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COMPARATIVE ASSESSMENT OF TRANSPORTATION SUSTAINABILITY RATING SYSTEMS

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The construction industry contributes a significant amount of greenhouse gas emissions to the environment. This highlights the need for this industry to implement sustainable practices to mitigate its negative effects. Sustainability in the construction industry involves considering project development in terms of economic, social, and environmental aspects (triple bottom line). In the transportation sector of the construction industry, several transportation sustainability rating systems (TSRS) have been developed to measure and promote sustainability. However, studies show that these TSRS have not been developed within a consistent "sustainability scope". This raises the question of the consistency of these TSRS in measuring sustainability of transportation projects. This study assesses three prominent TSRS to determine how each measures sustainability with respect to the triple bottom line. The TSRS that are in the scope of this study are: (i) Envision – a third-party rating system, (ii) INVEST– a self-assessed rating and, (iii) GreenLITES – an in-house developed self-assessed rating system for the New York State DOT. Results show that while these three rating systems provide different levels of credits/points with respect to the triple bottom line, they all place the highest focus on the environmental aspect.

Keywords: Envision, Invest, GreenLITES, TSRS.

1 INTRODUCTION AND PURPOSE

The construction industry contributes a significant amount of greenhouse gas emissions (Yudelson 2008). As such, the industry needs to implement sustainable development practices to mitigate its economic, social, and environmental impacts (Simpson 2013). Green buildings are said to reduce energy consumption by 30%, save water by 30 – 50%, diminish carbon emissions by 35% and provide a construction waste reduction of 50 – 90% (Yudelson 2008). However, implementing sustainable development practices in the construction industry should not only be limited to buildings, but also be applied in other sectors of the industry such as the transportation sector – the sector of the industry that is involved in the construction of transportation infrastructure.

Sustainability rating systems are tools that help to guide the assessment of construction projects against a collection of sustainability best practices that cover the three aspects of sustainability: economic, social, and environmental (Griffiths *et al.* 2015). There are several sustainability rating systems developed to measure project performance in both the building and transportation sectors of the construction industry. Transportation Sustainability Rating Systems (TSRS), developed to measure transportation project features and actions against a sustainability

standard, can be used to quantify the project's progress against that standard (Veeravigrom *et al.* 2015).

In recent years, there has been an increase in the development of transportation sustainability rating systems (Veeravigrom *et al.* 2015). However, studies show that these TSRS have not been developed with a consistent "sustainability scope" ("the breadth of sustainability addressed and the prioritization within") (Griffiths *et al.* 2015, Veeravigrom *et al.* 2015). Thus, a project, run through more than one of these rating systems may be high performing on one rating system and low performing on another. This brings about the question of the consistency of these rating systems in measuring sustainability. There is, therefore, the need to assess multiple TSRS to determine how each measures sustainability with respect to the triple bottom line. The purpose of this study is to assess three prominent TSRS to determine how each measures sustainability with respect to the triple bottom line. The TSRS that are in the scope of this study are: (i) Envision – a third-party rating system, (ii) INVEST – a self-assessed rating system and, (iii) GreenLITES – an in-house developed self-assessed rating system for the New York State Department of Transportation (NYSDOT). These rating systems were chosen because of their prominence and wide-spread use in the United States as well as the distinct characteristic each rating system provides as stated above.

2 REVIEW OF TSRS STUDIED IN THIS RESEARCH

2.1 Envision

The Envision rating system is a holistic rating system used to rate the sustainability of infrastructure such as bridges, roads, railways, pipelines, water treatment systems, dams, airports, landfills, levees and other civil infrastructure (ISI 2017a). It is a third-party rating system that provides a framework used to rate the economic, community and environmental benefits of infrastructure projects regardless of the size of the project (ISI 2017b). A third-party rating system is one which requires the presence of a sustainability professional accredited by the rating system on a project team to carry out ratings for a project; qualifying the project for verification by a professional employed by the rating system and finally certification.

The Envision rating system has a total of 60 performance objectives, otherwise known as credits/criteria (ISI 2015), that address the impacts of the triple bottom line on sustainability in the design, construction and operation phases of an infrastructure project (ISI, 2017b). These 60 credits that have a maximum achievable point of 809 are classified under five categories: Quality of Life, Leadership, Resource Allocation, Natural World and Climate, and Risk. These five categories are further divided into 14 subcategories (ISI 2015).

