SYNTHESIZING EXPERIENCES OF IMPLEMENTING ASSET MANAGEMENT IN THE WORLD:

Lessons Leaned from Pavement Management Case Studies

The objective of this paper is to identify factors for successful implementation of asset management systems by reviewing studies of implementation of asset management tools in foreign countries. First, this research begins by reviewing implementation cases in foreign countries to capture processes, needed resources and strategies to deal with problems, and benefits. Then, the paper summarizes practices in the US and compare the US's experiences to the experiences in foreign countries to capture the factors required for successful implementation in the US. The paper, finally, explores a direction for successful implementation and addresses future needs to deal with the barriers.

Keywords ***Asset Management, Pavement Management, successful implementation, United States, foreign countries***

水澤大輔
MIZUSAWA, Daisuke
イリノイ大学シカゴ校都市計画公共政策学部博士課程

スー　マクニイル
Sue MCNEIL
デラウェア大学土木工学科教授

1——Introduction

Asset management systems (AMS) are tools to support the systematic process of maintaining, upgrading, and operating physical assets cost-effectively. Such systems include asset inventory, condition assessment and performance modeling, maintenance and rehabilitation alternative selection and evaluation, methods of evaluating the effectiveness of each strategy, project implementation, and performance monitoring. The benefits from asset management include more clearly defined objectives, more consistent approach to prioritization, more transparency in decision-making, more efficient and effective use of funding, improved communication between stakeholder expectations and asset performance, improved understanding of trade-offs, better information to support investment decisions, and increased benefits to system users[1), 2)].

Yet, there are several barriers to implementing AMS in agencies. The 2004 Transportation Research Board (TRB) Asset Management Peer Exchange Meeting addressed six barriers : (1) lack of integration using more sophisticated analytic tools to evaluate and prioritize maintenance and rehabilitation (M&R) projects ; (2) database issues such as existing legacy system and costs for data collection ; (3) lack of adequate communication tools and methods for different audiences ; (4) jurisdictional issues such as gaps between asset management approaches used by different agencies ; (5) institutional issues such as lack of coordinated and consistent asset management implementation ; and (6) implementation and development costs[3)]. Many ideas for dealing with the barriers were solicited from participants in the meeting. Although it is important to synthesize ideas from best practices and meetings within the US, we can have opportunities to extend our ideas to break through the barriers from foreign countries' experiences.

The objective of this research is to identify factors for successful implementation of AMS by reviewing studies of implementation of various asset management tools from experiences in foreign countries, in terms of policy, technology, institutions, and funding. Since the largest body of documented international experience is in pavement management, and since pavement management is a significant activity and pavements account for up to 60 percent of the total assets in a typical agency in the US[4)], this research focuses on pavement management as one element of asset management. First, the research begins by reviewing implementation cases in foreign countries to capture the process, the needs to deal with asset related problems, and the benefits from asset management. Then, it summarizes practices in the US and compares the US's experience to the experiences in the foreign countries reviewed in order to capture the factors required for successful implementation in the US. Given a result of the comparison study, finally, the paper explores a direction for successful implementation and addresses future needs to deal with the barriers.

2——IMPLEMENTATION IN FOREIGN COUNTRIES

Pavement management systems (PMS) form a foundation for AMS. Many countries have been utilizing PMS. For example, the Highway Design and Maintenance Standard Model (HDM-4) developed by the World Bank and the World Road Association (PIARC) is used in more than 100 countries[5]. In addition, private consulting companies are disseminating their PMS products to many countries[6]. Hence, it is assumed that there are many PMS implementation cases in foreign countries.

This research reviews twenty research papers[7)~26)] representing thirty-three different countries, listed in Table—1.

■Table—1 Countries Studied by Area

Areas	Countries	Note
Asia	Iran, India, Pakistan, Laos, Malaysia, Philippines, Thailand, Vietnam	8countries
Africa	South Africa	1country
Europe	U.K., Italy, Switzerland, Denmark, Germany, Norway, Finland, Austria, Hungary, Croatia, Latvia, Slovenia	12countries
Former Soviet Union	Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan	8countries
South America	Brazil, Colombia	2countries
Oceania	Australia, New Zealand	2countries

The papers address various pavement management implementation practices in terms of four primary components : (1) information and decision-support systems : (2) modeling : (3) integration : and (4) international development. The implementations supporting international development are beyond the scope of this paper and are not considered in detail.

Information systems provide asset inventory and condition derived from various surveys. Using the systems, users can recognize current asset configuration such as scale, quantity and location, and condition such as usage and deterioration. The systems consist of databases, which can store immense quantities of information related to assets, and decision-support systems. The decision-support systems can be specific to the PMS or analysis tools in the PMS that provide optimal solutions such as budgetary needs and work orders for M&R while taking into account remaining life of assets by making full use of data stored in the information systems.

Modeling develops, calibrates, and upgrades representations of the deterioration process and road user effects used in the PMS to estimate future deterioration of assets and benefits/costs of M&R projects as well as key parameters within the models.

