Toward a future of attractive infrastructure maintenance: Looking back at support activities for regional implementation of new technology

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Expectations for regional implementation support teams

The introduction of new technology to the job sites of infrastructure maintenance is strongly desired to make the work in this field more attractive, efficient, and sophisticated. However, developers of new technology often wonder why the amazing new technology they developed is not being widely used. On the other hand, local officials in charge of managing public infrastructure fret over what technology they should introduce in what manner to resolve budgetary and manpower shortages (Fig. 1).

To meet the need for resolving the problems of both sides, SIP Infrastructure Regional Implementation Support Teams were selected in August 2016 as part of the technology for infrastructure maintenance, renovation, and management ("SIP infrastructure") (PD: Prof. Yozo Fujino), a project under the Cabinet Office's Cross-ministerial Strategic Innovation Promotion Program (SIP). Twelve teams including local universities have been undertaking various activities to have local municipalities use (implement) new technologies developed by "SIP Infrastructure." These included supporting the introduction of seeds, supporting fulfillment of needs, coordination within regions, establishing networks, and cultivating human resources. The Japanese Congress for Infrastructure Maintenance (JCIM), which was organized in autumn of 2016 as well, has been working toward the creation of an infrastructure maintenance market and formulation of a framework and system for implementing new technology, primarily through regional forums. The support teams for regional implementation have carried out their activities in close cooperation with JCIM.

This report summarizes the results of the activities of these support teams. At the end of the report, this article reviews the activities of the teams, describing what were found and obtained through the activities, referring to the content of the report, to assist future activities.

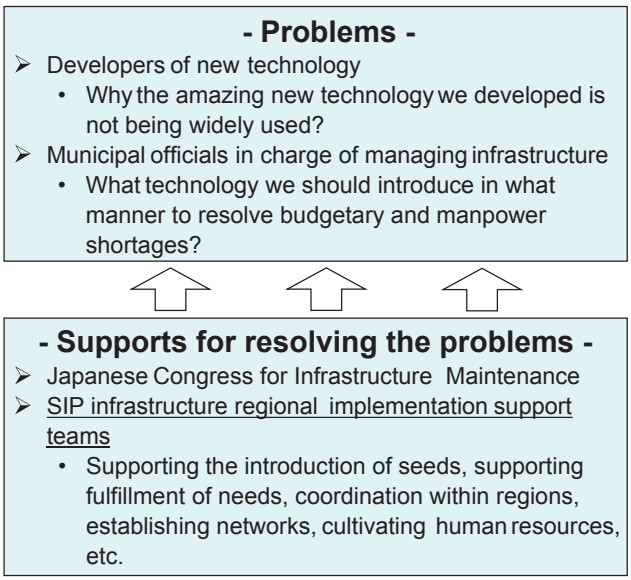

Fig. 1 Problems and support activities for regional implementation of new technology

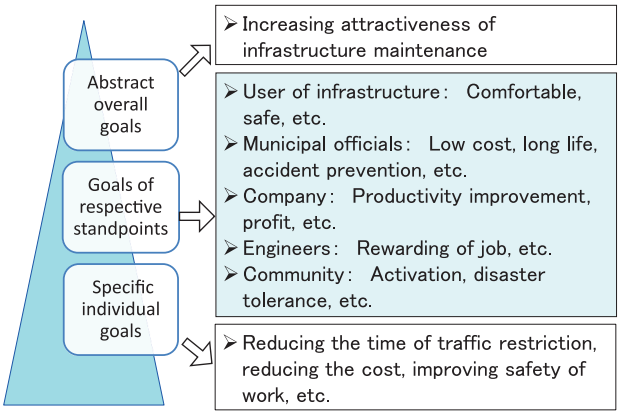

Fig. 2 Typical goals of infrastructure maintenance

Goals varying from one standpoint to another

Figure 2 shows typical goals of infrastructure maintenance. No one opposes abstract overall goals of "increasing attractiveness" and "increasing efficiency and sophistication." As pointed out by Chun of Ehime University (article A-2 of this report), however, the goals of infrastructure maintenance are not the same when viewed from different standpoints. Efforts to be made for the introduction of new technology also vary depending on the standpoint.

