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# Building Integrated Project and Asset Management Teams for Sustainable Built Infrastructure Development

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## Abstract

**Purpose** – The aim of this study is to investigate the relevance of the RIVANS concept for integrating project management (PM) and asset management (AM) for total asset management (TAM). The specific objectives are to: test the RIVANS for TAM concept postulated by Kumaraswamy (2011) and Kumaraswamy et al. (2012); discover ways to enable PM and AM teams to work in an integrated manner; and recommend strategies and operational measures to promote greater team integration in the industry.
**Design/methodology/approach** – This study is based in Hong Kong with parallel studies in the UK, Singapore and Sri Lanka. Through a comprehensive questionnaire, a case study on an organization engaged in both D&C and O&M works, interviews and hosting a workshop (all conducted with experienced industry practitioners and experts), a set of recommendations is derived to guide the industry towards greater team integration.
**Findings** – Early involvement of O&M staff is important for better anticipating obstacles and learning from past experiences but PM and AM teams generally work independently with limited interaction. Priorities of the stakeholders are often different. Knowledge management is increasingly important but knowledge sharing is not always a priority. The three focus areas in the set of recommendations developed from Hong Kong are: I) Organizational/Management Structure, Procurement Strategies and Operational Mechanisms; II) Fostering Culture of Team Building and Providing Additional Means of Communication; and III) Informal Communication Tools.
**Originality/value** – There has been little research into the communication, interaction and integration between PM and AM priorities and teams. However, increasing industry emphasis on sustainable buildings, end-user satisfaction and designing for maintainability dictates that PM and AM teams must work closer together, hence the imperative for mapping useful directions to be pursued.

**Keywords:** project management, asset management, supply chain management, relationally integrated value networks (RIVANS), team building, facility management

**Article Type:** Research Paper

## Introduction and Background

Traditionally in built infrastructure development, interaction and communication between project management (PM) teams (i.e. involving those who plan, design, construct, and deliver the built asset) and those in asset/facilities management (AM) (i.e. operation, maintenance, and possibly demolition and materials/components recycling) are usually limited. As society increasingly expects much more from these development projects and environmental awareness increases, industry trends and priorities have shifted towards sustainability, delivering greater end-user satisfaction, lifecycle considerations, designing and constructing for maintainability and deconstruction (CIRC, 2001; Ugwu and Haupt, 2007; Ortiz et al, 2009; and Yip and Poon, 2009). Naturally, the working relationships and linkages between PM and AM teams must adapt to these changing needs. Well-structured feedback from operations and maintenance (O&M) personnel to those in design and construction (D&C) are indispensable in achieving these goals.

The work of Colledge and Bryant on relational contracting highlighted the importance of building good working relationships and the value this brings to a project such as increase in mutual trust, co-operation and innovation (Colledge, 2005; Colledge, 2004; and Bryant and Colledge, 2002). Case studies conducted by Colledge (2005) revealed that establishing commercial relationships such as building network relations, working in partnering frameworks and project alliances can deliver higher value both in the project itself, as well as beyond the project over the built asset life, such as more innovation, higher productivity and greater acceptance and appreciation from the community. Furthermore, Colledge (2005) pointed out that as the commercial relationship builds, focus on trust and partnership becomes more important than the terms within a contract.

Loosemore and Hsin (2001) stated that in facilities management, functional performance (i.e. how the facility serve its purpose to cater to the needs of its occupiers – such as space, layout, ergonomics, etc.) has greater influence on an organization's core objectives than physical and financial performances. Efforts to measure performance using specific KPIs can potentially run into the danger of focusing predominantly on the business needs of the organization performing the maintenance works rather than the strategic needs of organizations or businesses that rely on those facilities, thus leading to the misalignment with organizational objectives (Loosemore and Hsin, 2001). It is therefore even more pertinent to identify and target such long term organizational objectives during the project development and management phases, so that they are incorporated in advance in broader KPIs for planning and evaluating operations and maintenance.

The concept of Relationally Integrated Value Networks (RIVANS), a holistic framework proposed in the mid-2000's, for 'relational' integration aimed at achieving higher overall value in the construction industry was proposed by Kumaraswamy et al. (2005). The aim of this study is to investigate the relevance of the RIVANS concept for integrating PM and AM for total asset management (TAM). The specific objectives are to: test the RIVANS for TAM concept postulated by Kumaraswamy (2011) and Kumaraswamy et al. (2012); discover ways to enable PM and AM teams to work in an integrated manner; and recommend strategies and operational measures to promote greater team integration in the industry. This paper first explains RIVANS and proposes how it could be extended to TAM. The core research methodology is then described, followed by the findings from this multi-pronged research approach. Thereafter, recommended strategies and operational measures are presented. The final section comprises the conclusion, implications of this study and the way forward for the industry.

## Relationally Integrated Value Networks (RIVANS) for Total Asset Management (TAM)

The RIVANS concept goes beyond typical structural integration (such as procurement modes like design-build or design-build-operate). With RIVANS, relational forces within client-led supply chain networks in PM are strengthened to achieve higher performance (Kumaraswamy et al, 2010). It encourages stakeholders to engage in cross-linked value networks with common value objectives and

added incentives to integrate by focusing on the overall value that can be thereby extracted. Properly aligning value streams of stakeholders is crucial to untangle and rebundle some potentially conflicting value objectives arising from divergent agendas.

The above approach also addresses some shortcomings identified by Gottlieb and Haugbolle (2013) in continuing attempts to achieve integration towards 'collaboration' through 'partnering', without 'understanding and managing the contradictions between existing institutionalized activity systems in construction of production, values and interests'. Also, Eriksson and Ossi (2007) had noted that 'cooperative relationships are not easily achieved in construction' as they require 'changes in several elements of the traditional procurement procedures'. In parallel, Eriksson (2007) also found that 'cumulative values of cooperation are much higher in lasting relationships than in occasional transactions. Thus, the best way to facilitate cooperation between rational players is long-term contracts'.

Addressing the above issues among others, in targeting value-driven long term supply chain network integration, the RIVANS concept is illustrated in Figures 1 and 2. The goal is to blend co-operation with competition to generate healthy 'co-opetition', where the network co-operates to increase their combined competitiveness together, so that they are able to compete better against other competitors or networks (Kumaraswamy et al, 2010).

**< Figure 1 >**

**< Figure 2 >**

*Extending RIVANS to TAM*

The natural progression, given increasing demands for sustainable infrastructure, is to adopt a longer-term perspective to cover the operations, usage and maintenance phases of the built asset by extending RIVANS to "total asset management" (TAM) i.e. to encompass the hitherto separated functions and segregated management of built assets. According to Edgar and Teicholz (2001), asset management should be treated as a supply chain issue and given the same attention as end products or services. When a design and implementation project is commenced, asset managers must give full consideration to the commissioning, operational and end-of-life phases of the physical asset (Schuman and Brent, 2005). The management of these built assets is often perceived as a controlling function rather than a managing function but if properly developed, the role of asset/facility managers can add organizational value as well (Loosemore and Hsin, 2001).

