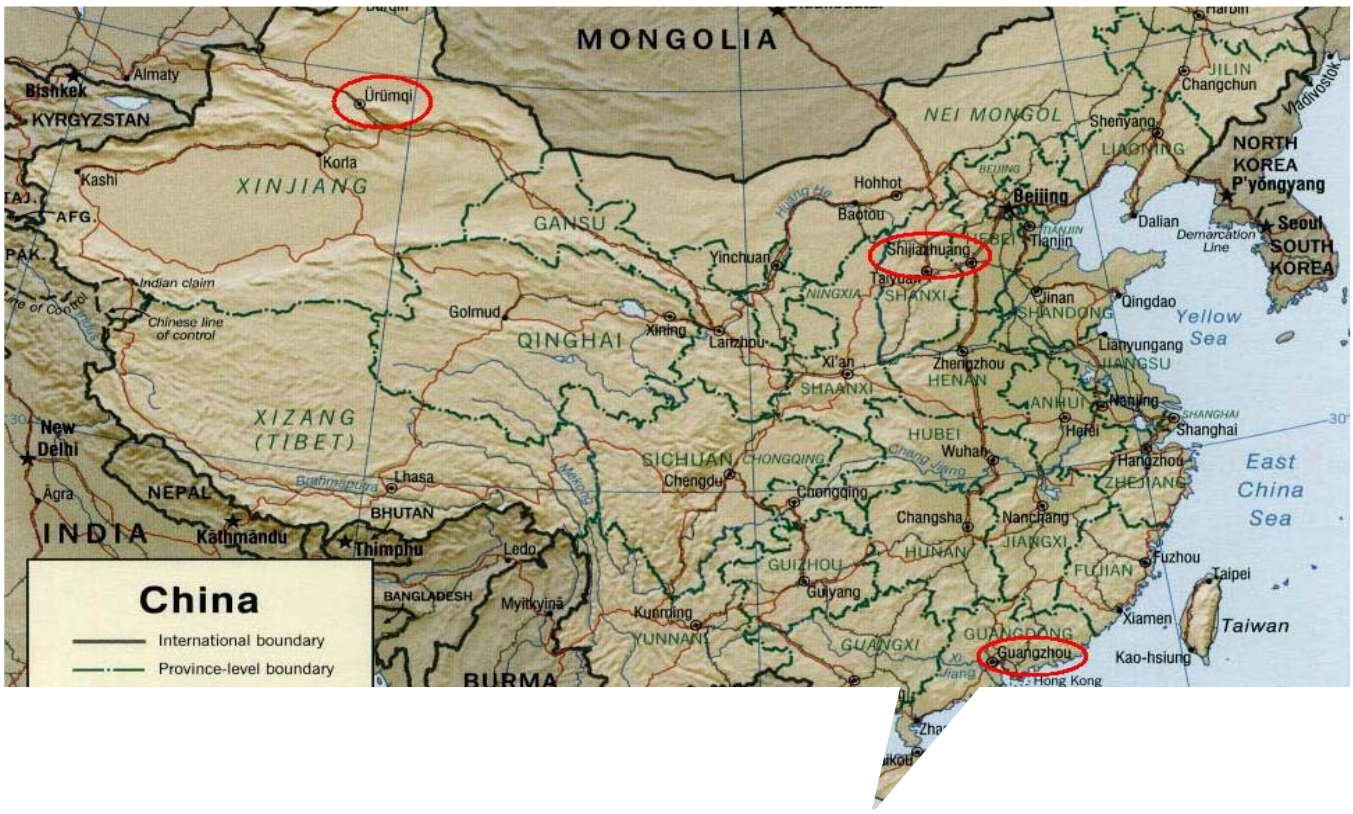

The World Bank

Road Infrastructure Management for Three Cities in China

Support to the Bank on the Highway Portfolio in EAP (Final Report)

August 2007

RAMBOLL

This consultant's report does not necessarily reflect the views of the World Bank or the cities that participated in the study. The World Bank and the cities cannot be held liable for its contents

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Prepared by Jens Hede
Checked by -
Approved by Jens Hede

Rambøll Danmark A/S
Bredevej 2
DK-2830 Virum
Danmark

Phone +45 4598 6000
www.ramboll.dk

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1. Executive Summary

The World Bank is supporting road agencies in a number of cities in implementing cost effective maintenance approaches, optimising the use of the scarce maintenance funds available. Some of the projects have experienced problems during the implementation, leading to significant delays.

As to improve the implementation of similar projects, a selection of projects has been reviewed (Urumqi, Guangzhou and Shijiazhuang), as to find common issues and lessons learned which could be adopted to improve the quality of future projects.

The lessons learned from the reviewed projects fully substantiate the recommendations in the World Bank report[1] 'Success Factors for Road Management Systems' (published after the commencement of the reviewed projects). Thus the main recommendation is for future projects to fully adopt the recommendations given in that report.

However there are a number of additional recommendations which should be considered. These include activities when (i) formulating the project; (ii) when implementing the project; and (iii) after project implementation.

During project formulation it is important: (i) that a suitable project organisation is setup, providing clear communication lines; (ii) that some capacity of the client is build during the formulation, as to enable the client to better facilitate the project description; (iii) that operational budgets (organisation, system and data collection) would be estimated and agreed with the client; and (iv) that the services packaging is carried out carefully.

It terms of the TOR (implementation), it should be ensured: (i) that the consultant is requested to post at least some key staff with the client; (ii) that the technologies adopted is suitable to the client's capabilities; (iii) that project output is made tangible as soon as possible (preferably by phasing the system deliveries); (iv) that training requirements would be elaborated; and (v) that the requirements to the bridge management systems would be elaborated.

It should also be considered that the consultant should assist the client after the development and installation of the system with: (i) system operation and analysis; (ii) data collection; (iii) adopting system output in the business processes; and (iv) provide refresh training.

Finally, it should be ensured that the copyrights issues are clear before the project is tendered, including needs for annual system maintenance agreements.

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[1] Success Factors for Road Management Systems, The World Bank, 2005

2. Study Background

The Bank has been undertaking urban road management system (RMS) projects in three cities in China: Guangzhou (P003614), Urumqi (P045915), and Shijiazhuang (P056596). The projects have each faced their own sets of challenges and issues, ranging from replacing the principal consultant (Guangzhou) to time delays and institutionalization issues.

The recent Bank report 'Success Factors for Road Management Systems' identified that to be successful, there probably need to be a convergence of people, processes and technology, supported by adequate funding. The objective of this study is to review the progress to date on the three urban projects above, identifying how the Bank should approach similar activities in the future to increase the likelihood of success. By bringing together the shared experiences of the three projects, it should be possible to improve the quality of future activities.

2.1 Approach & Sources

The Consultant has visited each of the three project cities; each visit having a duration of 2-3 days. During the visits interviews have been conducted with representatives from: (i) the project management offices (typically the Transport/Project Office); (ii) the road agencies (end users); and (iii) the involved consultants. Interviews in the road agencies included decision-makers as well as operational staff. The list of people met in each of the three cities is enclosed as Annex 1.

Further to the interviews the Consultant has reviewed relevant project documents as far as they where available in English.

The survey generally focussed progress and efforts within the success factors (people, processes and technology), and tried to analyse the underlying reasons for the problems experienced in the projects. The analysis included all phases of the projects including: (i) project design; (ii) system design; (iii) system implementation; and (iv) system institutionalisation.

The interviews were structured using the matrix enclosed as Annex 2. The matrix included some key issues, though the issues indicated by no means were meant to be exhaustive.

During the analysis of the data and information collected, the Consultant has sought to find common problems between the projects, as to draw general 'lessons learned'. Also more specific project problems which could be applicable to other future projects have been analysed.

3. Urumqi Urban Road Maintenance Management System

Urumqi, the Capital of Xinjiang Uygur Autonomous Region, is located in the north-western Region of China and is one of the four main gateways (together with Beijing, Shanghai and Guangzhou) to the neighbouring countries.

The length of the urban road network in Urumqi is about 1,160 km and includes expressways, trunk roads, secondary roads; and local roads. Most of the roads are in asphalt concrete (1,100 km), the rest of them in cement concrete. There are 30 bridges/overpasses and 36 underpasses/tunnels.

Based on field surveys in 2003, it was reported that more than 35% of the roads needed immediate major maintenance and rehabilitation. As the funds allocated for maintenance is very small compared to the needs, the roads are under rapid deterioration.

Urumqi Municipal Engineering and Appearance Management Bureau (MEAMB), which is affiliated to Urumqi Municipal Construction Commission and Municipal Government (UMCCMG), have been vested with the responsibility of maintenance, construction and management of the road network. Under the Urumqi MEAMB there are several divisional or district level road agencies that are responsible for maintaining their individual regional or district road networks. One of these is the newly formed Asset Management Centre.

As to close the significant gap between maintenance needs and current funding levels and to use available funds more cost-effectively, MEAMB has partnered with the World Bank in taking steps towards improving its road management approaches (through the Urumqi Urban Transport Improvement Project, UUTIP). A component of the UUTIP is the development and implementation of an Urban Road Management System, named Urumqi Road Maintenance Management System (URMMS). The system will be operated and managed by the Road Asset Management Information Centre, under the Asset Management Centre.

3.1 Project Description

The objectives[2] of the project is '…to provide Urumqi municipal government decision makers with a modern management tool that can be used to improve the current business process in maintenance and management of the municipal road network'.

[2] Terms of Reference for Development of Urumqi Urban Road Maintenance Management System

The project aims at developing an effective urban road management system (Urumqi Road Maintenance Management System, URMMS) for applications in: (i) database and information management of pavements, bridges and structures; (ii) performance evaluation and prediction of road deterioration; (iii) strategic planning for road network maintenance; (iv) multi-year maintenance and rehabilitation programming; and (v) prioritisation of road maintenance projects within given budget constraints.

The scope of work of the consultant procured to assist MEAMB includes: (i) review exiting road network practises in road maintenance; (ii) identification of main issues and needs for operational improvements in road management; (iii) design and development of a database structure and information management subsystem; (iv) develop procedures for collection of pavement and bridge condition data; (v) Design functional models and analysis tools; (vi) integrate road maintenance subsystems into a single framework (including pavement management, bridge and structural database management); (vii) participate in system installation and operation training during the project implementation phase; and (viii) provide a complete set of user documents and manuals.

The main part of the services thus concentrates on developing and installing the URMMS system; while the client will be responsible for data collection and system institutionalisation. The project does not require the consultant to undertake the services on site in Urumqi.

The project is implemented in five phase: (i) investigations and evaluation of maintenance business processes and overall system architecture; (ii) development of data collection procedures and criteria for performance measures; (iii) design and development of functional models; (iv) assist in collection of a complete set of sample data; and (v) submission of application package and provision of training.

In the TOR there were no requirements in terms of local presence during project implementation. A total input of 50 man-months of international and domestic staff had been estimated in the TOR (equivalent to an average of five full time staff during the project period).

3.2 System Requirements

In the project description is listed a range of functional and software requirements. The main requirements are summarised below.

The deliverables by the consultant includes: (i) road and bridge database; (ii) road management system; (iii) bridge management system; and (iv) a geographical information system.

Generally it is required that the system would be based on an existing windows based application, which would be customised to meet the needs of MEAMB. The

system, to be supplied in three copies, should run in local networks or as stand alone. All language should be in Chinese.

The road and bridge *database* should be based on Oracle or SQL Server, and would store information on traffic, bridges, pavement attributes and pavement performance. The data to be stored would include:

- Road Network Inventory; including all roads (length, width, lanes, surface type, structure, materials, drainage etc.) and bridges (elements)
- Surface Distress Data; including a range of different surface distress data
- Roughness/Riding Comfort; data from automated roughness measurements
- Deflection-Based Structural Testing; date from FWD measurements
- Bridge Condition Survey: bridge components and their condition (rate)
- Traffic Data; including classified counts, AADT, bus and truck route designation, growth rates, and axle load data
- Historical Information; such as rehabilitation and construction information, maintenance information, and historic performance data

The database should include validation models and features for data batch uploading. Furthermore there should be security and access levels to ensure database integrity.

The *Road Management System* should be able to evaluate the pavement condition using a range of indices; such as pavement condition index (PCI), ride comfort index (RCI) or structural adequacy index (SAI). The system should be developed based on local conditions for road class, pavement structures and material properties, traffic levels and environmental conditions.

The system should be able to analyse needs (unconstrained) for routine maintenance (up to ten years) and rehabilitation (up to five years). The needs should be analysed using user-defined trigger values for a range of pavement performance parameters.

It should be possible to prioritise the needs (constrained) under different budget envelopes and to analyse the network condition under the given budgets (planning). The prioritisation should use economic as well as non-economic models. The TOR states that ‘the analyses should be based on deterministic modelling such as in HDM-4 and must be suitable for both short and long-term maintenance and rehabilitation programming’.

The requirements to the *Bridge Management System* are only marginally described in the TOR. The system should establish a bridge preservation programme using a decision tree or other similar approaches.

The system should be able to undertake analysis on project level as well as network level. It is required that the prioritisation procedures should integrate bridge as well as pavement maintenance and rehabilitation needs.

The requirements to the *Geographical Information System* are only marginally described in the TOR. The GIS should be imbedded or dynamically linked to the database and should be able to display data on maps and access images.

3.3 Current Progress

The consultant mobilised in May 2005 and the project was expected to be completed by July 2006. Project completion is significantly delayed, and currently the complete date is estimated to July 2007. However this deadline would most probably not be met.

A review of the project progress is given in a separate volume enclosed as Annex 3. Below is provided a brief summary.

Of the five phases only phase i) and ii) has been completed (review of current road network practises and identification of the main problems and needs for road management improvements). The remaining phases are either ongoing or yet to be initiated.

The system will be based on a COTS[3] system (EXOR). This system is still being adjusted and adapted to the specific needs of MEAMB. An important part of this adaptation is integrating the EXOR with the HDM-4 system. The proposal stated[4] that 'Customisation work will involve the integration of all the EXOR software modules; incorporation of HDM-4; development of Chinese language support and application and function customisation to implement the specific workflows identified in the earlier project phases' and that the installation would be done 11½ months after the commencement of the project. During the negotiations the World Bank expressed concerns about the ability of the EXOR software to meet the requirements of the TOR but the software vendor confirmed that the application did indeed comply.

Unfortunately, the software vendor was not able to deliver functionally compliant software in a timely manner which has delayed the project. Two years after the project commenced the system is not installed and MEAMB has not received prototypes of the systems as to familiarise them selves with the system navigation and functionalities.