Accomplishment of some of the specific individual goals, such as "reducing the time of traffic restriction" and "reducing the cost," are easy to evaluate in numerical terms. However, others among the goals of respective standpoints are difficult to evaluate. For example, "safe and comfortable" and "rewarding," etc., are difficult to evaluate numerically. In contrast, future "accident prevention" is difficult in the sense that one can do nothing now but to strive for the goal, with judgement of whether or not the goal was achieved only being possible in the future.

Possibility of support activities by local universities

Information exchange between the public and private sector tends to be inhibited partly due to the erroneous belief held by municipal officials in charge of infrastructure management that the Ethics in Government Act prohibits even information exchange between them and private technology developers. For this reason, information "seeds" of new technology tends to remain unrecognized by municipal officials, while the needs of the officials are unlikely to be known by technology developers. Nevertheless, municipal officials, corporate engineers, and technology developers had lively exchanges of information and opinions at briefing sessions and open field tests held by local universities (C-1, etc.). Furthermore, these activities initiated by local universities led to the definition of performance requirements, evaluation of performance, and formulation of guidelines for new technology that are currently lacking (C-6). These activities of the support teams demonstrated the usefulness and possibility of implementation support for new technology, with local universities playing the key role in the collaboration among industry, municipalities, and academia. This is one of the accomplishments of the support activities for regional implementation.

In order to have the support activities for regional implementation of new technology take root in the civil engineering field of local universities, it is crucial to establish a sustainable cycle of the following steps: (1) incorporation of these activities in the Japan Society of Civil Engineers (JSCE); (2) publication of their results as peer-reviewed papers; (3) granting of academic degrees including master's and doctoral degrees on the basis of these achievements; and (4) acquisition of research funds including government research grants. The "SIP Infrastructure Program Coordination Committee" chaired by Tadayuki Tazaki has already been organized in JSCE, in which Subcommittee on Promoting Regional Implementation of New Technologies chaired by Keitetsu Rokugo was formed in fiscal 2018. The foundation for the above-mentioned cycle is thus being laid.

Seeds-driven and needs-driven

In this report, Obayashi (A-6) points out that projects can be expressed as combinations and chains of seeds and needs as shown in Fig. 3 of A-6 (page: 28) and that developments are classified into two types: seeds-driven and needs-driven. By developing this insight, it is understood that seeds to meet needs do not have to be in the form of new technology but rather can be anything, such as existing technology with track records, or information, people, organizations, or rules instead of "technology" in a narrow sense. In short, it can be interpreted that anything can be used in various new combinations to resolve the needs that have been difficult to meet by conventional approaches and combinations (Fig. 3). In the activities of the Gifu University team to apply robotic technology (RT) to periodic inspection of Kakamigahara Bridge (C-6), not only a combination of robot inspection techniques was provided but also draft guidelines were formulated by organizing a committee consisting of members from various positions. Furthermore, the team fulfilled the needs by combining various factors such as a proposal for conducting preliminary research assisted by RT prior to visual inspection at a close distance.

In the local support activities by Ozawa et al. of the University of Tokyo team (C-4), specific needs of each municipality selected were taken up to be resolved in cooperation with supporters (construction consultants). This approach is new, but the so-called implementation of new technology is not highlighted. This can therefore be regarded as needs-driven regional support. On the other hand, Hisada et al. of the Tohoku University team (C-3) disseminated a database system that is a new technology developed by "SIP infrastructure" to municipalities, making various adaptations. This can be regarded as seeds-driven regional support. The above-mentioned activities of the Gifu University team to apply RT to periodic inspection of Kakamigahara Bridge (C-6) can be regarded as an intermediate type between seeds-driven and needs-driven types.