Transactional forces (e.g. involving any contractual agreements) between PM and AM teams are usually very limited with weak collaborative supply chain networks (Kumaraswamy et al., 2012). While relational forces may exist (such as a consultant trusting a preferred contractor or a few 'tried and tested' contractors), these forces remain fragmented, lacking structure and common shared goals. This often leads to improvised approaches for managing stakeholders and supply chain networks in a given project. With the extension of RIVANS to cover the O&M aspects, the target is to shift away from the one-way knowledge flows typical in built asset management into a system of two-way flows where synergies can be generated through information transfer and feedback between various stakeholders involved in project management as well as asset management. As highlighted in Figure 3 (developed from Kumaraswamy, 2011), the core question is how to move from the present 'silo'-segregation and 1-way information flows to integration and 2-way knowledge flows. The following section highlights the core methodology and reported research tasks in exploring the potential for addressing this key question through RIVANS for TAM.

**< Figure 3 >**

**Methodology**

A four-pronged research approach was undertaken, as described in this section, in order to gain a deeper understanding of existing working relationships between PM and AM teams in practice, seek the views and level of acceptance from the construction industry, identify existing good practices for team building, and ultimately derive recommendations for implementing the RIVANS for TAM concept.

The first research activity was an industry-wide survey conducted with construction industry practitioners engaged in D&C and O&M works to solicit their views on specific aspects of integration between PM and AM teams. Data were collected using a structured questionnaire. This questionnaire was divided into four parts. In the first section, respondents were asked to rate how strongly they agree that better value or synergies can arise from a range of activities aimed at bringing together D&C and O&M personnel and linking the supply chains in PM and AM. The second section firstly asks for the type of integration that can best achieve better value or generate synergies from the list of activities stated in Section 1. The three forms of integration are: i) Functional – merging functions like having design and construction under the same organization; ii) Relational – collaboration through co-operative relationships between partners with shared goals; and iii) Transactional – linking partners through formal means like joint ventures or forming alliances. The second part involves a series of potential common goals and objectives where the respondents were asked to rate the level of importance of each. The third section seeks to find out the perceived level of importance of various stakeholders for deriving better value and exploiting synergies between D&C and O&M supply chains. The final section is for collecting specifics of the respondent such as the type of organization they are employed in, the type of work they are involved in and their experience in the industry. A total of 104 responses were received from respondents with an average of 18.8 years of experience in the industry. 46.2 percent of the respondents were predominantly experienced in D&C, 26 percent in O&M, while the rest were either listed as “others” or not specified. 32.7 percent of the respondents were from client organizations, 23.1 percent from consultants, 12.5 percent from contractors, 3.8 percent from sub-contractors, 6.7 percent from academia, and the rest were either listed as “others” or not specified. The questionnaire is in Appendix 1.

The second research activity was a detailed case study conducted on a leading public transport organization. This case was chosen because unlike most PM and AM teams that mostly work independently, this organization is engaged in both D&C and O&M works. Such an arrangement should imply that the interaction and communication between the two would be better. Data for the case study were collected from interviews with 13 senior-level personnel and experts from both PM and AM (known as the ‘Projects Division’ and ‘Operations Division’ respectively at the organization), overview and walkthrough of their communications and knowledge management systems, as well as attending a stakeholder engagement meeting. Profiles of the case study interviewees are in Appendix 2.

The third research activity was a set of semi-structured interviews which were carried out with six construction industry experts engaged in PM and/or AM works. The purpose of the interviews was to solicit feedback regarding the RIVANS for TAM concept, understand the existing working relationships between PM and AM personnel within the industry, their means of communication, sustainability and lifecycle considerations, end-user requirements, catering to public needs, as well as potential obstacles for implementing the proposed concept. Profiles of the general industry interviewees are in Appendix 3.

The fourth research activity was a workshop attended by senior-level construction industry experts. The purpose of the workshop was to brainstorm strategies and measures to implement RIVANS for TAM. A total of 33 participants attended the workshop and their profiles are in Appendix 4. The workshop began with presentations on the RIVANS for TAM concept, interim findings, and outline of the workshop (purpose, scope, specific instructions, etc.). Participants were then divided into three

groups based on their area of expertise. The themes of the three groups were: 1) Identifying and Pursuing Common Values between "Design & Construction" and "Operations and Maintenance" Teams; 2) Re-structuring of Supply Chains and Changes Needed in Procurement Systems for Promoting Integrated Value Networks; and 3) Changing Industry Culture, Norms and Mindsets. After the group discussions, a rapporteur from each group (selected among the participants) presented the key points from their respective group, followed by a consolidation session where the participants shared their concluding thoughts.

## Findings

The summarized findings from the survey, case study, semi-structured interviews and workshop are presented below.

*Questionnaire Survey*

Given space limitations, only the key findings from this survey are highlighted here, while the detailed findings are explained in Kumaraswamy et al (2012). The top three ways in which better value / synergies can arise, were perceived as: 1) lifecycle optimization options and opportunities; 2) sharing relevant information such as building specifications, as-built drawings, construction records and O&M performance data; and 3) addressing sustainability issues.

The top three aspects that can best achieve better value for each type of integration are presented here. Functional integration can be best achieved through "sharing relevant information such as building specifications, as-built drawings, construction records and O&M performance data" (60.9%), "lifecycle optimization options and opportunities" (58.7%) and "joint use of ICT tools" (46.2%). Relational integration can be best achieved through "expanded long-term business opportunities" (56.2%), "integrated team building" (52.7%) and "integrated business continuity management" (52.2%). Transactional integration can be best achieved through "similar procurement protocols between D&C and O&M" (22%), "expanded long-term business opportunities" (25.8%) and "integrated business continuity management" (23.9%).

The top three most important common goals in achieving better value are: "common project goals - e.g. cost, quality, time, safety"; "effective and efficient information sharing"; and "efficient resource utilization & management".

The top three stakeholders considered most important for deriving better value by mobilizing / exploiting synergies between D&C and O&M supply chains are: Clients; Designers and Principle Consultants; and Main Contractors within D&C. Within O&M, the most important stakeholders are: Clients; Users; and Main Contractors. The findings from this survey provide an overview of industry perceptions toward the potential of greater integration between PM and AM teams, and pave way for subsequent research activities (i.e. case study, interviews and workshop).

*Case Study*

Background

After meeting with 13 senior-level experts from the Projects Division and Operations Division, as well as the unique Operations Projects team that serve as the bridge between the two divisions, it was found that the Operations Division is involved in nearly every stage of the project development process to contribute their input on the design since the beginning of a project. There are design review processes in place (conducted by the staff from the Operations Division) to ensure that input, suggestions and concerns raised by Operations personnel are adequately addressed in the designs. Many of the interviewees (Interviewees 1, 2, 3, 4, 8, 9 and 10) acknowledged that early involvement of Operations

staff in projects is important for better anticipating obstacles and drawing on past experiences from an operator's viewpoint. This is a crucial basic element that, unfortunately, is not the common practice in the rest of the industry (as revealed from the general industry interviews and discussed below).

Types of Meetings

While there is of course a wide range of high and mid-level management meetings for exchanging ideas, sorting out working arrangements and enabling communication between the different divisions within this type of major organization, the key types of meetings that are most relevant and significant to the inter-relationship and integrated team building between PM and AM personnel are highlighted here. The Technical Management Steering Committee Meeting is an organizational-level meeting attended by senior-management personnel and is held monthly, serving as a bridge between the two divisions. This is where new technologies, technological feasibility, and previous experiences are shared. Furthermore, any technical issues related to new or future projects and applications of new technologies for upgrading existing projects are also discussed at this meeting.