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[3] Commercial-off-the-shelf System

[4] Information provided by the World Bank (the Consultant did not have access to the proposal)

The implementation has been further delayed by the data needed for the digital mapping (which is to be delivered by MEAMB) not being complete. An issue with the delivery of the data was identified in early 2006[5]. This means that the GIS mapping feature of the URMMS cannot be completed, and that the road network definition and inventory attributes, which will form the basis for the database, is not prepared, thus basically leaving the database empty.

Most of the data collection equipment has been purchased (Falling Weight Deflectometer (FWD), Ground Penetration Radar (GPR), Road Surface Profiler (RSP), Friction tester), though of the equipment is still it the 'boxes'. None of the equipment has yet been employed for data collection (only for training). However the visual inspections (carried out manually) are near completion. But as long as the road network data has not been uploaded to the database, it will not be possible to store any condition data (for this the location referencing system needs to be in place).

So far the training has been sparse, and mainly comprised introductions. The following training has been applied: i) overview of road maintenance management (1 day); ii) overview of RMS (1 day); iii) overview of data collection (2 days); iv) introduction to EXOR (½ day); and v) overview of HDM-4 (½ day).

Finally, the consultant is, in parallel to the system development, updating manuals and translating these into Chinese.

3.4 Main Issues

Based on the review of the project, some important issues have been identified.

The project is significantly delayed; the programming has not been completed, the digital mapping is still ongoing, while some equipment has not even been mounted yet. Generally both MEAMB and the consultant are responsible for the delays. While some of the tasks are interdependent, many of the delayed tasks could proceed independently.

The objective of recommending the adoption of COTS software is that it should allow for rapid prototyping and implementation. This ensures that the agency has the maximum length of time during the project to become familiar with the system and understand its use in the organisation. These benefits have not materialised for this project, as the delays in the vendor providing a suitable software platform have created problems.

MEAMB has adopted rather advanced data collection equipment (FWD, GPR, RSP and friction tester). The suppliers of this equipment are requested to train MEAMB staff in using the equipment and in data analysis.

[5] The World Banks supervision mission, January 11-2, 2006

Based on the interviews with the involved staff, it seems plausible that they will be able to operate the equipment, if budgets are available, but that they are rather weak in data analysis, which at best will be done rather statically (using the setup provided as part of the training). Further, it seems that the staff finds it difficult to relate the data collection to the RMMS system and its analysis models.

Thus it is doubtful if the equipment will ever play the central role intended. This issue is amplified by the fact that MEAMB has not allocated the needed vehicles for the surveys. Of the surveys needed, only the visual condition survey is being carried out.

Even though the project has been running for 2 years, MEAMB has still only little appreciation of the system they will adopt. The short presentations and the reports (progress reports and technical reports) give only an overall understanding of the system. To really appreciate the system, it needs to be made more tangible.

In terms of system institutionalisation, MEAMB needs to fully understand, that the system will move them from a purely condition driven maintenance programming approach to an economically driven approach. Such move, often leads to surprises, as funds under constrained budgets might be suggested to section where the condition is no yet severe (focusing on asset preservation).

Further it needs to be made more clear, how the system will support them in maintenance planning and programming, and how this fits with the current business processes.

MEAMB will establish an Information Centre, which will be responsible for operating and maintaining the URMMS. The centre is still not furnished with any permanent staff, but 4-5 staff is currently seconded to the centre (though they are still very much involved in their previous tasks as well). It is important that this centre will be made fully operational as soon as possible, including the necessary budgeting.

Figure 1 URMMS Room in Urumqi

The training has so far been rather sparse and mostly has taken the form of introductions. For the system to be institutionalised a significant training effort needs to be applied.

The planned exposure trips within China has not materialised so far (not approve by the Project Executive Office, PEO). Hence the involved staff has missed out on the benefits on being inspired by other similar projects.

MEAMB has no plan on how to sustain knowledge within the Information Centre. Neither do they have an explicit plan on how the new coming staff to the Information Centre will be training and prepared for their tasks.

3.5 Main Lessons Learned

Below is outlined some of the main lessons learned based on the issues identified.

Generally it must be concluded that the involvement of MEAMB during project design quite limited. MEAMB is the executing agency and receiver of the assistance; however they do not have much capacity within road asset management. They have not used such principles previously and they have not been trained on the principles before the arrival of the consultant. Thus while MEAMB might understand the benefits of having a road asset management system, they know only little about the subject.

Realising that the MEAMB has only limited knowledge of RMS systems, the PEO have employed an external international specialist to assist in reviewing the work carried out by the consultant (the same specialist also developed the TOR). While this makes sense, in terms of responding to the consultants work, it also provides the MEAMB with 'an excuse' not to involve them self fully in the project and adds very little to the capacity building of MEAMB, which is also visible in the fact, that MEAMB has only little understanding of the system they are about to receive.

This situation could have been approved if the capacity of the executing agency, the MEAMB, would have been improved prior to system development and implementation. Currently the client finds it difficult to relate and respond to the work of the consultant (who fields experts within road asset management). This situation is also difficult for the consultant, as he cannot discuss make agreements with his direct counterpart. Finally it is deemed that the many reviewers (PEO, MEAMB, international specialist) of the project output contribute to the delays.

The TOR focuses primarily on the technologies to be adopted (including data collection technologies) and less on the organisational issues and processes which are equally important as documented the World Bank published Success Factors for Road Management Systems' report. It is clear that the MEAMB has not been able themselves to develop the needed organisational structures and prepare the supporting processes needed to make the project a success.

However even within the technology factor, the technologies adopted seem too complex for MEAMB. Even though MEAMB is a novice within road asset management, the technologies adopted includes some of the most advanced equipment on the market (including road surface profilers, FWD equipment and GPR). This is all equipment which is based on advanced technologies which requires specialised maintenance and calibration. Further, the analysis of some of the data requires rather specialised capabilities (such as FWD back-calculations or analysis of GPR output).

As MEAMB has never worked systematically with data collection and never used any advanced equipments, the adopted data collection equipment represents a giant step for MEAMB. However the consultancy assistance provided in undertaking this step is marginal.

Generally the system requirements given in the TOR seem feasible for MEAMB. As mentioned above, the World Bank expressed concerns prior to contract signing as to the ability of the software to meet the requirements in the TOR. In hindsight it could have been useful to have a thorough demonstration of the software compliance prior to the contract being signed as well as a firm delivery schedule.

Of concern is the requirement of HDM-4 integration. HDM-4 provides many of the analysis functionalities needed in road asset management, but is also a rather complicated system; both in terms of data needs and in terms of system operation. Adopting HDM-4 as the 'analysis engine' in a road asset management system will

require a significant capacity building effort; which is not really catered for in the TOR.

The result of the focus on technologies and less on people and processes is also a physical distance between MEAMB and consultant. The consultant has not been embedded with MEAMB, but have only visited the organisation and presented their main conclusions. The system development and customisation has been carried out at the premises of the consultant far away from Urumqi.

The World Bank has informed that this was pointed out by the Bank prior to the contract being signed: '...While it is not efficient for the project to have staff in Urumqi who are not required, at the same time it is the Bank's view that project requires that the majority of the staff time be done in Urumqi. The Consultant should therefore revise their staffing plan accordingly. This should also ensure that there is continuity of leadership in Urumqi, specifically, they need to have the Team Leader or his Deputy in Urumqi for the entire length of the project'. In their response to the Bank the consultant noted that this was not a requirement of the TOR and therefore was not allowed for in the proposal. It is therefore important that future projects ensure that remote work on the project is minimised.

A consequence of this remoteness is that it has been difficult for MEAMB to track progress (other than what the consultant reports in his progress reports) and that the dynamics which should enable MEAMB to be involved in shaping the URMMS is lost. It also means, that MEAMB is not provided with the day-to-day assistance they need for institutionalisation of the system and the related revised processes.

The project is divided into several packages: (i) URMMS development and implementation; (ii) Digital mapping (road network inventory data and GPS coordinates); (iii) procurement of equipment; and (iv) data collection. While an international consultant is engaged to assist with the first package, the three latter packages were basically client deliveries, though the consultant should provide some advice. The client requested a local consultant to undertake package (ii). However, as the client deliveries are delayed significantly, it also influences the progress of the engaged consultant. Consequently the consultant has been requested to be more involved in these deliveries, though being outside the scope of the TOR.

It is thus important that the packaging of the services is carried out carefully, and that client deliveries shall match the capabilities of the client. In the case of Urumqi, the client was left with deliveries (such as equipment procurement or data collection) he did not well understand.

A sustainable data collection, which is often the one of the most difficult parts to succeed in, was not given the attention needed. While the consultant was requested to provide advice on data collection procedures, it was basically assumed that the actual collection of the data could be handled independently by MEAMB. During the visit to the client, none of the procured equipment has been put into use, and it must

thus be concluded, that this approach has failed. Hence, the consultant needs to be much more involved in the data collection as to assist and guide the client.

The TOR requested the consultant to provide training in system operation and management. In the Instructions to Consultants (Data Sheet) it is mentioned, that training is a specific component of the assignment; however the requirements in the TOR in terms of 'Training and Technology Transfer' are quite general, and the whole section is less than ½ page. This does not stimulate the consultant to focus much of his effort in training.

It seems that the funding which needs to be provided by the client to operate the system and data collection equipment is not yet in place. Thus, the organisational unit, which will receive the services, has not been established and the counterparts are only working on the project part-time. This does not stimulate ownership and it significantly effect the capacity building during project implementation.

The consultant is required to supply software support for a period of one year after the completion of the services. Beyond this period MEAMB must sign a maintenance agreement with the software supplier. At the time of signing the contract MEAMB did not appreciate the implications of this and while a temporary solution has been found (by reducing the number of licensed users), in the longer term the high costs for maintenance and support may create difficulties for MEAMB.

4. Urban Road Pavement, Bridge and Drainage Facility Management Systems for Guangzhou City

Guangzhou, the capital of Guangdong Province, is located on the Pearl River Delta, in the south-eastern part of China and is a very modern city (similar to Hong Kong or Bangkok). Its population is about 8.4 million.

The length of the urban road network is about 400 km, including the Inner Ring Road. The pavements comprise asphalt pavements as well as cement concrete pavements. There is 210 bridges, of which 16 crosses the Zhujiang river, 85 crosses other rivers; 48 interchanges; and 61 pedestrian bridges.

The main responsibility of road and bridge maintenance rests with the Guangzhou Municipal Engineering Maintenance Department (GMEMD) under the Guangzhou Municipal Administrative and Landscaping Bureau (GMALB).

The organisation lacks modern management technologies and thus partnered up with the World Bank (through the Guangzhou City Centre Transport Project, GCCTP) to implement a number of components, focusing on improving the city's urban transportation system. One of the components is development and implementation of a Urban Road Management System, named Urban Road Pavement, Bridge and Drainage Facility Management System (PBDFMS).

4.1 Project Description

The TOR[6] of the project was revised during the course of the project implementation in connection with the replacement of the prime (lead) consultant. While the overall project objectives remained the same, some of the detailed tasks were revised. The description below is based on the revised TOR.

The overall objective of the services '…is to improve the performance and efficiency of the maintenance of the urban transport facilities in Guangzhou, to optimise and rationalise the distribution of maintenance funds, and to ensure the continuity and systematisation of the maintenance management through the introduction of modern technology and equipment'.

The main purpose of using the developed system includes: (i) support a more efficient use of the scarce maintenance funds; (ii) systematically accumulate maintenance experience; (iii) systematically accumulate historic data; (iv) predict future damage of road assets; and (v) improve working efficiency of the routine maintenance management of the city's transport facilities.

The scope of work includes: (i) design and develop a complete PBFMS; (ii) install application software and all supporting programmes; (iii) collect data and information needed for operating the system; (iv) modify digital maps of the main urban area of the city; and (v) implementation of training and technology transfer programmes.

The implementation of the project is divided into four phases: (i) system construction phase (requirements study, system design and development, data collection and digital mapping); (ii) system trial operation preparation phase (information preparation, manuals, training and users' data collection); (iii) system trial operation phase (system testing, system perfection); and (iv) system inspection and acceptance phase.

Of the long list of main tasks given in the TOR, far the most is referring to the system to be developed. Though the consultant should make some recommendations in terms of organisational issues, the consultant would not be involved in implementing such recommendations.

The consultant was required to set up their own office facilities in Guangzhou for the purpose of the assignment. In the TOR it was estimated that the services required an input of 172 man-months of international and domestic staff (equivalent to an average of about eight full time staff during the project period).

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[6] Development of Urban Road Pavement, Bridge and Drainage Facility Management System for Guangzhou (undated)

4.2 System Requirements

The TOR includes a rather detailed report with specifications for the system to be developed. These requirements are prepared by a local consultant and are deemed not meet international standards; though they do describe the basic needs. The main requirements are summarised below.

The deliverables by the consultant includes: (i) management information system; (ii) pavement management system; (iii) bridge management system; (iv) drainage infrastructure management system; and (iv) a geographical information system. Each of the three applications would have the following sub-systems: (i) static information management (inventories); (ii) dynamic information management (performance data, historic data); and (iii) evaluation, prediction and evaluation analysis. During project implementation the drainage infrastructure management system was taken out of the project (and thus is not included in the description below).

The system to be delivered should be a state-of-the-art PBDFMS, fully integrated with GIS and with a Chinese user interface. The system should be tailored to the Bureau levels as well as the Department level. It is noted that there is no mention about building the system on an existing application.

The *Management Information System* should be developed as a client/server application. There are no specific requirements to the database management software to be adopted. The data should be able to store information on roads, bridges, drainage infrastructure and traffic, and should include functions such as: (i) information management (data maintenance, information browsing, information search, information statistics and reports); (ii) map management; (iii) connection between user levels (bureau and department); and (iv) interface designing. The database should be able to store digital pictures and video/audio data.

A range of functional requirements are given for the *Pavement Management System*; including pavement evaluation and statistics, pavement deterioration prediction, annual and long term maintenance plans and network condition under alternative investment scenarios.

The system should be able to handle a number of evaluation models, such as pavement condition index (PCI), pavement riding quality (based on roughness measures with laser profilometer), road structure bearing capacity (measured by FWD) and road skid resistance (British Pendulum). Distresses used for the computation of the PCI should be collected by automated digital imaging systems. It is specified that the evaluation methods should be combined to one overall condition rating (pavement quality index, PQI). It is further required that prediction models (pavement deterioration) should be established for a subset of the evaluation models.

Maintenance decision models should take into account: (i) structural capacity; (ii) pavement surface condition; (iii) pavement riding quality; (iv) base materials; and

(v) traffic volumes. Maintenance decision threes should be developed to estimate maintenance and rehabilitation needs. The prioritisation model required is rather simple, compared to the other system features. Under budget constraints projects are selected using combinations of road class, PCI, pavement strength and roughness.