Rating a project using the Envision rating system involves the use of three tools: the self-assessment checklist, the online scoring module, and the verification/awards program. These tools can be used independently or in combination based on the project type or the project phase in which it is being applied (Shivakumar *et al.* 2014). The Envision certification/award has four categories: Platinum (50% of total applicable points), Gold (40% of total applicable points), Silver (30% of total applicable points) and Bronze (20% of total applicable points) (ISI 2017c, Shivakumar *et al.* 2014).

2.2 INVEST

Infrastructure Voluntary Evaluation Sustainability Tool (INVEST) is a self-assessed web-based transportation sustainability rating system (FHWA 2017a). A self-assessed rating system is one which does not require an INVEST recognized sustainability professional on the project; neither

does it require third-party verification by INVEST. INVEST consists of sustainability best practices known as criteria and it covers the entire lifecycle of transportation projects made up of planning, design, construction and the operations and maintenance phases (FHWA 2017a). INVEST can be used to evaluate the sustainability best practices implemented by a project currently under construction (Brodie *et al.* 2013). It also provides guidance on sustainability best practices that can be applied to a transportation project as well as help the project team set realistic sustainability goals. It can be used to measure the sustainability of completed transportation projects. (Brodie *et al.* 2013).

INVEST is composed of four modules: System Planning for States (SPS), System Planning for Regions (SPR), Project Development (PD) and Operations and Management (OM) (FHWA 2017a, Simpson 2013). The Systems Planning (SPS and SPR) and the Operation and Maintenance modules are designed to assess agencies' programs while the Project Development module assesses projects from the planning phase through the construction phase (FHWA 2017a). The Project Development module has a total of 33 criteria and maximum achievable points of 171 (FHWA 2017b). INVEST has four levels of achievement: Platinum (60% of total applicable points), Gold (50% of total applicable points), Silver (40% of total applicable points) and Bronze (30% of total applicable points) (FHWA 2017c).

2.3 GreenLITES

The GreenLITES Project Design Program began in September, 2008 as a self-assessed program that recognizes transportation projects in which sustainable practices are integrated extensively (McVoy *et al.* 2010). This program is a mandatory tool for use on all NYSDOT projects and is applied to the plans, specifications and estimates of these projects in the design phase (NYSDOT 2017b, Simpson 2013). The GreenLITES program utilizes a scorecard which the project team reviews with the aim of selecting sustainable practices that can be integrated into the project (McVoy *et al.* 2010, Simpson 2013). This program has maximum achievable points of 278 and contains 175 credits (criteria) that are divided into five categories: Sustainable Sites, Water Quality, Materials and Resources, Energy and Atmosphere and Innovation or Unlisted. There are four levels of achievement that can be attained under the GreenLITES Project Design Program (McVoy *et al.* 2010). They are GreenLITES Certified (15 – 29 points), GreenLITES Silver (30 – 40 points), GreenLITES Gold (45 – 59 points) and GreenLITES Evergreen (60 points and above) (McVoy *et al.* 2010, NYSDOT 2017a).

3 COMPARATIVE ASSESSMENT OF TSRS STUDIED IN THIS RESEARCH

All three rating systems apply to the Planning, Design, Construction as well as Operations and Maintenance phases of construction. Tables 1 – 5 display similarities and differences the three rating systems have as discussed under the following five categories that are common to all three rating systems respectively: the environment category, the quality of life category, the materials category, the energy category and the water quality category. The tables also show the percentage of each rating system allocated to the different categories. The points allotted to each category mentioned in the tables below are gotten from the points allotted to these categories in the rating systems' scorecards. These categories do not represent the entirety of the rating systems as there are other categories which are not common to all three rating systems. In the tables, the notation "◊" indicates that the item is covered in another place, whereas "×" indicates that the item is not included in the rating system at all.

Table 1: Points achievable by Credits related to the Environmental Category in each Rating System.

Rating System	Site Vegetation	Siting	Biodiversity	Ecological Connectivity	Habitat Restoration	Improve pedestrian and Bike Access	Environmental Training	Noise Mitigation/ Abatement	Emission Reduction	Monitoring and Maintenance	Reduction of Light Pollution	Percentage allotted in system
Envision	◊	99	55	◊	◊	◊	◊	◊	◊	◊	◊	**25%**
INVEST	6	◊	◊	4	7	6	1	7	2	◊	3	**21%**
GreenLITES	14	13	◊	◊	19	◊	×	◊	◊	◊	3	**29%**

Table 2: Points achievable by Credits related to the Quality of Life/Social Category in each Rating System.

