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# Drivers of Innovation In Financing Transportation Infrastructure: A Systemic Investigation

Ali Mostafavi
*Purdue University*, amostafa@purdue.edu

Dulcy Abraham
*Purdue University*, dulcy@purdue.edu

Charlene Sullivan
*Purdue University*, sullivaa@purdue.edu

# DRIVERS OF INNOVATION IN FINANCING TRANSPORTATION INFRASTRUCTURE: A SYSTEMIC INVESTIGATION

**Ali Mostafavi[1], Dulcy Abraham[2], and Charlene Sullivan [3]**

## ABSTRACT

Traditional methods of financing infrastructure, which include gas taxation, tax-exempt bonds, and reserve funds, have not been able to meet the growing demand for infrastructure. Innovative financing systems have emerged to close the gap that exists between the available and needed financing sources. The objective of the study presented in this paper is to assess determinants of innovative financing in the U.S. transportation infrastructure using a systemic approach. Innovation System of Systems approach is adopted for systemic assessment and a case-based research approach is utilized to explore the constituents of innovative financing for U.S. transportation infrastructure. The findings, which include constructs regarding the players, practices, and activities are used to create a model to enable understanding the dynamics of the drivers and inhibitors of innovation and, thus, to derive implications for practice. The model along with the constructs provides an analytical tool for practitioners in the U.S. transportation infrastructure.

## KEYWORDS

Innovative Financing, Innovation, Transportation Infrastructure, System Analysis, Policy.

## INTRODUCTION

Infrastructure is driver of economic development which enhances the economic competitiveness of the nation. In 2009, the American Society of Civil Engineers (ASCE) gave U.S. infrastructure a grade of "D" (ASCE, 2009). The deteriorating condition of U.S. infrastructure affects its economic performance levels and therefore impacts its economic competitive advantage while countries such as China are expanding their infrastructure investments to enhance their economic competitiveness. To improve the current close-to-failing condition of U.S. infrastructure to a good functioning condition an investment of $2.2 trillion is required within the next five years (between 2009 and 2014). Transportation infrastructure is one of the highest ranking sectors affecting the nation's economic productivity. Financing entails providing capital for projects, while funding involves raising that capital, and delivering infrastructure includes constructing and operating them. Infrastructure is financed either on a pay-as-you-go basis or by borrowing. Taxation and user-pay are the common methods of funding. Infrastructure is delivered either publicly or

[1] Ph.D. Candidate and Research Assistant, School of Civil Engineering, Purdue University, 550 Stadium Mall Drive, West Lafayette, IN 47909-2051, USA, Phone 765/543-4036, FAX 765/494-0644, amostafa@purdue.edu.

[2] Professor, School of Civil Engineering, Purdue University, 550 Stadium Mall Dr., West Lafayette, IN 47907-2051, USA, Phone 765/494-2239, FAX 765/494-0644, dulcy@purdue.edu.

[3] Professor of Finance, Krannert School of Management, Purdue University, 425 State Street West Lafayette, IN 47907-2056, USA, Phone 765/494-4382, sullivaa@purdue.edu.

privately (Ploeg, 2006). While the methods for financing, funding, and delivering infrastructure are limited, there is a continuum of tools that can be employed for implementing each method. The combination of tools used for financing, funding, and delivering infrastructure forms the financing mechanism. Examples of traditional tools available to implement these basic methods include property taxes and reserve funds (pay-as-you-go), pooled vehicles and amortized debentures (borrowing), fuel taxes (taxation), flat rate (user fees), and fully public delivery.

The challenge facing infrastructure policymakers is that traditional tools and mechanisms for funding and financing transportation infrastructure have not been able to meet the challenges for financing infrastructure. The challenges include unavailability of required capital, cash flow problems, and unfavorable risk-return profiles of infrastructure for private investors, which rise due to population growth, aging of existing infrastructure, evolving infrastructure investment risks (from commercial risks to political risks), rising standards (e.g., environmental regulations) and competing capital, and budgeting priorities. As the U.S. Secretary of Transportation commented in 2009, addressing the issues of the nation's transportation system and other infrastructure would require "out-of-the-box" (innovative) thinking (Reinhardt, 2009). Innovative financing has globally emerged to offer new financing tools and mechanisms for funding, financing, and delivering infrastructure projects that complement traditional mechanisms to address the existing demand and to enhance economically sustainable global infrastructure. Recent emerging tools which have been adopted by the transportation sector in the U.S. for funding, financing, and delivering infrastructure include but are not limited to leaseback agreements (e.g., Indiana Toll Road), State Infrastructure Banks (SIBs), Grant Anticipation Revenue Vehicles (GARVEE) Bonds, and availability payment mechanism (Mostafavi and Abraham, 2010).