The system should be able to output an annual maintenance programme and a long term plan (5-10 years). The road network condition under different budget scenarios is to be expressed by PCI.

The *Bridge Management System* should be able to manage inspections (daily, regular and special); and include evaluation and decision models; statistics and inquiry models; and report functions. The inspections would give the condition of each bridge element. These conditions would be used to compute the bridge condition index (BCI), for which the detailed formulas and factors are given in the TOR.

Bridge maintenance needs should be ranked using a combination of BCI and traffic volume. The system should: (i) be able to give simple maintenance strategy suggestions (including maintenance plans, priorities and costs estimates over a short and medium term period); (ii) be able to provide warning of dangerous bridges; and (iii) be able to give a route indication for overloaded vehicles.

There are not specific requirements to the *Geographical Information System*; though a list of theme maps is given. However integration with GIS in mentioned throughout the description of the information management system and the description of the system applications. Thus it is clear, that the GIS is envisaged to play a significant role in the PBDFMS.

4.3 Current Progress

A review of the project progress is given in a separate volume enclosed as Annex 4. Below is provided a brief summary.

The (original) project was started in October/November 2004, and was planned for a period of 22 months (up to August 2006). But the cooperation between the consultant and the client became difficult, and progress halted. As the parties could not reconcile, it was decided to replace the lead consultant with one of the sub-consultants (who was working with a similar project in another city in China Mainland).

This new contract (and revised TOR) was signed in July 2006 and was planned to be completed by December 2007. However, the system, which is far from ready, should according to the contract schedule have been ready by March 2007; thus the project is still several months behind schedule.

This is critical as the World Bank loan will complete by end of 2007. This means that there is a real risk of rushing the system development and programming through and that the client does not have sufficient time for their system acceptance test.

While the GMEMD indicates delays in system programming as the main reason for the delays, the consultant indicates: (i) system programming; (ii) delays in procurement of hardware; and (iii) digesting of acquired knowledge as main reasons for the delays.

Of the many main tasks listed in the revised TOR, the consultant has only completed a few (those related to the preliminary tasks, such as reviewing existing processes and procedures, establish revised requirements and outline the preliminary design of the PBDFMS). The Detailed Design of the system has not yet been agreed on, and only the surface condition survey of data collection programme required for populating the database has been started.

Due to pressure from the client, the consultant has installed a 'prototype' of the system. The intension from the consultant was that this prototype was just to play with, to get an idea of what how such systems can look like. However as this 'prototype' does not meet the requirements of the PBDFMS, the installation has lead to confusion and further discussions on the performance of the consultant.

Only very little training has been provided so far; most of it related to data collection using the purchased ARAN vehicle.

4.4 Main Issues

Obviously, the significant delays and the changes of the lead consultant are issues which have affected the project implementation. Some of the main reasons for these issues seem to be a lack of resources allocated by the consultant, poor relationship between the client and the consultant, and lack of focus and actions by the client.

GMALB has very high expectations to the system to be delivered. The client has resources available (human as well as economical) and is much better off then the other road agencies visited. GMALB has already developed and operates related asset management systems, such as the advanced 'DigiM' system[7]. Thus even though the client has not worked with road asset management principles before, it is deemed that he will be able to absorb the rather complex and advantaged equipment adopted for data collection and use this equipment to collect the needed data, provided that the client will be training sufficiently.

It is clear that the expectation of what the consultant is preparing to deliver does not match the expectation of the client. It seems that the consultant plans for supplying

[7] 'Digital Municipality'; GIS based system which integrates the asset management of a range of assets (infrastructure, parks, utilities, water, gas, waste water).

his COTS system (ICON) and customise this, while the client clearly expects a bespoken system, built 'from the ground' to meet the client's detailed needs. As the project has suffered from significant delays, this problem has been 'hidden' until a rather late stage of the contract implementation. The mismatch between expectations would have become more clear, had the system been made tangible on an early stage.

Due to the delays in the contract implementation, the client has not yet established the unit which will take ownership of the system and be responsible for data collection. For the time being, the consultant works with a working group. This means that the working procedures and processes can not be institutionalised during the implementation of the project.

Even though not requested to do so, the consultant is using the clients purchased equipment (ARAN vehicle) and counterparts to carry out the data collection. This builds capacity at the client. However, some of the needed equipment has not yet been approved by GCCTPO or has not yet been procured. This obviously delays the data collection. To progress the consultant could hire his own equipment, but this will do little to built capacity at the client.

While the staff is currently learning how to used the procured equipment, they have little understanding of data processing and how the data will be used in the road asset management system.

At this very late stage, the Detailed Design of the system has not yet been agreed upon. This constitutes a significant risk to the timely project completion. Further there is a risk, that even when agreement is reached, the client will not fully understand the system until it has been made tangible; this might lead to new discussions and further delays.

The consultant has not yet made his work tangible to the client. The prototype installed has only marginal relation to the system expected, thus the client is getting increasingly frustrated and nervous about the deliveries.

The cooperation between the client and the consultant has improved compared to the situation before the replacement of the lead consultant, but is still rather difficult. If the cooperation is not improved further, there is a risk of further delays.

It seems that the consultant is not supplying the resources expected. A particular problem raised by the client is the quality of the reports submitted. Even though all reports should be submitted in Chinese and English, only Chinese versions have been submitted so far. This means that some of the key staff of the consultant has not been involved and reviewed the reports, as they do not read or understand Chinese.

The PBDFMS is a specialised application under this 'DigiM' umbrella, and the systems will on a later stage be integrated (by GMALB themselves). There has been some

degree of coordination between the 'DigiM' system and the PBDFMS system; though not to the degree where the two systems would be compatible.

Figure 2 Guangzhou's 'DigiM' System

The consultant should as part of his services prepared operational plans for system operation, data collection and for the organisation processes. At least for the latter the client reports, that he has 'given up' on the consultant being involved.

Due to the rather chaotic implementation of the project, it is doubtful that the client will fully understand the role of the system in their business processes, and the use of the system to support actual maintenance planning and programming.

4.5 Main Lessons Learned

It seems that the work relations between the client and the consultant have affected the project implementation significantly. This has lead to misunderstandings and a mismatch between expectations to the project output. The issues have been amplified by a client not used to working with international consultants and a consultant who has done little work overseas. Further the project is rather large (38 man-months of international specialists and 132 man-months of local specialists), and is deemed to be on the boarder of the capacity of the consultant.

As the system development has been delayed significantly, there has been little tangible output to facilitate the discussions between the client and the consultant.

The original lead consultant did not perform as could be expected, and was thus replaced by one of his sub-consultants. It has been reported, that one of the main reason was, that he did not field the staff promised in his proposal. Yet the consultant was working almost 1½ year on the contract before being replaced. This is too long for problems like this to build up.

It is deemed that many of the cooperation issues could have been reduced, if the consultant (at least part of his team) was embedded with the client. In this case, issues could have been addressed on the rise; rather than letting them built up.

As for the Urumqi project, the GMEMD has not yet seen the system which they are about to adopt. If the system was developed and supplied in modules, GMEMD would be able to track progress and gradually digest the system functionalities. It would also facilitate the discussions on expectations.

As for all three projects, data collection (except for some test data) has been put in the hands of the client. This makes sense in terms of capacity building, but needs to be accompanied by suitable technical assistance.

The data collection equipment was procured on a separate budget and handled directly by the client. Thus the consultant had only little influence on the suitability of the equipment, as his role was reduced to prepared guidelines for data collection procedures. Client tends to opt for the most advantaged equipment on the marked, and might be less concerned with how this equipment fits with the road asset management system. In fact the two are interdependent, and should be developed in parallel. Further the client needs to better understand how the processed data is used in the analysis and estimation of the maintenance and rehabilitation needs, including how each data item (and thus equipment) contributes to the estimations.

Delays in the procurement and in approving the equipment have directly affected the progress of the project. Thus the packaging of the project components is very important in terms of project implementation.

5. Shijiazhuang Road Maintenance Management System

Shijiazhuang, the capital of Hebei Province, is a rather new city located about 250 km south west of Beijing. The city has a population of about 3 million.

Shijiazhuang's road network includes four horizontal major arterial roads; eight major artery roads; three ring artery roads around the city centre; and eight arterial roads coming in and out of the city centre. There are about 30 bridges.

The total length of the urban road network is about 500 km; 90% of this being with flexible pavement structures. Currently there is no clear statistics on pavement condition. However generally, even though these roads have receive significant mainte-

nance over the past decade, the roads constructed in the 1950's (which only has a thin asphalt layer) are now facing serious condition problems (inadequate strength and instability problems). Pavements constructed later (with stronger pavement structures) shows only few signs of deterioration.

The Shijiazhuang Road and Bridge Maintenance Department (SRBMD) is currently in charge of the city's annual road condition survey, maintenance plan and construction work. They invest about USD 1 million every year in road network preservation. The SRBMD is organised in two independent units; (i) Road Maintenance Centre; and (ii) Road and Bridge Construction Centre. Each of these comprises a number of sections.

In order to use public fund more cost-effectively for road and bridge maintenance, SRBMD has partnered with the World Bank (through the Shijiazhuang Urban Transport Project, SUTP) to strengthen its road maintenance institution. A component of the SUTP is development and implementation of an Urban Road Management System, named Shijiazhuang Road Maintenance Management System (SRMMS). The system will be operated and managed by the Maintenance Section under the Road Maintenance Centre.

5.1 Project Description

The main objective[8] of the project '…is develop a Shijiazhuang Road Management System (SRMMS) that will help SRBMD analyse road investments and their economic impacts on transportation serviceability and preservation of the road network'.

More specifically the objectives are to; (i) review the results of the Stage I project; (ii) provide a modern software tool (SRMMS) that can be used for managing effectively the city's roads and bridges; (iii) assist in populating the system with data; and (iv) use the system to develop road and bridge maintenance strategies and investment programmes.

The Stage I project, carried out by a local consulting firm, prepared technical specifications and requirements for the development of the SRMMS. The output of the studies (a series of sixteen reports) provided background information for the consultant.

The scope of work includes: (i) review of current road maintenance processes: output from Stage I; and identify technical needs for the SRMMS system; (ii) review current practise in road management, including needs for institutional strengthening surveys and data collection methods; (iii) develop a sustainable data collection programme; (iv) design and develop the database structure and information management system; (v) develop functional models and analysis models for modelling pavement deterioration; (vi) implement a simple rule-based system for determining

[8] Consulting Services for Development of Shijiazhuang Road Maintenance Management System, November 2004

bridge investment options; (vii) implement a decision support system for short term and long term maintenance and rehabilitation; and (viii) supply and install the system and give training during the project implementation phase.

The services to be provided by the consultant almost entirely focus on the system development (technologies), while organisational issues and data collection will be the responsibility of the client, with only little assistance from the consultant.

The project is implemented in the following phases: (i) business process and system design; (ii) data collection procedures; (iii) information management subsystem; (iv) decision support system; and (v) supply and install hardware.

The consultant was required to set up their own office facilities in Shijiazhuang for the purpose of the assignment. In the TOR it was estimated that the services required an input of 100 man-months of international and domestic staff (equivalent to an average of ten full time staff during the project period).

5.2 System Requirements

In the project description is listed a range of functional and software requirements. The main requirements are summarised below.

The deliverables by the consultant includes: (i) database and information management sub-system; (ii) pavement management system; (iii) bridge management system; and (iv) a geographical information system.

The system should be based on an existing 'state-of-the-art' road management system and customised and adapted to local conditions. The system should be open for later modifications. The system, window-based and entirely in Chinese language, should operate in local networks as well as stand alone. Data security and access levels should ensure data integrity.

The *database* (Oracle or SQL Server) should be capable of storing, tracking and maintaining information on traffic, bridges, pavement attributes and pavement performance data. Automated data upload from data acquisition systems should be possible while applying data validation rules. The data should include:

- Inventory Data; including all aspects of roads (length, width, lanes, pavement surface, pavement structure and materials, drainage) and bridges (no requirements provided)
- Surface Distress Data; including a range of different surface distress data
- Roughness/Riding Comfort; data from automated roughness measurements
- Deflection-Based Structural Data; data from FWD measurements

- Bridge Condition Data; simple condition data from visual inspections (ratings)

- Traffic Data; traffic counts (classification, bus and truck designation, AADT, growth rate) and axle load data

- Historical Data; construction data, maintenance data, and performance data

The *Road Management System* should be able to create homogeneous sections based on user defined criteria. Based on the surface distresses the system should be able to estimate surface distress index (SDI) and pavement condition index (PCI). Pavement condition should be evaluated by a range of locally adopted methodologies: Benkelman Beam Rebound Ratio (Y), Distress Rate (DR), International Roughness Index (IRI), LSZZ and British Polishing Number (BPN).

Pavement performance curves should be based on local conditions, including pavement type, traffic loads, subgrade materials and conditions. The models should be customisable to adopt other information as they become relevant. Performance prediction models should be established for pavement condition index (PCI), surface distress index (SDI) and structural adequacy index (SAI).

The system should be able to undertake two main types of analysis: (i) project level analysis (short term maintenance programming, less than five years); and (ii) network level analysis (strategic maintenance planning, more than five years). Both types of analysis should be performed under unconstrained as well as constrained budgets and should be able to output the network condition in terms of overall bridge and pavement performance indications.

The analysis should be based on pavement performance models, decision trees and selection criteria. The 'cost-effectiveness' for different strategies, which is used to prioritise needs under different budget envelopes, should be evaluated using the PCI as condition indicator. In addition to this, the system should be able to use multiple pavement performance parameters, including surface distresses, roughness and structural strength data to evaluate present and future condition of the road network.

The requirements to the *Bridge Management System* are only marginally described in the TOR. For bridges it is required that the system should be able to '…establish a bridge maintenance programme'. A simple rule-based system for the prioritisation among the estimated needs should be adopted.

The prioritisation procedures should integrate bridge and pavement maintenance and rehabilitation treatments.

The requirements to the *Geographical Information System* are only marginally described in the TOR. The system should be tightly integrated (either imbedded or dy-

namically linked) with a Geographical Information System. The GIS should provide access to the data in the SRMS and display these data on maps.

5.3 Current Progress

The project started in June 2005, and was planned for completion in April 2006; hence the project is now more than one year delayed. The main reasons for the delay are reported to be: (i) an underestimation of time needed for the system programming; (ii) delays in procurement of hardware; and (iii) digesting of acquired knowledge.

A review of the project progress is given in a separate volume enclosed as Annex 5. Below is provided a brief summary.

Only phase (i) has been reported as completed. The rest of the phases are still ongoing; though some are very near completion (ii and iii).

The procedures for data collection has been prepared, but not yet approved by SRBMD. Furthermore the software needed for the PDA's which will be used for the data collection of visual surface distresses are still being developed.