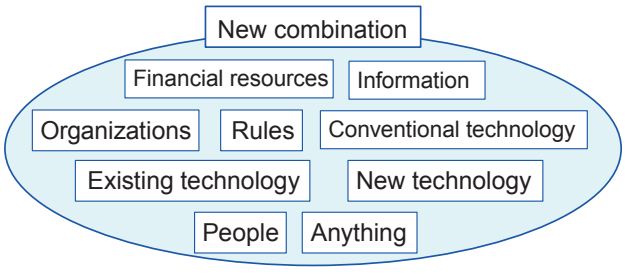

Fig. 3 New combination to resolve the needs

Table 1 Obstacles to the implementation of new technology perceived from different standpoints

Positions	Major causes	
Ordering parties	Attitudes of people in charge widely vary	- The organizational mission is unclear. - Enthusiasm gap between head and local offices. - Resistance to changes.
	Significant energy and effort are required for introduction	- Fairness should be ensured. - Basis for external explanation (account audit) is necessary. - Basis for internal explanation (organizational consensus) is necessary.
	Great risk in the event of trouble	- Who takes responsibility is unclear. - Constant and continuing support is not assured.
Developers	Investment decision for development is difficult	- First-mover advantage from development is not assured. - Investment recovery in a short time is difficult. - It is difficult to grasp the market (scale, continuity).
	Required specifications are unclear	- Needs for new technologies (required performance/precision) are unclear. - Appropriate cost for ordering parties is unknown. - Content and period of technical support required are unknown.
	Government's situation is unknown	- Each organization or local government is in a different situation. - Method of order placing and introduction conditions are difficult to understand. - Attention to industry officials is required.

Promotion of implementation by distributing and mitigating responsibilities

Table 1 (simplified Table 2 of A-4) gives various examples of obstacles to the implementation of new technology perceived from different standpoints. These were collected through listening surveys conducted on the order-placing parties and technology developers. Obstacles on the side of technology developers include the ambiguity of the needs of the order-placing party with regard to the performance requirements and accuracy. Unclearness about the method of order placing and conditions of introduction also discourages implementation. Obstacles on the side of order-placing parties mainly consist of psychological stress, such as resistance to change, the nuisance of providing explanations to account auditors, and uneasiness due to a lack of clarity about where responsibility lies. Measures shown in Fig. 4, including "expansion of administrative right," "positive attitude of the head of the organization," and "evaluation and certification of technology," are easy to understand when viewed as measures to distribute/mitigate the psychological stress (particularly responsibility) of the order-placing parties. This brings to mind various other measures. Note that the idea of "distribution"

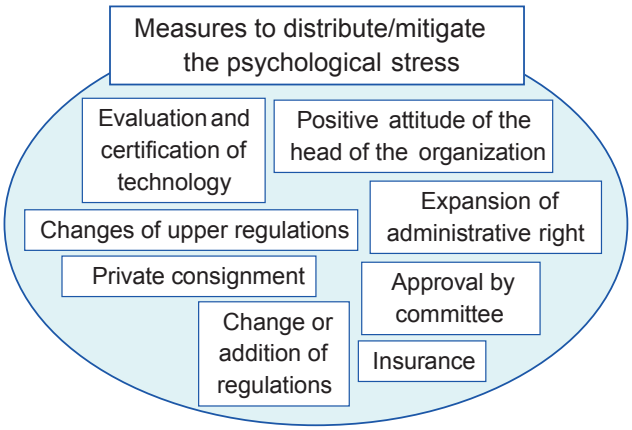

Fig. 4 Distribution/mitigation of the psychological stress of the order-placing parties

was given from Mr. Tadayuki Tazaki. In this report, Takamatsu (A-9) points out the importance of expanding the independence and discretion of localities.

Problems and countermeasures of and efforts for implementation of new technology

Table 2 gives examples of problems and countermeasures when implementing new technology. As stated above, many implementation support teams for regional implementation carried out briefing sessions and open field tests to transfer information on seeds of new technology to municipal administrators and local maintenance engineers, who are the users, while transferring the needs of the users to technology developers. These were appreciated by both technology developers and users. In the activities regarding the application of RT to periodic inspection of Kakamigahara Bridge (C-6), the support team formulated draft guidelines to compensate for insufficient standards, presented performance requirements to facilitate understanding of the RT to be used, evaluated the RT by field testing, and proposed a method of utilizing robotic techniques in an optimal combination. The team pointed out that the inspection cost can be reduced by changing the "preliminary research by RT followed by thorough visual inspection at a close distance" to "screening research by RT followed by visual inspection at a close distance only where required" and utilizing AI. Generally speaking, difficulties hard to predict from experience tend to arise when applying new technology or a new approach. To avoid or minimize such difficulties, sufficient measures should be taken, such as to begin slowly with trial use on a small scale and to collect information on such difficulties from similar cases. Education is also important to foster positive-minded staff who can enjoy changing and being changed for the better.