At the project level, a stakeholder engagement meeting is held weekly where, via video conferencing, representatives from project teams of on-going projects, project headquarters (which provide technical support to project teams), and the public relations unit gather to discuss any recent issues that came up concerning the broader community stakeholders (district councilors, police, fire department, highways department, drainage services, and the general public). During the meeting where the research team was granted access, the issues covered include: traffic management for soil transport to the project site; drainage blockage after heavy rainfall; and details regarding the exhibition tour (as part of the public engagement plan) for a particular project.

To further extend the team working environment to include partners from outside the organization, design workshops are held weekly where consultants and contractors are invited to discuss various issues encountered such as constructability, design details, etc. so as to better meet the needs of the client (i.e. the case study organization). In some cases, the consultants or contractors may suggest how to design or build a component better based on their previous experiences and expertise. The client is open to such recommendations and may agree to those alternative solutions and willing to absorb the extra cost, if any, provided that it can deliver better value. However, these decisions are made case-by-case and approved depending on the situation and budget allowance. The meetings highlighted here serve as great examples of how to enhance communication and interaction between project stakeholders from both inside and outside the organization.

During the interviews with Interviewees 1, 2, 3 and 4, it was discovered that after the completion of a project, contractors are invited back to speak with the client to discuss obstacles encountered during construction and what techniques, improvements or support from the client would be beneficial in future projects.

Knowledge Management

The research team met with the knowledge management experts from both the Projects and Operations Divisions for three walkthrough sessions. It was discovered that there is a centralized information and communication technology (ICT) tool, albeit with separate customized portals for each of the two business divisions. Within the system, there is a comprehensive set of templates (which can be specifically tailored according to the specific project needs) for items such as the project definition document, service requirements, functional requirements, and design and operations standards with specifications. These templates are accessible by the staff with the appropriate security clearance levels.

There are also designated folders where CADD drawings for different projects can be stored and shared between users working on the same project. Furthermore, certain relevant project information

(including certain CADD drawings) is made available to consultants and contractors involved in a project. This helps to ensure that everyone involved in the project has the same, updated information so that changes are clearly referenced and noted, and that proper references to drawings or specifications can be made. Experiences and lessons learnt from past projects are also captured into the system. Users with sufficient access levels can retrieve information from previous projects through a comprehensive search tool built into the system.

In addition to the formal project-related information, the system also allows for the arrangement of informal team building activities such as group discussions, sporting events and outings where staff can engage and interact with other colleagues (within their own division or in other divisions) on a more personal level, all of which helps to build a stronger working relationship. Through the discussion forums in the system, new ideas, experiences and alternative solutions are shared between colleagues and some of these solutions do get documented and implemented in actual projects.

Challenges identified from the Case Study

Even though there is strong management support with comprehensive ICT infrastructure in place to encourage team building, there are still challenges that need to be overcome. Promoting greater inter-departmental knowledge sharing has only taken place in recent years and still considered to be at an early stage according to Interviewee 5. Knowledge management is becoming increasingly important due to the ever-increasing amount of information and data available. Therefore, having a user-friendly system that makes all of the information and data easily accessible is crucial.

Interviewees 1 and 3 identified several other challenges. One of which is that knowledge sharing is not always a priority among the staff, especially those engaged in project-specific work who are focused on (and often have their performance evaluated based on) timely completion of their tasks and deliverables. It is often up to individual department heads to encourage their subordinates to engage in knowledge sharing, rather than having a clear top management mandate to share knowledge. Staff continuity was identified as yet another obstacle in knowledge sharing and capturing lessons learnt from completed projects. With project-specific staff being reallocated to other projects soon after completing their tasks on the previous project, it is often difficult to track down certain staff members to document their experiences. On some occasions, the staff members working on post completion reviews project do not posses first-hand experience from the project, particularly from earlier phases, and need to rely on second-hand information. All of this leaves room for further improvement measures to be devised to promote even greater team integration.

*General Industry Interviews*

As confirmed from the six non-Case Study interviews, the common industry practice is indeed that PM and AM teams generally work independently of one another with limited interaction. Objectives and goals of consultants, contractors and facilities managers/operators are different, each with limited knowledge and appreciation for the needs, leave alone priorities, of other parties. For example, Interviewees 14 and 15 noted that consultants always wish to design signature/landmark projects that can enhance their firm's image to attract future jobs with elements and components that may not be the most easily accessible for maintenance, whereas contractors are most concerned with completing the job promptly so they can receive payment and move on to other contracts. Maintenance/operations personnel on the other hand, are focused more on maintainability, ease of access, durability, reliability and minimizing maintenance/operating costs. Overall, these stakeholders have different mindsets and lack the motivation and appropriate mechanisms to strive towards working more closely with other parties and share knowledge.

Interviewees 16 and 17 noted the industry trend towards outsourcing O&M works due to factors such as cost efficiency and risk transfer. However, this will inevitably make communication, building strong relationships and capturing/sharing experiences between PM and AM teams even more difficult.

Echoing the opinion of Interviewee 5 from the case study organization, Interviewee 14 also noted that knowledge management is a major challenge, given information overload from technology advances. Indeed there are still instances where drawings get lost or a staff-member is unable to find the latest version of certain drawings.

Finally, Interviewees 16 and 17 highlighted that protecting/safeguarding end-user benefits is becoming more important with greater involvement from clients and more engagement with end-users and the general public. Since O&M teams have a much closer and longer-term interaction with end-users, they are better positioned to understand their needs, and convey them to the designers (for making improvements or modifications, etc.). However, as mentioned by Interviewees 14 and 17, the level of involvement in design and development from O&M personnel largely depends on the client's requirements. The earlier the O&M team gets involved, it is likely that more financial resources will be required, so the client must also justify the net benefits of bringing the O&M team on board earlier.

*Workshop*

The majority of the workshop participants agreed that clients are in the best position to bring together all the parties involved since the consultants, contractors, maintenance companies and operators would all like to satisfy the clients in order to establish a good reputation and secure future jobs. Like the general industry interviewees, many workshop participants agreed that these stakeholders all have performance goals that may not align with those of the other parties. For example, consultants may wish to design unique showcase projects, contractors wish to finish the job early, while maintenance/facilities management companies are more focused on business continuity and safety so they would like to slow down and think more about the prolonged effects of the decisions being made and the potential consequences. Several participants shared experiences of extra time and costs involved, or work that needs to be re-done due to O&M teams not being part of the design process. Furthermore, Participants 5 and 28 noted that clients and designers need to be aware of future technological trends, associated costs and upgrades to determine whether they should invest in components that can extend the service life of the built asset. Therefore, it is essential to demonstrate and convince construction clients of the importance and benefits of involving all the stakeholders earlier.

Participants 4 and 32 mentioned that classifying asset type and expectations is needed before discussing value, performance and evaluation, and this should be clearly stated in the 'Facility Brief' since different types of assets have different associated values which must thus be measured differently. Participants 7 and 8 added that 'usability' should also be included as part of the evaluation criteria. Different types of assets will have different criteria and definitions of usability (e.g. an airport – accessibility, security checks, etc. versus a shopping mall – location, the right shops, car parking, etc.), and this would be closely tied to the user experience. Participant 3 suggested that PM and AM teams should place more emphasis on how to unlock existing value that is already embedded within the project. For example, the location of an electrical and mechanical control/maintenance room can be designed or relocated to a more convenient location on site that would enable O&M staff to access the room more easily.