The SRMMS is based on the ICON software (which is a COTS system, primarily used in USA). The system has been customised in terms of road management, but still needs to be refined to meet the requirements in the TOR; particularly the pavement condition and deterioration models need further development. Furthermore the part of the system related to bridges has not been fully developed yet.

The system is already installed on the server, and can be and is used by SRBMD. They use this prototype of familiarise themselves with the software as it develops.

The manuals and documentation is still under preparation.

Figure 3 Urban Road Maintenance

5.4 Main Issues

Even though the project is significantly delayed, there seems to be a good cooperation between the SRBMD and the consultant, and there is not a long list of major issues, which need to be resolved.

This is despite the fact that the SRBMD has expressed that it has been difficult to work with an international consultant (even though the deputy team leader has a Chinese background). Differences in language, physical distance and ways of working have contributed to misunderstandings and project delays.

The GIS has been supplied by the consultant. But currently the GIS system can only be used rather statically; showing the road network data currently in the database. However road networks evolve and SRBMD needs to able to input new roads. Further they should be able to tailor new theme maps. For this a third party software is needed. This should be procured and SRBMD staff should be trained in using it.

A particular problem is the copyright to the system. As it is based on a COTS system, copyrights would typically rest with the software supplier (in this case the consultant), while the parts specifically developed under the contract to meet the clients local requirements would be the properties of the client. However this has not been agreed upon, and both parties now claim they have the full copyrights.

The consultant is required to supply software support for a period of one year after the completion of the services. Beyond this period SRBMD must sign a maintenance

agreement with the software supplier as to be able to make changes to the core system (ICON in this case). This has come as a surprise to SRBMD, and the issue has not been resolved.

5.5 Main Lessons Learned

SRBMD has a good understanding of the RMS output, and how the system can be used to assist the organisation in planning and programming. The fact that they have already requested system adjustments indicates that they have a good knowledge of the system and its capabilities.

It seems that both parties have been flexible during design and development of the system. This builds on trust and open communication lines.

The fact that a prototype of the system was installed early on in the project has helped in supporting the communication between the two parties and match expectations. The client, who does not have much previous experience with road asset management, quickly got something tangible to work with and practise on, which facilitated his capacity building.

Being involved in the Stage I project, the client has been pre-exposed to principles of road asset management, organisational issues, discussed system requirements and analysis models. This has prepared SRBMD for the design and implementation and for the dialog with the consultant, by building capacity before the mobilisation of the consultant.

It is apparent that the technologies adopted suits the capabilities of SRBMD. The system is based on a well proven system, which is then adjusted to meet the specific requirements of SRBMD. This customisation makes it easier for SRBMD to adopt the system, as they will be able to work with the methodologies which they already know.

Furthermore, the analysis models adopted in the SRMMS are rather simple and easy to understand. The user does not need to reflect on a long list of analysis controls to derive reliable output. Thus the user can quickly generate the needed system output.

Finally the data collection requirements have been made simple. Basically the system is based on visual inspections, but the estimates can be improved by including other pavement condition parameters, such as roughness, pavement strength or friction. Thus the data requirements have been set to realistic levels.

The effectiveness of the visual data collection will be improved by using PDA's during the survey enabling a direct uploading of the collected data to the database (and thus skip time consuming data entries from paper forms to the database). As most of the staff is already using mobile phones, they can easily learn how to use the PDA's.

As the client's capacity within application of road asset management principles develops, the client will also be able to make use of more and more advanced approaches.

It is thus considered that the technologies adopted for the system and for data collection are suitable for the capacity level of the client.

One of the unresolved issues is the copyrights to the system. It is important that the copyright issues are crystallised at the very beginning of the project, before it is tendered to consultants.

The consultant has provided training gradually as the modules have been completed. This means that even though the consultant has not yet delivered the training envisaged (there will be a full 2 weeks training when the system is complete), the staff of SRBMD can navigate the system and perform example on analyses.

Finally the SRBMD has already considered how they will train other staff themselves.

6. Broader Issues

Each of the projects have their own set of issues; but some of the issues are common between the projects, and can provide the basis for common lessons learned, which could benefit future projects.

Such common lessons learned and the resulting overall recommendations are discussed below.

6.1 Project Phases and Success Factors

Besides looking at the success factors as formulated in the World Bank report mentioned in the beginning of this document, the broader issues also relates to different phases of the project; including (i) project design and formulation; (ii) project implementation; and (iii) system institutionalisation.

As opposed to the system implementation, which can be succeeded in months, institutionalisation, where the client really get the system and the processes 'under his skin', is counted in years. Thus the institutionalisation is included as a separate phase.

6.2 Overall Recommendations for Future RMS Projects

All the projects were started before the publication of the report 'Success Factors for Road Management Systems'. It is therefore no surprise that none of the three projects reviewed meet the report's recommendations with regard to the balance between technology, people and processes. Generally the projects focus too much on the technology factors, while the people and processes factors were neglected.

Thus *the first and foremost* recommendation is to fully adopt the findings in above mentioned report in future projects. This means that while the system design (requirements and functionalities) and implementation are important, institutional factors (client commitment, policies, business processes, organisational issues and job descriptions), data collection (equipment, technologies, training, quality assurance and management), and extended and multi-level training programmes are equally important. Thus the TOR needs to be much more balanced between the 3 success factors. The generic TOR for road management systems (available for download from www.road-management.info) goes some way to ensuring this balance.

Of the three projects reviewed, it seems that the project in Shijiazhuang is most likely to succeed. The technologies (system and data collection) adopted seems suitable for the client; the client seems committed by allocating the necessary staff; and there is a good working relationship between the client and the consultant.

Overall there are a number of issues, which are common for the three projects, including: (i) significant delays; (ii) the clients not used to work with international consultants; (iii) TOR focuses almost entirely on system technologies; (iv) project organisation; (v) project packaging (client being responsible for data collection; (iv) not using a technical assistance approach, where the consultant is embedded with the client; and (vii) services focus on development, not including much support after installation.

6.2.1 Project Formulation and Design

Often the road asset management components are small compared to the overall programmes (in the case of the three projects evaluated, the RMMS components made up less than 2% of the overall project). However, this small component, is often the one which affects their 'way of doing' business the most.

Being such a small component, it does not take up much focus during project preparation. This is especially problematic, as the clients are often on unknown territories when it comes to road asset management. They have not previously been exposed in details to the principles; most road agencies can relate to road construction and maintenance activities (which dominates the assistance), but not to road asset management.

Further, when the TOR is being prepared, the client finds it difficult to challenge the suggestions made by the expert preparing the TOR and express their needs.

It is thus recommended that, while preparing the road asset management sub-component, time is spend on 'educating' the client, in terms of exposing him to road asset management principals and systems. This is especially important, as the need for a road asset management system is often originated by pressure from the World Bank rather than expressed by the client. Clients can thus quickly end up agreeing to something they do not really what or know why they need.

An important part of the discussions with the client during sub-component design is the questions of adopting and customising COTS systems or request a bespoke system. The client needs to be made clear on the advantage and disadvantages for each approach, as to be able to make an educated decision, which fits into the overall strategy of the client.

As part of this it needs to be crystallised who holds the property rights to which part of the system. If the system is bespoke, this is clear – the client holds all copyrights (as long as this is written in the contract). For COTS systems, the client needs to know that the rights to the core part of the system will rest with the suppliers, while the client will hold the rights to those parts of the system which is developed specifically for him. It can not be recommended that the consultant is requested to surrender the rights to the COTS system as well, as this might restrain some suppliers from submitting proposals, and might drive up the cost.

If COTS systems are to be adopted, it is recommended that the consultant would be requested to present the system as part of the contract negotiations. During this presentation the consultant should illustrate the current features of the system and highlight the needed system adjustments to meet the requirements in the TOR.

Furthermore the needs for system maintenance budgets need to be clearly understood by the client. No system, COTS system or bespoke, is static, and budgets and maintenance contracts are needed to continuously ensure that the system meets the developing requirements of the client. At least for two of the three projects, the clients have been surprised when they learned about the needs for entering in maintenance contracts.

Also related to budgeting, the World Bank is recommended to estimate, together with the clients overall budgets needed for operating the system once in place (human resources, data collection, hardware etc.). Detailed budgets can be developed as part of the consulting services during project implementation. But often the needed budgets surprise the road agencies and they have not made provision for such budgets when the project takes off. This means that the system institutionalisation will suffer from the very beginning, as budgets for e.g. data collection (which can be a significant expenditure) will not exist.

For the two projects where data collection equipment or other important services (e.g. digital mapping) was made an important part of the project, but to be supplied by the client (in separate packages), the delays have affected the progress of the work of the consultant.

Generally it is recommended that the deliveries which affect the consultant should be within his sphere of control, or be completed before the mobilisation of the consultant, unless it can be assured that the deliveries are timely and to the needed quality. Thus project packaging becomes an important task and it should be ensured that the part undertaking the tasks have the required capabilities and understanding how the equipment can be put into use in relation to road network asset management.

An important task during preparation of the TOR for the sub-component is to balance the expectations of the client to what would be sustainable. Often the client would opt for advanced technologies, as it is perceived that this would put less pressure on the resources during operation; while in reality the client would be better off adopting less advanced technologies.

While this is arguably also part of the inception phase of the consultant, it would be advantageous if this was discussed and cleared to some degree with the client when preparing the TOR.

Much of the above preparation of the client could be put into a brief training course (2-3 days), which could be provided to the client when preparing the sub-component. Such training course should include road asset management principles, presentation of the success factors, presentation of different technologies and approaches (systems as well as data collection technologies[9]), copyright issues, budgets and organisational issues etc.

It is recommended that the World Bank would develop such a standard training package, which would then, during the preparation of the sub-component, be conducted by World Bank staff or consultants as appropriate. The training course could also be used to develop a road asset management mindset of the client, and thus increase the client's commitment to the project.

Often the TOR comprises development of a road management system (RMS) *and* a bridge management system (BMS); this is the case for all three projects reviewed. However, the TOR almost entirely focuses on the requirements of the RMS; while the requirements for the BMS are much weaker. This tends to shape the focus of both the consultant and the client; thus leaving the BMS as an appendix to the RMS, which would have less chances of succeeding.

It is thus recommended that the TOR would be more balanced in terms of requirements to the RMS and BMS (probably by detailing the requirements to the BMS). As it is suspected that the experts preparing the TOR are having a background within

[9] Data Collection Technologies for Road Management, The world Bank, 2007

roads, it should be considered to add a bridge maintenance specialist to the team preparing the TOR.

6.2.2 Project Implementation Issues

It is obvious that the capacity and capabilities of the consultant will play an important role in the successful implementation of a project. Some of the projects required a significant staff input over periods of time, which might be considered at the capacity border of some of the consultants. It is deemed, that this has contributed significantly to the project delays, as the consultants have been unwilling or not been able to employ the needed resources.

Further, the consultant will undertake most of the work and will also be guiding the client in his decision-making. Thus a good cooperation between the client and the consultant is imperative.

A common feature between the projects visited is the project organisation. For all projects a 'project office' has been established, which deals with the overall implementation of the World Bank financed project. The consultant submits reports to this project office, while his counterparts come from the executing road agencies. Further the project offices sometimes have engaged technical consultants to assist them. The consultant needs to liaise with all three parties.

This makes communication lines rather diffuse and is deemed to contribute to the delays and problems in formulating the needs and requirements. Thus the project implementation organisation should be considered carefully.

Another common feature between the projects is that none of the teams were embedded with the client. Liaison between the client and the Consultant is based on more or less frequent visits, while the bulk of the services are performed at the office of the consultant. It is deemed that this has contributed to the project delays, as the consultants have not had the needed focus on project progress.

With this approach it is very difficult to sustain any capacity building. Further the dynamics of a participatory approach is lost, as liaison cannot be done on a daily level; which also contributes to the difficulties in cooperation, misunderstandings and in understanding the actual needs of the client.

It is thus recommended to minimise the remote work. At least the team leader (or his deputy) should be embedded with the client during the entire contract period and his role will be expanded to include also institutional issues, as to better integrate the system with the business processes.

If the team leader and possibly other team member are embedded with the client, it will also make it easier for the client to track progress, as the consultant can present progress made more frequently in formats other than progress reports. The consult-

ant would also be able to pressure the client to complete those tasks which remains with the client.

Having one (or some) of the key staff positioned on site, would also ensure that the consultant would provide the necessary resources for undertaking the tasks within the timeframe, as delays might hit him economically (if contract addenda can not be justified). Working on a distance from home office, it does not really cost the consultant anything, to postpone the work.

Decision-makers and operational staff should be exposed to systems and data collection through visits to similar agencies that have successfully implemented systems. However it is recommended that such trips are undertaken in the very beginning of the project, as this is part of the 'education' of the client to build his understanding of road asset management, inspire the agency to better formulate its wishes and needs, and thus providing the agency with capabilities to critically respond to the suggestions and recommendations made by the consultant.

Implementing a Road Asset Management System relates to the 'way of doing business', thus it has significant components of institutional development – and institutional development takes time, if to be successful. This is also the conclusion in recently released World Bank report 'A Decade of Action in Transport'[10].

This needs to be reflected in the TOR, which often provides very little time for the consultant to provide the services. Ten months were given in Urumqi and Shijiazhuang projects; while considerably longer time (22 months) was given in Guangzhou. For other projects implementation periods as short as seven months has been reported.

A short timeframe does not nurture a participatory approach, as the consultant is under constant time pressure. The consultant would thus tend to retract and carry out the development, without much involvement from the client, as this inevitably would slow down development progress.

As it is generally recommended that the consultant would also be involved in the organisational and institutional issues related to adopting road asset management systems and principles, this would also require longer project periods, and such issues takes time to change.

It is important that the consultant during contract implementation provide tangible output to the client at an early stage. Especially with COTS systems, this becomes important as the development team doing the customisation would most likely sit in the consultant's headquarters, far from the client. If the system is only installed when it is made ready for the clients' approval test, it might be too late to get the client's ideas included.

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[10] A Decade of Action in Transport – An Evaluation of World Bank Assistance to the Transport Section, 1995-2005; Independent Evaluation Group/the World Bank, 2007

Thus it is recommended that the system should be delivered in modules during the implementation phase rather than as a whole at the end of the phase. This will give the client time to digest the module, make it easier to track progress and will assist the consultant in focusing his programming effort.

As far as possible, it is recommended that local decision-parameters are adopted. It is likely that the counterpart staff involved would already have experience in using such parameters which will make it easier for them to adopt the system. Further it will probably be able to find local support and it will be possible to benchmark system output with other cities/agencies in the region.