Table 3 gives examples of efforts for implementing new technology by different standpoints. It is advisable that municipal officials administrating structures

Table 2 Problems and countermeasures when implementing new technology

Problems	Examples of countermeasures		
Needs not encountered with seeds	Hold briefing sessions and open demonstration tests		Activities by SIP infrastructure regional implementation support teams
Nonconformity to standards	Improve or establish standards	Carried out for Kakamigahara Bridge	
Hard-to-understand technology	Define performance requirements, conduct performance evaluation, present methods of utilization		
Cost	Estimate the cost, suggest methods of cost reduction		
Difficulty in ensuring fairness	Include a neutral body		
Trouble	Begin with a small-scale trial, take sufficient preliminary measures, collect information on troubles in similar cases, emphasize experience, purchase insurance		
Psychological factor	Distribute and mitigate psychological stress, foster positive-minded staff who can enjoy changes		

Table 3 Examples of efforts for implementing new technology

Position	Examples of efforts
Municipal official in charge of infrastructure management	- Express their wish for technology to save cost and labor for solving the problems of budgetary, manpower, and technical shortfalls - Also demonstrate that the solution to the problems may not necessarily involve new technology
Ministry of Land, Infrastructure, Transport and Tourism MLIT	- Organize standards, performance requirements, methods of evaluation, estimation, and order placing (most important)
Developer of new technology	- Formulate a development plan with a clear intention for practical implementation (For instance, add new technology to conventional technology currently in use; accumulate experience at companies not under national audit, etc.)
Supporter for implementation (university, etc.)	- Regard support for implementation as an area of research activity (Improve the management of academic societies, judgment of theses, and distribution of research funds)
Contractor	- Actively utilize new technology for proposal making, etc.

demonstrate more strongly that, while they wish to resolve shortfalls in budget, manpower, and technology, the solution may not necessarily include new technology. New technology, particularly unfamiliar sophisticated technology, requires organization of its standards, performance requirements, and methods of evaluation, cost estimation, and order placement. The role of officials from the Ministry of Land, Infrastructure, Transport and Tourism in the position of being able to move these matters forward is very important. For developers of new technology, it is important to advance development with a clear intention of practical implementation, such as to add new technology to conventional technology currently in use, accumulate field experience at companies in the fields of railways, electrical power, etc., that are not under national audit, and carry out technical development together with the users of the technology. As stated above, further improvements are desired in the management of academic societies, judgment of theses, and distribution of research funds, so that researchers at universities and other institutions, who are in a neutral position, feel comfortable in supporting regional implementation. It is desired to establish a system, such as proposal making, in which active utilization of the new technology by the contractor will lead to an increase in orders.

No single magic bullet

The planned period of the activities of "SIP infrastructure," as well as the support activities for regional implementation included in it, is going to end in March 2019. The support activities for regional implementation of new technology under the initiative of local universities are currently in the stage where their effectiveness has been demonstrated. It is hoped that the support activities take root in local universities in collaboration with the activities of NCIM. Public funding is essential for support activities for the time being. It is also hoped that the findings obtained from the support activities for regional implementation in Japan are utilized for enhancing the efficiency and sophistication of infrastructure maintenance in developing countries in Asia and Africa in cooperation with the Japan International Cooperation Agency (JICA) (D-9).

From the next fiscal year, it is strongly hoped that the approaches listed in Table 3 will be put into practice and more of such attempts will be made. There is no single magic bullet for making the infrastructure maintenance field more attractive and implementing new technology on a regional level. Knowing that people at different positions think differently with different goals, it is important to continue to make efforts at respective positions, working toward a change for the betterment of the entire infrastructure maintenance field.