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# **Challenges and Barriers to Establishing Infrastructure Asset Management: A Comparative Study between Libya and the United States**

**Wesam Beitelmal, Keith R. Molenaar and Amy Javernick-Will**

Department of Civil, Environmental and Architectural Engineering,

University of Colorado Boulder, Boulder, Colorado, USA

**Eugenio Pellicer**

School of Civil Engineering, Universitat Politecnica de Valencia, Valencia, Spain

# Challenges and Barriers to Establishing Infrastructure Asset Management: A Comparative Study between Libya and the United States

## ABSTRACT

**Purpose** – The increased need for, and maintenance of, infrastructure creates challenges for all agencies that manage infrastructure assets. To assist with these challenges, agencies implement asset management systems. This exploratory research investigated and compared the importance of barriers faced by agencies establishing transportation asset management systems in the US and Libya to contrast a case of a developed and developing country.

**Design/ methodology/approach** – A literature review identified twenty-eight potential barriers for implementing an asset management system. Practitioners who participated in decision-making processes in each country were asked to rate the importance of each barrier in an online survey questionnaire. Descriptive statistics, Kendall Concordance W, and Mann-Whitney were used to analyze the collected data.

**Findings** – Through an analysis of 61 completed questionnaires, 14 barriers were identified as important by both the US and Libyan practitioners. Eleven additional barriers, primarily in the areas of political and regulatory barriers, were determined to be important only for Libya. These 11 barriers provide reasonable insights into asset management systems' barriers for developing countries.

**Practical implications** – The barriers identified from this research can assist decision makers to recognize and overcome these barriers when implementing asset management systems, while recognizing the importance of country conditions.

**Originality/ value** – The research identified standard barriers to implementing asset management systems. It also identified barriers that were specific to the country context, such as political and regulatory barriers in Libya. When viewed with the asset management literature, the results show broad applicability of some asset management barriers and the need to contextualize to country context (e.g., developing countries) for other barriers.

**Keywords** – Asset Management, Infrastructure, Barriers, Implementation, Developing and Developed Countries, Survey

**Paper type** – Research paper

## INTRODUCTION

It is important to manage infrastructure assets, especially those in transportation, systematically in both the construction and maintenance phases (FHWA 2007; Uddin et al. 2013). In particular, reliable and safe transportation can enhance a country's economy and the quality of life for their citizens (Cooksey et al. 2011; Osei – Kyei and Chan 2015). In many developed countries, asset managers are concerned with the future ability of their physical facilities to match increasing public demand for infrastructure by maintaining and replacing aging assets (Uddin et al. 2013; Grussing 2014). For instance, asset managers within the United States (US) need to invest approximately US \$3.6 trillion in all infrastructure sectors by 2020 (RepCard 2013). In developing countries, asset management is becoming increasingly essential, especially given the impending population growth and infrastructure needs within these countries (Elhakeem and Hegazy 2012). These needs will impact the infrastructure expenditures of developing countries (excluding operation and maintenance), which experts expect to rise from 0.9 to 2.3 trillion by 2020 (Bhattacharya et al. 2012). Unfortunately, while asset management is critical in both developed and developing country contexts, there is a dearth of literature that addresses the implementation of asset management systems in developing countries.

Formal asset management approaches offer a promising way to optimize infrastructure resources. While different asset management definitions exist (BSI 2008; FHWA 2007; IIMM 2011; Pocock et al. 2014); this paper defines asset management as a “decision-making framework guided by performance goals, cover[ing] an extended time horizon, draw[ing] from economics as well as engineering, and consider[ing] a broad range of assets” (FHWA 2007, p.3).

Despite the tremendous current and future growth of infrastructure assets in developing countries, many developing country agencies do not yet have a systematic process to manage their assets (Alkilani and Jupp 2012; Gwilliam 2003; Heravi and Hajihosseini 2011; Mushule and Kerali 2001; Pinard 1987; Sohail et al. 2002; Wijnia 2009). However, as these countries develop asset management systems, they need to understand the barriers they may face when implementing these systems. Therefore, this research explores the barriers in the establishment of an asset management system, focusing specifically on two contexts—the US and Libya—to compare and contrast barriers from a developed and developing country context.

## LITERATURE REVIEW ON POTENTIAL ASSET MANAGEMENT BARRIERS

Since the 1990s, agencies in developed countries have implemented asset management systems with a goal of improving efficiency and preserving asset value through timely and cost-effective decisions. To determine potential barriers, the research team first conducted a literature review, searching for articles related to asset management implementation barriers, challenges and/or difficulties that agencies/organizations faced during their effort to implement infrastructure management systems. In addition, the research team analyzed frameworks for asset

management systems within four main standards: FHWA (FHWA 2007), PAS 55 (BSI 2008), IIMM (2011), and AASHTO (2013). From this review, the authors identified the barriers that are explored in this study.

This in-depth literature review resulted in a comprehensive list of potential barriers for implementation of asset management systems. The research team combined similar barriers proposed by previous contributors in order to summarize and condense these barriers. For instance, three challenges —no long-term plans, no integration among departments, and no integration among systems' objectives such as pavement and bridge management systems— were grouped into a common barrier named 'lack of strategic plans for organizations'. Following this procedure, the authors identified 28 potential barriers for implementing asset management in an organization. The research team then grouped these barriers using the affinity diagram technique (Carnevali and Miguel 2008) into seven macro classification categories, including: planning/decision making; managerial / organizational; information resources; human resources; social; finance resources, and local knowledge. For instance, 'lack of recognizing budget constraints' and 'shortage of financial resources' were affinity grouped into the category 'Finance Resources'. Table 1 presents the 28 barriers, along with the primary references for each barrier, according to their grouped categories. These grouped categories are discussed briefly below.

Vanier (2001) emphasizes the importance of planning and decision making in asset management. The goals of asset management have to be consistent with the strategic goals of the agency (Schraven et al. 2011; Arif and Bayraktar 2012). If strategic plans, along with long-term measurable goals for these plans do not exist, then differences emerge and escalate between individuals, departments, and divisions (Amekudzi et al. 2002). In addition, processes need to be in place to manage and control the assets and resources efficiently (McNeil et al. 2000; Hassanain et al. 2003) and investigate and consider stakeholder's needs (Poister et al. 2013; FHWA 2007; Schraven et al. 2011, Shiferaw et al. 2002).

Past research has indicated the importance of strong leadership to support the implementation of the asset management system (Cooksey et al., 2011; Lizarralde et al. 2013; Brunetto et al. 2014). This implies that top management has to support the implementation, provide resources (Mizusawa and McNeil 2006), ensure clarity in expectations, scope and job descriptions (Arts and Van Lamoen 2005; Atkinson et al. 2006; PMI 2013; Ziara et al. 2002; Shiferaw et al. 2012), and ensure that communication channels exist between departments (Vanier 2001; FHWA 2007; Hawkins and Smadi 2013). Management also needs to establish and ensure that monitoring procedures, criteria, and standards are available and used (McNeil et al. 2000; Moon et al. 2009; Arif and Bayraktar 2012; Mizusawa and McNeil 2006).

Standards for obtaining, documenting, sharing and tracking data are also needed, with authors pointing to the lack of these standards as the root cause of many asset management issues (FHWA 2007; Cooksey et al. 2011; Hawkins and Smadi 2013). Without data there is no information, and without information, the decision making process fails (FHWA 2007; PMI

2013). Furthermore, data cannot be integrated or shared, making knowledge sharing difficult across departments within an organization (Halfaw, 2008; Ugarelli et al. 2010) or across agencies (FHWA 2007).