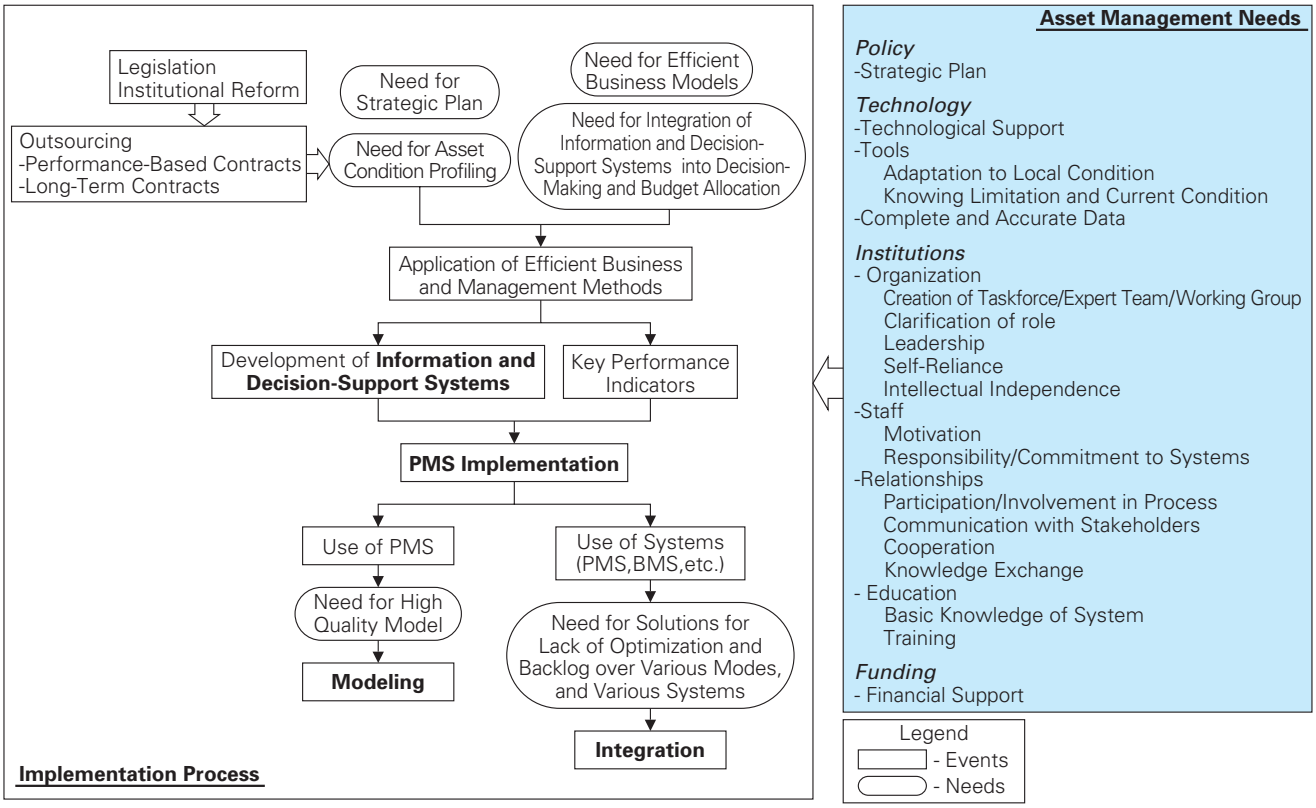
Integration is how different systems, such as PMS and BMS, relate to each other physically or through regulation in order to be able to prioritize M&R projects based on a common evaluation platform or establish a common standard for M&R project evaluation, respectively.

The experiences reported in the literature for specific countries are categorized using these four components as shown in Table—2. Again international development is included for completeness but is not included in any detail.

■Table—2 Countries Studied by Component Considered

Components	Countries
Information systems and Decision-support	Iran, India, Malaysia, Thailand, South Africa, Italy, Switzerland, Denmark, Germany, Finland, Austria, Croatia, Latvia, Slovenia, Former Soviet Union, Brazil, Colombia, Australia, New Zealand
Modeling	Philippines, Australia
Integration	Norway, Hungary, U.K
International Development	Asia (Laos, Pakistan, Philippines, Vietnam, Kyrgyzstan, Uzbekistan) *Strictly, Kyrgyzstan and Uzbekistan are categorized in the Former Soviet Union.

After grouping the countries, key factors which represent the motivation for implementation, events that occurred during the implementation, and lessons learned as reported in the papers are extracted and synthesized in Figure— 1. The largest box surrounded by the solid line (on the left side of the figure) represents the implementation process for pavement management consisting of three components : information and decision-support systems ; modeling ; and integration. Within the box, there are small boxes addressing events relevant to implementation such as institutional change and technology adoption, and ovals representing needs derived from previous events or societal demands in the process. The needs also result in the events where occurring further development. The activities are undertaken by government and agencies and are directly related to implementation. Also, the shaded large box on the right hand side of the figure describes asset management needs for implementation for all components. It should be borne in mind that the process and needs may not reflect real implementation practices because the literature review is subjective and papers reviewed may not contain complete descriptions of the relevant practices. This review is intended to illustrate the concepts and diversity of experiences.