The importance of knowledge management and Building Information Modeling (BIM) is increasing. Many participants agree that knowledge databases and BIM systems play an important role in projects. Whenever there is doubt about certain project elements, these tools can help eliminate those uncertainties. Participant 5 shared his past experience where misinterpretation of project information led to consultants having to redesign the layout for a part of the project. These databases and systems can also be useful when existing infrastructure need to be upgraded or additions have to be made. It is also vital to capture knowledge and lessons learned after project completion for more effective use of resources rather than investing in new systems for different projects. Instead of PM and AM teams each developing their own knowledge management or BIM systems, it would save time and resources

to have the client commission and own an integrated system which both PM and AM teams would build and use.

Regarding procurement, some participants noted that the alignment of objectives among the different stakeholders is usually constrained by contractual agreements which generally protect the client rather than benefit end-users. In addition, existing procurement systems are not normally structured in a way that encourages cooperation since the tender assessment is still mainly based on the tender price. It was proposed that certain design contracts can be expanded to cover O&M (where appropriate), with incentives and penalties to provide motivation and responsibility sharing. For the consultant-selection process, Workshop Group 2 proposed that new requirements can be introduced to encourage better consideration of O&M needs (e.g. whole lifecycle management and O&M proposals).

The participants generally agreed that public consultation is becoming increasingly common in public projects and that public accountability is a key concern. Therefore, there is less willingness to take on increased risks with new ideas/approaches unless there is clear commitment and support from senior management, which leads to a lack of creativity and innovation. It was proposed that end-users should be more actively involved in the project inception stage so that their needs can be given better consideration.

As observed from the case study, organizations engaged in both D&C and O&M works are good examples for the rest of the industry for integrating PM and AM teams. This view was further supported at the workshop. Participant 10 (from another such organization) pointed out that "function" and the built infrastructure's ability to serve its intended purpose(s) are of higher priority than the cost. This is particularly important for essential infrastructure that serves a significant portion of the population. He further commented that O&M staff in this type of organization can offer practical, constructive design input and accurate estimates of O&M costs. Since they should also be able to relate easier to the PM teams within their same organization, this type of organization can serve as a test bed for the type of O&M feedback mechanism envisioned for the RIVANS for TAM concept.

## Recommended Strategies and Operational Measures

After analyzing the results from the questionnaire, case study, general industry interviews and workshop, a set of recommended strategies and operational measures were derived. The three strategic focus areas are: I) Organizational/Management Structure, Procurement Strategies and Operational Mechanisms; II) Fostering Culture of Team Building and Providing Additional Means of Communication; and III) Informal Communication Tools. These focus areas and the respective operational examples are illustrated in Figure 4.

**< Figure 4 >**

*I) Organizational/Management Structure, Procurement Strategies and Operational Mechanisms*

Under this focus area, it is recommended that a common platform be established such that D&C and O&M teams are linked in an organizational structure where the two branches would be more structurally integrated so that periodic meetings at both organizational and project levels can be systematically arranged. This would enable both teams to come together and establish common goals/objectives, and discuss important issues that may arise during key milestones of the project. This would be particularly beneficial at certain stages/phases of a project such as project definition/briefing (enabling O&M personnel to offer their input from the beginning), post construction/handover (to ensure smooth transition and proper transfer of responsibilities), and post occupancy review (so that end-user feedback can be relayed back to the D&C team for improvements, upgrading or capturing lessons learned for the benefit of future projects). Special working groups or task forces comprised of

personnel from both sides can also be set up as necessary to target specific/urgent issues or help bridge the two sides to further cement the entire team.

It is particularly important to start off a project right by being able to identify a suite of potential procurement and delivery strategies (e.g. suitable contract types, templates for non-contractual or contractual partnering, project-based or long-term strategic alliances, framework agreements, etc.). The wide range of options needs to be thoroughly considered to find one that would be most appropriate for the specific nature and conditions of the project. Figure 5 illustrates the potential routes towards fully integrated value building with various procurement and delivery strategies mapped out in terms of the degree of bonding (i.e. level of integration) versus the degree of binding (contractual rigidity). The idea is to guide the industry from traditional contracts (which are rigid and have a low level of stakeholder integration) towards alternatives like contractual partnering, alliances, framework agreements, strategic partnering and non-contractual partnering, which have a higher degree of team bonding as well as higher flexibility. Eventually, it is envisaged that the industry would gradually embrace the RIVANS for TAM concept where long-term relational networks are built.

**< Figure 5 >**

The third element is to establish continuous evaluation and improvement measures. One example is to invite consultants, contractors, sub-contractors and maintenance/operations managers to debrief the client after project completion so they can share their experiences, challenges, solutions and any innovative ideas developed throughout the project. This will also help various stakeholders to better understand the needs and obstacles faced by other parties. Furthermore, performance criteria, key performance indicators (KPI's), typical target values or ranges of KPI's could be agreed in advance so that all the stakeholders can focus on achieving the same targets.

*II) Fostering Culture of Team Building and Providing Additional Means of Communication*

The first recommended measure under this focus area is making available some tools for nurturing a team building environment. This includes the allocation of resources, venues and time for team members to communicate and interact outside of structured meetings but within the work environment so that staff can freely share ideas in a pressure-free, off-the-record setting. This can range from simple coffee breaks to specially planned brain-storming sessions.

The second measure is to promote team bonding through organizing group activities (such as field trips, sporting events, outings, etc.) to offer team members a chance to get together and interact with each other informally outside of the work environment to get to know each other better and build more sustainable and better relationships. Joint activities and personal interactions enable staff from different firms to experience and gain deeper understanding of the culture of their partners (Cooper and Gardner, 2003).

*III) Information & Communication Tools*

The third focus area involves building up actual tools or infrastructure needed to support RIVANS for TAM that can be employed by all stakeholders to better handle information transfer and support team communication needs. The evolution of supply chain management has seen a shift of emphasis from efficiency to effectiveness, through the contribution of ideas and expertise from suppliers and partners (Miles and Snow, 2006). It is recommended that a common supplier relational database be developed (either in-house or by a third party consultant), then kept and maintained by the client for better record keeping and tracking of suppliers for their project(s). Figure 6 shows the envisaged information flow in such a database. The main project stakeholders (client, project managers, designers, main contractors, sub-contractors and maintenance/operations managers) would be feeding information into and retrieving information out of the database, whereas the suppliers would only be feeding information into the database since they are not directly and actively engaged in the project, but would be able to

contribute by providing specifications, updated product information, new products available and any notices, warnings or recalls on products used on a specific project when necessary.

**< Figure 6 >**

It is envisaged that the common supplier database would be divided into different categories of suppliers including 'building materials', 'electrical and mechanical', and 'specials components', where some suppliers would be used in D&C only, some in O&M only, and some would serve as suppliers for both. The client would ultimately own and upkeep the database for each project and may share with the operator/maintenance contractor during the service life of the built asset. The common supplier database is geared towards a specific project, but it is possible that a client may possess numerous databases for different projects (as shown in Figure 7). In such cases, the databases would be interlinked so that a supplier may be shown to be supplying materials or products for several projects. Having a series of relational databases like this can help clients better keep track of suppliers, products and components used for their built assets and enable them to share this information with their operators and maintenance partners for future replacements and upgrades. The layout and specific fields of the proposed common supplier relational database are shown in Figure 8.