The objective of this paper is to assess the financial innovation in the U.S. transportation infrastructure using a systemic approach to explore the determinants of financial innovations in infrastructure. This paper aims to answer the following questions: (a) who are the players affecting development and diffusion of innovative financing mechanisms (b) what are the current norms and practices of the players (c) what activities do the players implement for innovative financing and (d) what are the drivers of innovation in infrastructure finance.

First, the framework for systemic analysis of innovation is introduced. Then, a case-based research approach is implemented to abstract the constituents of infrastructure finance innovation system. A group of 14 experts from organizations engaged in innovative financing in the U.S. transportation infrastructure sector are interviewed to identify the determinants of innovative finance. Then, propositions pertaining to the constituents of the system are developed using inductive analysis. The propositions could provide a basis for systemic assessment of financial innovation processes for transportation infrastructure and, thus, enhancement of the innovative finance policy analysis by understanding the dynamics of the innovation process.

## FRAMEWORK FOR SYSTEMIC ANALYSIS OF INNOVATION

According to *System of Innovation* theory, innovation and technology developments are the result of the complex set of relationships among actors in the system [Freeman (1987), Lundvall (1992), Nelson (1993), Edquist (1997), and Edquist (2004)]. Systemic assessment

of innovation requires an analysis framework to capture the dimensions and elements of analysis. To address the challenges of traditional System of Innovation approaches in creation of such framework (Chang and Chen, 2004), Mostafavi et al. (2011a) have proposed an analysis framework called Innovation System of Systems (I-SoS) for systemic analysis of innovation. The analysis framework, as shown in Figure 1, consists of three dimensions: definition, abstraction, and implementation. The scope of this paper is limited to the definition and the abstraction dimensions of analysis of the financial innovation process since there is no priori study on the abstraction of the constituents of infrastructure finance innovation system.

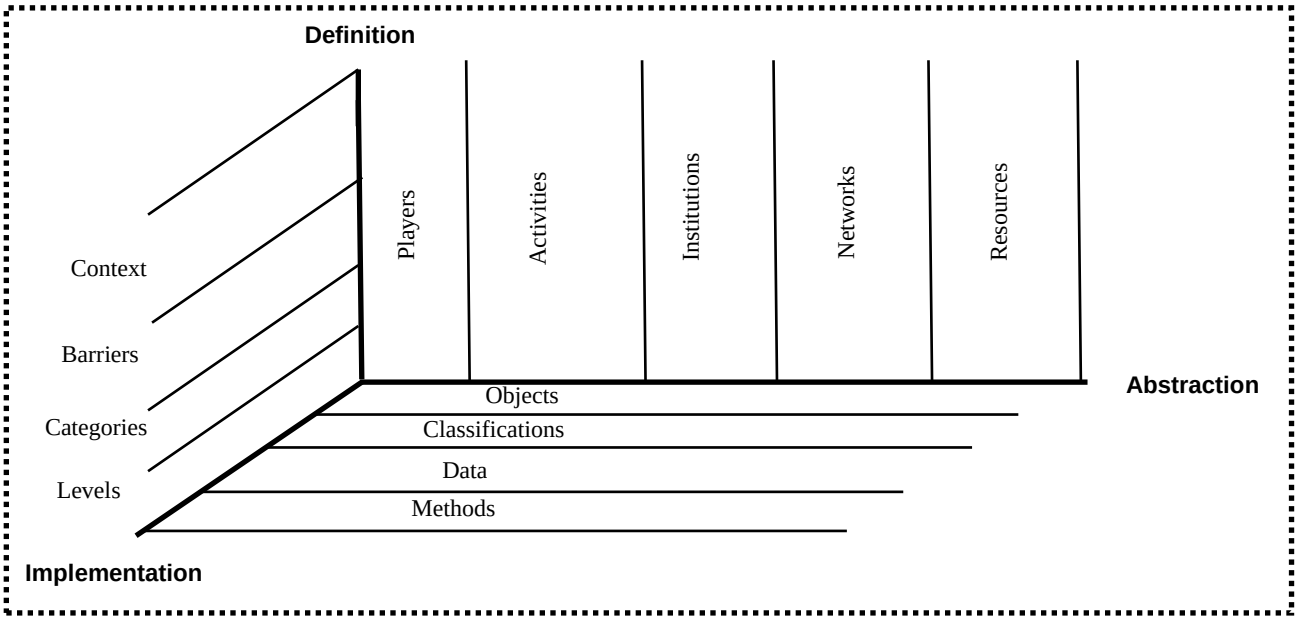


Figure 1- Framework for systemic analysis of innovation (Mostafavi et al. 2011a)