It is recommended that the requirements of training should be detailed much more in the TOR. Often the TOR just requires '…and train ends users in system operation…', maybe combined with a brief description of maximum half a page. While this is basically what is required, it does not emphasis the importance of training during the implementation and will probably affect the focus of the consultant.

Thus it should be required to undertake a Training Needs Assessment Review (TNAR), include capability surveys, capability gaps, outlining (and later detailing) individual training sessions and modes for evaluation of the effect of the training.

6.2.3 Post Implementation Issues

All three projects where ongoing when visited by the Consultant. Thus they do not add to the experience on sustaining the systems developed and implemented. The recommendations below are given based on experience from similar, but completed projects.

A common feature between the three projects is, that the support to be delivered after the system has been developed and installed, mainly includes system maintenance. Assistance in system management and analysis, adaptation of system output in relation to the business processes and deriving sound and robust maintenance plans and programmes, and other tasks related to sustaining the institutionalising of the system, is left out.

Institutionalisation of systems such as road asset management systems takes years, not months. Thus as a minimum it is recommended that the consultant for at least 2-3 years is requested to assist the client on site, during critical tasks (data collection planning, system operation, analysis and reworking of output, refreshing capabilities). It should be mentioned, that his approach has been seen on recent World Bank projects.

6.2.4 Terms of Reference

In the sections above some suggestions to be considered when detailing the TOR have been given; including (i) improved balance (in terms of requirements) between pavement management and bridge management; (ii) enhanced requirements to training; (iii) clearly describe if bespoken or tailor-made systems should be supplied; (iv) require consultants locally present during project implementation; (v) enhanced project implementation time as to enable the agency to absorb the acquired capabilities; (vi) enhanced requirements to post implementation support; (vii) improved phasing of system deliveries; (viii) enhancement of the consultants involvement in institutional and organisational issues; and (ix) enhancement of the consultants involvement in data collection (application of equipment).

Further to these recommendations, caution should be taken when detailing the model requirements; especially if bespoken systems are to be requested. Rather the TOR should detail the input and output requirements, and let the consultant detail the models. Such models would typically be core parts of bespoken systems; and thus by detailing the models in the TOR, systems which would have been suitable for the agency, might be ruled out, unless significant changes to the system core would be carried out by the consultant.

Finally it can be highly recommended that the recommendations given in the World Bank published report[11] 'Generic Terms of Reference for Supply and Installation of Road Management Systems' would be adopted.

[11] Generic Terms of Reference for Supply and Installation of Road Management Systems, The World Bank, January 2007

Annex I
List of People Met

List of People Met, China, Field Trip, April 11-26, 2007

Urumqi

Name	Position	Organisation
Mr. Harat	Deputy Director	MEAMB
Mr. Huan Fujun	Director of Roads and Bridge Management/Team Leader of RMMS Project	MEAMB
Mr. Ma Xin Jun	Member of RMMS Team	MEAMB
Mr. Zhao Zhilung	Member of RMMS Team	MEAMB
Mr. Zhang Bing	Member of RMMS Team	MEAMB
Ms. Li Xia	Member of RMMS Team	MEAMB
Ms. Dildar Zakir	Planning & Procurement Section	Urumqi Urban Transport Improvement Project Office
Mr. Jiangbo Ning	Deputy Team Leader	Aktins
Dr. Li Ningyuan	RMMS Specialist	Individual International Expert (by email only)

Shijiazhuang

Name	Position	Organisation
Mr. Yan Shuhua	Division Chief of Road Maintenance Section	SRBMD
Mr. He Zhenwei	RMMS Team Leader	SRBMD
Mr. He Bing	Member of RMMS Team	SRBMD
Mr. He Yanbin	Member of RMMS Team	SRBMD
Mr. Chao Tah Wei	Leader of PMS Team	Goodpointe
Mr. Darwin Dahlgren	Project Principal	Goodpointe (by email only)
Mr. Tony Kadlec	Vice Project Manager	Goodpointe (by email only)
Ms. Zhang Min	Interpreter	SUTPO

Guangzhou

Name	Position	Organisation
Peng Jieang	Vice Director	GZ City Centre Transport Project Office
Li Hongbao	Vice chief engineer	GZ City Centre Transport Project Office
Zhou Xiaorong	Engineer	GZ City Centre Transport Project Office
Marie Mei	Senior interpreter, engineer	GZ City Centre Transport Project Office
Zhang Shibo	Vice Department chief	GZ Municipal Administrative & Landscape Bureau
Cheng Pu	Principal of Dig. M	GZ Municipal Administrative & Landscape Bureau
Yang Liang	Engineer	GZ Municipal Administrative & Landscape Bureau
Liu Qingyang	Vice director	GZ Municipal Engineering Maintenance Department
Luo Shiliu	Chief engineer	GZ Municipal Engineering Maintenance Department
Huang Run	Vice director	Maintenance Office under the GZMEMD
Yao Hongchun	Engineer	Maintenance Office under the GZMEMD
Li Zhizhong	Engineer	Maintenance Office under the GZMEMD
Li Tianbing	Engineer	Maintenance Office under the GZMEMD
Lu Conglin	Head of consultant group	Changsha Sino-Tech Co.
Mr. Chao Tah Wei	Deputy Team Leader	Goodpointe (met as part of the visit in Shijiazhuang)

Annex II
Structure for Interviews

Road Infrastructure Management for Three Cities in China – Structure for Interviews

	Project Design and Formulation	URMS Design	URMS Implementation	URMS Institutionalisation
Technology	Who identified the needs for URMS (why have the URMS) Who made the TOR/How was client involved in the process	How much hands-on involvement COTS/Bespoken Fit with current business processes	System testing/Approval Test	System upgrades Maintenance Agreements
Processes	Organisational setup/changes Policies/management Existing data collection/equipment Evaluation of proposals	Outsourcing Role of the URMS Information Quality Levels Quality Assurance	Operating procedures (business processes) Annual Reports Awareness Campaigns	Organisational setup
People	Clients knowledge of RMS	Counterparts involvement Study tours	How much training/training programmes (training at different levels) Job descriptions Local participation in training Workload Agency vs. Consultant	How will training be sustained
Funding	Specific recurrent/operating budgets (current/future)		Project budgets	Operating Budgets

General Issues:

- Previous experience working with international consultants
- Corporation with consultants/project implementation (time, technology, resources, economy)
- Current progress
- Problems experienced by client/consultant (technical, corporation)

Annex III
Urumqi Urban Road Maintenance Management System
Project Progress and Recommendations for Actions

The World Bank

Urumqi Urban Road Maintenance Management System

Project Progress and Recommendations for Actions

June 2007

RAMBOLL

The World Bank

Urumqi Urban Road Maintenance Management System

Project Progress and Recommendations for Actions

June 2007

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Prepared by Jens Hede
Checked by -
Approved by Jens Hede

Rambøll Danmark A/S
Bredevej 2
DK-2830 Virum
Danmark

Phone +45 4598 6000
www.ramboll.dk

Table of contents

1. Executive Summary

The Consultant undertook a review of the Urumqi Urban Road Maintenance Management System project, focusing on current project status and identification of the main issues to be resolved to improve the likelihood of success.

The review of the current project status reveals that the project is significantly delayed (more than one year); primarily due to delays in system programming, though factors such as delays in procurement of hardware, delays in data collection equipment procurement, and delays in digital mapping also have contributed to the overall delays.

Only the first introductory deliveries (such review of current processes, maintenance practises, organisation, main problems and existing capabilities) have been completed, while the main deliveries are still to be completed. Most significantly this includes the URMMS system itself, which has not yet been completed, even though the consultant has had two years to develop it.

Some important obstacles to the project progress have been identified. The digital mapping, which also includes the inventory surveys is still ongoing, and need to be completed urgently as to populate the URMMS database. Also the collection of condition data should be commenced immediately, as most of the needed equipment has been delivered. Further the URMMS system needs to be urgently completed and installed at the dedicated computers at the client as soon as possible, allowing the client to familiarise himself with the system before the final training. Finally the client needs to fully establish the organisation unit which will be responsible for the URMMS management and operation.

2. Introduction

The Consultant (Ramboll) visited Urumqi in the period April 13-17, 2007 and had meetings with relevant staff of Urumqi Municipal Engineering and Appearance Management Bureau (MEAMB), Project Executive Office (PEO) and the RMS consultant (Atkins).

This report includes: (i) a review of the current progress of the project component; and (ii) recommendations on actions which could lead to an improved likelihood of success of the project component. It should be noted, that the review has not included a technical review of the Urumqi Road Maintenance Management System (URMMS).

The general lessons-learned during the project is discussed in a separate document (Road Infrastructure Management for Three Cities in China).

3. Current Status

The consultant mobilised in May 2005 and the project was expected to be completed by July 2006. Project completion is significantly delayed, and currently the complete date is estimated to July 2007. However this deadline would most probably not be met. The main reasons for the delays includes: (i) underestimation of the system programming; (ii) delays in hardware procurement; (iii) delays in data collection procurement; and (iv) delays in digital mapping.

Based on the meetings and review of documents the following progress, as compared to the scope of work, can be reported:

Scope of Work (as given in TOR)	**Reported Progress**
Review the current Urumqi road network and practices in road maintenance, including road maintenance organization, data and historic information, collection methods, maintenance policy, technical standards, institutional framework, evaluation methods, construction methods, and application of new technologies used in road maintenance management.	Completed. The RMS consultant undertook a review and reported the findings in the 'Business Review Working Paper' (September 2005). The report has been approved by PEO/MEAMB.
Identify the main problems and needs for operational improvements in road management, including needs for re-structure of the current road maintenance organization, institutional strengthening and staff training, data collection methods for pavement and bridge condition surveys, road performance measures and evaluation, economic analysis of alternative maintenance strategies, establishing investment policies and standards.	Completed. This was included in the report mentioned above. The report included a number of recommendations to MEAMB. Many of these recommendations were only on a rather general level and not in a format ready for being adopted by MEAMB. However, one specific recommendation has been adopted by MEAMB: the establishment of a unit which would take ownership of the URMMS (the Road Asset Information Centre).

Design and develop the database structure and information management subsystem. The system should be linked to the data collection procedures established below. It is envisaged that the system will have a GIS interface to simplify its use.	Ongoing. The RMS consultant is still adjusting and adapting the EXOR commercial-off-the-shelf system, which will be the backbone of the URMMS. The data from the digital mapping which is needed to furnish the database is not yet completed (client delivery). The asset items and the associated attributes which will be managed in EXOR have been identified by the MEAMB. It is not clear how the system will integrate with GIS (interfaced or imbedded).
Develop an appropriate procedure for collection of pavement and bridge condition information, including roughness, surface distresses, and other condition surveys. The data collected during the system development should be sufficient enough for meeting requirements by pavement and bridge management. The procedures will need to consider survey frequencies and extent according to the class of road, so that a consistent use of the system can be sustained after completion of the project.	Ongoing. The RMS consultant has issued the 'Data Collection Working Paper' (official version dated in April 2007, but in draft several months back). The paper basically gives guidance in planning of surveys and includes recommendations on survey frequencies and extent (sampling). Further the RMS consultant has prepared specifications for the agreed equipment and submitted the 'Data and Equipment Proposal' (April 2007). The agreed equipment has been procured, though some of it (surface profiler and friction tester) is still in boxes, waiting for the supplier to set it up. The FWD and GPR are operational, but not put into use. It should be noted that the equipment suppliers have not been requested to carry out validation test as part of the supplies. The visual inspections are close to completion. This survey has been carried out manually, as the software for the PDA's is not ready yet (expected by end of May/early June). The Information Centre has not played a role in this visual data collection.

Design functional models and analysis tools used in Urumqi RMMS for performance measures, evaluation and deterioration prediction of pavements and bridges based on Urumqi's situation. The analyses should be based on deterministic modelling such as in HDM-4 and must be suitable for both short and long-term maintenance and rehabilitation programming. Thus, the system will need to provide outputs at the project level (i.e. identifying the specific treatment for individual sections), and the network level, showing the implications of investments for the entire road network. The treatments applied shall be selected based on some form of decision tree matrix, which takes into account the economic efficiency of the treatment as well as technical considerations.	Ongoing. HDM-4 has been adopted. Though the HDM-4 software will not be changed, the EXOR system needs to be configured to include the data needed for the analysis and for storage of analysis output. Steps have been taken to calibrate the HDM-4 models to Urumqi conditions.
Integrate road maintenance subsystems, including pavement management, bridge and structural database management into a single framework, creating a software tool that can be used for managing effectively the city's road pavement and bridge networks, ensuring optimal use of public funds, which is consistent with the overall objective of the Urumqi Urban Transport Improvement Project financed by the World Bank.	Ongoing. The consultant is currently designing and coding the interface with HDM-4. This integration will not include routines for homogeneous sectioning. The road network will in EXOR be divided into static sections; each of these will be analysed in the HDM-4. It is unclear how GIS will be integrated with the URMMS.
It is essential that the system meet the core business needs of the MEAMB. It must be able to perform such functions as preparing monthly reports to trace budget and maintenance activities, record maintenance works and construction costs.	Not initiated. The RMS consultant will need to agree with MEAMB about reporting formats and monitoring processes.

Participate in system installation and operation training during the project implementation phase, including road condition surveys and data collection, system operation, reporting management and basic problem shooting techniques. The MEAMB must be able to operate the system to produce the necessary work plans and reports.	Ongoing. Some of the database hardware and software has been installed at MEAMB. The RMS consultant has conducted the following training: ▪ Overview of road maintenance management (1 day) ▪ Overview of RMS (1 day) ▪ Data collection (2 days) ▪ Introduction to EXOR, using M5 in UK as example (½ day) ▪ HDM-4 overview (½ day) The RMS consultant has planned for another 1 week user training in the URMMS when the system development has been completed.
Provide a complete set of documents in both English and Chinese, including user manuals, database structure dictionary, system operation and maintenance manuals, technical specifications for software developing including data definition of the system, and application introduction.	Ongoing. The RMS consultant is updating manuals and translating these into Chinese.

4. Recommended Actions

Based on the review of the project, it seems that apart from the delays, a number of issues remain critical. MEAMB has not yet seen the URMMS, some data collection equipment has not yet been installed, MEAMB has yet to start data collection, MEAMB will probably not be able to undertake the needed data analysis, and they need much more training, especially in HDM-4 to be able to operate it and output realistic results. Furthermore the delays in the digital mapping make it impossible to store any data in the database.

Based on meetings and current status of the project and the identified critical issues, the following actions are recommended to improve likelihood of success.