Rating System	Improve Community Quality of Life	Stimulate Sustainable Growth and Development	Enhance Public Health and Safety	Improve Site Accessibility Safety and Wayfinding	Preserve Historic and Cultural Resources	Preserve Views and Local Character	Provide for Stakeholder involvement	Improve Infrastructure Integration	Extend Useful Life	Educational Outreach	Enhance Public Space	Percentage allotted in system
Envision	25	16	16	15	16	14	◊	◊	◊	◊	13	**22%**
INVEST	◊	◊	10	×	3	◊	◊	◊	◊	2	3	**1%**
GreenLITES	◊	◊	◊	×	◊	◊	◊	×	◊	◊	◊	**0%**

Table 3: Points achievable by Credits related to the Material Category in each Rating System.

Rating System	Reduce Net Embodied Energy	Support Sustainable Procurement Practices/Hazardous Material Minimization	Bio-Engineering Techniques	Use Recycled Materials/Reuse and Repurpose Materials	Use Regional Materials	Divert Waste from Landfill	Reduce Excavated Material Taken Offsite	Provide for Deconstruction and Recycling	Percentage allotted in system
Envision	18	9	×	14	10	11	6	12	**10%**
INVEST	3	◊	×	22	×	◊	5	◊	**18%**
GreenLITES	×	6	8	48	4	◊	◊	◊	**24%**

Table 4: Points achievable by Credits related to the Energy Category in each Rating System.

Rating System	Reduce Energy/Electrical Consumption	Traffic Flow Improvement	Use Renewable Energy	Reduce Petroleum Consumption	Commission and Monitor Energy Systems	Stray Light Reduction	Reduction of Pavement Materials Emissions	Infrastructure Resilience	Percentage allotted in system
Envision	18	×	20	◊	11	◊	◊	◊	**6%**
INVEST	8	◊	×	×	×	◊	3	12	**13%**
GreenLITES	10	29	×	15	×	3	◊	◊	**37%**

Table 5: Points achievable by Credits related to the Water Category in each Rating System.

Rating System	Manage Stormwater	Reduce Pesticides and Fertilizer Impacts	Prevent Surface and Groundwater Contamination	Protect Freshwater Availability	Reduce Potable Water Consumption	Monitor Water Systems	Best Management Practices (Permeable Pavement)	Percentage allotted in system
Envision	21	9	18	21	21	11	◊	**12%**
INVEST	6	×	×	×	×	×	5	**6%**
GreenLITES	10	×	×	×	×	◊	10	**7%**

4 DISCUSSION

The Envision rating system is an infrastructure sustainability rating system that applies not only to road transportation projects but also to other infrastructure projects such as pipelines, airports, landfills, levees, railways, water treatment systems, dams and other civil works components (ISI 2015). This rating system, being a third-party verified system, requires that an Envision certified sustainability professional be on the project team for projects that seek Envision certification and recognition (ISI, 2015). With its five categories and 60 credits, the Envision rating system can be said to give the following distribution of its ratings to the economic, social and environmental aspects of sustainability respectively: 15%, 22% and 63%. The Envision rating system has been applied to at least 38 projects since its inception to date (ISI 2017d).

The INVEST rating system has seven project scorecards intended to cater to diverse types of project depending on the project type and its location (FHWA 2017b). Six of these scorecards have pre-determined credits that will apply to projects that fall under these scorecards. However, one of these scorecards, the Custom Scorecard, allows a project that does not fit into the other scorecards to develop criteria (credits) that best suit it (FHWA 2017b). Therefore, a project's final score is determined based on criteria that are relevant to the project (Simpson 2013). The INVEST rating system allocates the following distribution of its ratings to the economic, social and environmental aspects of sustainability respectively: 12%, 16% and 72%. The INVEST rating system has been used to evaluate at least 1844 projects to date (FHWA 2018).

Of the three systems, the GreenLITES rating system places the greatest focus on the environmental aspect of sustainability with a percentage allocation of 86%. The economic and social aspects of sustainability have ratings of 10% and 4% respectively.