The skills shortage within the construction sector is noted by many researchers (e.g., Yankov and Kleiner 2001; Dainty et al. 2004; Lobo and Wilkinson 2008), and asset management programs require that these individuals also have adequate knowledge of asset management systems or receive training (Smadi and Akili 2006; FHWA 2007). This need for specific knowledge causes additional challenges for human resources when hiring and requires additional training.

Reluctance or resistance to change has been thoroughly analyzed (Oreg et al. 2013) and can occur (1) whenever an infrastructure asset is deployed (Garande and Dagg 2005) and (2) when an asset management system is implemented (Hawkins and Smadi 2013). Resistance to change needs to be anticipated by recognizing stereotypes likely to resist change (Davis and Songer 2009) and having leadership create well-designed strategies in advance of deployment (Trader-Leigh 2002).

Funding is required in order to operate, maintain, and renovate current infrastructure assets. Over the last decade, several authors have highlighted the increasing shortfall in public funding in different sectors and countries (FHWA 2007; Uddin et al. 2013; Grussing 2014).

Several barriers were noted regarding local knowledge. A lack of local knowledge may increase the risk of using technical or organizational processes or models that are not compatible with local conditions (Wall 1993; Ofori 1994; Bakuli 1994; Sohail et al. 2004; Shiferaw et al. 2012). Furthermore, studies have highlighted challenges from the lack of common objectives amongst different stakeholders that have different missions and agendas (FHWA 2007; Lizarralde et al. 2013) or from a lack of trust between the different stakeholders, which hampers the implementation of the asset management system (Ika et al. 2012). Regulations that enhance accountability help to promote transparency and hamper corruption, which are particularly important for public projects.

Table 1 summarizes the barriers considered in this study that formed the basis for the development of the survey questionnaire. We recognized that asset management systems are expected to play an increasingly essential role in developing countries given the estimated population growth and infrastructure needs within these countries (Ofori 1994; Gwilliam 2003; Lizarralde et al. 2013). However, we also found that they have rarely been considered in the academic literature (Rasolonjatovo et al. 2015), with the notable exception of Pinard (1987) who identified barriers to implementing pavement management systems in developing countries. As a result, this research focused on the following research question: what are the barriers that infrastructure organizations face when establishing and implementing an asset management system and how do they vary between developing and developed economies?

**TABLE 1 POTENTIAL BARRIERS GROUPS BY CATEGORIES**

Barriers to establish asset management systems	References
<b>Planning/ Decision making:</b>	
<b>Lack of strategic plans for organizations</b> (e.g., no long-term plans, no integration among departments or units, no integration among systems' objectives such as pavement and bridge management systems)	Cooksey et al. 2011; Vanier 2001; Schraven et al. 2011; FHWA 2007; Arif and Bayraktar 2012; Short and Kopp 2005
<b>Lack of knowledge about stakeholders' needs</b> (e.g., unidentified, no communication channels with the stakeholders)	Poister et al. 2013; Shiferaw et al. 2002; FHWA 2007; Schraven et al. 2011
<b>Lack of identified processes and control procedures</b> (e.g., no consideration for budgets scenarios; no criteria to optimize use of funds; undefined repairs' strategies)	Mizusawa and McNeil 2006; McNeil et al. 2000; Hassanain et al. 2003; Halfawy, 2008; Arif and Bayraktar 2012
<b>Inconsistent decisions by the decision makers</b> (e.g., the organization decides to build a wastewater treatment plant without taking into account a project to connect the network's pipes)	Grussing 2014; Shiferaw et al. 2002; FHWA, 2007; Schraven et al. 2011; Arif and Bayraktar 2012; Vanier 2001; Flyvbjerg 2007
<b>Managerial/ Organizational:</b>	
<b>Poor management of existing infrastructure</b> (e.g., unidentified; no communication channels with the stakeholders no consideration for budgets scenarios; no criteria to optimize use of funds; undefined repairs' strategies, no data about the deterioration rates for roads, bridges; use a non-updatable management system)	Vanier 2001; Short and Kopp 2005; RepCard 2013; Uddin et al. 2013
<b>Lack of top management support</b> (e.g., no action decisions are taken about any management system development; no long term support of management plans; no implementation of planned criteria)	Brunetto et al. 2014; Lizarralde et al. 2013; Mizusawa and McNeil 2006; Cooksey et al. 2011
<b>Lack of communication channels within organizations and departments</b> (e.g., different departments do not share their plans to create a general plan for the organization)	FHWA 2007; Brunetto et al. 2014; Cooksey et al. 2011; Lizarralde et al. 2013; Vanier 2001; Yankov and Kleiner 2001
<b>Lack of scope and job description within the organization/ agency</b> (e.g., there is no clear identification of the responsibilities and authorities for managers in different levels in the organization)	Atkinson et al. 2006; Arts and Van Lamoen 2005; Ziara et al. 2002; PMI 2013
<b>Lack of performance monitoring</b> (e.g., no clear criteria; no announced indicators; unclear procedures)	Cooksey et al. 2011; McNeil et al. 2000; FHWA 2007; Mizusawa and McNeil 2006; Arif and Bayraktar 2012; Vanier 2001

(Continued)

<b>Barriers to establish asset management systems</b>	<b>References</b>
<b>Information resources:</b>	
<b>Lack of data standard</b> ( e.g., no processes for documentation; unidentified required data; unreliability and inadequacy of data; no use for the available data)	Cooksey et al. 2011; Halfawy 2008; Ugarelli et al. 2010; Hassanain et al. 2003; Vanier 2001; FHWA 2007; Burns et al. 1999
<b>Lack of data about the implemented phases of the plans</b> (e.g., the organization does not know the actual and current projects stages)	FHWA 2007
<b>Lack of shared knowledge of asset management principles and systems across similar governmental units</b> (e.g., These units should share the data and procedures that have enhanced their performance)	FHWA 2007; Halfawy 2008; Hawkins and Smadi 2013
<b>Human resources:</b>	
<b>Lack of knowledge transfer between consulting (outsources) and local owners</b> (e.g., required consist outsourcing for the same scope of work in the future)	Schraven et al. 2011; Ashraf and Uddin 2013
<b>Shortage of human resources</b> (e.g., number of suitable people is not available)	Yankov and Kleiner 2001; Dainty et al. 2004; Lobo and Wilkinson 2008
<b>No trained staff</b> (e.g., management staff is not qualified)	Yankov and Kleiner 2001; Dainty et al. 2004; Lobo and Wilkinson 2008; Mackenzie et al. 2000; Hawkins and Smadi 2013
<b>Social:</b>	
<b>Departments unwilling to submit to overall framework</b> ( e.g., individuals and departments do not want to change their traditional daily work, each department has its own plans and objectives)	FHWA 2007; Cooksey et al. 2011
<b>Resistance to change from local culture</b> (e.g., people could refuse to delay their needs according to the organization's comprehensive plans, which were established based on the budget constraints and its availability)	Davis and Songer 2009; Hawkins and Smadi 2013; Trader-Leigh 2002; Schuitema et al. 2010
<b>Finance Resources:</b>	
<b>Lack of recognizing budget constraints</b> (e.g., organizations contract for more than they can afford)	Burns et al. 1999; Wooldridge et al. 2001; Vanier 2001; Sohail et al. 2002; FHWA 2007; Benito et al. 2008; Acerete et al. 2009; Uddin et al. 2013
<b>Shortage of financial resources</b> (e.g., the organization could not cover the needed budget to run and update the system)	Burns et al. 1999; Vanier 2001; Schraven et al. 2011