■Figure—1 Process and Needs of Pavement Management Practices

2.1 Process

Briefly, the process for incorporating the three components is explained as follows :

2.1.1 Information and Decision-Support Systems

The implementation cases related to information and decision-support systems were motivated by legislation requiring outsourcing to utilize long-term performance-based contracts in Australia and New Zealand[7), 8), 9)], and institutional reform introducing a style of business similar to the private sector in South Africa, thereby relying on outsourcing[10)]. Also, implementations in Malaysia and Italy can also be assumed to be motivated by outsourcing directly[11), 12)].

Given the motivation by governments or top-management, transportation agencies recognized that a strategic plan and asset condition profiling were needed to implement outsourcing. A strategic plan identifies specific goals, objectives for supporting the goals, and strategies for reaching goals over a long-range planning horizon. Hence, the plan is a necessity to guide outsourcing contracts to desired goals identified by agencies. In parallel, asset condition profiling is important to show current condition and how close the agencies get to their goals through outsourcing.

In addition, the systems implemented in many countries were motivated by the recognition of needs for efficient business models including processes and tools, and integration of systems into decision-making and budget allocation in the transportation planning process such as comparison between construction and M&R and comparison among various M&R projects. Since, for example, countries such as Iran, Thailand, Austria, and the former Soviet Union did not possess any systems for pavement management, agencies were strongly motivated to implement decision-support systems[13), 14), 15)]. Although India had owned PMS since 1990, an agency upgraded decision-support functions in it because the system did not truly match their needs and had not been used[16)]. On the other hand, Switzerland and Germany owned information systems which could store and query asset inventory and condition data. However, because the systems could not analyze and process optimal solutions such as budgetary needs and work orders for M&R, agencies developed decision-support system — PMS[14)].

Once agencies recognized the needs, they tried to apply efficient business and management methods and developed the systems. At the same time, they defined key performance indicators to capture asset condition. Finally, some agencies implemented the systems to achieve their goals and the execution of outsourcing contracts, while others implemented PMS per se in conjunction with the application of deterioration models derived from their historical data or other agencies. Prior to the following processes, PMS implementation

was definitely occurred.

2.1.2 Modeling

The model enhancements reported occurred after implementation and support the decision-support system (i.e., PMS). These enhancements were motivated by the need for high quality road deterioration and road user effect models in order to obtain more accurate projection of asset deterioration, budgetary needs and work orders for M&R. Examples of this aspect were observed in the Australia[17] and Philippines[18].

2.1.3 Integration

Integration also occurred after implementation and use of PMS due to the lack of optimization and backlog of projects across various modes such as pavement and bridge. Although there were various management systems in Norway, they were stovepipe systems that prevented decision-makers from prioritization of operation and maintenance for different modes using a consistent decision-making[19]. Hungary owned PMS only and developed a combined PMS with BMS having the same mathematical model to be able to optimize M&R projects between pavement and bridge[20]. Interestingly, the United Kingdom developed integrated PMS standards for assessment and maintenance needs in the nation, in order to plan maintenance expenditure effectively, whereas individual agencies used different PMS[21] following a consistent set of principles[1].

2.2 Asset Management Needs

To support these three components throughout the process there are specific asset management needs in terms of policy, technology, institutions, and funding. In other words, these needs address existing problems in pavement management implementation through case studies of experiences in foreign countries. There are four categories as follows :

2.2.1 Policy

Strategic Plan : The South African and Finnish cases mentioned that the agencies developed a strategic plan that set long-term management goals and objectives and monitoring performance using performance indicators against the objectives[10]. As mentioned in the discussion on information systems, outsourcing and institutional reform motivate agencies to introduce a strategic plan and then information systems including PMS. In Finland this is referred to as an "objectives approach". Since the road agency is assigned goals and objectives by the Ministry, there is merit in that different organizations can share common contexts for the strategic plan, thus being able to conduct the same objective approach at all organizational levels[22].

2.2.2 Technology

Technological Support : Several countries such as Malaysia, Philippines, and Brazil received support from international organizations for implementation[11), 18), 23]. The technological support is critical for agencies where there is little technological support for turnkey implementation of projects.

Tools : Experiences in the former Soviet Union and India emphasized the context in which the tools are being applied.

- Adaptation to Local Condition : Usually, PMS must be adapted to local conditions to obtain more accurate analysis results and match with agencies' needs[13]. Without the adaptation, PMS may not be used by agencies as India case shows[16].
- Knowing the Limitations and Current Condition : After systems are implemented and users understand the systems, they understand the limitations and performance condition of the systems[13]. This will motivate them to find solutions and update the systems.

Complete and Accurate Data : Many cases (e.g., Italy, Finland, Former Soviet Union, Thailand, etc.) identify problems of incomplete and inaccurate data. Even if agencies implement systems, they cannot obtain complete asset inventories and condition data, and cannot analyze budgetary needs and work order for M&R projects without complete and accurate asset data[12), 13), 17), 22), 24), 25]. Therefore, beside preparation of survey methods and equipment, database systems, and training for survey and data handling is critical.

2.2.3 Institutions

Organization : The supporting organizational structure has several elements.