The Envision, INVEST and GreenLITES rating systems also have unique aspects in the credits covered by each of them. A unique aspect of the Envision rating system is the category; Quality of Life. This category, along with its credits, specifically focus on the social aspect of the triple bottom line. The other rating systems being studied place some focus on the social aspect of sustainability. The INVEST rating system has its credits individually outlined without being sectioned into categories, however, in the GreenLITES rating system, credits related to the social aspects are embedded in categories that focus on the environmental or economical aspects of sustainability. Another unique aspect of the Envision rating system is the Leadership category which places focus, solely, on stakeholder involvement on a project. This category is important as it highlights the importance and benefits of applying integrated project delivery to a project. While the INVEST and GreenLITES rating systems touch on this aspect, the importance and benefits of involving all stakeholders on a project is not highlighted as much. A unique aspect of the GreenLITES rating system is the focus it places on resources (Material and Energy). 61% of

its score are allocated to the resources. The Envision rating system focuses 23% of its score on resources while INVEST rating system focuses 31% of its score on resources.

5 CONCLUSIONS

The comparative analysis of three transportation sustainability rating systems shows that all three rating systems recognize and support sustainability best practices that cut across the triple bottom line. However, even though they all place the highest focus on the environmental aspect, priority and ratings given to each aspect of the triple bottom line by each rating system differs. Another difference these rating systems have is their application. While INVEST can be applied by anyone on a project team, Envision must be applied by a certified Envision sustainability professional who is a part of the project team and GreenLITES can be applied by members of a department of transportation that are part of the project team.

Further research should be carried out to determine how different transportation projects perform when these rating systems are applied to each project. This will help to see in greater detail how these rating systems measure sustainability of transportation projects.

References

Brodie, S., Ingles, A., Colville, Z., Amekudzi, A., Peters, R. W., and Sisiopikou, V., Review of Sustainability Rating Systems for Transportation and Neighborhood-Level Developments, *The Second Conference on Green Streets, Highways, and Development*, 337-354, Texas, USA, 2013.

FHWA, About INVEST, retrieved from https://www.sustainablehighways.org/100/about.html, 2017a.

FHWA, About the Project Development Module. Retrieved from https://www.sustainablehighways.org/900/about-the-project-development-module.html, 2017b.

FHWA, Who Can Use the Project Development Module. Retrieved from https://www.sustainablehighways.org/905/who-can-use-the-project-development-module.html, 2017c.

FHWA, Who is using Invest?. Retrieved from https://www.sustainablehighways.org/1399/who-is-using-Invest.html, 2018.

Griffiths, K., Boyle, C., and Henning, T., Infrastructure Sustainability Rating Tools–How They Have Developed and What We Might Expect to See in The Future, *IPWEA 2015: Sustainable Communities Sharing Knowledge*, Rotorua, New Zealand, 2015.

ISI, Envision Guidance Manual. Retrieved from https://sustainableinfrastructure.org/portal/files/GuidanceManual.pdf, 2015.

ISI, Envision. Retrieved from https://sustainableinfrastructure.org/envision/, 2017a.

ISI, Envision - How it Works, retrieved from https://sustainableinfrastructure.org/envision/how-it-works/, 2017b.

ISI, Envision Fact Sheet, retrieved from https://sustainableinfrastructure.org/brochure/fact-sheet/, 2017c.

ISI, Project Awards. Retrieved from http://sustainableinfrastructure.org/envision/project-awards/#3/48.22/-95.89, 2017d.

McVoy, G. R., Nelson, D. A., Krekeler, P., Kolb, E., and Gritsavage, J. S., *Moving towards Sustainability: New York State Department of Transportation's GreenLITES Story*, 2010.

NYSDOT, GreenLITES. Retrieved from https://www.dot.ny.gov/programs/greenlites, 2017a.

NYSDOT, Project Design Program. Retrieved from https://www.dot.ny.gov/programs/greenlites/project-design-cert, 2017b.

Shivakumar, S., Pedersen, T., Wilkins, S., and Schuster, S., Envision: A Measure of Infrastructure Sustainability, *Pipelines 2014: From Underground to the Forefront of Innovation and Sustainability*, 2249-2256, 2014.

Simpson, S. P., *A Framework for Assessing Transportation Sustainability Rating Systems for Implementation in US State Departments of Transportation.* Colorado State University, 2013.

Veeravigrom, M., Muench, S. T., and Kosonen, H., A Global Framework for Sustainable Roadway Rating Systems, *Transportation Research Board 94th Annual Meeting*, Washington D.C., USA, 2015.

Yudelson, J. a. M. T. A., Book Reviews-The Green Building Revolution, *Journal of Real Estate Literature*, 16(2), 253, 2008.