(Continued)



Barriers to establish asset management systems	References
<b>Local knowledge</b>	
<b>Infrastructure performance models are not specific to local conditions</b> (e.g., organization uses performance prediction models with no consideration to the local conditions such as number of users and local environment; these conditions could be different from the original assumptions of the model)	Cooksey et al. 2011; Vanier 2001; Halfawy 2008; RepCard 2013; Uddin et al. 2013; Grussing 2014
<b>Using an incompatible technology with local conditions</b> (e.g., very sophisticated systems, which are not compatible with other procedures)	Ofori 1994; Wall 1993; Bakuli 1994; Javernick-Will 2009; Javernick-Will & Scott 2010; Javernick-Will and Levitt 2009
<b>Using an incompatible operational process with local conditions</b> (e.g., asking for specific data, which the operators do not have the tools to determine)	Shiferaw, 2002; Bakuli, 1994; Wall 1993; Sohail et al. 2002; Javernick-Will & Scott 2010
<b>Lack of regulations to enhance accountability</b> (e.g., there are no regulations that force organizations to use a clear criteria in making their decisions, such as cost- effectiveness, to select among candidate projects)	Sohail and Cavill 2008; Wooldridge et al. 2001; Burns et al. 1999; Benito et al. 2008; Acerete et al. 2009
<b>Lack of trust between different organizations and departments</b> (e.g., departments do not provide reliable information about their performance between each other, departments change data in the regular reports and meetings to be in good shape)	Ika et al. 2012; Burns et al. 1999
<b>Prevalence of corruption</b> (e.g., at the government level, consulting level)	Sohail and Cavill 2008; Kenny 2009; Nordin et al. 2011; Golden and Picci 2006; Bowen et al. 2012
<b>Undefined contracting criteria</b> (e.g., undefined processes for contracting type (delivery method) selection; undefined contract documents for different type of contracts; undefined procedures for contractors' selection)	Mollaoglu-Korkmaz et al. 2013, Kumarasawy et al. 2005, Garvin 2010
<b>Centralized decision-making</b> (e.g., no permission for the branches to make any decisions; everything is done in the main office)	Lizarralde et al. 2013, FHWA 2007
<b>Political participation interfering with projects' decisions</b> (e.g., city's representative influences the decision makers in their selection of programs and projects to support his/her reelection)	Flyvbjerg, 2007; Short and Kopp 2005; Lewis 2007; Acerete et al. 2009; Desbordes and Vauday 2007

## RESEARCH METHOD

The goal of this research was to identify and assess the effect of barriers on the implementation of asset management systems. Moreover, this research aimed to explore whether the barriers to implementing asset management systems differed between the US and Libya as example cases of developed and developing economies. To solicit responses, authors targeted practitioners in the US and Libya who were involved in infrastructure management decision-making processes. Within this section, authors first describe the contextual setting of Libya and the US, followed by a description of the questionnaire and the data collection process. Finally, they explain the data analysis.

## RESEARCH SETTING

For this study, the researchers selected two countries—Libya and the US—as representative examples of a developed and developing country context to identify and contrast barriers to implementing asset management systems. The World Bank (WB) classified Libya as a developing country (WB 2015). Libya has a substantial roadways network —ranked 45/223 (CIA 2015)—as personal cars and road networks are the primary transportation modes within Libya. There is no public transportation within the cities and, other than airplanes, there is often no public transportation between cities. Geographically, Libya’s greatest population growth during the last decade has been in its major cities. To represent the Libyan perspective, the research team solicited participation from practitioners within Tripoli and Benghazi, the largest cities in terms of population in the country. Libya was also selected for convenience due to the first author’s knowledge of the languages, culture, and practice in transportation engineering.

The selection of the US as a representative example of a developed country’s perspective was based upon the country’s extensive experience with different infrastructure management systems. Moreover, it has the largest roadways network in the world —ranked 1/223 (CIA 2015). Because US standards and specifications are the main references in Libya’s engineering and managerial fields, comparing and contrasting these countries during the analysis is especially relevant.

To generalize the findings from this research, the authors provide general characteristics for both countries in Table 2 based on both the World Bank and the World Factbook (CIA 2015):

**TABLE 2 COUNTRY CRITERIA**

Country	World Bank designation	Length of roadway network (KM)	Ranking (Out of 223)	Primary transportation mode	Years of experience with asset management systems (Years)
Libya	Developing	100,024	45	Roads and highways	0
The US	Developed	6,585,610	1	Roads and highways	25

## QUESTIONNAIRE DESCRIPTION

To investigate potential barriers in implementing asset management systems, this research team administered questionnaires to practitioners. The practitioners were selected from public agencies (in both countries) and professional associations (in Libya). They needed to meet two conditions. The practitioners needed to be actively involved in infrastructure decision-making processes; and they had at least five years of experience in asset management, being selected from public agencies (in both countries) and professional associations (in Libya). The questionnaire contained three sections: the respondent's management experience, the barriers that affect the infrastructure asset management systems, and the respondent's contact information. Because one of the research goals was to compare the experience of implementing asset management systems in a developing country and developed country context, the authors first asked the respondent's the source of their experience —whether this was from developing countries, developed countries, or whether they had experience in both contexts. They were also asked about their current position and organization. This information was used to descriptively compare the two groups.

In the second section, some previous explanation was included about the Federal Highway Administration's asset management system framework (FHWA 2007). This framework has three main phases (see Figure 1):

- (1) Generating a framework, including establishing goals, policies, and strategic plan, determining tools and indicators, and enhancing communication about generating strategic plans within different stakeholders, resulting in an asset inventory list that rates infrastructure conditions.
- (2) Evaluation, optimization, and budget allocation, including establishing programs and selection criteria with consideration to the networks' performance, resulting in a reliable implementation plans in both long and short terms.
- (3) Implementing and monitoring, including collection of data on performance, satisfaction of infrastructure, updating infrastructure performance conditions, and implementation progress for the plans.

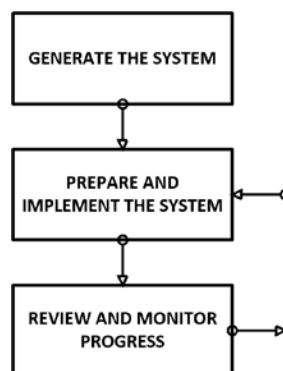


Figure 1. Framework for Asset Management Implementation (developed from FHWA 2007)

This framework was provided to the respondents in order to provide a context for the whole process and unify the terminology for the participants allowing comparative assessments. Using this framework as a conceptual reference, the authors presented the 28 previously identified barriers (Table 1) under their affinity-grouped categorizations. Participants were asked to rate the effect of each obstacle on the establishing processes of the system, in the following way: How much of an effect do the following barriers have on implementation of asset management systems?