- Creation of team : Implementation cases in Malaysia, Austria, and New Zealand created an exclusive team to handle the implementation process[7), 11), 14), 25]. Although the names of the teams are different (i.e., taskforce, expert team, and working group), the functions are common to proceed with implementation by facilitating stakeholder input and disseminating common vision or goals.
- Clarification of roles : This reduces work redundancy among staff and increases their responsibility for their roles. Also, this avoids conflicts among policy, administration, and services when conducting institutional reform[10].
- Leadership : Leadership is a thrust to move implementation forward to achieve success. Leadership at the top-level of the organization is required.
- Self-reliance : This factor is important to ensure sustainability of improved economic performance of agencies, especially in developing countries[25].

・Intellectual independence : In addition to self-reliance, intellectual independence is important in all aspects of agency decision-making. A good solution will not come from external consultants but from the inside[25]. If an agency depends on external consultants, they cannot deal with problems by themselves quickly and take time to ask the consultants solutions. This will obstruct continual usage of PMS.

Staff : Within the organization, staff must have attributes that support AMS development and implementation.

・Motivation : In Finland, staff in a road agency are provided maximum bonus of 3.5% of their annual pay by the Ministry if they achieve yearly objectives of performance-based maintenance[22]. The motivation contributes to putting cost-effective pavement management into practice.

・Responsibility/commitment to systems : This means that users have to be responsible for and committed to use the systems that have been implemented continuously. This will integrate the systems into agency's decision-making process of M&R project evaluation and budget allocation, thus being able to utilize system performance[16), 26].

Relationships : Connections among participants, processes and tools were identified as key.

・Participation/involvement in process : Four implementation cases[7), 10), 23), 24)] emphasize this factor which provides various benefits such as sharing common vision, cooperation, and knowledge exchange.

・Communication with stakeholders : Communication will promote vision or goals among stakeholders and agencies can win pubic support for more funding[10].

・Cooperation : Close cooperation between staff and with other organizations during implementation allows them to conduct necessary works smoothly, thus achieving implementation effectively[14), 21), 26].

・Knowledge exchange : This factor contributes to solving problems in front of agencies during implementation process as well as system users after implementation[14), 25].

・Support from stakeholders : Lack of support from stakeholders such as political and public brings problems in implementation of initiatives[25].

Education : Successful implementation requires participants to be knowledgeable in terms of basic systems and have access to specialized training.

・Basic knowledge of system : Without systems knowledge, such as how to use a personal computer, it is difficult to obtain knowledge from training easily[13]. In addition, having knowledge of systems may allow staff to move from traditional work practices to new procedures. It is expected that the staff's fear of change will be removed.

・Training : Four cases[10), 11), 13), 26)] identify the importance of training, which enhances use of systems and allows users to obtain desired results by following adequate process gained by training.

2.2.4 Funding

Financial Support : As described in Technological Support, Malaysia, Philippines, and Brazil were technologically supported by international organizations for implementation. Simultaneously, financial support was provided to initiate implementation projects[11), 18), 23)].

2.3 Benefits

Sixteen implementation cases address various benefits obtained from the three components : information and decision-support systems, modeling, and integration as follows :

2.3.1 Information and Decision-Support Systems

Australia, Italy, Finland, and Germany cases articulate significant cost savings due to pavement management using the systems[8), 9), 12), 14), 22)]. For example, an agency in Finland reached optimal road condition level while its financing had decreased by 50 percent[22]. Since those countries, except Germany, deploy performance-based contracts and/or strategic planning, the cost reduction may come not only from the systems but also the contracts and/or planning. The Australian case explains that the achievement of the cost savings was brought by targeting critical maintenance activities, use of innovative materials, appropriate material application and proficient inspectors[8].

Cases from Brazil, Denmark, Croatia, Latvia, Slovenia, and Colombia all address program optimization while taking into account budget constraints where the highest benefit is obtained[23), 26)]. Also, the Swiss case describes identification of necessary corrections to satisfy the needs of the national roads[14]. Iran determined guidelines for road maintenance obtained from optimum maintenance methods resulted in PMS[15]. Obviously, the systems contribute to creating a rational pavement management plan with available budget.

Furthermore, there are many intangible benefits reported as follows :

・Manageable and predictable road network[8), 12)]
・Improved performance of management activity[8), 22)]
・Improved communication[22]
・Reduction of responsibilities of administration by sharing with contractors[8), 12)]
・Consistent data used throughout the process[22]
・Impact assessment of cost increase or benefit

decrease[23), 24)]

- A good overview of present condition of network[26)]
- Comparison of the returns to be expected from each maintenance strategy alternative[14), 23)]
- Being able to monitor asset condition and maintenance costs[24)]
- Improvement of quality of performance curves (i.e., deterioration models) due to data collection and processing[14)]

2.3.2 Modeling

The Australian case identifies the benefit of greater confidence in forecasting future conditions, establishing maintenance programs and substantiating budget requirements with appropriate deterioration models[17)].

2.3.3 Integration

The Norwegian case proposes an AMS framework to addresses the benefit that AMS project prioritization can cover different areas such as pavement and bridge operations and maintenance. Also, it mentions the benefit of considering socio-economic factors (e.g., user costs and other community costs) in the prioritization process[19)]. Because most management systems such as PMS and BMS can consider the socio-economic factors, this benefit is applicable to the information and decision-support systems.

