A Transdisciplinary Approach to Innovative Transportation Solutions

Connecting the Dots....

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Abstract

Integrating public health professionals as part of the team involved in the planning and development of transportation infrastructure projects will provide a competitive advantage not only from a market perspective but also in terms of strategic decision-making. This transdisciplinary approach will help to eliminate miscommunication of priorities by partnering transportation and public health professionals so that innovative and multidimensional problem solving can take place. The emphasis is on implementing practical solutions through mutual communication, capacity building, and sustainable change/growth that will impact the sociopolitical, environmental, and economic factors of the transportation infrastructure. To this end, a cultural shift in transportation project planning and development can occur based on a systematic evidence-based methodology in which challenges become opportunities. In this proposed scenario, public health professionals are able to contribute the skill-set necessary to effectively evaluate the health impact of a proposed facility by implementing qualitative and quantitative measures that complement the accepted cost-benefit analysis of facility accountability. It is vital for both transportation and public health professionals to maintain their specific expertise and freely exchange information based on lessons learned so that causal links to planning and design issues can lead to improvements in best practices, policy making and community livability.

Acknowledgement

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1.0 Introduction
The success of the US economy is dependent on the efficiency, flexibility, and safety of its transportation infrastructure. This involves the integration of transportation modalities, just-in-time manufacturing and advanced technologies to move goods, services and information between businesses and customers. In conjunction, creating logistic mechanisms that increase transportation efficiencies requires the development of partnerships, political alliances, and business arrangements that leverage regional economic development to ensure long term sustainability of a community and improvements in quality of life. With this said, the mantra of “do more with less” has set in motion a cultural shift within the field of transportation planning and development. Due to re-engineering efforts, the United States Department of Transportation (USDOT) has been transitioning to a business model in which the public (or customer) influences demand and financial support through fares, tolls and tax revenues in the transportation market. Providing mobility to the public is a product that over time is shifting more of the costs to the end-user. Taking this into consideration, quantity and price determine demand and maximum utility of transportation services. As a customer, the public is requiring performance accountability with any increase in price needing to demonstrate an increase in value-added to an asset. Transportation is becoming less about the construction of a particular facility and more about integrating the economics and science behind informed decision-making with responsible land use, design, funding streams and the beneficial impacts of a transportation network on the affected community.

Transportation is a vital component to community sustainability in terms of accessing health care, education, employment, leisure activities, and social networks. Along the life course, an individual makes choices regarding mobility from one place to another that impact the contexts of social well-being.1 Depending upon the place of residence (i.e. urban, suburban or rural), an individual may choose to walk; ride a bicycle; use public transit, rail; or drive a motor vehicle.1 “These choices are influenced by the availability of alternatives within a community, perceived constraints, attitude (social pressure), socioeconomic status, habit, information, and personal evaluation. Transportation mode choice has been correlated with life trajectory events such as employment and education, which are interconnected with maximizing individual utility.”1 Utility as it relates to personal benefit and budgetary constraints such as travel time, distance to and from a destination, incurred cost, distance and time to reach a transport mode are all interconnected with choice.1 Thus, an individual’s activity pattern, decision processes, behavioral rules, and the travel environment characterize a person’s behavior with respect to the multidimensionality of choice.1

Decisions regarding the planning and development of a transportation infrastructure project, whether it is a complete street, an Interstate or non-Interstate highway, a public-private partnership toll facility, or an intermodal facility connection, result in changes to sociopolitical, economic and environmental sustainability. Therefore, a transportation project, just like a public health program has become an entrepreneurial pursuit based on completing the project on budget and on time. This concept integrates science, alternative funding and delivery options and performance metrics of a multilevel process that has the potential to impact society on a local, national and global level.

A proposed transdisciplinary or cross-disciplinary approach to workforce development merges lessons learned and best practices from the fields of transportation and public health. To this end, policies are implemented that expand on the existing transportation system to facilitate short run improvements in the market by meeting the demand for health and performance...
metrics and long run improvements in infrastructure financing and sustainability. A transdisciplinary approach aims to:

1. Eliminate cross-discipline miscommunication between public health and transportation professionals by providing an educational resource to facilitate the exchange of information required to improve community planning and policy development.