Using this framework as a conceptual reference, the authors presented the 28 previously identified barriers (Table 1) under their affinity-grouped categorizations. Participants were asked to rate the effect of each obstacle on the establishing processes of the system, in the following way: *How much of an effect do the following barriers have on implementation of asset management systems?*

To rate the effect of each barrier, the research team developed a 0-5 scale. The authors implemented (Saaty and Vargas 1991) a procedure for designing and defining the scale. Qualitative descriptions were provided for: 0, do not know: no idea about its effect on this stage; 1, very low effect: no extra time, no extra effort to overcome this obstacle; 3, moderate effect: extra time, extra effort to overcome this obstacle; and 5, very high effect: significant extra time, significant extra effort to overcome this obstacle. In addition, if a participant thought that there were additional barriers, s/he had the opportunity to suggest up to three additional barriers and rate their affect using the same scale.

The final section asked the participants about contact information, just in case the research team needed further clarifications on the answers or the respondents were interested in receiving a copy of the final research report.

## DATA COLLECTION

The researchers piloted the questionnaire with three practitioners from Libya and two from the US to investigate the clarity and comprehensiveness of the questionnaire's design and content. Pilot participants were asked to comment on where the designed scale was appropriate and whether the questions were comprehensive. Participants did not identify new potential barriers, and all felt that the scale was appropriate; however, some assessment statements were re-written based upon practitioners' advice. For example, we changed "Lack of consistent decisions based on clear criteria" to "inconsistent decisions by the decision makers" based on the feedback from the practitioners.

This research was exploratory; therefore, purposive sampling was conducted. In cases where the goal of the research is to approach a phenomenon, individuals can be purposefully chosen from the population to best analyze the primary phenomenon (Onwuegbuzie and Collins 2007). To be included in the survey, participants had to have a minimum of five years' experience managing infrastructure systems. They also had to be responsible for, or involved in, the implementation

process of asset management systems at either a state Department of Transportation (DOT) or the Federal Highway Administration (FHWA) in the United States; the Ministry of Infrastructure and Housing or the Ministry of Transportation in Libya; or at public and private consulting companies that worked in the US or Libya. We initially began administering the survey to people who fulfilled our research design criteria that we knew from our past work and research. We then asked them to identify additional colleagues who satisfied our criteria for inclusion with whom we could share the questionnaire.

Ultimately, through this process of working with federal and state agencies, we identified 160 potential survey respondents that fulfilled the criteria. These questionnaires were administered to agency members (94 from the US and 66 from Libya) using an online survey questionnaire (Qualtrics) from March to June 2013. Out of the 160 questionnaires we administered, 87 were returned, representing a 54% response rate. Of the 87 that were returned, 28 were excluded due to missing at least one of the following: the context of experience, cumulative experience, or current position and organization. The research team removed these responses from further analysis because of a lack of reliability in the information. Thus, the researchers ultimately analyzed 61 responses, which included 29 Libyan practitioners (44% of responses) and 32 American practitioners (34% of responses). Table 3 shows the respondents' descriptive statistics.

**TABLE 3 THE DESCRIPTIVE STATISTICS FOR THE RESPONDENTS**

Current organization		Cumulative experience (in years) in infrastructure management systems				TOTAL
		1-5	6-10	11-15	Over 15	
USA	State DOT	5	8	3	14	30
	Other: e.g., FHWA	0	0	1	1	2
	<i>Total Years</i>	5	8	4	15	<b>32</b>
Libya	Ministries	1	3	4	5	13
	Other: e.g., Consulting	4	1	2	9	16
	<i>Total Years</i>	5	4	6	14	<b>29</b>

### ANALYSIS TECHNIQUES

The researchers used a two-step analysis for accuracy and completeness. First, the internal agreement among the respondents within each group was assessed separately. The authors used Kendall Concordance W test and investigated the mode's distribution. The Kendall test confirms the validity of the data for future analysis (Chan et al. 2009, 2010). Based on the calculated p-value, the authors accepted the validity of the questionnaires' results for further analysis. After confirming the agreement in judging the responses for each group, an additional analysis was carried out to investigate the modes of the assessments for each barrier. Because it reflected a conflict among the respondents' opinions, any barrier with two modes distributed in

two sides of the moderate-effect category was ignored in further steps of the analysis, because it meant that practitioners held conflicting opinions.

In the second analysis (country comparison), the barriers that showed agreement between the two groups were explored through the Mann-Whitney test. We used the Mann-Whitney test due to the ordinal nature of the data. This test is used to investigate if the two groups of practitioners have the same opinion (come from the same population) about the effect of these barriers (Siegel and Castellan 1988). In accordance with similar research studies, any obstacle with a significance value less than 0.05 indicated that a large variation existed between the perspectives of the practitioners from Libya and the US. These results are presented in the following subsections.

## RESULTS AND DISCUSSION

### *INTERNAL AGREEMENT*

Table 4 presents the Kendall coefficients of concordance (W) for the ranking of barriers. All show a statistical significance with  $p = 0.000$  for all computed W. Therefore, the authors found the assessment within each group consistent. The tests demonstrated the validity of the questionnaires' data for further analysis.

**TABLE 4 RESULTS OF KENDALL'S CONCORDANCE ANALYSIS FOR AM BARRIERS**

Test Statistics	Libya	USA
N	29	32
Kendall's W <sup>a</sup>	0.144	0.212
Chi-Square	112.521	183.297
Df	27	27
Asymp. Sig.	0.000	0.000

a. Kendall's Coefficient of Concordance

Examining modes gave an indication about the clarity of the barriers to the practitioners, as well as their patterns of understanding. Therefore, those barriers needed additional explanation and/or one-to-one discussion about their meaning. According to the data type, which is ordinal, the researchers calculated the median values for the rates of the barriers. These values were used to rate the barriers in each group of the responses, rating from 0 (do not know) to 5 (very high effect). Libyan responses presented one mode in all the rating results, showing consistency in the respondents' opinions. Within the US group, one obstacle, *prevalence of corruption* was in two modes. Eight responders rated the obstacle in two different categories (very low and high). Therefore, *prevalence of corruption* was not analyzed in the US group's obstacle list because it needs more explanation and/or discussion.

Table 5 shows the median value for each of the barriers to implement asset management systems for Libya and the US. Median values for the barriers' effect ratings fell between 3 and 5 (moderate and very high effect, respectively); this observation reflected a small range of variation among the respondents of the same country. The Libyan respondents identified 25 out

of 28 barriers as having a high or very high effect on the implementation processes of the system. Only three barriers were identified that had a moderate effect: *resistance to change from local culture in the community; infrastructure performance models are not specific to local conditions; and using an incompatible technology with local conditions*. In comparison, US respondents rated 14 of the 28 barriers as having high or very high effects of the system and rated 14 of the 28 barriers as only having moderate effects. Because three of the barriers — *resistance to change from local culture in the community; infrastructure performance models are not specific to local conditions; and using an incompatible technology with local conditions* — were rated as having only moderate effects—rated 3 based on the assessment scale—by both countries, they were removed from further comparative analysis.