The case from the United Kingdom is different from the Norwegian case since they integrated PMS standards for assessment and maintenance needs nationally. As a result, they obtained benefits[21)] :

- Minimized PMS development costs to the public purse, and
- Provided an assessment of the overall funding requirements and ensured a consistent and equitable distribution of funds.

3——PRACTICES IN THE US

The US transport system has been developing since the nineteenth century. For example, in 1893, the Office of Road Inquiry started roadway research, construction of pre-interstate highways, and traffic surveys[27), 28)]. After the era of major new highway construction, transportation issues changed from a focus on the expansion of the system network to increasing the efficiency of operating and managing the existing system. M&R costs would continue to increase over time because of infrastructure deterioration caused by increases in the vehicle miles of travel, the increase in heavy trucks, aging infrastructure, and inappropriate M&R strategies. At the same time, the performance would degrade because M&R cannot catch up with the pace of deterioration of infrastructure due to the reasons aforementioned and an agency cannot afford to invest in the additional M&R needed due to budget constraints. Simultaneously, the degradation in performance will raise user costs. Hence, transportation agencies such as state DOTs had implemented pavement management systems. For example, Caltrans started collecting road performance information and using a PMS in 1977[29)]. Recently, outsourcing incorporating performance-based contracts in road management has been initiated in several states such as the District Columbia[30)] to execute more cost-effective maintenance. Similar to the foreign counties' cases, outsourcing requires both agencies to profile asset condition and contractors to utilize information and decision-support systems including PMS.

The Intermodal Surface Transportation Efficiency Act (ISTEA), enacted in 1991, provided encouragement for states to develop AMS for specific types of assets. ISTEA initially required states to have six AMS (pavement management systems, bridge management systems, etc.) that cover all Federal-aid infrastructures by 1996, in order to optimize available funds in preserving the national transportation infrastructure[31)]. The passage of the ISTEA enhanced and encouraged the development of AMS applications. Although the ISTEA management system requirement was rescinded in 1995, the National Highway System Designation Act of 1995 encouraged continued development and implementation of the ISTEA's management system[32), 33), 34)]. Furthermore, ISTEA required agencies to introduce a long-range plan in their transportation planning[35), 36)]. Agencies are using a systematic strategic planning approach to address future goals, objectives, and recommendations consisting of both capital investment and operation programs for the transportation system. In order to achieve their goals of the strategic plan, management systems, which are a vehicle for showing assets' performances, are required[37)].

Over the last decade, the Office of Asset Management of the Federal Highway Administration (FHWA) and arms of professional organizations, the American Association State Highway Transportation Officials (AASHTO) and the TRB, have been studying best practices and disseminating to states asset management concepts extracted from their studies[34), 38)]. Politicians, engineers, planners, and academicians have identified AMS as tools to support cost effective maintenance, upgrading, and operations decisions related to physical transportation assets.

The Governmental Accounting Standard Board Statement 34 (GASB 34) is another factor encouraging PMS implementation. In 1999, the GASB 34 guidelines were instituted requiring state and local agencies to

report the book of the physical assets and to improve accountability to the public in terms of transportation services[39]. These guidelines also motivated some agencies to develop and implement integrated AMS so that they can evaluate their assets' value and include their value on the financial reports using an inventory system and investment analysis in AMS and private sector business principles[40].

Some states instituted a strong driver, legislation, which motivates agencies to utilize AMS and execute efficient business. For example, the state of Michigan passed Act 499 of the Public Acts of 2002 which established the Transportation Asset Management Council (TAMC) to advise the State Transportation Commission on a statewide asset management strategy for maintaining, preserving, and improving Michigan's federal-aid eligible roads and bridges and the process and necessary tools needed to implement the strategy[41]. The state of Vermont also passed Sections 24 and 25 of Act No. 64 in 2001. They require the state agency to submit asset management plan (i.e., list of assets and those condition, deterioration rates, annual funds necessary to fund M&R at the recommended performance level, M&R activities, and comparative cost differential between maintaining the infrastructure, utilizing a preventive maintenance program and deferring those maintenance costs) to the House and Senate Committees on Transportation[42].

However, the barriers to implementing AMS identified in the 2004 TRB Asset Management Peer Exchange Meeting[3] are significant. In addition, most participants in the peer exchange insisted with one voice that cost is a critical issue and barrier. Without showing that the benefits of AMS implementation exceed the costs for AMS implementation and operation, the implementation will not be realized. In particular, upper-level managers are interested in benefits that can be translated into monetary values[43], because they will decide whether AMS have to be implemented in the M&R planning process based on their economic decision.

As future research to address these barriers, the participants in the meeting identified the followings[3] :

- Research to deal directly with the barriers mentioned above,
- Educational initiatives to facilitate knowledge exchange through Local Technical Assistance Programs (LTAP), and training courses, and
- Information exchange such as case studies, concepts of asset management, and components of AMS through publications and internet-based dissemination.