Critical Issue	Recommendation
Digital Mapping	
The digital map including the inventory data, which is a client delivery in the project, has not yet been supplied by the Urban Survey and Design Institute (USDI), to which the task has been outsourced.	The map needs to be completed urgently and should have the utmost attention of MEAMB. This presupposes that the payment issue between MEAMB and UDSI will be solved.
It is understood, that some data manipulation, including sectioning of the road network, needs to be undertaken before the data is suitable for upload to the URMMS database. MEAMB will be responsible for this. The USDI should by now have at least one district ready.	MEAMB should aim at establishing a full set of data for at least one district as soon as possible. Hence it is recommended that the digital mapping data for one completed district is supplied to MEAMB immediately, while USDI complete the rest of the districts. MEAMB can then process this district and the data be uploaded to the database and used for system testing and user training. MEAMB can continue processing the rest of the data when completed by USDI.
Condition Data	
The data collection equipment has been procured and supplied (FWD, GPR, Skid resistance and surface profiler, PDA's). It is informed that the suppliers of FWD and GPR have provided training in operation of the equipment; though it seems only on a very limited scale and mainly focused on operation of the equipment. Based on the interviews it seems that MEAMB's staff will not be able to analyse and expound the data collected and have very limited understanding of the data's relation to the URMMS.	It is recommended that the equipment suppliers will be requested to provide more training in analysis of the data collected in the field (this must be assumed outside the scope of the RMS consultant). It is further recommended that the RMS consultant will be requested to present the relation between the condition data (including the visual inspections) and the RMMS database and analysis application (HDM-4), as MEAMB seems to have only a weak understanding of the benefits of the data to be collected.

MEAMB informed that one of the main reasons for the surveys not being commenced is lack of suitable cars. Through the project MEAMB has procured one vehicle (a minibus), which internally in MEAMB has been exchanged for another and older minibus. This vehicle cannot be used as towing vehicle for the FWD and friction testing equipment. It is deemed that at least two cars are needed for the baseline data collection survey in 2007.	It is recommended that MEAMB immediately allocates a minimum of two suitable vehicles for the data collection; one of these permanently. The supplier of the Road Surface Profiler and the Friction Tester should be called to Urumqi to mount the equipment and provide the necessary training in system use and in data analysis. The Road Surface Profiler should be mounted on the permanent vehicle. MEAMB should immediately start collecting data with the equipment ready for use. When the rest of the equipment is operational, also the data collection using this equipment should be commenced. It is recommended that the surface profile would be measured during the night, where there is no traffic. This would also free the car for FWD testing during the day.
The Data Collection Working Paper submitted by the consultant can be used for the planning of the surveys, while the instructions and training provided by the equipment suppliers can be used for the actual data collection. However it seems that MEAMB is not ready to undertake the surveys independently.	It is recommended that the RMS consultant will be requested to train MEAMB in management of road condition surveys and data collection. Such assistance is deemed part of the scope of work of the RMS consultant. In relation to the Data Collection Working Paper it is recommended that the RMS consultant should be requested to update it with quality assurance procedures and step-by-step guidance in how to perform and manage the data collection in the field.
Visual inspection of surface distresses is nearing completion; though the staff of the Road Asset Management Information Centre is not involved. As the software needed for the procured PDA's is not finished, the surveys have been recorded using paper format.	The data should be keyed into the URMMS database manually, when the RMS consultant has installed the RMMS software. This presupposes that the road network referencing has been uploaded to the database (see also about digital mapping above).
Traffic volumes are a key input to the maintenance programming. However traffic surveys have not been started.	It is recommended that the traffic surveys would be started as soon as possible.

Organisation	
Based on the recommendation of the RMS consultant, MEAMB has agreed to establish a special unit (Road Asset Information Management Centre) responsible for operation of the RMMS and for data collection. The establishment of the unit has been approved by MEAMB on August 2006, but has not yet been established in full. Out of the 15 staff planned for the unit; 8 has been nominated; though only 3 seems to be active. Of these only one staff is working full time on the project.	It is recommended that the unit be established immediately and the needed staff assigned full time to the unit. The current period with data collection and installation of the URMMS system is one of the most sensitive phases for success or failure of the project. Hence it needs to be ensured that the body designed to build up the knowledge are ready and operational.
It is understood that no budget have been allocated to the Road Asset Information Management Centre as yet, though budgets have been applied for several times. For the second half of 2007 a budget of 1.5 million RMB has been applied for.	As to enable the unit to be established and be operational, budget allocations are imperative. It is recommended that the requested budget is approved as soon as possible.
RMMS System	
The data management and analysis tool in the URMMS is by large comprised by the EXOR, GIS and HDM-4 software. EXOR and GIS will be used to manage and update data, while the HDM-4 will be used to analyse data for maintenance planning and programming. So far MEAMB has only been introduced to the EXOR and HDM-4 systems through relative short presentations. Nothing tangible has been supplied.	It is recommended that the HDM-4 software be handed over to MEAMB as soon as possible. The HDM-4 is a standard system which will not be recoded for this project. Hence the software can be handed over to MEAMB, who can then test its ability to use the software. If the current capabilities are not sufficient more training will need to be supplied by the consultant. It is also recommended that a test version of the EXOR and GIS system would be installed on the dedicated server as soon as possible, as to enable MEAMB to familiarise themselves with the software, before the adjusted version will be supplied along with the necessary training. This will increase the capabilities of the MEAMB staff, and prepare them to the later training and Client Approval Test.

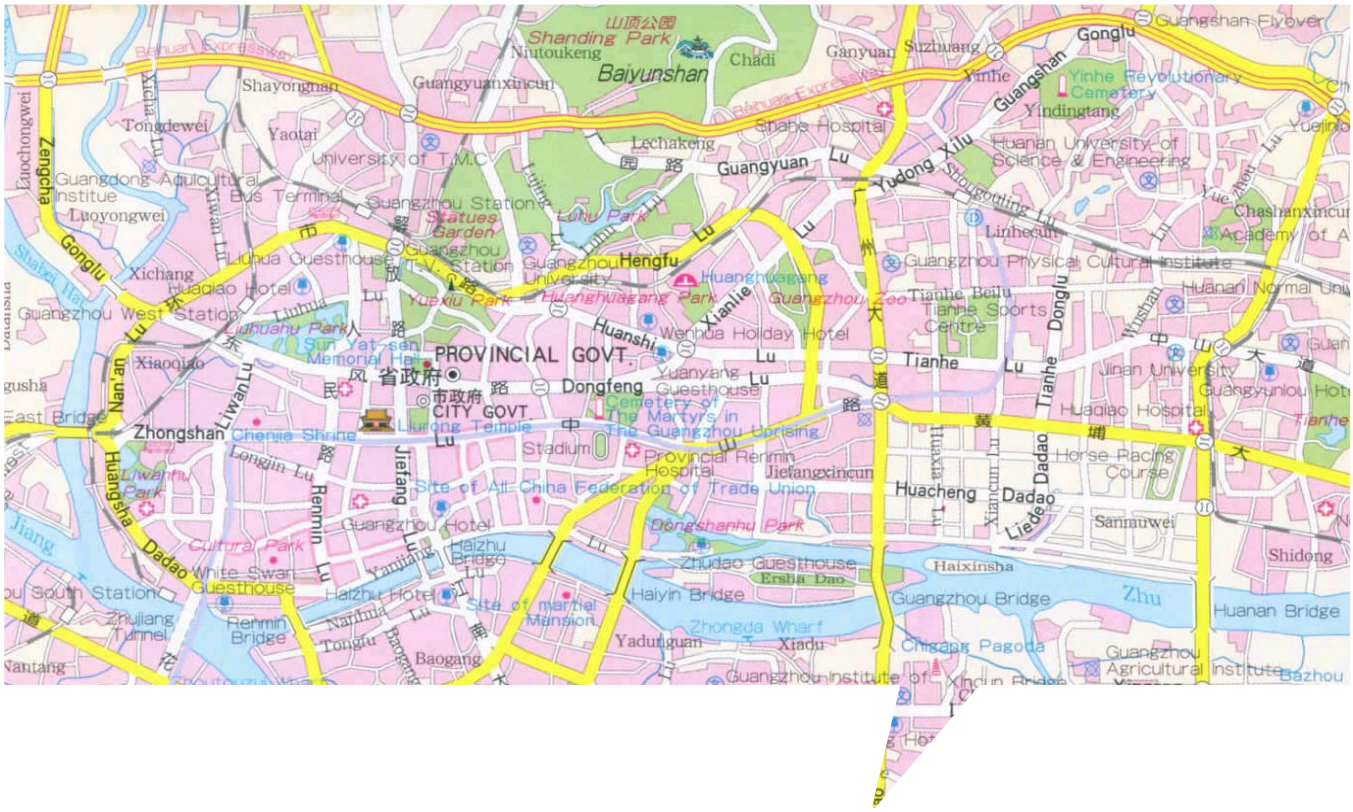
Business Processes	
From the interviews with relevant staff of MEAMB, it became evident that clear procedures have not been prepared on how the RMMS will be imbedded with the current business processes of MEAMB. While MEAMB does have an idea what the URMMS will output (maintenance programmes), it is unclear how this output will be used to derive robust maintenance programmes ready for implementation. Many steps need to be carried out where the HDM-4 derived output is reworked using rational and transparent approaches. Further all the activities which need to be carried out to manage the road network and the RMMS database and software, should be described and detailed, including a URMMS Planning and Programming Cycle.	It is recommended that MEAMB clearly and explicit describes how the RMMS will be adopted within MEAMB's business processes, including type and timing of all related activities.
Training	
The TOR calls for the consultant to train MEAMB staff which '*…must be able to operate the system to produce the necessary work plans and reports'*. The training planned for the remaining part of the Contract seems to be too short to achieve this important goal, and will at best make MEAMB able to use the system only statically.	Hence it is highly recommended that the training effort is stepped up and the URMMS consultant will provide relevant MEAMB staff with considerably more training than currently planned. Training shall include user training in EXOR, HDM-4 and the GIS. Further training in system software/hardware management is needed. The EXOR system will provide the needed input to the HDM-4 analysis, while the analysis has to be carried out in HDM-4. Thus user capabilities in HDM-4 are vital for MEAMB to be able to produce plans and programmes. HDM-4 is a rather complicated tool, which takes time to be familiar with, and a considerable training effort needs to be applied to ensure the users achieve the needed capabilities.

Ongoing Support	
The TOR of the RMS consultant does not include any operational support after the system delivery – only system support. Hence the first time MEAMB is to use the URMMS to perform maintenance planning and programming, the RMS consultant has already demobilised. Even if the user training is stepped up (see above), it will still be difficult for MEAMB to run the system in full the first time and achieve reliable output. Only if the URMMS output reasonable and reliable maintenance plans and programmes, will the URMMS be accepted and adopted by MEAMB.	Hence it is recommended that the contract of the RMS consultant would be enhanced to include, as a minimum, assistance during the first full use of the URMMS.
Road Asset Information Management Centre	
The main focus, as expressed by MEAMB, of the Road Asset Information Management Centre will be updating and operating the RMMS and generate maintenance plans and programmes. However, the unit will management a wealth of information which could benefit a range of related units. Hence it is important that the whole organisation, as well as external stakeholders will be informed about the information managed by the unit, as to enable these units to request and benefit from the efforts undertaken.	It is thus recommended that an awareness campaign would be tailored and conducted. This should include presentations as well as reports on the data in the database. It is also recommended, that the annual report currently issued to management, would be enhanced to include a more detailed description of the condition of the road and bridge assets, including development trends, based on the URMMS database. This report should also be distributed among other units and external stakeholders.

Annex IV

Guangzhou City Urban Road Pavement, Bridge and Drainage Facility Management System

Project Progress and Recommendations for Actions



The World Bank

Guangzhou City Urban Road Pavement, Bridge and Drainage Facility Management System

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RAMBOLL

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Approved by Jens Hede

Rambøll Danmark A/S
Bredevej 2
DK-2830 Virum
Danmark

Phone +45 4598 6000
www.ramboll.dk

Table of contents

1. Executive Summary

The Consultant undertook a review of the Guangzhou City Urban Road Pavement, Bridge and Drainage Facility Management System project, focusing on current project status and identification of the main issues to be resolved to improve the likelihood of success.

Due to inadequate performance of the original consultant, he was in the middle of July 2006 replaced by one of the sub-consultants. A new contract was agree upon aiming at completing the project by late 2007.

The review of the current project status reveals that the project is significantly delayed (more than one year compared to the original contract, and more that three months compared to the revised contract); primarily due to delays in system programming, though factors such as delays in procurement of hardware and digesting of acquired knowledge also have contributed to the overall delays.

Only the first introductory deliveries (such review of current processes, maintenance practises, organisation, main problems and existing capabilities) have been completed, while the main deliveries are still to be completed. Most significantly this includes the PBDFMS system itself, which has not yet been completed. The consultant has installed a 'prototype' of the system, but this only meets few of the requirements in the TOR. The training provided so far is also scanty.

Some important obstacles to the project progress have been identified. The cooperation between the client and the consultant has improved since the replacement of the consultant, but still needs to be improved if the project deadline is to be met. As the project implementation is now under a significant time constraint, it is important that a detailed and phase delivery plan is prepared and adhered to. As to support the population of the database, the procured equipment should be approved urgently, and used for the data collection. Equipment not yet procured should be procured immediately.

The consultant shall complete the system programming as soon as possible, by allocating much more resources and as soon as possible install a prototype of the system at the client, which meets most of the requirements given in the TOR. In parallel, the consultant should complete the trial data collection as soon as possible, using the client's data collection equipment.

2. Introduction

The Consultant (Ramboll) visited Guangzhou in the period April 23-25, 2007 and had meetings with relevant staff of Guangzhou City Centre Transport Project Office (GCCTPO), Bureau of City Engineering and Gardening of Guangzhou Municipality (BCEGGM), Guangzhou Municipal Administrative and Landscaping Bureau (GMALB), Guangzhou Municipal Engineering Maintenance Department (GMEMD) and the QA company (Dr. Lu). The RMS consultant (GoodPointe) was interviewed during the Consultants stay in Shijiazhuang.

This report includes: (i) a review of the current progress of the project component; and (ii) recommendations on actions which could lead to an improved likelihood of success of the project component. It should be noted that the review did not included a technical review of the Pavement, Bridge and Drainage Facility Management System (PBDFMS).

The general lessons-learned during the project are discussed in a separate document (Road Infrastructure Management for Three Cities in China).

3. Current Status

The (original) project was started in October/November 2004, and was planned for a period of 22 months (up to August 2006). But the cooperation between the consultant and the client turned bad, and progress halted. As the parties could not reconcile, it was decided to replace the lead consultant with one of the sub-consultants.

This new contract (and revised TOR) was signed in July 2006 and was planned to be completed by December 2007. However, the system, which is far from ready, should according to the contract schedule have been ready by March 2007; thus the project is still several months behind schedule.