**< Figures 7 and 8 >**

The final recommended measure is the development of an internet or intranet-based communication platform made accessible to all project stakeholders involved. Since different clients and other stakeholders have different budgets, resource capabilities and project needs, this type of communication platform can range from simple e-mail/instant messaging groups and basic ftp sites for stakeholders to share relevant files, to more comprehensive, customized web applications and document managing software similar to the one used by the case study organization.

**< Figure 9 >**

## Conclusion and Further Discussion

Balancing financial benefits with delivering value to society and being environmentally sensitive has become a crucial management issue (Walker, 2000). Commitment and recognition from senior management at PM and AM firms is essential. They must recognize these trends and act collectively to adapt to this change. The first objective of this study was to test the RIVANS for TAM concept. It was found that the RIVANS for TAM concept is vital for building links between PM and AM teams, which are conspicuously absent in the construction industry, with the exception of some large-scale organizations that are engaged in both D&C and O&M works. The general industry interviews and workshop hosted by the research team reflected an overall positive response on the proposed concept from industry players, with much potential to be tapped.

The second objective of this study was to discover ways to enable PM and AM teams to work in an integrated manner. The case study with the public transport organization serves as an excellent example of good industry practice for team building and integration. It demonstrated the synergies that can be released by bringing PM and AM teams together in a well-structured manner and the positive response from other parties by involving the AM team from the onset of a project.

The third objective was to recommend strategies and operational measures in support of the RIVANS for TAM concept. The recommendations may be used to guide the construction industry towards building vital links between the project stakeholders involved in D&C works and those in O&M. Under the RIVANS for TAM concept, the ideal outcome is to bridge these different stakeholders and develop better team integration so that their communication can be enhanced, thereby releasing synergies to deliver greater value with a sustained 'overall value vision' during the service life of the

built assets for meeting long-term sustainability goals. As proposed in Figure 9, project managers / designers and facilities / maintenance/operations managers would be able to share their experiences, lessons learnt, improvement measures and feedback from clients and end-users. They would also be able to discuss with their respective contractors, sub-contractors and suppliers on ways to improve client satisfactory, how to enhance the end-user experience, and new methods or products available. Clients and end-users, meanwhile, would be able to convey their feedback (i.e. level of satisfaction, comments and improvements they wish to see, etc.) This enhanced communication network, as a whole, would contribute greatly towards meeting long-term sustainability goals.

Colledge (2005) illustrated three economic models in construction (markets, networks and hierarchies) and their corresponding governance structures (classical contracting, neo-classical contracting and relational contracting, respectively). The associated features of the different governance structures were also listed: adherence to legal frameworks, use of legal remedies and standardized contract planning in classical contracting; focus on longer-term relationships, development of relational tendencies and contract provisions catering for flexibility in neo-classical contracting; and significant sharing of benefits and burdens, greater interdependence, and commercial relationships taking on equal or greater importance to legal agreements in relational contracting (Colledge, 2005). This paper has taken another step forward by mapping out the routes towards fully integrated value building, and by proposing strategic focus areas and operational examples for RIVANS for TAM, i.e. in the particularly useful and all-pervading domain of built assets.

Loosemore and Hsin's (2001) work explored the relationships between the core business objectives of organizations and the facilities they use, and found that fragmentation and mismatches existed in the various sectors that were investigated (including hospitals, hotels and education facilities). Helping to align the objectives of different stakeholders (particularly those between PM and AM teams) of a project is indeed what the outputs from this paper could help achieve, through illustrating the envisioned multilateral communication and exchange of knowledge and experiences between facilities/maintenance/operations managers and other stakeholders (project managers, designers, clients, end-users, contractors, sub-contractors and suppliers), as well as suggesting tools to aid the process such as the relational supplier database.

The three strategic focus areas presented in this paper offer a holistic approach that covers 'hard' management aspects (i.e. organizational structure and procurement) and 'soft' aspects (i.e. fostering a culture of team building), as well as suggesting tools needed for all of this to happen (i.e. common supplier relationship database and internet/intranet platform for information sharing). The mindsets of clients are gearing increasingly towards issues like greater end-user satisfaction, (social, environmental and financial) sustainability, lifecycle considerations, designing and constructing for maintainability and deconstruction. It would be naturally fitting for PM teams to work and communicate more closely with their counterparts in AM who interact more closely and directly with end-users and over a longer period of time with clients.

While focused research into each of the above areas may now be initiated, it may be timely to tie this to commencing some trials on pilot projects to test the above recommendations. Since it is not easy to convince industry in general without hard evidence of real net benefits, such trials may be considered in the first instance, by organisations that are responsible for both PM and AM. They are better positioned for easier implementation and for reaping faster and greater direct benefits in terms of overall value from such integration.