Also, methods to quantify benefits are required to justify AMS implementation using public resources, that is, to show the cost-effectiveness of AMS[3]. Therefore, it is imperative to quantify the benefits of AMS implementation and demonstrate that the benefits exceed the implementation and operating costs, in order to disseminate and implement AMS in agencies. Agencies, especially, in states where there is no legislation, need methods to recognize the benefits of AMS. The quantification of benefits of AMS will be a most crucial factor to implement AMS for all agencies.

4——COMPARISON BEWTWEEN FOREIGN COUNTRIES AND THE US

From the review of AMS experiences focusing on PMS, in foreign countries and the US, the following similarities and dissimilarities are observed. The similarities show worldwide trends in management strategies, while the dissimilarities show the characteristics of the US and where possible, identify asset management needs relative to the international experiences reported in the literature. It is noted that the comparisons are subjective and do not provide a complete picture of implementation cases because the documentation provided in the literature is not necessarily comprehensive.

4.1 Similarities

Throughout the world, the environment in which transportation agencies operate has several common features, although there are differences in the degree of development, and extent and complexity of the transportation system. Since, for example, Asia supported by international organizations generally embraces minimum requirements of transportation systems due to resource constraints, they are required to introduce effective maintenance methods to achieve sustainable development. Agencies in the US also need effective maintenance due to the extensive system stock and budget constraints. The needs for efficient business practices and integration of systems with decision-making and budget allocation are observed in many countries including the US.

In addition, outsourcing utilizing long-term performance-based contracts has been gaining acceptance in many countries. This contract type has been more widely used in foreign countries and has been introduced in the US recently. Hence, the motivations to implement PMS are similar and most countries are on the same track. It also means that the needs identified from foreign countries' cases are generally applicable to the US.

By and large, the needs addressed in foreign

countries' cases are similar to those in the US such as technological and institutional issues.

4.2 Dissimilarities

The focus of the foreign countries' case studies range from information and decision-support systems to modeling and integration, while the US agencies seem to focus on integration, which is an advanced feature in the PMS development process as shown in Figure—1. This may come from the relative advanced levels of asset management in the US where PMS have been implemented since the 1970s and AMS have been evolving with influences from ISTEA and GASB 34.

Another dissimilarity is the decision-making process. Particularly in Europe, the decision-making is centralized to determine management process and system standards[14), 21), 22)]. For example, Austrian federal ministry created a special taskforce to motivate PMS implementation. Most of state administrations agreed in principle to follow the decision to use specific application made by the taskforce. On the other hand, in the US, the process is decentralized because the responsibility for building AMS is entrusted to local and regional agencies.

Also, needs related to strategic planning and personnel are rarely listed in the barriers identified by the participants in the Peer Exchange Meeting. Rather, the responses at the meeting focus on technological and large-scale institutional issues such as research, education, and information provision. Since ISTEA required agencies to introduce a long-range plan in their transportation planning[36)], they develop a strategic plan systematically. Thus, it is assumed that there is no need to address a strategic plan. Regarding the needs for personnel, these needs may have already been incorporated into individual agencies or the focal point of the meeting was different from qualitative issues. Otherwise, these needs are completely neglected by agencies in the US.

Furthermore, the need for methods to quantify the benefits of AMS is stated by the US only. The US may be more sensitive to use public resources on transportation investment.

5——CONCLUSIONS AND RECOMMENDATION

This research reviewed papers from thirty-three different countries to identify the factors for successful implementation of PMS, one AMS element. The factors were divided into the four components and then categorized by the motivation for development, related events, and the lessons learned. Then, the factors categorized were synthesized as the implementation process and asset management needs for pavement management. After that, the research summarized US experiences and compared it to the experiences in the foreign countries to capture what kinds of factors are required for successful implementation in the US.

The comparison shows that the motivation and needs for AMS are almost the same for foreign countries and the US. However, several differences are observed as follows. First, the US focuses on integration rather than implementation of information and decision-support systems and modeling. This suggests that the US is in the advanced development process of AMS implementation. Second, the decision-making process in the US is more decentralized than foreign countries federal system. Without an authority that has a leadership and coordination function, it is difficult to implement AMS among various level agencies. Certainly, the partnership of FHWA, AASHTO, and TRB is an alternative model to a central government in foreign countries that provide technical support and disseminated information. Third, the needs regarding strategic planning and personnel are rarely observed in the US. It is not required to address the need of strategic plan since agencies have already developed the plan in their transportation planning process. As for needs related to personnel, US agencies might be better able to check whether their resources are sufficient to support implementation. Fourth, the need for quantitative methods to address benefits of AMS is identified by the US only. It is expected that countries whose resources are inadequate will need methods to justify AMS investment in the future.

As a result, the factors for successful implementation to deal with the barriers in the US are to strengthen the role of the partnership among FHWA, AASHTO, and TRB as leaders and coordinators and to seek the resources needed for implementation in term of agency personnel. Although the factors may not directory affect the barriers, they will create the foundation to provide effective solutions such as tools, functions, and methods.

The environment in which agencies operate worldwide appears to be converging on similar issues as technology is developed and knowledge and experiences are exchanged worldwide. The asset management needs extracted both from foreign countries and from the US are common keys to deal with the barriers in the US in addition to other countries. Although this research did not involve Japanese cases of AMS implementation

(as there is little documentation of Japanese experiences), presumably, the needs are applicable to solve barriers existing in Japan.