While GMEMD indicates delays in system programming as the main reason for the delays, the RMS consultant indicates: (i) system programming; (ii) delays in procurement of hardware; and (iii) digesting of acquired knowledge as prime reasons for the delay.

Based on the meetings and review of documents the following progress, as compared to the scope of work, can be reported:

Scope of Work (as given in TOR)	Reported Progress
To make a comprehensive investigation on existing city transportation facilities and current maintenance management. To prepare a requirement analysis report on the basis of the technical specifications.	Completed. Two reports have been issued; (i) Survey Investigations and (ii) Requirement Analysis. Both reports have been approved.
To put forward a preliminary design of the proposed PBDFMS, including mainframe, system flow chart and user manual, and to submit it to the client for approval.	Completed. The user manuals have not been submitted. These will await the completion of the system development.
To develop and submit a pavement, bridge and drainage facility identification system, and describe how the identification system jointly operates with the Guangzhou PBFMS.	Ongoing. The RMS consultant has submitted some recommendations, including a conceptual design, accompanied by rather basic descriptions. The report has not been approved yet by GMALB/GMEMD.
In accordance with China's relevant national standards and local codes, to determine the criteria for evaluating the present conditions of the pavements, bridges and drainage facilities, prepare report relating to those standards and submit it to the Client for approval.	Ongoing. The report has been submitted by the RMS consultant and commented by GMEMD, who now awaits the revised report.
To determine data categories of the pavement, bridge and drainage facility management to be entered, including spatial data and attribute data of the geographical information system for pavement, bridge and drainage facilities.	Ongoing. The report has been submitted by the RMS consultant and commented by GMEMD, who now awaits the revised report.
To convert and handle public utilities (pavement and bridge) digital maps and non-digital maps relating to the system scope, so as to make them meet the requirements for storage, queries, display, analysis and use of the system's geographical information system and management system.	Ongoing. The GMEMD has been informed that the delivery is close to completion (80%), but has not seen any tangible results so far.

To work out methods, procedures and basic units for data collection. Collect part of the data of the pavements, bridges and drainage facilities and make site notes. [...]. There should be adequate data for effective operation of the Guangzhou PBFMS so as to make a decision-making system which is able to generate reliable results. The client will not provide any human resource and materials for data collection.	Ongoing. Data collection manuals have been submitted in drafts. GMEMD has requested the manuals to be expanded with technical/operational details (e.g. how to do sampling). A data collection plan/programme has also been requested by GMEMD. The ARAN vehicle has been used to collect data for 70 km of pavement (roughness, rutting and video). However the data has not been processed yet. Collection of other data has not been started (pavement strength, bridge inventories and conditions etc.)
Trial test on the Guangzhou PBFMS can be made with local data. Trial test content involve all types of Guangzhou's pavements, bridges, and drainage facilities.	Not commenced.
To undertake the detailed design of the Guangzhou PBFMS. The system must maintain an interface between the GMALB and its maintenance management department, connected with 'Digital Utility' system, so as to ensure effective internal transfer and transmission.	Ongoing. Revised Detail Design report to be submitted in April 2007 (deadline not met).
To work out technical standards for the detailed system test, those are used for evaluating the result of the trail test of the Guangzhou PBFMS and the formal online test. Before evaluating the system, technical test standards should be approved by the client.	Not commenced.
To prepare and submit basic classification/code system of the geographical information system, The basic classification/code system must comply with China's relevant national standards.	Not commenced.
To determine the weight evaluation standard for damage of pavement sections, bridge facilities; and separately develop a decision-making support model for subsystems of the pavements, bridges and drainage facilities.	Ongoing. The RMS consultant has submitted his recommendations and GMEMD has commented on the report. The final standard will be decided when details of the data to be collected have been prepared.

To work out analysis methods, evaluation methods and future condition predicting methods for the pavement, bridge and drainage system.	Ongoing. The RMS consultant has submitted his report. This report needs to be elaborated for GMEMB to better understand the principles/methods. GMEMD has not yet requested the RMS consultant to elaborate the report.
To integrate management information system, geographical information system and decision making support system to form a pavement, bridge and drainage facility management system and develop monitoring displays for different terminal users.	Ongoing. A prototype has been installed, but in the view of GMEMB this prototype does not relate to the system requested. The RMS consultant informs, that the prototype is only to 'play with', and has been installed after some pressure from GMEMD.
In accordance with the requirement report, analysis results, to determine programmes for data collection, data classification, data processing, data exchange, data quality management, data renewal and backup, prepare and design data receiving systems, exchange modules and management methods.	Ongoing. Some general concepts have been included in progress reports. However no compiled report/manual has been produced yet.
To provide a configuration plan for system's software and hardware, including system software configuration such as operating system, geographical information system, database management system, browser, and hardware configuration such as internet server and database server, etc.	Completed. The GMALD/GMEMD has undertaken this delivery themselves. The work has been found suitable by the RMS consultant.
To develop a database for the Guangzhou PBFMS and install necessary management tools for the database.	Not commenced (see also comment on prototype above)
To collect data, input data, search data and analyse data, and process and report related information on the basis of those data.	Ongoing (see comments on data collection above).
According to the actual data of Guangzhou's pavement, bridge and drainage facilities, install, adjust and operate the Guangzhou PBFMS.	Not commenced.

On the basis of the system's need and Guangzhou's conditions, to provide a system operation plan, including organisational setup, functional distribution, human resources allocation, regulations, working procedures, data collection documents, fees analysis, which shall be used for future operating base of the system.	Ongoing. The RMS consultant has submitted an operational plan. This is found too simple by the GMALD/GMEMD. However, it seems that GMALD/GMEMD does not expect that the RMS consultant would provide more input to this task.
Provide the user with comprehensive training, including domestic and overseas trainings.	Ongoing. Some training has been provided, but GAMLD/GMEMD expects much more training to be provided.

4. Recommended Actions

Based on the review of the project, it seems that the project implementation has been rather poor; best illustrated by the replacement of the principal consultant. This replacement has improved the situation, but the working relationship and progress is still not good.

It seems that the cooperation between the client and the consultant is rather hostile, and that they find it difficult to 'understand' each other. This results in many frustrations from both parties.

As the project completion date is nearing (the project is to be completed by the end of 2007), it is important that the rest of the project would be implemented more smoothly as the project now enters a critical phase where deliveries are being made tangible and the client needs to absorb the deliveries.

Based on meetings, current status of the project and the identified issues, the following actions are recommended to improve the likelihood of success.

Critical Issue	Recommendation
GMALB intends to establish a new centre (Road and Bridge Management Centre), which will take ownership of the PBDFMS. This unit will manage and operate the system and will undertake the necessary data collection surveys. The proposed centre is currently submitted for governmental approval, and it has been informed that the centre is likely to be approved.	GMALB/GMEMD has informed that the centre will not be established until the PBDFMS system and the data collection equipments have been approved. Until the establishment of the centre, the PBDFMS working group and counterparts will be responsible for the system development. It would be sensible that as many of the end users of the system and equipment as possible would be involved in this implementation of the technologies. This would assist in gradually building up capacity (in terms of resources and capabilities). To this end, it is recommended that the centre is established as soon as possible as to be ready to receive the PBDFMS system when completed and the data collection equipment when approved. When the receiving body is established, operating procedures and processes can be prepared and adopted.
The Road and Bridge Management Centre is planned to be staffed with about 70 staff when fully operational.	As only a limited number of GMALB/GMEMD staff is involved in the current system development and adaptation of the data collection equipment, significant training effort needs to be undertaken to bring the many new staff up to the required capacity levels. It is recommended that GMALB, in close cooperation with the RMS consultant, prepares a training plan which aims at providing the staff with the needed capabilities. The RMS consultant should be requested to train-the-trainers for the training programme (empowering GMALB/GMEMD to continue the training after the demobilisation of the RMS consultant). Such a training plan could also be used to guide the recruitment, as staff does not need to be hired until they can receive the necessary training.

The project is delayed compared to original contract. Even compared with the revised contract (signed in June 2006), progress is already about 3 months behind schedule (over a 10 month period). GMALB/GMEMD suspects that the RMS consultant is not allocating enough resources to the project, which thus still moves quite slowly.	The project has to be completed before the end of 2007. The consultant has in the middle of April revised his working schedule to reflect the latest delays. If is important that the deadlines in this revised schedule will be met, and GMALB/GMEMD is recommended to closely follow progress and ensure that deadlines are met rigorously. It is recommended that the remaining deliveries would be broken into smaller deliveries. This to facilitate that progress can be measured and that GMALB/GMEMB can review tangible output as soon as they become available. It is also important that GMALB/GMEMB or the RMS consultant resist 'cutting corners' due to the stressed time schedule. Deliveries are to be met (time and quality) by allocating sufficient resources, not by scaling down the work load/scope. In parallel, GMALB/GMEMB should ensure that obstacles hampering progress is removed. This includes prompt and clear responses to the RMS consultant's questions and work.
With this project, GMEMD has procured some of the most advanced data collection equipment on the market. Previously not doing much data collection, implementation of the new equipment is a very large step for the organisation and involved staff. It is vital that the equipment will be kept operational as to provide the data needed for the PBDFMS. The equipment needs to be maintained and regularly calibrated.	It is understood that the suppliers of the equipment are represented in China (some even in Guangzhou). This makes maintenance easier. It is recommended that agreements are made with the suppliers in terms of maintenance and calibration of the equipment. Specific budgets should be allocated accordingly.
The data collection equipment has been procured, but the FWD has not yet been approved by GCCTPO, and the Bridge Inspection Vehicle has not yet been delivered.	As the equipment should be used for the trial data collection to furnish the PBDFMS database (currently undertaken by the RMS consultant in cooperation with GMEMD), the equipment needs to be made ready for use as soon as possible.

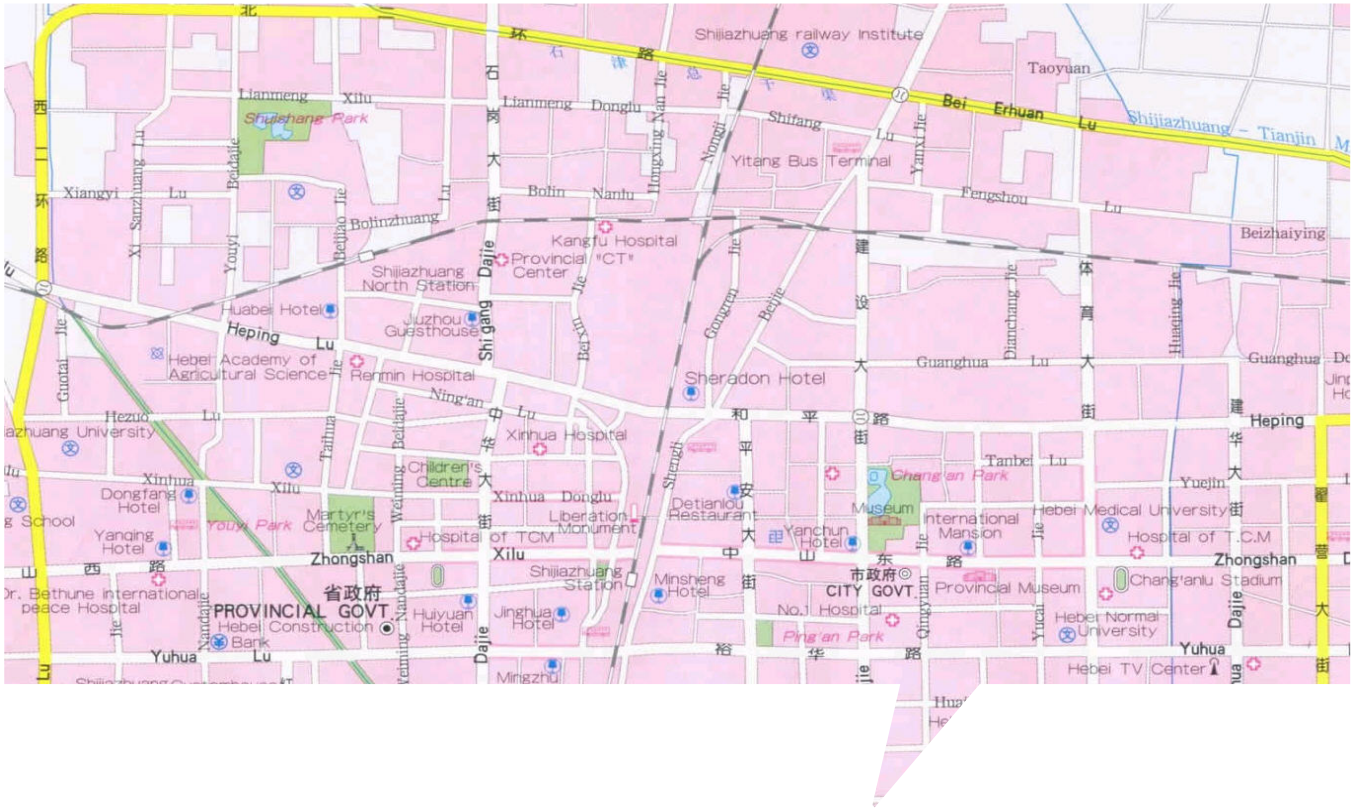
While the staff of GMEMD is currently learning how to use the data collection equipment, they seem to have relatively little knowledge about how the data collection output is used in the PBDFMS.	It is recommended that the RMS consultant should undertake a training seminar where the relation between the data collection programme and the data needed and used in the PBDFMS are discussed. This will provide GMEMD with a better understanding on why to collect the data, and how this links to maintenance management.
The cooperation between GMALB/GMEMD and the RMS consultant still seems to be problematic, even after replacing the prime consultant, though is has been recognised that the replacement of the prime consultant has improved the situation significantly. The communication is rather hostile, it seems difficult to reach common grounds of understanding, and there seem to be little trust between the parties. Some effort has been made in reaching a common understanding; the detailed design report being an example. However the project is in a very critical stage, where deliveries are being made tangible, under a very compressed time schedule.	While it is recognised that discussions between GMALB/GMEMD and the RMS consultant often provides improved decisions, the cooperation and communication between the two parties still seems to contribute significantly to the delays. An important issue is the final requirements of the PBDFMS. The GMALB/GMEMD expressed that they have very high expectations to the final product (this is also reflected in the approach to data collection equipment, where some of the most advanced technologies are being adopted). Furthermore GMALB/GMEMD expects the system to be a tailor-made system (bespoken), which meets all the local detailed requirements of the agency. However the RMS consultant bases the system on a commercial-off-the-shelf product which will be customised. The expectations to the final product need to be harmonised. If the project is to be completed in time, it is important that common ground can be found. This will only be possible if both parties are working towards the same goal (and goal here is defined in terms of system functionalities and analysis etc.). Even though it has been reported, that the GMALB/GMEMD basically agrees with the Detailed Design, there is a risk, that when this has been put into a computer software it will not match their expectations, as it is difficult for GMALB/GMEMD to evaluate the functionalities etc. based on written reports. They would need something more tangible before they can really understand what is delivered. It is recommended that the RMS consultant, preferably the project manager, would spend more time on site with GMALB/GMEMD during the remaining part of the contract. The project manager should provide a link between the GMALB/GMEMD requirements and the RMS development