2. Encourage partnerships and collaboration between public health and transportation professionals that encourage innovative and strategic problem solving by merging discipline specific ideas.

2.0 Knowledge Gap and Educating the Workforce

Education and training between public health and transportation professionals must be reciprocal to facilitate a sustainable transportation system and avoid silos. For instance, if public health professionals are to speak with credibility and effectively advocate for policy changes that affect transportation infrastructure projects, such as requiring a health impact assessment (HIA), they must possess a working knowledge of the logistics involved in the design and construction of a facility along with the metrics already in place to evaluate the health consequences of a proposed project. At the same time, transportation professionals need to be acutely aware of the qualitative and quantitative performance tools available to measure livability. This degree of understanding is achieved through open interpersonal communication while remaining cognizant of culture and professional backgrounds.

3.0 What is Public Health?

There seems to be a common misnomer among transportation professionals regarding the role and function of public health as a stakeholder in infrastructure projects. Modern public health practice is not only made up of physicians and nurses dedicated to preventing disease or caring for infirmed populations. The field is made-up of individuals with specific training on the causal association of an exposure and the resultant health affect from a physical, psychological and social perspective. Public health professionals are trained in the conceptual, analytical and applied sciences integrated with a set of core values including; assessment, assurance and policy development. Public health professionals are a multidisciplinary team including but not limited to: epidemiologists; biostatisticians; occupational experts; sociologists; lawyers; policy analysts, outreach educators…AND…federal transportation agency staff (i.e., DOT, FHWA, AASTHO etc.); economists; civil engineers; urban and regional planners and many others. As a result, a partnership between public health and transportation professionals has the capacity to improve the overall process of developing the nation’s transportation infrastructure and serving the needs of a growing population while remaining fiscally accountable as a result of evidence-based informed strategic decision-making.

4.0 Transportation-Public Health Link

The Transportation-Public Health Link (T-PH Link) is a working group within the Community Health Planning and Policy Development (CHPPD) Section of the American Public Health Association (APHA). The mission of CHPPD is to develop and advocate for health planning, policies and practices that promote health equity, community empowerment and social justice. The T-PH Link, unlike other organization-based committees is open to non-APHA members. The T-PH Link is based on a conceptual process of the transportation infrastructure as a system working in synergy to affect the sociopolitical, environmental, and economic factors of an
existing or proposed facility. This is achieved through an analysis of a diverse set of performance metrics based on the multi-dimensionality of integrative problem solving. A framework such as this has the flexibility to account for individual determinants acting at different levels within the transportation system. In this manner, it is possible to understand the impact of a proposed facility as part of the entire transportation system without segmentation and the impact on health and livability.

The overall mission of the T-PH Link is to develop and implement a network composed of key public health and transportation stakeholders and agencies at the local, state and national level. This network advocates for the branding of transportation as a public health service in an effort to increase awareness within the respective professional and service communities. The emphasis is on the implementation of practical solutions, effective partnerships, capacity building, sustainable change/growth, and alternative funding options that improve the planning and development of the transportation infrastructure. In addition, the T-PH Link advocates a thorough understanding of the built environment as it relates to the health and safety of communities to ensure the appropriate design, allocation and utilization of resources in an integrated, equitable, and sustainable manner for the future of America’s transportation infrastructure needs.

The T-PH Link supports the inclusion of public health professionals as part of the team involved with the design, planning and development of proposed and rehabilitated transportation infrastructure projects. In this way, public health professionals are able to provide solid research, performance metrics, and strategic management methodologies required to effectively evaluate the impact of a proposed facility. By applying concepts familiar to both parties while building upon existing knowledge; effective decision-making can occur through mutually beneficial partnerships between public health and transportation professionals. The addition of a public health approach including planning and development, continuous process improvement, impact evaluation, qualitative and quantitative data analyses, and public outreach and education, drive the process. As funding streams continue to shrink and the demand for accountability and efficiencies increase, it will be imperative for transportation to partner with the public health community to provide strategic goals, transparency, and innovative ideas that meet the health and transportation needs of a growing population.