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## Figures

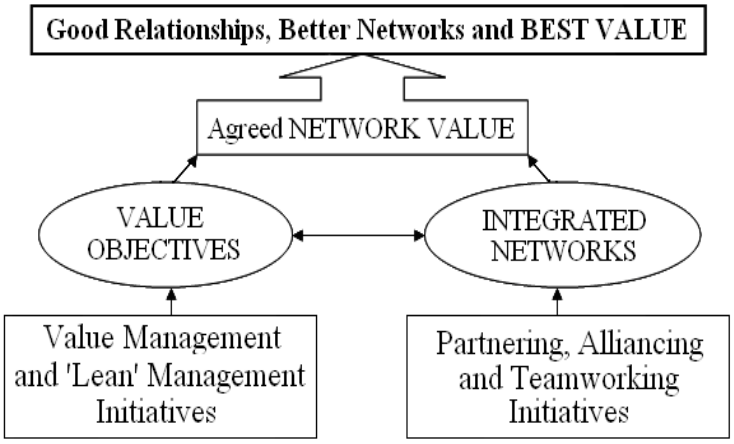


**Figure 1** - Basic Thrusts in RIVANS

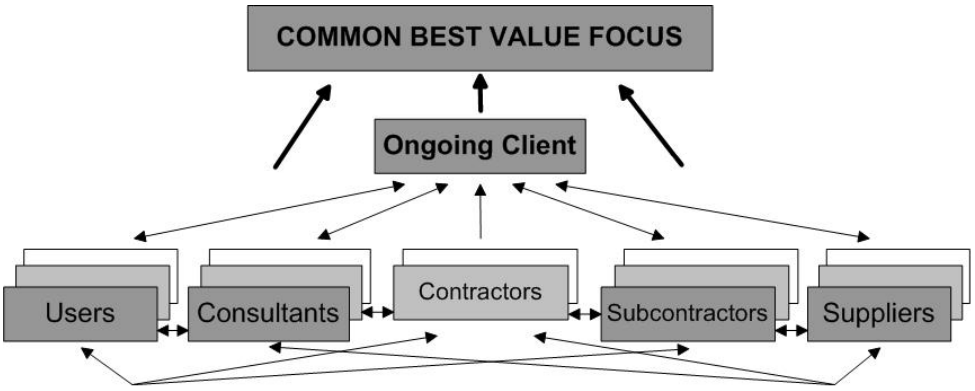


**Figure 2 -** Conceptualizing a 'large' (ongoing) Client's RIVAN

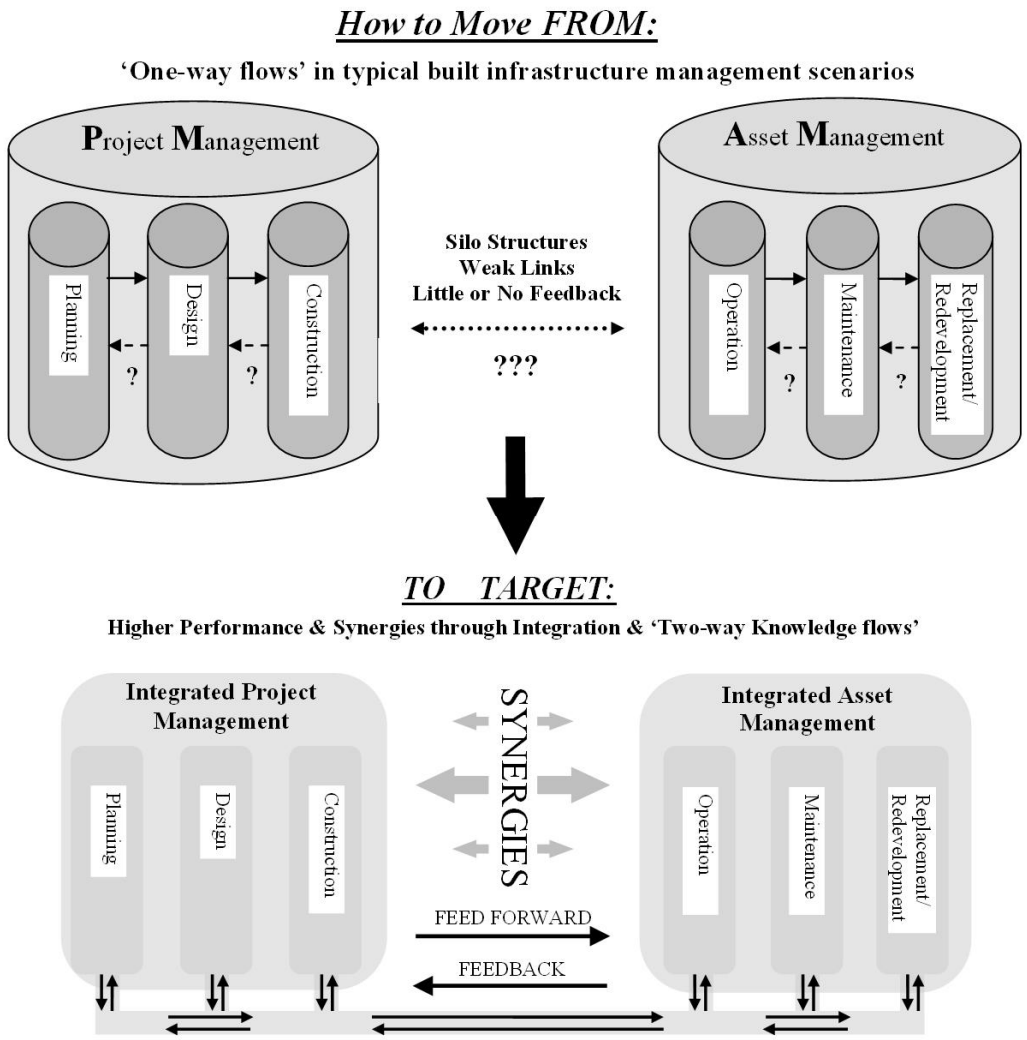


**Figure 3** – Moving from 'One-way Flows' to 'Two-way Knowledge Flows'

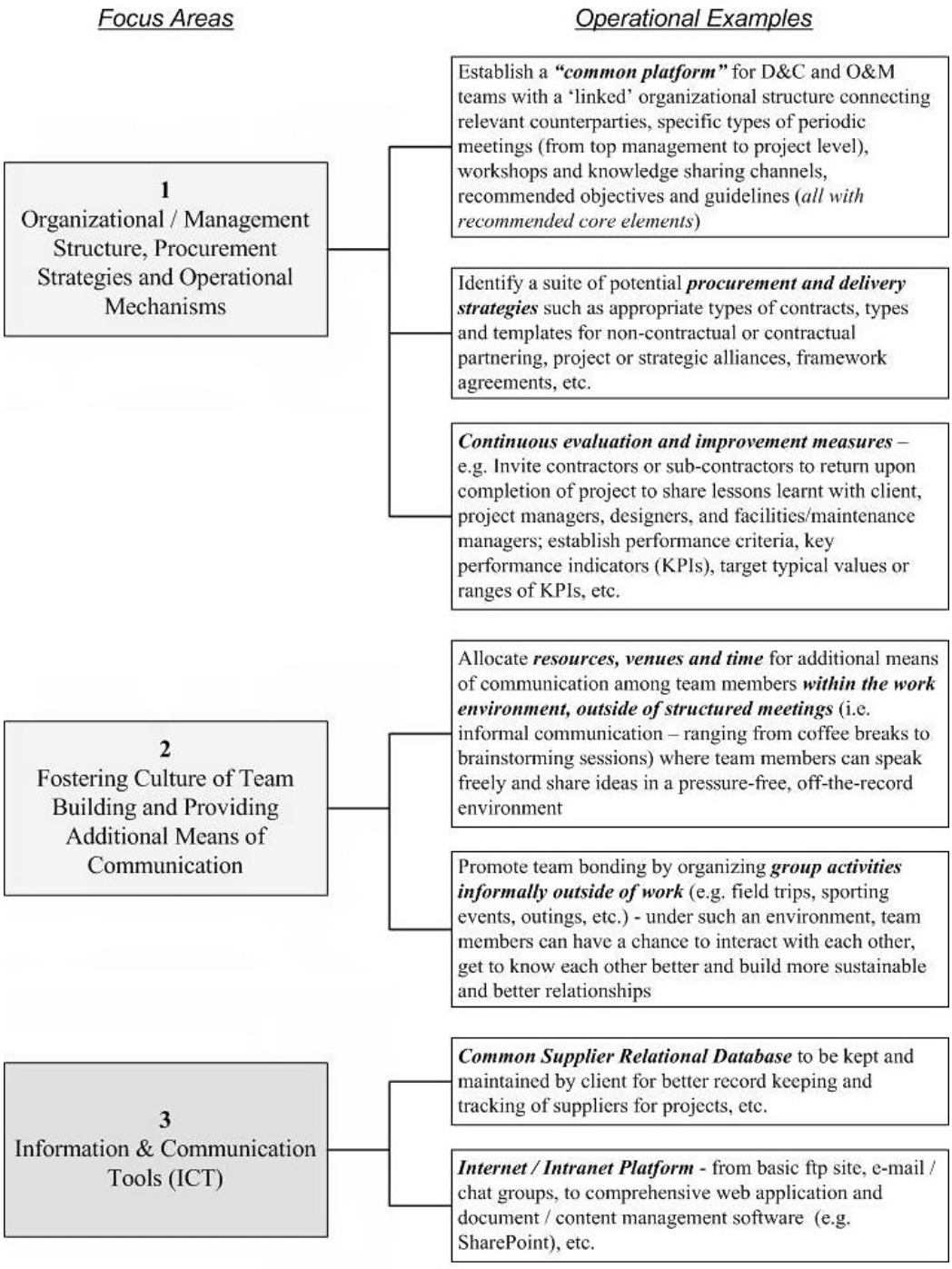


**Figure 4** – Recommended Focus Areas for Implementing RIVANS for TAM

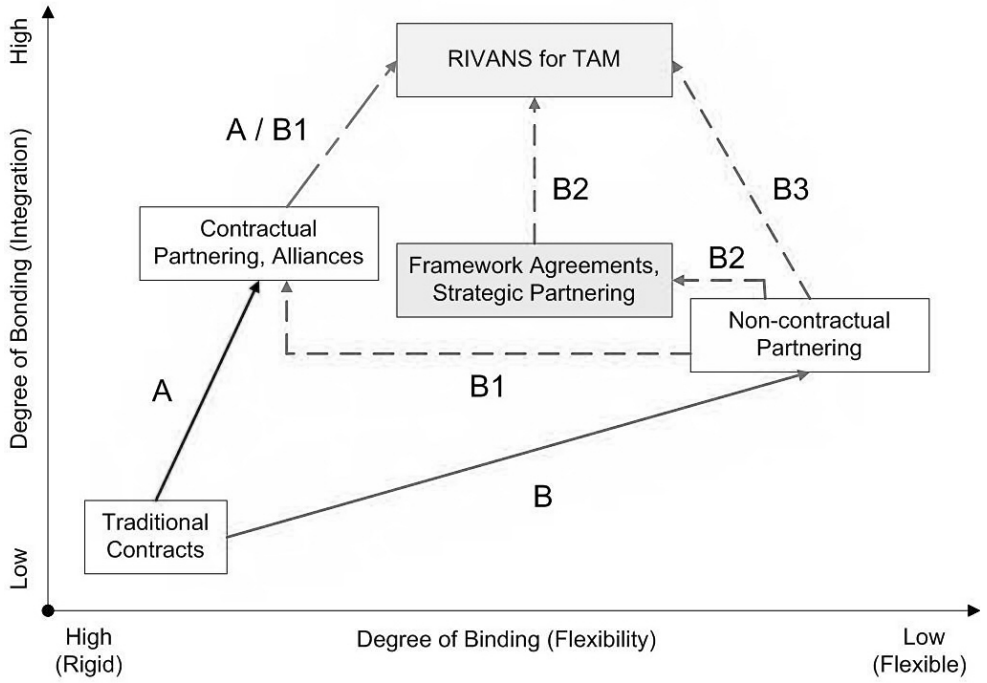


**Figure 5** – Roadmap of Potential Routes towards Fully Integrated Value Building

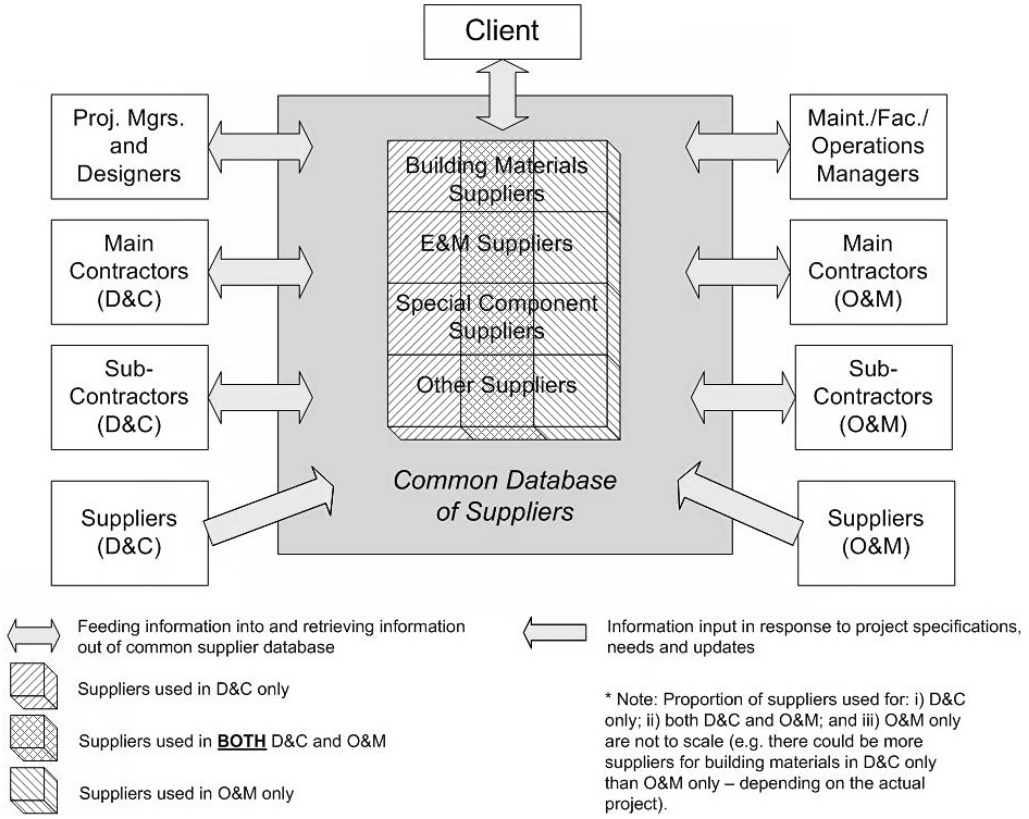


**Figure 6** – Bilateral Information Input and Access in Common Supplier Database (for Single Project)

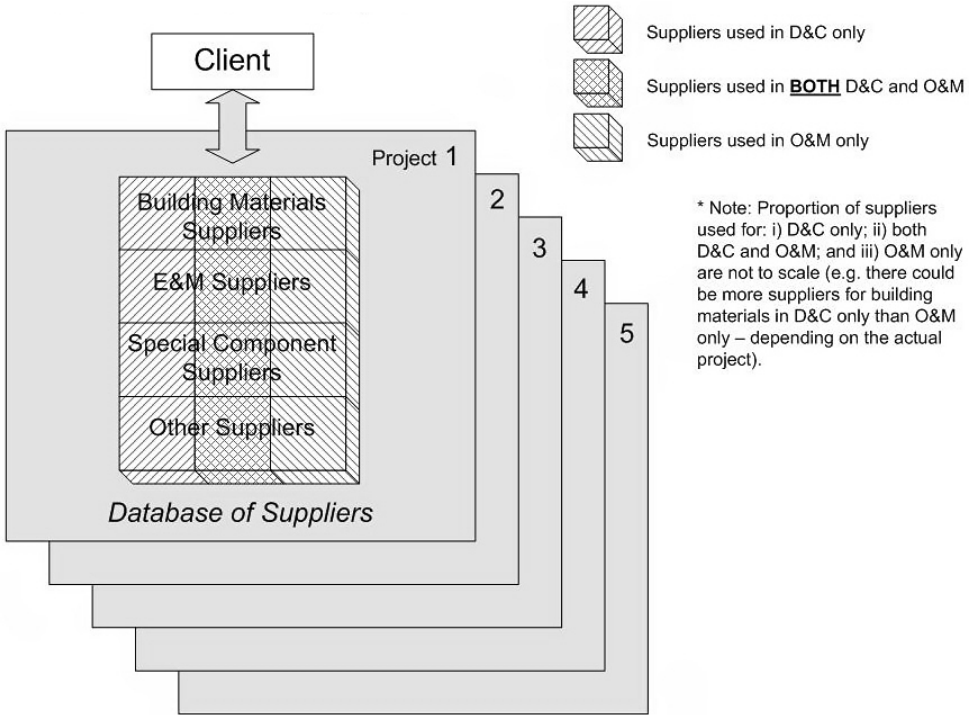


**Figure 7** – Client Owning Multiple, Interlinked, Relational Databases for Different Projects

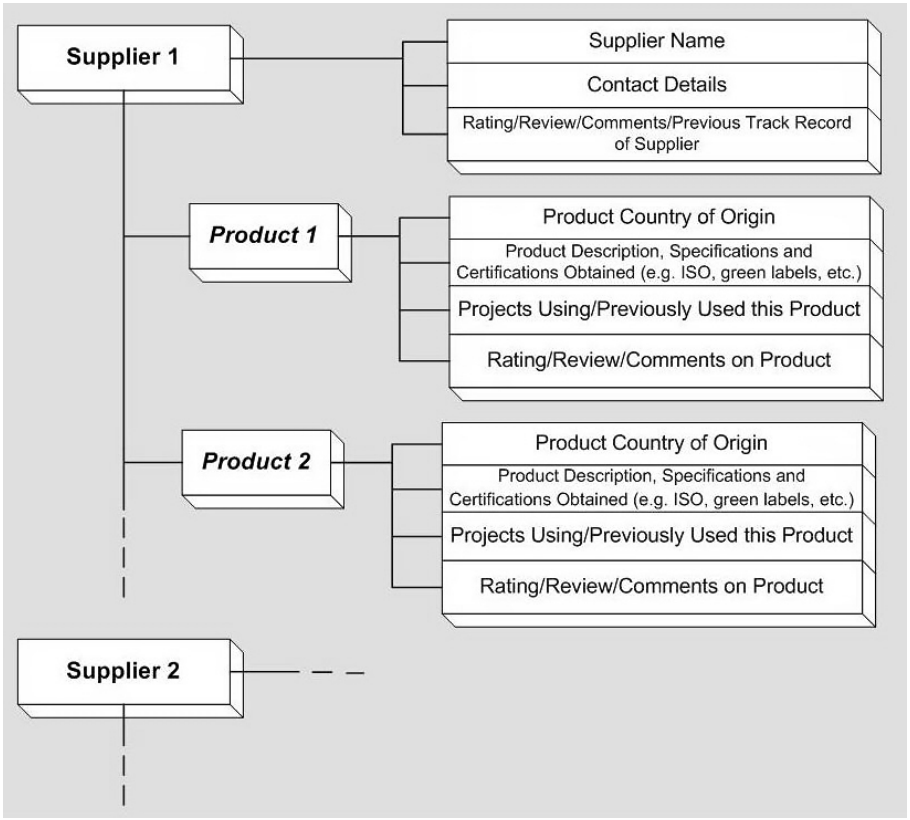