The analysis begins with the definition phase. In this case, the *context* of the analysis is the assessment of innovative financing mechanisms in the transportation infrastructure in the U.S. In this context, three *categories* of financial innovation are considered in the analysis: (a) different use of traditional financing tools (e.g., earmarking property taxes for capital investments), (b) creation of new tools (e.g., build America bonds), and the use of familiar methods used in other sectors (for instance, the Grant Anticipation Revenue Vehicle which has been used for financing water infrastructure) (Ploeg, 2006). *Levels* of analysis include sub-national (local), national, and global levels which means players, activities and interactions within and across these levels are assessed. *Barriers* in the analysis include the heterogeneity of the players and the activities within and across different levels of analysis, which add to the complexity of the analysis (Mostafavi et al. 2011b).

The abstraction phase, which is of particular interest in this paper, includes identification of the *players*, *institutions (norms and practices)*, *activities*, *networks*, and *resources* within and across the different levels of analysis (sub-national, national, and global). In the following sections, these elements are identified using a case-based research approach. Fourteen (14) experts from organizations engaged in innovative financing of transportation

infrastructure were interviewed to capture detailed information pertaining to the players, institutions, and activities in the system.

## CASE-BASED RESEARCH APPROACH

The case-based research approach focuses on understanding the dynamics present in a system, especially in areas where there is no priori hypotheses (Eisenhardt, 1989). In this study, a case-based research approach is selected to identify the elements of the abstraction dimension of analysis for three reasons. First, there is no priori hypotheses pertaining to the organizations and activities involved in financial innovation in infrastructure. Second, in the *System of Innovation* literature, the case study method, which had not been addressed properly thus far, was introduced by Edquist (2001) as the best way to build theories regarding the determinants of innovation. Third, the case-based method is an ideal research strategy for addressing research questions regarding "how" things occur in the investigation of dynamic processes (Yin, 2003). The process of case study research includes the following steps: problem and context definition, data collection, data analysis, and initial hypotheses induction.

The problem and context of this analysis were the assessment of financial innovation for transportation infrastructure in the U.S. The mode of data collection included interviews with experts from organizations engaged in innovative finance who had significant knowledge and experience in innovative financing of transportation infrastructure specifically. The interviews were conducted between March and July 2010 and were taped for consequent transcription and review. Table 1 shows the organizations represented by the different interviewees. The interview included open-ended questions such as "What is the current state of practice regarding innovative financing of transportation infrastructure in your organization?" and "What are the engaged organizations in innovative financing of transportation infrastructure?" The open-ended interview questions facilitated discussion of the emergent topics to be discussed within and across the interviews. The interviews were analyzed through transcription and coding for our use in hypotheses induction. Coding refers to deciphering the transcribed interviews and labeling the pieces of information pertaining to the players, institutions, and activities. In the analysis, it is not the words themselves but rather their meaning that matters (Miles and Huberman, 1994). The codes are refined through pattern analysis to summarize groups of codes into constructs as will be explained in subsequent sections.

Table 1- Informants interviewed for data collection

| Organization | Number of experts interviewed |
|---|---|
| Federal Agencies | 2 |
| State Departments of Transportation | 2 |
| Global Institutional Investors | 2 |
| National Institutional Investors | 2 |
| National Financial Consulting Firms | 2 |
| Universities (Academia) | 4 |

## CONSTITUENTS OF FINANCIAL INNOVATION SYSTEM

The first element of the abstraction phase is identification of the players. The major groups of players in the infrastructure financing process were identified as follows: federal and state

agencies, global and national institutional investors, consulting companies, and the general public.

The group of federal players includes the federal government (e.g., legislative components such as the U.S. Congress), the Federal Highway Administration (FHWA) within the U.S. Department of Transportation (USDOT) and the American Association of State Highway and Transportation (AASHTO). State agencies include state governments, state departments of transportation (DOTs), regional district offices, and toll road authorities. Institutional investors include investment banks, venture capitalists, wealth firms, and pension funds. Examples of global institutional investors include Macquarie Group, Cintra, and Brisa; and an example of a national institutional investor is Goldman Sachs. Consulting and advising firms, as well as law firms, are another group of players, and include the Jeffery Parker and associates, Goldman Sachs, and the P3 Development Company. Finally, the general public is an important group of players at either the sub-national or the national level.