The T-PH Link is committed to educating and improving the understanding of the benefits that can be realized from an effective collaboration between public health and transportation professionals. Therefore, the T-PH Link regularly submits abstracts and proposals for conference presentation in both disciplines (Example provided in Appendix A). For a complete description on past and future presentations, please visit the T-PH Link website at www.transpotohealthlink.com.

5.0 Best Practices and Lessons Learned

Collaboration between public health and infrastructure professionals has shaped the nation. John Snow is the physician credited for removing the Broad Street well pump handle from the city center in Soho, England during the Cholera outbreak (Black Death). In 1858, John Snow identified the pattern of disease and traced it back to the source; contamination of the water supply from the polluted Thames River. Snow is considered the father of epidemiology hence a partnership emerged between environmental assessment and public health. Developed in the 1970’s, the Haddon Matrix is considered as the foundation of transportation safety and injury prevention based on an epidemiological perspective. William Haddon was a physician, an
engineer and a public health professional at a state health department. He combined his skills to develop an innovative approach to road safety by describing the synergy between host (person), agent (energy transfer through the vehicle) and environment (physical and social contexts) and socioeconomic factors. This model is now the basis of the FHWA Highway Safety Improvement Program Manual. These examples represent only a couple of the societal benefits gained by a partnership between public health and transportation. How does this proposed relationship translate to the challenges faced by transportation in the present day?

5.1 Federal Transportation Gas Tax and the Public Health Cigarette Tax

There is continued political debate regarding the status of the federal gas tax – related to the fact that the original legislation did not include an adjustment for inflation. Although the current gas tax is 18.4¢ per gallon, if the tax had been adjusted for inflation, it would have equaled 28¢ in 2011. This may not appear to make much of a difference however visual inspection of Figure 1, demonstrates the revenue lost over time between the nominal and real gas tax with equalization in the current market. A real gas tax would have provided the much needed revenue to support the transportation trust fund over time even with a decrease in vehicle miles traveled (VMT). In 2012, the high price of gas compounded by decreases in VMT and improved vehicle efficiency, has resulted in further decreases in gas tax revenue needed to support the nation’s crumbling transportation infrastructure.

![Figure 1 Tax per gallon over time.](http://www.enviroknow.com/2011/09/09/the-federal-gas-tax-should-be-indexed-to-inflation/)

Interestingly, public health did not learn from the experiences of the federal gas tax. Figure 2 shows the decline in the size of the revenue increase realized from increases in the Michigan cigarette excise tax over time and decreasing cigarette sales. Although the goal is to decrease health care costs resulting from the adverse health impacts of chronic smoking such as lung cancer and cardiovascular disease, there are potentially adverse consequences to states that have become dependent on cigarette excise tax revenue. Thus, the long run effects of a higher cigarette excise tax may reduce smoking rates, but also decrease state-level cigarette revenue.
required to support important public health programs without additional tax increases. The key point is that without a built-in adjustment for inflation, the tax has to be increased through additional legislation, which opens the enacted law to the political process and further debate.

![Figure 2](https://example.com/figure2.png)

**Figure 2** Courtesy of Scott Darragh, PhD Economist, Michigan Department of Treasury

Taking this example one step further from a policy perspective, it is possible to integrate lessons learned from public health regarding the regressive nature of a proposed increase in the gas tax or other user fee mechanisms that would adversely impact low income vehicle users. The basic economic principle is that as price increases demand decreases. Some transportation policy advocates have suggested that a portion of the revenue made from increases in the gas excise tax should be reallocated to support programs serving the low socioeconomic segment of the population. Public health has direct experience in evaluating the effectiveness of the federal and state cigarette excise tax. Here’s the lesson, with Michigan as an example in cigarette tax revenue scenario, unless there are legislative mandates attached, this policy does not work. Cigarette tax revenues have been used to fund other state activities or programs aimed at the general population instead of the low socioeconomic populations as intended. It is a lesson learned from another discipline that can help mitigate the negative and influence positive decision-making in the field of transportation.