**TABLE 5 MEDIAN VALUES FOR BARRIERS’ ASSESSMENTS TO IMPLEMENTING ASSET MANAGEMENT**

Barriers under their groups		Median values	
		Libya	The US
<b>Category 1: Planning/ Decision making</b>			
1	Lack of strategic plans for organization	5	4
2	Lack of knowledge about stakeholders’ needs	4	3
3	Lack of identified processes and control procedures	4	4
4	Inconsistent decisions by the decision makers	5	4
<b>Category 2: Managerial/ Organizational:</b>			
1	Poor management of the existing infrastructure	4	4
2	Lack of top management support	4	5
3	Lack of communication channels within organizations and departments	4	4
4	Lack of scope and job description within the organization/ agency	4	3
5	Lack of performance monitoring	4	4
<b>Category 3: Information resources:</b>			
1	Lack of data standard	4	4
2	Lack of data about the implemented phases of the plans	4	3
3	Lack of shared knowledge of asset management principles of systems across similar governmental units	4	3
<b>Category 4: Human resources:</b>			
1	Lack of knowledge transfer between consults (outsources) and local owners	4	3
2	Shortage of human resources	4	3
3	No trained staff	4	4
<b>Category 5: Social:</b>			
1	Departments unwilling to submit to overall framework	4	4
2	Resistance to change from local culture in the community*	3	3
<b>Category 6: Finance resources:</b>			
1	Lack of recognizing budget constraints	4	4
2	Shortage of financial resources	4	4
<b>Category 7:Local knowledge:</b>			
1	Infrastructure performance models are not specific to local conditions*	3	3
2	Using an incompatible technology with local conditions*	3	3
3	Using an incompatible operational process with local conditions	4	3
4	Lack of regulations to enhance the accountability	4	3
5	Lack of trust between different organizations and departments	4	4
6	Prevalence of corruption	4	3
7	Undefined contracting criteria	4	3
8	Centralized decision making	4	3
9	Political participation interfering with projects’ decisions	4	4

\*Three barriers are removed from further analysis

## COUNTRY COMPARISON

To compare the two groups' responses, the authors isolated barriers that had a "high" or "very high" effect on the implementation of asset management systems. The findings showed 14 barriers that both groups identified as important. Eleven additional barriers are identified with "high" or "very high" effect according to the Libyan practitioners only. The researchers conducted the Mann-Whitney test for comparing independent samples to test the statistically significant differences for these agreements about the 14 barriers—agreement cluster. Only one obstacle — *lack of trust between different organizations and departments* — had statistically significant differences between the groups. This obstacle did, however, rate high in its effect in both groups' responses; thus, the researchers argue that it should be an important variable for discussion.

**TABLE 6 RESULTS OF MANN-WHITNEY ANALYSIS FOR AM IMPORTANT BARRIERS**

No.	Test Statistics <sup>a</sup>	Mann-Whitney U	Exact Sig. (2-tailed)
1	Lack of strategic plans for organization	412	0.428
2	Lack of identified processes and control procedures	390	0.263
3	Inconsistent decisions by the decision makers	353	0.087
4	Poor management of the existing infrastructure	407	0.395
5	Lack of top management support	423	0.522
6	Lack of communication channels within organizations and departments	420	0.503
7	Lack of performance monitoring	415	0.466
8	Lack of data standard	462	0.984
9	No trained staff	358	0.111
10	Lack of recognizing budget constraints	434	0.654
11	Shortage of financial resources	368	0.134
12	Lack of trust between different organizations and departments	330	0.035*
13	Political participation interfering with projects' decisions	369	0.157
14	Departments unwilling to submit to overall framework	407	0.382

a. Grouping Variable: Two Categories

\*Statistically significant different between the groups' opinions

## INTERPRETATION OF THE RESULTS

This exploratory research provides insights into the similarities and differences in the barriers that developing and developed countries face. The statistical differences, although weak in some comparisons, provide a starting point for further explanation into the causes of these differences. Ultimately, a better understanding of these challenges will help infrastructure organizations enhance their organizational performance.

For more understanding of the ratings and the differences between the two groups, the researchers discuss the barriers by category and explore possible reasons behind these



differences based on the literature and comments from the participants. The discussion will start with the 14 important barriers for both countries and then will discuss the 11 barriers that were only important for Libya. The discussion will be presented through the seven categories for convenience.

#### *IMPORTANT BARRIERS FOR BOTH LIBYA AND THE US*

**Planning / Decision Making:** The three identified barriers in this category were: *lack of strategic plans for organization; inconsistent decisions by the decision makers; and lack of identified processes and control procedures*. Those barriers reflect the importance of organizational planning for implementing asset management systems. Decisions must be consistent, and in line with long-term strategic plans for the organization (Smith 1992). In addition, agencies must have clear processes and procedures for employees to follow during implementation.

**Managerial / Organizational:** Four barriers were identified in this category: *poor management of the existing infrastructure; lack of top management support; lack of communication channels within organizations and departments; and lack of performance monitoring*. To establish an asset management system, practitioners in both groups emphasized that organizations should determine and evaluate the conditions of their current management systems. Identifying the strengths and weaknesses of the current management system is a critical step to build upon current systems (Dewan 2004; Gwilliam 2003; Lord-Attivor and Jha 2009; Razak 2009). In addition, top management support has an essential role in enhancing the success of the asset management systems' establishment (FHWA 2007; Hawkins and Smadi 2013; Smith 1992). Another aspect, related to work performance, is the sensitivity and importance of developing communication channels between different departments and determining how those departments monitor, evaluate and control the quality of their work (Kulkarni and Miller 2003; Smith 1992).

**Information Resources:** Only *lack of a data standard* was considered as an important obstacle, based on both groups' ratings of potential barriers in this category. This obstacle relates to the difficulties of creating and finding forms for the data to be transferred and used between participants across different phases of the asset management system (Amekudzi et al. 2002; Cooksey et al. 2011). These standards should be clear, understandable, and meaningful for all who will be involved across the establishment's phases (Kulkarni and Miller 2003).

**Human Resources:** *no trained staff* is the only obstacle in this category that rated as an important obstacle. Organizations should focus on to enhance the probability of successful asset management implementation. The staff is responsible for implementing the plans. Without knowledgeable staff, the plans will not be translated into actions (FHWA 2007). Moreover, any trials to establish an asset management system without trained people will decrease the probability of success. As one of the Libyan practitioners noted in the questionnaire comments, "training, quality control of the performance, and motivation of the staff are the most essential factors in the success of infrastructure management systems."

Finance Resources: Practitioners from Libya and the US agreed that two barriers were rated important in this category: *lack of recognizing budget constraints*; and *shortage of financial resources*. In general, finance is a primary component to success in the establishment and implementation of any infrastructure management system. Organizations should understand their budget limitations and design and plan their programs and projects according to those limitations (Alkilani and Jupp 2012; Sharaf et al. 2008; Vanier 2001; Walker and Jones 2012).

Social: The only barrier judged as important by both groups was *departments unwilling to submit to overall framework*. A department's refusal to cooperate or change its traditional work style can lead to failure of infrastructure management systems (FHWA 2007). Knowing the whole picture of strategic plans for the organization may help to enhance departments' willingness to comply with asset management plans and increase the probability of success (FHWA 2007).

Local Knowledge: The practitioners agreed that two barriers were important in this category: *lack of trust between different organizations*; and *departments and political participation interfering with projects' decisions*. Trustful communication channels can save time and money by reducing rework and encouraging cooperative learning. Reliability of data and information has been found to increase the trust amongst the parties who will be involved across the life cycle of the assets (Mizusawa and McNeil 2006). Politicians can also be barriers. One of the US respondents stated that "upper management's biggest fear [from implementing the asset management system] seemed to be the loss of power in decision-making." Meanwhile, one of the Libyan respondents said, "the political aspect dominates all decisions. This results in unplanned projects. Stakeholders are never taken into consideration."

