detailed “scripts” for Causal Loop Diagramming-related workshops.
- Community-based System Dynamics (<https://link.springer.com/book/10.1007/978-1-4614-8763-0>): Thorough reference on using Causal Loop Diagramming with a variety of partners and/or community members.
- A Resource Hub for tools related to Vision Zero, a Safe System approach, and collaborative road safety work (<https://www.roadsafety.unc.edu/profdev/resource-hub/>).

Conclusion

A Safe System approach requires sustained and strong collaboration among multiple agencies, organizations, and individuals that influence and shape transportation systems. Systems thinking tools provide practical and structured tools for creating and sustaining these types of collaborations, helping partners shape transportation safety-related goals, plans, and actions in a shared manner. Our hope is that the descriptions, case studies, and how-to guides included in this toolkit provide an increased understanding of specific systems thinking tools that can notably support communities in their Safe System work.

Contact Us

For more information on the tools, workshops, or systems thinking tool application to transportation safety, please reach out to Becky Naumann at RNAumann@unc.edu.

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Appendices

The following appendices provide case studies and how-to guides for each of the five systems thinking tools covered in this toolkit—for use at strategic planning or brainstorming meetings or workshops.

Appendix A. The 5 Rs Case Study

Appendix B. The 5 Rs How-to Guide

Appendix C. Goal and Action Alignment Mapping Case Study

Appendix D. Goal and Action Alignment Mapping How-to Guide

Appendix E. System Support Mapping Case Study

Appendix F. System Support Mapping How-to Guide

Appendix G. Balance of Petals Case Study

Appendix H. Balance of Petals How-to Guide

Appendix I. Causal Loop Diagramming Case Study

Appendix J. Causal Loop Diagramming How-to Guide

Appendix A. The 5 Rs Case Study

Appendix B. The 5 Rs How-to Guide

Appendix C. Goal and Action Alignment Mapping Case Study

Appendix D. Goal and Action Alignment Mapping How-to Guide

Appendix E. System Support Mapping Case Study

Appendix F. System Support Mapping How-to Guide

Appendix G. Balance of Petals Case Study

Appendix H. Balance of Petals How-to Guide

Appendix I. Causal Loop Diagramming Case Study

Appendix J. Causal Loop Diagramming How-to Guide



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