### 5.2 Health Impact Assessment

Health Impact Assessment (HIA) has become increasingly prominent as a data driven tool to assess the “livability” of transportation infrastructure projects. The World Health Organization (WHO) defines HIA as a means of assessing the health impacts of policies, plans and projects in diverse economic sectors using quantitative, qualitative and participatory techniques. The key to HIA is to understand the manner in which the individual elements, factors and performance measures are packaged to reflect the impact of a project on the affected community (Figure 3).
Unfortunately, transportation professionals have been left on their own to decipher exactly what a HIA is while new regulations on livability become part of the proposal and award process void of financial incentive or supplemental support. The irony is that transportation professionals have unknowingly conducted a form of HIA even before HIA became “in vogue”. These performance tools are reflected in EPA’s NEPA environmental review and environmental impact assessment processes when environmental justice is extended to the entire population, Context Sensitive Solutions (CSS), and Sustainable Return on Investment as the basis of transportation infrastructure projects. For example, the definition and application of CSS developed by the US DOT is the foundation of program decision-making and engineering design that ensures that community input, land use, safety and mobility are taken into account during the all phases of a project.9

In September 2011, the National Research Council (NRC) published recommendations on Health Impact Assessment (HIA).10 The main premise of these broad recommendations is to demonstrate that HIA can be implemented as a tool in instances in which there is “added value” to a project. HIA is not intended to replace existing performance metrics and may not be appropriate for every transportation project however this is not the message that is being communicated to the public or to transportation professionals. Based on a transdisciplinary approach that merges lessons learned and best practices from the fields of transportation and public health, a policy that expands on the existing transportation infrastructure project evaluation system is the most cost-effective and efficient proposal to facilitate long-term sustainability and a positive impact on the health of communities.

5.3 Sustainable Return on Investment (SROI)

HDR’s Sustainable Return on Investment (SROI) process assesses the benefits of a transportation infrastructure project and a green business case as compared to a no build...
The SROI model includes four phases, which are very similar to the four phases of the HIA (all information pertaining to the SROI model has been reproduced with permission):¹¹

I. Development of a structured and logical plan (assessment of “how” all the variables and assumptions interact to determine the impact of a project).

II. Quantifying the input data and assumptions (statistical probability/uncertainty analysis of the project elements).

III. Risk assessment session with stakeholders (discussion of step 2 elements).

IV. Model Simulation and forecasting results (data modeling of various project scenarios and statistically based probability distributions).

The SROI model promotes transparency, accountability, and efficient use of all social resources necessary to maximize the “triple bottom line” of economic, social and environmental value (Figure 4).¹¹ In addition, the SROI methodology builds on best practices in Cost-Benefit Analysis and Financial Analysis methodologies, complemented by state-of-the-art Risk Analysis and Stakeholder Elicitation techniques.¹¹

Figure 4 Graphic Courtesy of Eric C. Bill, Senior Economist, HDR Inc.

The SROI process identifies the significant impacts of a project and values these impacts in monetary terms, while accounting for non-monetary benefits and external costs and benefits (Figure 5).¹¹
In essence, the SROI is a feasibility study in conjunction with the monetized value of non-cash costs of environment, community variables and external benefits. Together the SROI elements determine the overall utility (full value) and risk of a project. The SROI model also represents an ecological approach that provides a "general framework for understanding the nature of people’s transactions with their physical and socio-cultural surroundings." Therefore “people” are the determining factor influenced both by the physical (e.g., geography, architecture, and technology) and social environment (e.g., culture, economics, and politics). Human utility (health/well-being) is multifaceted with an interplay among all of the elements and factors of the SROI model. Interestingly, the SROI concept is the basis of public health planning and program development within the built environment.