#### *IMPORTANT BARRIERS FOR LIBYA*

The barriers that only apply to Libya represent the greatest contribution of this research, as they may be more broadly representative of developing countries that have similar characteristics. The Libyan respondents rated some barriers with a severe effect on the system where the US practitioners rated them with moderate effect. A discussion of the potential reasons for these differences, based upon the literature and questionnaire responses, is provided by category in the paragraphs that follow.

Planning / Decision Making: Libya's practitioners emphasized the importance of *lack of knowledge about stakeholders' needs on system establishment*. They realized that their decisions were based on the physical condition of the assets only, without considering the real needs of communities or developing any communication strategies (Kulkarni and Miller 2003). The US respondents did not rate this obstacle in the "important" range.

Managing / Organizational: The obstacle Libyan practitioners rated important here was *lack of scope and job description within the organization/agency*. Inconsistent decisions and random work orders in organizations drive practitioners in Libya to emphasize the need for clear job

descriptions at all organizational levels. Better scope and job descriptions would lead to stability in the organization's productivity even if there were replacements in the staff and/or managers.

**Information Resources:** Two barriers in this category were rated in the "important" range in Libyan responses, including: *lack of data about the implemented phases of the plans*; and *lack of shared knowledge of asset management principles of systems across similar governmental units*. Traditional management procedures, in Libya as in other countries, do not encourage sharing successful experiences and knowledge among departments and organizations (Dewan 2004; Gwilliam 2003). Changing this principle will enhance the performance, productivity, and quality of departments' and agencies' outputs (FHWA 2007). The information exchange will hopefully, in turn, reduce the required learning time across similar governmental units.

**Human Resources:** *lack of knowledge transfer between consultants (outsources) and local owners*; and *shortage of human resources* are the barriers rated "high" in this category. As mentioned in the common barriers discussion, staff personnel are responsible for implementing plans. Organizations may need to focus on improving the quality of their staff by transferring the knowledge to their employees, who will then be able to perform similar work in the future. In addition, organizations require an appropriate number of knowledgeable staff members to run the system efficiently and effectively.

**Local Knowledge:** Five barriers in this category were rated with a high effect (important) in Libyan responses: *using an incompatible operational process with local conditions*; *lack of regulations to enhance accountability*; *prevalence of corruption*; *undefined contracting criteria*; and *centralized decision-making*. Respondents encouraged organizations to build an asset management system based on minimum available information and data (Mushule and Kerali 2001). Exporting a sophisticated system at the beginning will not support decision makers, but it can complicate processes and procedures and drive all parties to deny implementation. Practitioners also emphasized the role of accountability, which should be enforced through regulations (Lord-Attivor and Jha 2009). Agencies and organizations may need to work towards enhancing transparency at all levels of authority. Moreover, the involvement of a wide range of an organization's branches in decision-making processes increases employee dedication to, and responsibility for, system success. Employees begin caring about their organization's reputation and image as a whole (FHWA 2007). Furthermore, announcing an organization's contracting processes and criteria will reduce corruption within work processes and procedures.

## CONCLUSIONS, RECOMMENDATIONS AND FUTURE RESEARCH

This paper has presented the findings from a survey conducted with both Libya and the US as representative of developing and developed countries, respectively. The questionnaire examined the effect of 28 barriers, which were gathered through an intensive literature review. The assessment of the responses in each group led us to consider which responses were statistically consistent according to the Kendall Concordance test. The coefficients confirmed the agreement among the respondents' opinions in each group about the barriers' effect on asset

management systems. The Mann-Whitney test results indicated that the two groups are statistically different in the opinions about only one of the barriers from the agreement cluster (14 barriers), although it fell in the “important” range for both groups. On the other hand, 11 barriers were rated in the “important” range in Libyan responses but “moderate” in the US group.

As predicted, most of the barriers under the *lack of knowledge* category, which relate to the political and regulatory conditions of the countries, were statistically different between the two groups. Moreover, *lack of reliable information and data* in Libya’s organizations and agencies reflected in rating those barriers with “high” effect. Hesitance in establishing asset management systems in developing countries was reflected in Libyan practitioners’ rating the effect of *shortage of human resources* higher than their US counterparts. Furthermore, enhancing the communication between different stakeholders is essential for trust’s development among them. Finally, a decentralized decision-making structure is a critical perspective for more effect management to fitful the infrastructure’s diverse needs.

This research illuminates the perspectives of a developing country, Libya, concerning the barriers to the implementation of asset management systems. Our results show that there are more similarities in barriers than differences. Overcoming political and regulatory barriers is essential to the success of any implementation of asset management in infrastructure organizations. Within developing countries, where regulations may be less developed and formalized, additional work should be done to investigate how the country context affects organizational decisions to implement asset management systems.

Finally, to investigate the reasons behind the differences and similarities in the two groups’ assessments of the effect of the barriers in depth, the authors suggest conducting new research using the lens of diffusion of innovation theory. Such research will help to better understand the cycle of improvements in the implementation process of asset management in infrastructure organizations.

This study faced difficulties in obtaining a high number of responses from both the US and Libya. For the US practitioners, there was little direct benefit for their organizations because the findings were focusing on developing countries. Libyan practitioners showed more enthusiasm to participate; however, there was no clear and easy way to get their contact information on a large scale. Another limitation was having only two countries as representatives to both developed and developing countries. If we combine the above limitations, the authors recommend future research to include a larger sample size from different countries as representatives of both contexts. Increasing the size of the groups and incorporating different countries will increase the generalizability and the reliability of the findings.

For a more in-depth understanding of the results, the authors attempted to analyze the responses from federal/state employees in the US as one group and ministry/consulting in Libya as a second group. It would be interesting to explore the different perspectives, within each

county, between the assets' owners and policy makers (e.g., state DOT vs. FHWA). However, the data set was not large enough to conduct a statistical analysis. Therefore, the authors considered this to be a limitation and a suggestion for future research. The authors expect that there are differences in their evaluation.

## REFERENCES

- AASHTO (2013). AASHTO Transportation Asset Management Guide—A Focus on Implementation — Executive Summary. American Association of State Highways and Transportation Officials, Washington D.C.
- Acerete, B., Shaoul, J., Stafford, A. (2009) "Taking its toll: the private financing of roads in Spain". *Public Money & Management*, 29(1), 19-26.
- Alkilani, S., and Jupp, J. (2012). "Paving the Road for Sustainable Construction in Developing Countries: A Study of the Jordanian Construction Industry." *Australasian Journal of Construction Economics and Building*, 1(1).
- Amekudzi, A., Herabat, P., Wang, S., and Lancaster, C. (2002). "Multipurpose asset valuation for civil infrastructure: Aligning valuation approaches with asset management objectives and stakeholder interests." *Transportation Research Record: Journal of the Transportation Research Board*, 1812(-1), 211–218.
- Arif, F., and Bayraktar, M. E. (2012). "Theoretical Framework for Transportation Infrastructure Asset Management Based on Review of Best Practices." *Construction Research Congress, American Society of Civil Engineers, USA*, 2349–2358.
- Arts, J., and Van Lamoen, F. (2005). Before EIA: Defining the scope of infrastructure projects in the Netherlands. *Journal of Environmental Assessment Policy and Management*, 7(1), 51–80.
- Ashraf, M.J., and Uddin, S. (2013) "A consulting giant; a disgruntled client: a 'failed' attempt to change management controls in a public sector organization". *Financial Accountability & Management*, 29, 2, 186-205.
- Atkinson, R., Crawford, L., and Ward, S. (2006). Fundamental uncertainties in projects and the scope of project management. *International Journal of Project Management*, 24, 687–698.
- Bakuli, D.L. (1994) "Pitfalls in technology transfer: Kenya's construction industry". *World Development*, 22(10), 1609-1612.