	team and thus continuously harmonise the expectations to the final product as it develops. It is also recommended that the World Bank would assist GMALB/GMEMD with a detailed technical review of the system processes and functionalities described in the Detail Design Report. This to review the adequacy of the proposed system in the context of GMALD/GMEMD.
The RMS consultant has, after some pressure from GMALB/GMEMD, installed a prototype of the PBDFMS at GMEMD. The prototype is far from completed, and seems to be meant as tool to 'play with'. However the prototype has created some frustration within GMALB/GMEMD as it does not meet many of the requirements set-out in the Detailed Design.	It is obvious that much system programming still remains as to bring the system to meet the requirements, and the prototype should not be taken as a representation of the system to be delivered. Due to the tight deadline for the completion of the project (and closing date of the loan) it is recommended that the remaining system development needs would be explicitly identified and a delivery plan be agreed upon. This plan should ensure that the missing modules will be delivered in smaller packages as they become available.
The GMALB is implementing a large scale computerised system ('DigiM') which integrates the management of important assets (includes water, gas, waste water, transport infrastructure, parks, and underground facilities). This system already includes a range of information on roads and bridges. The PBDFMS will be part of the 'DigiM', and will be the specialised application for roads and bridges. Similar systems will be developed for other assets. The integration will be carried out by BCEGGM when the PBDFMS system has been completed. It is understood that there has been some coordination between the development of the 'DigiM' system and the PBDFMS system, but not to a degree where the two systems would be compatible.	It is important that the PBDFMS system would be compatible with the 'DigiM' system, as to avoid too much reprogramming of the PBDFMS when the two systems are being integrated (after the demobilisation of the RMS consultant). It is recommended that the PBDFMS and the 'DigiM' systems will adopt the same location referencing systems and list of attributes (at least for the main attributes for roads, bridges and drainage which both systems are envisaged to use).

GMALB/GMEMD is generally dissatisfied with the quality of the reports, which they often do not approve. So far all the reports have been submitted in Chinese only (though the TOR states that reports should be issued in Chinese and English). It has been reported by GMALB/GMEMB that at meetings, some key staff of the RMS consultant did not know the content of reports submitted.	In the revised TOR it is stated, that the Project Principal is overall responsible for the quality of the work. This person, like many of the other key team members in the RMS consultant's team does presumably not understand Chinese. It must thus be assumed that such key staff is not involved in the development of the reports. It is recommended that GMALB/GMEMD requests the RMS consultant to submit reports in Chinese and English simultaneously. This to ensure that documents can be reviewed by all relevant staff of the RMS consultant before being submitted to GMELB/GMEMD. If this will not improve the quality of the reporting, GMALB/GMEMB should request the Project Principal of the RMS consultant to sign all documents. The aim of the above recommendations is to ensure, that documents are reviewed and approved by the relevant expert staff of the RMS consultant.
The contract includes study tours within China and to developed countries. While the domestic tour has been carried out, the overseas training/study tour has not yet materialised.	It is recommended that this tour be carried out as soon as possible and to inspire the staff of GMALB/GMEMD in the dialog with the RMS consultant. In order to ensure that the study tour will be adding value to the project, it is important that relevant technical staff from the PBDFMS working group will be made part of the group.
The RMS consultant should as part of his services prepare operational plans for system operation and data collection as well as organisational processes. Based on the discussions it was clear that GMALB/GMEMD viewed the system to be the most critical issue. Further it seems that GMALB/GMEMD has 'given up' on the RMS consultant being more involved in detailing the plans, procedures and processes.	Implementation of suitable plans and processes must be seen as critical to the success of any RMS implementation. If such plans and processes are not in place, any system would not be institutionalised. Hence it is recommended that the RMS consultant is requested to spend significant time during the reaming part of the contract, in developing operational plans and procedures for the Road and Bridge Management Centre and assist GMALB/GMEMD in implementing these.

Both the RMS consultant and the GMALB/GMEMD currently focus on the development of the system. The processes which need to be in place to institutionalise the system within the business processes of GMALB/GMEMD have not been developed. Due to the rather chaotic implementation of the project, it is doubtful that GMALB/GMEMD will be fully ready to understand the role of the system in the business processes, and use the system to support actual maintenance planning and programming.	It is recommended that the RMS consultant will be contracted to support GMALD/GMEMD during a period of 1-3 years after completion of the system development. The focus of this support should be two-fold: (i) system maintenance support; and (ii) operational support, including refreshment of training.

Annex V
Shijiazhuang Road Maintenance Management System Project Progress and Recommendations for Actions



The World Bank

Shijiazhuang Road Maintenance Management System

Project Progress and Recommendations for Actions

June 2007

RAMBOLL

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Checked by -
Approved by Jens Hede

Rambøll Danmark A/S
Bredevej 2
DK-2830 Virum
Danmark

Phone +45 4598 6000
www.ramboll.dk

Table of contents

1. Executive Summary

The Consultant undertook a review of the Shijiazhuang Road Maintenance Management System project, focusing on current project status and identification of the main issues to be resolved to improve the likelihood of success.

The review of the current project status reveals that the project is significantly delayed (more than one year); primarily due to delays in system programming, though factors such as delays in procurement of hardware and digesting of acquired knowledge also have contributed to the overall delays.

Only the first introductory deliveries (such review of current processes, maintenance practises, organisation, main problems and existing capabilities) have been completed, while the main deliveries are still to be completed. Most significantly this includes the PBDFMS system itself, which has not yet been completed, though a 'prototype' of the system (including the GIS) has been installed and is used by the client.

There seems to be only few issues, which could compromise the likelihood of success of the project. The system needs to be completed as soon as possible, and the remaining training needs to be delivered. As part of the training it should be ensured that the client works the system output into his business processes. The collection of roughness (and possibly also bearing capacity) should also be undertaken as to improve the maintenance needs estimations.

2. Introduction

The Consultant (Ramboll) visited Shijiazhuang in the period April 18-22, 2007 and had meetings with relevant staff of Shijiazhuang Road and Bridge Maintenance Department (SRBMD) and the RMS consultant (GoodPointe). It was unfortunately not possible to meet relevant staff of Shijiazhuang Urban Transport Project Office (SUTPO); though they did provide staff for translation.

This report includes: (i) a review of the current progress of the project component; and (ii) recommendations on actions which could lead to an improved likelihood of success of the project component. It should be noted, that the review has not included a technical review of the Shijiazhuang Road Maintenance Management System (SRMMS).

The general lessons-learned during the project is discussed in a separate document (Road Infrastructure Management for Three Cities in China).

3. Current Status

The project started June 23, 2005 and was planned to complete by April 2006. Hence the project is now more than 1 year delayed. While SRBMD indicates delays in system programming as the main reason for the delays, the RMS consultant indicates: (i) system programming; (ii) delays in procurement of hardware; and (iii) digesting of acquired knowledge as prime reasons for the delay.

Based on the meetings and review of documents the following progress, as compared to the scope of work, can be reported:

Scope of Work (as given in TOR)	**Reported Progress**
Review of current road maintenance process, the output from Stage I, and then identify technical needs for the proposed Shijiazhuang Road Management System (SRMS).	Completed. Questionnaires was developed and distributed to establish the current situation and the needs. Many of the recommendations in the Stage I analysis has been adopted in the project.
Review and comment on the SRBMD's current practice in road management, including needs for institutional strengthening, road condition survey and data collection methods.	Completed. The RMS consultant has detailed the business processes and linked these to the SRMS operation. SRBMD has adopted part of these recommendations. As to establish clear ownership of the SRMMS, the Road Maintenance Management Centre was established (part of the Stage I recommendations). In this unit the Maintenance Section has taken ownership of the system and will also be responsible for data collection.
Develop a sustainable data collection programme for the SRMMS.	Ongoing. The RMS consultant has developed a data collection programme, including guidelines in how to collect the data. This output has not yet been approved by SRBMD. The promised PDA's (6 units), with the needed software, which will be used for the visual pavement condition surveys have not been supplied.

Design and develop the database structure and information management subsystem (the road databank).	Completed. The database which provides the repository for the road and bridge information has been installed and is operational. The SRBMD can input the collected data and output asset information.
Develop functional models and analysis tools needed for modelling pavement deterioration.	Ongoing. The SRMMS currently installed on the server includes the basic pavement modules. However currently the evaluation and prediction models are based on PCI only. Works are ongoing to update these with other data, such as roughness and bearing capacity.
Implement a simple rule-based system for determining bridge investment priorities.	Ongoing. The prediction models for the BMS is not complete (planned to be completed by May/June). The BCI can be calculated, but no deterioration models can be applied.
Implement a decision support system for both short term and long term maintenance and rehabilitation projects programming and budgeting.	Ongoing. The basic models for the road evaluations are complete, but the modules for the bridges are still incomplete.
Supply and install the system and give operation training during the project implementation phase, including road condition surveys and data collection, system operation, reporting management and basic problem shooting techniques.	Ongoing. The version of the software installed includes many of the features planned. However as parts of the SRMMS software are not completed, the full system is not yet installed. It is especially the BMS parts which are still being developed (see also above). Much of the documentation is also still under preparation, including instructions on system management and user manuals. The RMS consultant plans for a two week user training when the SRMMS system is complete.

4. Recommended Actions

Based on the review of the project, it seems that apart from the delays, the project is successful so far, as the technologies adopted are deemed suitable for the road agency and the SRBMD have taken ownership. A clear sign of this is the fact that the SRBMD, based on their experience using the system, have had some additional requests to the installed SRMMS. Such requests only come from using the system.

Based on meetings, current status of the project and the identified issues, the following actions are recommended to improve the likelihood of success.

Critical Issue	**Recommendation**
The SRMMS is linked to a GIS mapping tool. However the SRBMD is not able to update the base map (adding new roads, change alignments etc.) and cannot add new themes (map layers). Road networks are not static. Nor is the data which should be presented on the maps. Hence it is important that SRBMD will be able to revise and add to the maps.	It is recommended that the necessary third party software be bought and SRBMD be trained in using it in the context of updating the SRMMS maps. This needs to be done, while the RMS consultant is still on board.
As part of the SRMMS installation, a number of standard reports have been developed. However SRBMD is not able to add new reports or adjust current reports. By experience, when the use of the system is being institutionalised, there will be requests for a number of additional report and formats not included in the system today. Currently such reports would have to be developed by exporting data and then use MS Excel/Word to further process the data.	The SRBMD should be able to add new reports and revise existing reports; if not by them selves then by engaging local consultants. It is recommended that SRBMD would be trained in doing so.

When the database has been fully developed and furnished with up-to-date data, the database will provide a wealth of information, which can be used by a number of organisational units.	It is recommended that the information in the database would be shared with other units. A first step in this could be publishing an Annual Report, documenting the current status of the road and bridge assets and the development trends. The report could also include an overview of the maintenance carried out during the year and how this affects the road asset condition.
Currently the SRMMS uses the results of the visual pavement surveys to estimate the current road condition (PCI) and predict current and future needs for maintenance. However SRBMD collects other important pavement data such as IRI, SN and BPN (British Polishing Number). These data, measured according to Chinese standards, are today only used as 'reference data' and not directly used in the evaluation/maintenance programming.	As the data listed provides SRBMD with a better understanding of the actual pavement condition; the pavement condition evaluation and the prediction models (deterioration models), as well as the maintenance and rehabilitation strategies should include these data. It is understood, that this is already being discussed with the SRMS consultant.
During the interviews, the SRBMD had difficulties in outlining the adopted methodology of the analysis of deterioration and how this relates to estimates of future needs for maintenance.	It is important, that SRBMD understands the analysis principals as to be able to continuously calibrate and improve the models, as they gain experience using the system. It is thus recommended, that the RMS consultant will provide further training in the adopted analysis approaches. It is understood that SRBMD has already asked the RMS consultant for such additional training.
An RMMS system is also a tool to communicate with stakeholders. Importantly the system can be used to make strategic expenditure analysis, which analyses the development in the road network condition under different budget scenarios. This helps decision makers, especially those deciding on budget allocations, understand the consequences of different budget allocations.	It is recommended that SRBMD would be trained by the RMS consultant in conducting strategic expenditure analyses using the SRMMS, and that SRBMD develop procedures for reporting the analysis to decision makers.

The SRBMD plans to carry out roughness and bearing capacity measurements with intervals of two years. The last collection of these data items was in 2003/04. Hence the data should be collected again in 2005/06. However, the surveys have not been undertaken due to shortage of funds.	The SRBMD needs to adopt the SRMMS and the data collection it is based on, as one of its core operations. Consequently specific annual budgets should be allocated. It is recommended that an annual budget allocation would be made to the SRMMS operation also covering data collection.
During the discussions it became evident that while backup are being carried out, the backup medium (CD's or external hard-drives) are not stored in a secure location.	It is recommended that the backup medium is kept at a secure place outside SRBMD's offices. This could be privately with one of the SRMMS counterparts.
The core of the SRMMS is based on a COTS system (ICON). To the surprise of SRBMD the copyrights of this part of the ICON will remain with the RMS consultant. SRBMD will only hold copyrights for that part of the SRMS which is developed specifically under this contract. Currently it has not been established to which parts of the installed SRMMS the SRBMD holds the copyrights.	It is recommended that the issue will be solved as soon as possible. The RMS consultant is also installing ICON at another city in China (Guangzhou), where it must be assumed that developed features would be common (e.g. Chinese language). This complicates the copyright issues. The ICON documentation at the start of the project could be used as guidance to establish which parts have been developed specifically for the project. However, it needs to be taken into consideration that the RMS consultant has supplied their web-based version, which was not fully developed at the beginning of the project. The development carried out by the RMS consultant moving the ICON software from the C/S to the B/S platform would probably be assumed to belong to the RMS consultant.
It has come as a surprise to SRBMD that a maintenance agreement needs to be entered with the RMS consultant, if changes or updates to the ICON system are to be adopted after the initial one year maintenance support included in the contract. No software is static; thus it must be assumed that needs for changes and updates will become the reality.	It is hence recommended that SRBMD enters a maintenance agreement with the RMS consultant. The RMS consultant has in his 'Project Deliverables Report' of September 2005 listed a number of possible agreements.