5.4 Business Intelligence

A major component to business intelligence is the ability to interpret qualitative and quantitative data, while assessing the effectiveness and sustainability of a project. A majority of the parameters indicated below are part of the SROI model and are only reproduced as a frame of reference. The last four (SMART Objectives, esri Community Analyst, Logic Model and QALYs) are just a few examples of the public health measures that can be integrated with the SROI model or other transportation evaluation tools which can be expanded to include health impact and/or outcomes.

- Life cycle costs
- Technology (i.e. off peak pricing VII, ITS, AET)
- Inter-Modal Connectivity
- Capital and Replacements Costs
- Operations and Maintenance (O&M)
- Commissioning and Decommissioning Costs
- Congestion Management
5.5 SMART Objectives

As part of an integrated fiscal and strategic approach (budget to business activities), a set of impact objectives need to be devised to connect activities with the intended results. This may seem like common sense, however, very few agencies, construction or service provider firms understand the proper methodology involved in developing an objective. “An outcome objective is quantifiable with realistic targets of a project written in an active tense and uses strong verbs such as plan, write, conduct, produce; rather than learn, understand or feel.” Objectives are specific, measurable, achievable, relevant and timely; reflecting clarity and direction along with increasing accountability. Each objective should consist of the following five elements:

1. Specific – Exactly what are we going to do, with and for whom?
2. Measurable – Is it measurable and can we measure it?
3. Achievable – Can we get it done in the proposed timeframe/in this political climate for this amount of money?
4. Realistic – Will this objective lead to the desired results?
5. Time – When will we accomplish this objective?

5.6 The Logic Model

The Logic Model is a public health tool used during the assessment and planning phase of a project. It is a systematic approach to communicating the purpose/assumptions, elements/factors, and the relationship of activities to goals/objectives (cause-and-effect relationship) of a project to stakeholders in terms of relevance, quality, and impact. The Logic Model links resources, activities, outputs, audiences, and short, intermediate, and long-term outcomes to describe the overall effectiveness of a project. Once a project has been organized using the model, critical measures of performance can be identified.
The individual characteristics indicated in the model can be tailored to meet the requirements of a specific transportation infrastructure project.

5.7 esri Community Analyst
An important point of analysis for any infrastructure project should include an assessment of the population demographic and psychographic segmentation in conjunction with geographic information. The geographic location of a proposed facility reflects a specific user mix and community characteristics (reflective of education and culture). “esri Community Analyst is an epidemiological tool to evaluate the demographic, health, economic, education, and business data variables, combined with instant reports and interactive color-coded maps to provide characteristics of any area geographic context such as congressional district, block groups, census tracts, or ZIP codes.”

5.8 Quality-Adjusted Life Years (QALY)
Quality-adjusted Life Years (QALY) is a widely accepted standardized public health measure of disease burden or in this case, injury and death as a result of a vehicle-related incident. A QALY includes both the quality and the quantity of life lived. It is used in assess the cost-effectiveness of a project or policy. The QALY is often used in cost-utility analysis to calculate the ratio of cost to QALYs saved for a particular project.

6.0 Policy Recommendations
Transportation infrastructure projects should incorporate a transdisciplinary approach that effectively and efficiently determine the sociopolitical, environmental and economic impacts, with the health of the affected community as the focus for long term sustainability. Based on the information presented in this paper, the following policies are recommended:
1. Support a cultural shift in transportation infrastructure planning and development as reflective of a systematic and evidence-based process driven by an integrated transdisciplinary approach to decision-making.

2. Encourage the combined use and interpretation of qualitative and quantitative data to make informed fiscal and strategic decisions.

3. Expand transportation workforce capacity by including trained public health professionals as part of the transportation infrastructure planning and development team.

4. Facilitate an exchange of information based on lessons learned and best practices from transportation and public health.