- Benito, B., Montesinos, V., Bastida, F. (2008) "An example of creative accounting in public sector: the private financing of infrastructures in Spain". *Critical Perspectives in Accounting*, 19, 963-986.
- Bhattacharya, A., Romani, M., and Stern, N. (2012). "Infrastructure for development: meeting the challenge." Centre for Climate Change Economics and Policy, Londres. [www.cccep.ac.uk/Publications/Policy/docs/PP-infrastructure-for-development-meeting-the-challenge.pdf](http://www.cccep.ac.uk/Publications/Policy/docs/PP-infrastructure-for-development-meeting-the-challenge.pdf).
- Brunetto, Y., Xerri, M., Nelson, S. (2014) "Building a proactive, engagement culture in asset management organizations". *Journal of Management in Engineering*, 30, 0414014-1/9.
- BSI (2008). PAS 55:2008: Asset Management. British Standards Institution, London.
- Burns, P., Hope, D., Roorda, J. (1999) "Managing infrastructure for the next generation". *Automation in Construction*, 8, 689-703.
- Carnevalli, J. A., and Miguel, P. C. (2008). "Review, analysis and classification of the literature on QFD—Types of research, difficulties and benefits." *International Journal of Production Economics*, 114(2), 737-754.
- Chan, A. P. C., Lam, P. T. I., Chan, D. W. M., Cheung, E., and Ke, Y. (2010). "Potential Obstacles to Successful Implementation of Public-Private Partnerships in Beijing and the Hong Kong Special Administrative Region." *Journal of Management in Engineering*, 26(1), 30–40.
- Chan, A. P. C., Lam, P. T. I., Chan, D. W. M., Cheung, E., Ke, Y., (2009). "Drivers for adopting public private partnerships—Empirical comparison between China and Hong Kong Special Administrative Region." *Journal of Construction Engineering and Management*, 135, 1115-1124.
- CIA (2015). The World Factbook, <<https://www.cia.gov/library/publications/the-world-factbook/rankorder/2085rank.html#ly>> (Nov. 18, 2015).
- Cooksey, S. R., Jeong, D. S. K. and Chae, M. J. (2011). "Asset Management Assessment Model for State Departments of Transportation." *Journal of Management in Engineering*, 27(3), 159–169.
- Dainty, A.R.J., Ison, S.G., Root, D.S. (2004) "Bridging the skills gap: a regionally driven strategy for resolving the construction labour market crisis". *Engineering, Construction and Architectural Management*, 11(4), 275-283.
- Davis, K.A., Songer, A.D. (2009) "Resistance to IT change in the AEC industry: are the stereotypes true?" *Journal of Construction Engineering and Management*, 135(12), 1324-1333.
- Desbordes, R., Vauday, J. (2007) "The political influence of foreign firms in developing countries". *Economics & Politics*, 19(3), 421-451.
- Dewan, S. A. (2004). "Pavement Management and Asset Management Side-by-Side." 6th International Conference on Managing Pavements: The Lessons, The Challenges, The Way Ahead.
- Elhakeem, A., and Hegazy, T. (2012). "Building asset management with deficiency tracking and integrated life cycle optimisation." *Structure and Infrastructure Engineering*, 8(8), 729–738.
- FHWA (2007). Asset Management Overview. FHWA-IF-08-008. Federal Highway Administration (FHWA), Washington, D.C.
- Flyvbjerg, B. (2007) "Policy and planning for large-infrastructure projects: problems, causes and cures". *Environment and Planning B: Planning and Design*, 34, 578-597.
- Garande, T., and Dagg, S. (2005) "Public participation and effective water governance at the local level: a case study from small under-developed area in Chile". *Environment, Development and Sustainability*, 7, 417-431.

- Garvin, M.J. (2010) "Enabling development of the transportation public-private partnership market in the United States". *Journal of Construction Engineering and Management*, 136(4), 402-411.
- Golden, M., Picci, L. (2006) "Corruption and the management of public works in Italy". In: *International Handbook on the Economics of Corruption* (Ed. S. Rose-Ackerman), Edward Elgar Pub., Cheltenham, UK, 457-483.
- Grussing, M.N. (2014) "Life cycle assessment management methodologies for buildings". *Journal of Infrastructure Systems*, 20, 04013007-1/8.
- Gwilliam, K. (2003). "Urban transport in developing countries." *Transport Reviews*, 23(2), 197–216.
- Halfawy, M. (2008) "Integration of municipal infrastructure asset management processes: challenges and solutions". *Journal of Computing in Civil Engineering*, 22(3), 216-229.
- Hassanain, M. A., Froese, T. M., and Vanier, D. J. (2003). "Framework Model for Asset Maintenance Management." *Journal of Performance of Constructed Facilities*, 17(1), 51–64.
- Hawkins, N., and Smadi, O. (2013). "Use of Transportation Asset Management Principles in State Highway Agencies." *NCHRP Synthesis of Highway Practice*, (439).
- Heravi, G., and Hajihosseini, Z. (2011). "Risk Allocation in Public—Private Partnership Infrastructure Projects in Developing Countries: A Case Study of the Tehran—Chalus Toll Road." *Journal of Infrastructure Systems*, 55.
- IIMM (2011). *International Infrastructure Management Manual*. National Asset Management Support Group, New Zealand.
- Ika, L. A., Diallo, A., and Thuillier, D. (2012). "Critical success factors for World Bank projects: An empirical investigation." *International Journal of Project Management*, 30(1), 105–116.
- Javernick-Will, A. (2009). "Organizational learning during internationalization: acquiring local institutional knowledge." *Construction Management and Economics*, 27(8), 783–797.
- Javernick-Will, A., and Levitt, R.E. (2009) "Mobilizing institutional knowledge for international projects". *Journal of Construction Engineering and Management*, 136(4), 430-441.
- Javernick-Will, A., and Scott, W. (2010) "Who needs to know what? institutional knowledge and global projects". *Journal of Construction Engineering and Management*, 136(5), 546–557.
- Kenny, C. (2009) "Transport construction, corruption and developing countries". *Transport Reviews*, 29(1), 21-41.
- Kulkarni, R. B., and Miller, R. W. (2003). "Pavement management systems: Past, present, and future." *Transportation Research Record: Journal of the Transportation Research Board*, 1853(-1), 65–71.
- Kumaraswamy, M.M., Rahman, M.M., Ling, F.Y.Y., Phng, S.T. (2005) "Reconstructing cultures for relational contracting". *Journal of Construction Engineering and Management*, 131(10), 1065-1075.
- Lewis, T.M. (2007) "Impact of globalization on the construction sector in developing countries". *Construction Management and Economics*, 25(1), 7-23.
- Lizarralde, G., Tomiyoshi, S., Bourgault, M., Malo, J., Cardosi, G. (2013) "Understanding differences in construction project governance between developed and developing countries". *Construction Management and Economics*, 31(7), 711-730.
- Lobo, Y.B., Wilkinson, S. (2008) "New approaches to solving the skills shortage in the New Zealand construction industry". *Engineering, Construction and Architectural Management*, 15(1), 42-53.