The other elements of the abstraction phase include identification of institutions (norms and practices). The discussion regarding the observed common themes pertaining to the institutions and activities of each group of players are presented for each group of players separately in the following sections.

**Federal Agencies**

The federal government facilitates invention and diffusion of innovative financing mechanisms through policies. An example of such policies is the Transportation Infrastructure Finance and Innovative Act (TIFIA). The TIFIA program provides federal credit assistance in the form of direct loans, loan guarantees, and standby lines of credit to finance surface transportation projects of national and regional significance.

FHWA developed the Innovative Finance Program to enhance innovative financing of transportation infrastructure through "learning" the best financing practices in other sectors and in other countries and creating guidelines to be used by states DOTs (FHWA, 2010). Similarly, AASHTO's Center of Excellence in Project Finance was developed to provide policy guidance pertaining to innovative financing. This center partners closely with FHWA's Innovative Finance Program for policy implementation. All categories of financial innovation (i.e., different uses of traditional tool, development of new tools, and adaptation of familiar tools from other sectors and countries), as defined in the definition phase, are of interest to AASHTO's Center of Excellence in Project Finance and the FHWA Innovative Finance Program.

*Construct 1a. Activities of the federal government: the federal government facilitates innovative financing by setting policies and providing credit assistance. Federal agencies do not initiate innovative mechanisms but do implement adaptation of best practices from other sectors and countries.*

*Construct 1b. Activities of players within the USDOT: the players within the USDOT learn the best practices from other sectors and countries and provide policies pertaining to all three categories of financial innovations to be used by states DOTs.*

*Construct 1c. Institutions of federal agencies: the objectives of federal agencies in practicing innovative financing are to increase the amount of fiscal space within the government budget, to reduce interest costs, and to accelerate projects.*

**State Agencies**

Innovative financing policies and best practices guidelines developed by federal agencies are provided to state governments and state departments of transportation to be adapted for financing projects. State governments practice innovative financing based on their transportation infrastructure development plans and needs. For instance, the capital shortfall in the State of Indiana in 2004 along with Indiana Governor Mitch Daniels' vision to turn Indiana into the "transportation logistics capital" of the U.S. led to the state leasing the Indiana Toll Road to a private consortium in 2006 through a leaseback innovative mechanism to provide capital for the unfunded $2.8 billion estimated capital plan while there was an inability to raise fuel tax as the traditional funding tool. State DOTs adapt policies and best practices provided by federal agencies based on their needs and based on the characteristics of projects (e.g., project risks, possibility of tolling in the project, and project priority) and economic conditions such as a recession.

Thus far, states such as Florida, Virginia, and Texas with significant needs for financing sources have implemented innovative tools, such as advance payment and shadow tolls, through public-private-partnership. As the states practice innovative financing, they learn in the process to adapt more innovative mechanisms. For instance, the state of Texas uses shadow tolls as an innovative funding tool for projects financed to facilitate private investments. As Texas DOT learned through adaptation of the mechanism, a Pass-through Financing program was developed in 2008 within Texas DOT that led them to consider the possibility of tolling for each project whether it is financed by private investors or it is financed using federal or state money. Furthermore, once a state succeeds in meeting its infrastructure demand by implementing innovative financing, other states are prompted to adopt the mechanism. The interviewees from the Texas and Florida DOTs mentioned that they have been contacted by other states DOTs asking about their experiences and lessons learned using innovative financing tools.

*Construct 2a. Institutions of states agencies: the extent to which innovative financing is implemented in a state depends on the state's need for financing and the state government's plans and visions to develop infrastructure*

*Construct 2b. Activities of states agencies: state DOTs facilitate innovative financing by crafting policies and best practices provided by federal programs based on the characteristics of the infrastructure project.*

**Institutional Investors**

Institutional investors invest in infrastructure either through infrastructure funds or through concession agreements. These investors seek long-term stable return (inflation-indexed return) that matches their investment portfolios. Global institutional investors who have invested in mature markets like Australia, Spain, and England since the early 1990s have started to participate in financing U.S. transportation infrastructure. For instance, the Macquarie Group (from Australia) and Cintra (from Spain) who invested in infrastructure in Australia and Spain, respectively, for over ten years have invested in highway projects (e.g.,

Chicago Skyway Bridge and Indiana Toll Road) in the U.S. The inclusion of global investors is an innovative method for financing U.S. transportation infrastructure.