Because, however, it is difficult to articulate how needs should be applied from literature review (i.e., which needs should be applied ; who should apply the needs ; and when and where the needs should be applied.), applying needs is still obscure task. Therefore, it is needed to investigate an efficient methodology to apply the needs throughout AMS implementation process based on discourse and knowledge that try to figure out complex problems across different stakeholders in the process, leading to the barriers.

NOTE

1 http://www.ukpms.com/index.asp

REFERENCES

1) Austroads. *Integrated Asset Management Guidelines for Road Networks*. AP-R202/02, Association of Australian and New Zealand Road Authorities, New South Wales, Australia, 2002.

2) U.S. Department of Transportation (US DOT), Federal Highway Administration (FHWA), *Asset Management, Advancing the State of the Art into the 21st Century through Public-Private Dialogue*, FHWA-RD-97-046, Washington DC, September 1996.

3) Transportation Research Board. Asset Management in Planning and Operations : A Peer Exchange. *Transportation Research Circular*, No. E-C076, 2005.

4) Transportation Research Board. Pavement Management Applications Using Geographic Information Systems : A Synthesis of Highway Practice. *NCHRP Synthesis*, No.335, 2004.

5) Transportation Research Board. Analytic Tools to Support Transportation Asset Management. *NCHRP Project 20-57*, Draft final report, November 12, 2004.

6) W. De Corte and E. De Winne. Pavement Management Systems through Europe : Similarities and differences. In *1st European Pavement Management Systems Conference*. CD-ROM. Hungary, 2000.

7) R. B. Smith, M. Rudge, and I. Marshall. Southland District (New Zealand) Road Asset Management Plan - Role of Policy Makers, Managers and Users. In *4th International Conference on Managing Pavements*. South Africa, 1998, pp. 1011-1024.

8) S. D. McKee. Benefits of Road Maintenance Management Contracts in New South Wales Australia. In *4th International Conference on Managing Pavements*. South Africa, 1998, pp. 1181~1193.

9) Noble J. W. B. Long Term Road Maintenance Contracts in Western Australia - Lessons Learnt. In *6th International Conference on Managing Pavements*. CD-ROM. Australia, 2004.

10) M. F. Mitchell. Opportunities for Pavement Management in South Africa as A Consequence of Institutional Reform in Road Management. In *4th International Conference on Managing Pavements*. South Africa, 1998, pp. 998-1010.

11) Bennett D. W., Salleh I. M., Hasan M. Z., and Toole T. Managing the Performance of Toll Roads in Malaysia. In *6th International Conference on Managing Pavements*. CD-ROM. Australia, 2004.

12) Crispino, M., Mismetti, G., Olivari, G., and Scazziga, I. First experience in developing a PMS for a province road network in Italy. In *6th International Conference on Managing Pavements*. CD-ROM. Australia, 2004.

13) Jørn Kristiansen. Implementation of Pavement Management Systems in 8 Republics of the Former Soviet Union. In *4th International Conference on Managing Pavements*. South Africa, 1998, pp. 1137-1153.

14) J. Litzka, I. Scazziga, and G. Woltereck. Experiences with implementation of similar PMS in Austria, Germany and Switzerland. In *1st European Pavement Management Systems Conference*. CD-ROM. Hungary, 2000.

15) Mansour Fakhri. Application of HDM-4 as A Road Management System in Iran. In *6th International Conference on Managing Pavements*. CD-ROM. Australia, 2004.

16) Cameron Taylor. Application of Pavement Management Principles in Andhra Pradesh India. In *4th International Conference on Managing Pavements*. South Africa, 1998, pp. 1060-1067.

17) Giummarra, G. J., Martin T. C., Choummanivong, L. Establishing Deterioration Models for Local Roads in Australia. In *6th International Conference on Managing Pavements*. CD-ROM. Australia, 2004.

18) Morosiuk, G., Pradhan, N., and Jimenez, N. Implementing A Pavement Management System For The Philippines. In *6th International Conference on Managing Pavements*. CD-ROM. Australia, 2004.

19) Sund, E. K., Johansen, J. M., and Solberg, K. The First Steps towards Integrated Asset Management in Norway. In *6th International Conference on Managing Pavements*. CD-ROM. Australia, 2004.

20) Bakó, M. Csicsely-Tarpay, L. Gáspár, and P. Szakos. The Development and Application of A Combined Highway-Motorway Pavement Management System in Hungary. In *4th International Conference on Managing Pavements*. South Africa, 1998, pp. 1091-1105.

21) C. R. Britton and R. F. S. McCandless. Implementation of a National PMS Standard for Local Roads in the UK. In *1st European Pavement Management Systems Conference*. CD-ROM. Hungary, 2000.

22) Jani Saarinen, Tuomas Toivonen, Vesa Mannisto, and Raimo Tapio. Pavement Management in Finland : Decision-Making From National Policies To Project-Level Programming. In *4th International Conference on Managing Pavements*. South Africa, 1998, pp. 1106-1120.