- Lord-Attivor, R., and Jha, C. (2009). "The Application of a Transportation Asset Management Program (TAMP) in Ghana." *Environmental Sciences and Sustainability*, WSEAS Press, 142–150.
- McNeil, S., Tischer, M. L., and DeBlasio, A. J. (2000). "Asset Management: What Is the Fuss?" *Transportation Research Record: Journal of the Transportation Research Board*, 1729(-1), 21–25.
- Mizusawa, D., and McNeil, S. (2006). "Exploring Barriers to and Needs for AMS Implementation Using Soft Systems Methodology." 2nd Annual Inter-university Symposium on Infrastructure Management (AISIM).
- Mollaoglu-Korkmaz, S., Swarup, L., Riley, D. (2013) "Delivering Sustainable, High-Performance Buildings: Influence of Project Delivery Methods on Integration and Project Outcomes." *Journal of Management in Engineering*, 29, 71-78.
- Moon, F. L., Aktan, A. E., Furuta, H., and Dogaki, M. (2009). "Governing issues and alternate resolutions for a highway transportation agency's transition to asset management." *Structure and Infrastructure Engineering*, 5(1), 25–39.
- Mushule, N. K., and Kerali, H. R. (2001). "Implementing of New Highway Management Tools in Developing Countries: Case study if Tanzania." *Transportation Research Board*, 1769, 51–60.
- Nordin, R.M., Takim, R., Nawawi, A.H. (2011) "Critical factors contributing to corruption in construction industry". 2011 IEEE Symposium on Business, Engineering and Industrial Applications (ISBEIA), 330-333.
- Ofori, G. (1994) "Construction technology development: role of appropriate policies". *Engineering, Construction and Architectural Management*, 1(2), 147-168.
- Onwuegbuzie, A. J., and Collins, K. M. (2007). "A typology of mixed methods sampling designs in social science research." *The Qualitative Report*, 12(2), 281-316.
- Oreg, S., Michel, A., and Todnem, R. (2013). *The Psychology of Organizational Change: Viewing Change from the Employee's Perspective*. Cambridge University Press, New York.
- Osei – Kyei, R., and Chan, A. P. C. (2015). "Developing Transport Infrastructure in Sub-Saharan Africa through Public–Private Partnerships: Policy Practice and Implications." *Transport Reviews*, 1–17.
- Pinard, M. (1987). "Factors affecting the development and implementation of pavement management systems in developing countries." 2nd North American Pavement Management Conference, 1299-1310.
- PMI (2013). *Guide to the Project Management Body of Knowledge (PMBok)*. Project Management Institute, Upper Darby (PA).
- Pocock, D., Hayes, A., Shetty, N., and Watts, J. (2014). "Leveraging the relationship between BIM and asset management." *Infrastructure Asset Management*, 1(1), 5–7.
- Poister, T.H., Thomas, J.C., Berryman, A.F. (2013) "Reaching out to stakeholders: the Georgia DOT 360-degree assessment model". *Public Performance & Management Review*, 37(2), 302–328.
- Rasolonjatovo, H., Lande, E., and Harison, V. (2015). "Active asset management: feasibility in Malagasy municipalities." *Public Money & Management*, 35(6), 417–422.
- Razak, R. (2009). "Road asset management system for Brunei Darussalam." *Road Engineering Association of Asia and Australasia (REAAA) Conference*, 13th, 2009, Incheon, Korea.
- RepCard (2013). "2013 ReportCard on America's Infrastructure." (2013). <<http://www.infrastructurereportcard.org/>> (Oct. 3, 2013).



- Schraven, D., Hartmann, A., Dewulf, G. (2011) "Effectiveness of infrastructure asset management: challenges for public agencies". *Built Environment Project and Asset Management*, 1(1), 61-74.
- Schuitema, G., Steg, L., Forward, S. (2010) "Explaining differences in acceptability before and acceptance after the implementation of a congestion charge in Stockholm". *Transportation Research Part A*, 44, 99-109.
- Sharaf, E. A., Abo-Hashema, M. A., and El-Hawwary, M. M. S. E.-D. (2008). "A framework for pavement RL prediction using KDD." CRC Press.
- Shiferaw, A.T., Klakegg, O.J., Haavaldsen, T. (2012) "Governance of public investment projects in Ethiopia". *Project Management Journal*, 43(4), 52–69.
- Short, J., Kopp, A. (2005) "Transport infrastructure: investment and planning. Policy and research aspects". *Transport Policy*, 12, 360-367.
- Siegel, S., and Castellan, N. J. (1988). *Nonparametric statistics for the behavioral sciences*. McGraw-Hill, New York.
- Smadi, O., and Akili, W. (2006) "Infrastructure asset management education: active learning and engagement-based practices." *Transportation Research Record*, 1957(1), 16-18.
- Smith, R. E. (1992). "Addressing institutional barriers to implementing a PMS." *Pavement Management Implementation symposium, 1991, Atlantic City, New Jersey, USA*.
- Sohail, M., Cavill, M. (2008) "Accountability to prevent corruption in construction projects". *Journal of Construction Engineering and Management*, 134(9), 729-738.
- Sohail, M., Maunder, D.A.C., and Miles, D.W.J. (2004) "Managing public transport in developing countries: stakeholder perspectives in Dar es Salaam and Faisalabad". *International Journal of Transport Management*, 2, 149-160.
- Sohail, M., Miles, D. W. J., and Cotton, A. P. (2002). "Developing monitoring indicators for urban micro contracts in South Asia." *International Journal of Project Management*, 20(8), 583–591.
- Trader-Leigh, K.E. (2002) "Case study: identifying resistance in managing change". *Journal of Organizational Change Management*, 15(2), 138-155.
- Uddin, W., Hudson, W., Haas, R. (2013). *Public infrastructure asset management*. New York: McGraw Hill.
- Ugarelli, R., Venkatesh, G., Brattebø, H., Di Federico, V., and Søegrov, S. (2010). "Asset management for urban wastewater pipeline networks." *Journal of Infrastructure Systems*, 16(2), 112–121.
- Vanier, D. (2001). "Why Industry Needs Asset Management Tools." *Journal of Computing in Civil Engineering*, 15(1), 35–43.
- Walker, R. G., and Jones, S. (2012). "Reporting on Infrastructure in Australia: Practices and Management Preferences." *Abacus*, 48(3), 387–413.
- Wall, D.M. (1993) "Building maintenance in the context of developing countries". *Construction Management and Economics*, 11, 186-193.
- WB (2015). "Middle East & North Africa (developing only) | Data." (2015). <http://data.worldbank.org/region/MNA?display=graph> (Nov. 18, 2015).
- Wijnia, Y. C. (2009). "Asset management for infrastructures in fast developing countries." *Infrastructure Systems and Services: Developing 21st Century Infrastructure Networks, (INFRA)*, 2009 Second International Conference on, 1–6.
- Wooldridge, S. C., Garvin, M. J., and Miller, J. B. (2001). "Effects of accounting and budgeting on capital allocation for infrastructure projects." *Journal of Management in Engineering*, 17(2), 86–94.

Yankov, L., Kleiner, B.H. (2001) "Human resources issues in the construction industry".  
Management, Research News, 24(3-4), 101-105.

Ziara, M., Nigim, K., Enshassi, A., and Ayyub, B.M. (2002) "Strategic implementation of  
infrastructure priority projects: case study in Palestine". Journal of Infrastructure  
Systems, 8(1), 2-11.