In addition to investment, institutional investors (both global and domestic) can educate public agencies at either the national or state level about the process and the benefits of the innovative mechanisms that they initiate. In fact, private institutional investors (e.g., Macquarie, Cintra, and Brisa) are pushing the frontiers of innovative financing by using their long-established expertise based on experiences in financing infrastructure projects in different countries. Greater involvement of the private sector in infrastructure development, financing, and management leads to greater potential for innovation (Garvin, 2007). Institutional investors (like all the investors) are looking for profitable infrastructure investment opportunities. Thus, they are motivated to innovate and create tools and mechanisms that make an infrastructure investment opportunity desirable for their investment portfolios. Their motivation and activities are different from what public agencies implement regarding innovative financing, which is either an adaptation or issuance of different types bonds (so-called "Plain Vanilla"). Institutional investors may use the tools provided by public agencies to develop a mechanism which is appropriate for the project of their interest. For instance, in the case of the North Tarrant Express project in Dallas, Texas, institutional investors (Cintra, Meridiam Infrastructure, and Dallas Police and Fire Pension System) took advantage of TIFIA loans to enhance the credit worthiness of the project to be able to issue private activity bonds. TIFIA enhanced the credit worthiness of the private activity bonds in the absence of monoliners.

Institutional investors need to receive signals from federal and state agencies to invest in the country's infrastructure, which will occur when federal and state agencies set established policies and programs for private investment in infrastructure. As a case in point, the TXDOT's Pass-through Financing program sent a signal to private institutional investors prompting them to participate in transportation infrastructure investments in the state of Texas.

Since investors tend to invest in the markets that they know, as the leading institutional investors start to experience successful investments, other investors are encouraged to enter infrastructure markets. An example of this case is the participation by pension funds in infrastructure investments. For instance, in 2009, Texas Police and Fire Pension System invested in the North Tarrant Express project in Dallas. It was the first investment of pension funds in transportation infrastructure in the U.S. It considered infrastructure market for investment after observing successful infrastructure investments made by other pension funds such as Australian pension funds and Ontario Municipal Employees Retirement System which made investments in infrastructure markets in Australia and Canada, respectively.

*Construct 3a. Institutions of the institutional investors: the objective of institutional investors for implementing innovative financing is to seek attractive returns on investments by seeking infrastructure investment opportunities that fit into their investment portfolios.*

*Construct 3b. Institutions of the institutional investors: institutional investors are looking for indications from public agencies to invest in infrastructure.*

*Construct 3c. Activities of the institutional investors: institutional investors are able to implement diverse innovative financing as opposed to what federal and state agencies are doing, which is considered as adaptation and issue of bond instruments.*

*Construct 3d. Activities of the institutional investors: global and national institutional investors can facilitate innovative financing by educating public agencies regarding the advantages of innovative mechanisms.*

**Consulting Companies**

Consulting firms provide advice to both public and private agencies regarding the benefits and processes related to innovative financing mechanisms. These agencies also facilitate innovative financing through research on the practices in other countries and other sectors (such as water, energy, and communication). Their activities complement what entities such as FHWA and AASHTO are doing to work more closely with state agencies to facilitate adaptation of the innovative guidelines provided by public agencies.

*Construct 4. Activities of consulting companies: consulting companies facilitate innovative financing through research and providing consulting services to state agencies to adapt innovative guidelines provided by federal agencies.*

**General Public**

The general public plays an important role in the development and/or the adaptation of innovative financing mechanisms because user-pay or taxation methods are used for funding infrastructure. Public perception is an important factor to be considered in evaluating innovative financing. Innovative mechanisms are not easily understandable by public. Therefore, it is important to educate the public regarding the existing condition of the nation's infrastructure, the growing demand for financing sources, and the advantages and impacts of implementation of innovative financing. Educating the public could reduce the likelihood of public objections to adoption innovative financing. Implementation of innovative financing might be perceived as disadvantageous, especially when it conflicts with public interests. For instance, mechanisms which include user-fee funding and long-term concession agreements raises public concerns and may lead to the perception of conflict of interest by the general public. An example of public and political objections includes the case of leasing the Pennsylvania Turnpike. In 2007, the Pennsylvania Governor announced his intention to lease the Pennsylvania Turnpike and implement tolls on I-80. When the Turnpike commission applied to FHWA for an expression of interest, there was an objection among community and business groups to the increased costs to travel as a result of leasing the Turnpike. Subsequently, there was political opposition and a state senator requested the Secretary of Transportation to turn down the application for leasing the Turnpike (Levy, 2008). Ultimately, the application was rejected by the Pennsylvania legislature.