7.0 References


15. The Logic Model of Program Planning and Evaluation (July 30, 2011). Retrieved From: www.uiweb.uidaho.edu/extension/LogicModel.pdf


17. ESRI Community Analyst (July 31, 2011). Retrieved From:
A Transdisciplinary Approach to Innovative Transportation Solutions

August 1, 2012


18. Quality-Adjusted Life Years (July 31, 2011). Retrieved From:

Appendix A

ACCEPTED: Invited Breakfast Session
American Public Health Association 140th Annual Meeting, Section of Community Health Planning & Policy Development (CHPPD)
October 27-31, 2012, San Francisco, California

A Transdisciplinary Approach to Assessing Impact across the Transportation Life Cycle

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Moderator’s Name: Natalie R. Sampson
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Invited Session Description:
Transportation has become a vital component to a people in terms of accessing health care, education, employment, entertainment, social support networks, and well-being, thus influencing one’s transitions across the life course. Decisions regarding the design, planning and development of a transportation infrastructure project; whether it is a complete street, an Interstate or non-Interstate highway, a public-private partnership toll facility, or an intermodal facility connection; all result in changes to sociopolitical, economic and environmental sustainability. Therefore, a transportation project, just like a public health program, has a life course and reflects a multilevel, multi-dimensional process impacting the health of a community.

Organized by Transportation-Public Health Link (T-PH Link), a subgroup of APHA’s Community Health Planning and Policy Development Section, this Invited Session is an educational seminar based on a transdisciplinary approach, focused on a mutual partnership between transportation and public health of best practices and lessons learned. The session will provide information to public health professionals regarding the lifecycle of a transportation facility and its impact on health. This will entail 5-6 presentations including design and planning, state of good repair, environmental review, and economic cost-benefit analysis from a transportation infrastructure perspective, which will be linked to the health impact assessment (HIA) process.

Education between public health and transportation professionals must be reciprocal to facilitate healthy, sustainable transportation systems and protect the health of communities. If public health professionals are to speak with credibility and effectively advocate for policy changes that impact transportation infrastructure projects, such as a required HIAs or additional assessments, public health professionals must possess a working knowledge of the logistics involved in the design and construction of a facility along with the metrics already in place to evaluate health impacts by the field of transportation. Members of the T-PH Link network have the knowledge and experience to provide this important information to public health professionals attending the 2012 APHA Annual Meeting.
Learning objectives:

(1) Eliminate cross-discipline miscommunication between public health and transportation professionals by providing an educational resource to facilitate the exchange of information required to improve community planning and policy development.

(2) Encourage partnerships between public health and transportation professionals that encourage innovative problem solving by merging discipline specific ideas to improve the health of communities.

Abstracts for Proposed Invited Session:

Abstract # 260559
Lead Author’s Name: Stephanie Yanovitz, BS (Architectural Engineering and Civil Engineering), Senior Transportation Planner, Sabra, Wang & Associates, Inc. (http://www.sabra-wang.com)
Title: Creating the Built Environment through a Cycle of Transportation Planning and Evaluation

Abstract # 259830
Lead Author’s Name: Stephen F. Mayer, PhD, PE, Business Development and Strategy Manager, Parsons Transportation Group, Parsons Corporation (www.parson.com)
Title: A State of Good Repair: Transportation Life Cycle Financing and Community Sustainability

Abstract # 259678
Lead Author’s Name: Ronald Deverman, MA, Associate Vice-President, HNTB (www.hntb.com); Immediate Past President, National Association of Environmental Professionals
Title: Health Impact Assessment and Transportation Decision-Making: Environmental Nexus

Abstract # 258229
Lead Author’s Name: Stephane Larocque, MBA, Senior Economist, HDR Inc. (www.hdr.com)
Title: Sustainable Return on Investment: The Economic, Social, and Environmental Business Case in a Transportation Infrastructure Context

Abstract # 260555
Lead Author’s Name: Ben Cave, Director of Ben Cave Associates Ltd. (http://www.bcahealth.co.uk); National Research Council Committee Member, 2011 HIA Recommendations
Title: Health Impact Assessment: A Transdisciplinary Approach

Abstract # 256794 (Optional)
Lead Author’s Name: Karyn M. Warsow, MS, MPH, DrPH Candidate, Johns Hopkins Bloomberg School of Public Health, Department of Health Policy Management and Leadership
Title: Allostatic Load: Whose Fault is it Anyway? A Life Course Perspective of Chronic Disease and the Impact of Surface Transportation