23) Jony Marcos do Valle Lopes, Gerard Liautaud, and Asif Faiz. HDM Economic Evaluation of Brazil's Federal Highway Network. In *4th International Conference on Managing Pavements*. South Africa, 1998, pp. 681-703.

24) R. B. Smith and S. Ruangwanich. Effective Management of Road Maintenance in Saturated Traffic Environment — Bangkok Experience. In *4th International Conference on Managing Pavements*. South Africa, 1998, pp. 1298-1311.

25) Vincent, S.P.R., Allan, R.R., and Vallely, P. A Regional Review of Road Funding Initiatives in Asia. In *6th International Conference on Managing Pavements*. CD-ROM. Australia, 2004.

26) Knudsen, F and Kirk, J. S. Successful Implementation of the Danish Pavement Management System - BELMAN - Abroad. In *4th International Conference on Managing Pavements*. South Africa, 1998, pp. 1121-1136.

27) Federal Highway Administration. General Roy Stone. http://www.fhwa.dot.gov/administrators/rstone.htm. Accessed December 19, 2004.

28) Federal Highway Administration. Building the Foundation. Richard F. Weingroff. http://www.tfhrc.gov/pubrds/summer96/p96su2.htm. Accessed December 19, 2004.

29) Jeremy Lea and John T. Harvey. Data Mining of the Caltrans Pavement Management System (PMS) Database. http://www.its.berkeley.edu/pavementresearch/PDF/PMS%20Datamining%20report%202.0.pdf. Accessed August 30, 2005.

30) Federal Highway Administration. DC Streets : An Innovative Partnership for Better Roads. FOCUS, July/August 2000. http://www.tfhrc.gov/focus/julaug00/dcstreets.htm. Accessed September 1, 2005.
31) Adjo A. Amekudzi and N. O. Attoh-Okine. Institutional Issues in Implementation of Pavement Management System by Local Agencies. In *Transportation Research Record : Journal of the Transportation Research Board, No. 1524*, TRB, National Research Council, Washington, D. C., 1996, pp. 10-15.
32) Institute of Transportation Engineers. *Transportation Planning Handbook*. Second Edition, Prentice-Hall, Inc., 1999.
33) Sue McNeil, Mary L. Tischer, and Allan DeBlasio. *Asset Management : Survey Responses*. 1999.
34) Sue McNeil, Mary Lynn Tischer, and Allan J. DeBlasio. Asset Management : What Is the Fuss? In *Transportation Research Record : Journal of the Transportation Research Board, No. 1729*, TRB, National Research Council, Washington, D. C., 2000, pp. 21-25.
35) Federal Highway Administration. Evaluation of Statewide Long-Range Transportation Plans. http : //www.fhwa.dot.gov/hep10/state/evalplans.htm. Accessed June 15, 2005.
36) Gayle, S. Chapter 12 : Urban Transportation Studies, *Transportation Planning Handbook*. Edwards ed. Institute of Transportation of Engineers, Washington, D. C., 1999.
37) D. Mizusawa and S. McNeil. Trinity in Transportation Planning : Strategic Planning, Asset Management, and Performance Measures. In *1st CSCE Specialty Conference on Infrastructure Technologies, Management and Policy*. CD-ROM. Canada, 2005.
38) Aileen Switzer and Sue McNeil. Developing A Road Map For Transportation Asset Management Research. *Journal of Public Works Management and Policy*, Vol. 8, No. 3, 2004, pp. 162-175.
39) U.S. Department of Transportation (US DOT), Federal Highway Administration (FHWA), *Primer : GASB34*, FHWA-IF-00-010, Washington DC, November 2000.
40) Lynne Cowe Falls and Susan Tighe. Analyzing Longitudinal Data to Demonstrate the Costs and Benefits of Pavement Management. *Journal of Public Works Management and Policy*, Vol. 8, No. 3, 2004, pp. 176-191.
41) Michigan Department of Transportation. A Strategic Approach To Managing Michigan's Roads and Bridges. May 2003.
42) Vermont Agency of Transportation. VTrans Asset Management Vision and Work Plan. Final report prepared by Cambridge Systematics, Inc., 2002.
43) Smadi, O. Quantifying the Benefits of Pavement Management. In *6th International Conference on Managing Pavements*. CD-ROM. Australia, 2004.

海外におけるアセットマネジメント導入の経験から成功要因を学ぶ：舗装マネジメント事例より

米国においてアセットマネジメントシステム（AMS）は発展してきているが，AMSの導入に際していくつかの障害が指摘されている．本報告は，AMSの一つの要素である舗装マネジメントシステムの導入事例に焦点を当て，AMS導入を成功へ導く要因を明らかにすることを目的とする．はじめに導入過程，導入障害の解決に必要なリソース及びストラテジー，AMS導入によりもたらされる利益を海外事例より把握する．そして米国における事例を取りまとめ，海外事例と比較し，米国における導入を成功に導くための要因を捉える．最後に，導入を成功させるための方向性を検討し，障害に対応するための将来における必要性を提示する．

キーワード ； **アセットマネジメント, 舗装マネジメント, 成功導入事例, 米国, 海外**

この号の目次へ　http://www.jterc.or.jp/kenkyusyo/product/tpsr/bn/no34.html