*Construct 5. Institutions of the general public: the challenge facing innovative financing is educating the public since public objection arises when innovative financing is complex or endangers public interests.*

**Networks**

The three major networks that exist in the infrastructure finance are networks of institutional investors, networks of public agencies, and networks among the general public (e.g., social networks). So, there are links among the public agencies, among the institutional investors, and among the public social network. Some institutional investors form coalitions (networks)

to communicate and find solutions to tackle existing obstacles for their investment in infrastructure. An example of such coalitions at the national level is the Sustainable Public Finance Coalition, a special working group dedicated to developing the core body of knowledge and leadership for the development finance industry (Council of Development Finance Agencies, 2010). Similarly, networks of public agencies, such as the Innovative Finance Initiative at FHWA, AASHTO's Center of Excellence in Project Finance, and states DOTs, have emerged to communicate and share knowledge with one other regarding the best practices and solutions for problems. The existence of networks among the general public facilitates education of the public and, thus, enhances implementation of innovative financing by addressing public objections to adoption of innovative financing. Despite the existence of these three networks within the U.S. transportation infrastructure finance system of innovation, these networks are isolated from one another and do not interact. The lack of interaction between the networks was mentioned by the interviewees as one of the inhibiting factors in implementing innovative financing.

*Construct 6. Networks in the infrastructure finance system: the existing networks in the U.S. transportation infrastructure finance system are isolated from each other. The lack of interactions between the networks inhibits the implementation of innovative financing.*

### Resources

Capital is the only major resource in the infrastructure finance. Capital resources are exchanged among federal and state agencies, institutional investors (capital markets), and the general public and into infrastructure. Innovative financing is about facilitating this exchange of capital into infrastructure in an economically and socially sustainable way through communication and knowledge transfer among the players of the system.

## DRIVERS OF INNOVATION IN INFRASTRUCTURE PROJECT FINANCE

The drivers of innovation are different for different players. The main driver for innovative financing for public agencies is the need for capital. On the other hand, for private institutional investors, the opportunity for a stable investment is a main driver. As the need for capital investments increase, the willingness of public agencies to implement innovative financing increases.

Other drivers of innovative finance include political attitude and public perception towards innovative financing. Political attitude and public perception change with expansion of the need for capital. The greater the need, the more open the people and politicians are to innovation. Need has been cited by the interviewees as the major driver of innovative financing. For instance, the main reason why states like Texas, Florida, and Virginia stand at the forefront of implementing innovative financing among all the states is that these states were in a greater need for infrastructure financing sources. For private institutional investors, the driving factor of investment opportunity leads to innovations to reduce risks and obtain a favorable return on the investment.

Global and national economic conditions, such as an economic recession, are other drivers of innovative financing. Global and national economic conditions do not eliminate the need for innovative financing but change the objectives of the players to innovate. For instance, private institutional investors implement innovative finance during economic booms to make

themselves competitive. During a recession, on the other hand, innovative finance is implemented to enable private investors to close deals. An example of innovation during a recession is the case of the North Tarrant Express in Dallas, Texas as discussed earlier in the paper. The economic downturn started in 2008, which led to the collapse of the monoliners market. Therefore, in order to facilitate Private Activity Bond issuance, institutional investors implemented innovative financing using a direct TIFIA loan to enhance the credit worthiness of the project.

The constructs pertaining to players, activities, and institutions in infrastructure finance can be integrated to form a model for understanding the dynamics of the innovative financing process to be used for policymaking purposes. For instance, when one examines the innovative financing mechanisms implemented in U.S. transportation infrastructure, it can be observed that these mechanisms are mostly pay-as-you-go financing rather than investments by institutional investors (USDOT, 2002). The reason lies at the existing divergence between the institutions of public agencies and institutional investors. While the federal agencies have tried to send a signal to institutional investors by creation of the Innovative Finance Program, the inconsistency in the flow of infrastructure opportunities due to existing political processes and federal /state rejections has led to futile efforts by private investors. For instance, in the case of the Pennsylvania Turnpike, the legislative approval process of the lease concession took two years and ultimately was rejected by the Pennsylvania legislature. The signal sent to institutional investors as a result of this rejection can have an impact on their willingness to invest in the market. Thus, they may tend to seek other markets to invest since their objective is to see a consistent flow of infrastructure investment deals. This has been the case for many institutional investors, such as Macquarie, Cintra, and Brisa, who have shifted their investment towards the Canadian infrastructure market. The Canadian government is effectively communicating to private investors about what is going to happen in the upcoming years and uses a pre-specified approach (i.e., standardized procurement processes and contract provisions for legislative approval of public-private-partnership projects). Thus, when the request for proposals for a project is released, the investors know that its legislative approval has been completed. A solution for this problem in the U.S. is for public agencies to create pre-specified processes (e.g. standardized procurement processes and contract provisions) to effectively facilitate institutional investors' participation (Garvin, 2010).

## PRACTICAL IMPLICATIONS

A preliminary model is created to represent the dynamics of drivers and inhibitors of innovation using the initial observations and constructs. The model (Figure 2) is used for inferring implications for practice. The causal relations between the factors are shown using arrows and signs in the model. A positive sign indicates that an increase in the cause will result in an increase in the effect factor while a negative sign indicates that an increase in the cause will result in a decrease in the effect factor, vice versa.

The model is helpful in understanding the practical actions to enhance the potential for innovative financing. According to the model, the following actions will help facilitating financial innovation in infrastructure:

1. Facilitating effective participation of private investors to tap their innovation potential by understanding their investment objectives and needs;

2. Increasing the public awareness regarding the critical condition of infrastructure in the U.S.;
3. Enhancing the flexibility by authorizing project sponsors at local level so a project sponsor is able to adopt a financing system that is appropriate for the project without any constraints imposed by regulations;
4. Reducing the probability of unsuccessful investment through establishment of pre-specified processes (e.g. standardized procurement processes and contract provisions) and through precise estimate of project costs and demand forecasts.

Another issue to be considered in the assessment of innovative financing using the constructs identified in this paper is that the players are in the learning process. As players learn, the activities of players and institutions could evolve. It can be expected that as the players communicate and learn, the nature of interdependencies among the players and their activities will evolve over time.

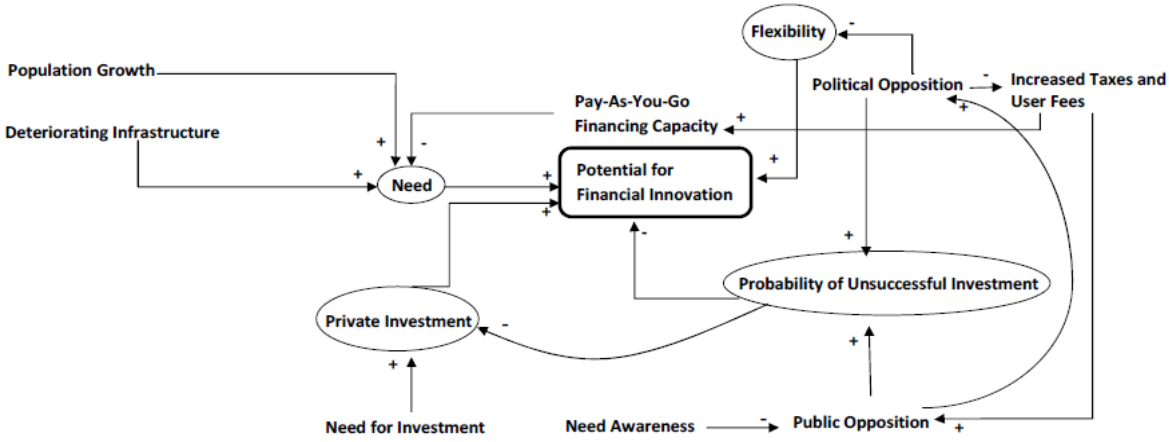


Figure 2- Preliminary model of drivers and inhibitors of financial innovation in infrastructure

## SUMMARY AND CONCLUSION

Innovative financing mechanisms have emerged to fill the existing gap between the demand for infrastructure and the availability of financing sources. This paper assessed innovative financing processes through a systemic approach to identify its constituents, which include the players, institutions, and activities. A case-based research approach was used, and 14 experts from organizations involved in innovative financing were interviewed to abstract the players, institutions, and activities. Based on the interviews, constructs pertaining to the each constituent are proposed. Based on the initial observations, the infrastructure finance System of Innovation in the U.S. transportation sector is in the learning process. Furthermore, education, flexibility, standardization of financing processes, private investors' participation and alignment of players' objectives were identified as important activities enhancing innovative financing. Further research is required to identify: 1) which activities from which organizations are important for the development and adaptation of innovative financing, 2) which institutional rules influence the players in implementing these activities, and 3) what activities and institutional rules are missing in the U.S. infrastructure finance network. Answering these questions can assist policymakers in making effective policies which

eventually can lead to enhancing the flow of capital to infrastructure using sustainable innovative financing approaches.

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**REFERENCES**

American Society of Civil Engineers (ASCE) (2009). *Report Card for America's Infrastructure*, Reston, VA, US.

Council of Development Finance Agencies (2010), Advancing Development Finance Knowledge, Networks, and Innovation, http://www.cdfa.net/cdfa/cdfaweb.nsf/pages/spfchome.html. Accessed in a period between June 2010 - July 2010.

Chang, Y.C., and Chen, M.H. (2004). "Comparing Approaches to Systems of Innovation: the Knowledge Perspective." *Technology in Society*, 26, pp. 17–37.

Edquist, C. (1997). Systems of innovation: technologies, institutions, and organizations, London, Pinter/Cassell.

Edquist, C. (2001). "The Systems of Innovation Approach and Innovation Policy: An account of the state of the art." *National Systems of Innovation, Institutions and Public Policies Conference*, Aalborg, Denmark.

Edquist, C. (2004). "Reflections on the System of Innovation Approach." *Science and Public Policy*, Vol. 31, 6, pp. 485-489.

Eisenhardt, K.M. (1989) "Building theories from case study research", *Academy of Management Review*, 14(4), pp. 532-550.

Federal Highway Administration (2010), Innovative Program Delivery Website, Project Finance Case Studies, http://www.fhwa.dot.gov/ipd/finance/index.htm. Accessed in a period between March 2010 - July 2010.

Freeman, C. (1987). *Technology policy and economic performance: lesson from Japan*. London: Frances Pinter.

Garvin, M. J. (2007). *America's infrastructure strategy: Drawing on history to guide the future*, KPMG LLP and Stanford University, Washington, D.C.

Garvin, M. J. (2010). "Enabling Development of the Transportation Public-Private Partnership Market in the United States", *J. Constr. Eng. and Mgmt.*, ASCE, 136, pp. 402 - 411.

Levy, S. M. (2008)."Public-Private Partnerships in Infrastructure." *Leadership. Manage. Eng.*, ASCE, Vol. 8, 4, pp. 217-230.

Lundvall, B. (1992). editor. *National systems of innovation: towards a theorem of innovation and interactive learning*. London: Pinter.

Miles, M. B., and Huberman, A. M. (1994). *Qualitative data analysis: an expanded sourcebook*. Thousand Oaks, CA: Sage.

Mostafavi, A., and Abraham, D. M. (2010). "Frameworks for Systemic and Structural Analysis of Financial Innovations in Infrastructure," working paper, Electronic Proceedings of 2010 Engineering Project Organization Conference (EPOC 2010), Engineering Project Organizations Society, November 4-6, 2010, South Lake Tahoe CA.

Mostafavi, A., Abraham, D. M., DeLaurentis, D., and Sinfield, J. (2011a). "Exploring the Dimensions of Systems of Innovation Analysis: A System of Systems Framework," *IEEE Systems Journal*, Volume 5, NO 2. pp. 256-265.

Mostafavi, A., Abraham, D. M., and DeLaurentis, D. A. (2011b). "Towards Sustainable Financial Innovation Policies in Infrastructure: A Framework for Ex-Ante Analysis," Proceedings of 2011

ASCE Workshop of Computing in Civil Engineering, Yimin Zhu and Raymond Issa, Eds., pp. 41-50, June 19-22, 2011, Miami FL.

Ploeg, C. V. (2006). *New Tools for New Times: A Sourcebook for the Financing, Funding and Delivery of Urban Infrastructure*, Canada West Foundation, Canada.

Reinhardt, W. (2009). *LaHood considers PPPs, more tolling*, Vol. 235, Public Works Financing, Westfield, N.J.

US Department of Transportation Federal Highway Administration (2002). Innovative Finance Initiative, Final Report , US.

Yin, R. (2003). *Case study research: Design and methods*. New York: Sage.