**Figure 8** – Fields within a Common Supplier Database

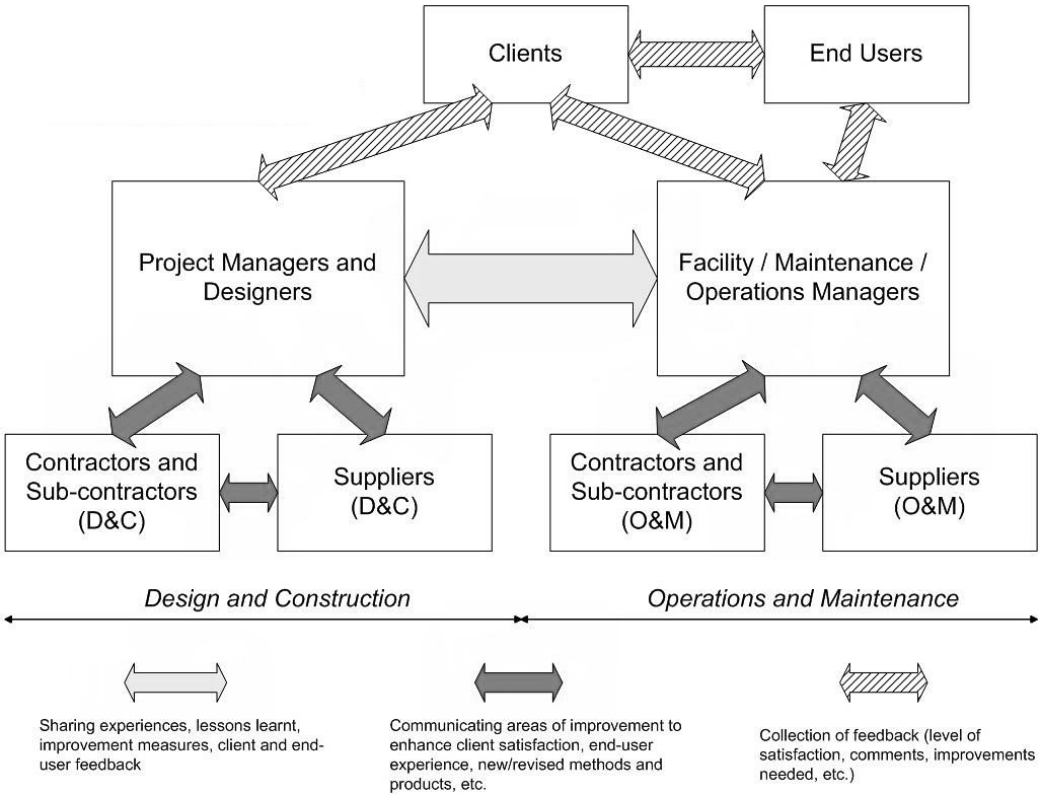


**Figure 9** – Multilateral Communication and Exchange of Knowledge and Experiences between Stakeholders

# Appendix 1 – Questionnaire Conducted with Industry Practitioners

**HKU - 'RIVANS *for* TAM' (Relationally Integrated Value Networks *for* Total Asset Management)**

**Section 1: Potential BETTER VALUE / SYNERGIES* by linking the usual supply chains in IPM (Infrastructure Project Management) with the usual supply chains in IAM (Infrastructure Asset Management)**

| ***Please indicate to what extent you agree that the appropriate integration of the following activities/ items between 'Design & Construction (D&C)' and 'Operations & Maintenance (O&M)', when appropriately mobilised, can yield*** *BETTER VALUE / SYNERGIES* **SYNERGIES:** 'Whole (both working together)' > sum of the two separate parts (working independently); **'BETTER VALUE'** - *for* Overall project life cycle value | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| 1. Better Value / Synergies arise from sharing relevant information (e.g. building specs, as-built drawings, construction records, **O & M (Operation & Maintenance)** performance data, etc.) - *between* 'D & C' (Design & Construction) *and* 'O & M' teams | | | | | |
| 2. Better Value / Synergies arise from addressing Sustainability issues more effectively through above sharing of relevant information | | | | | |
| 3. Better Value / Synergies arise from similar Procurement protocols between 'D & C' and 'O & M' | | | | | |
| 4. Better Value / Synergies arise from better (integrated) 'life cycle optimization' options/ opportunities e.g. when Designers have more knowledge of O&M issues *and* Asset Managers have better understanding of design intent and material/ equipment choices | | | | | |
| 5. Better Value / Synergies arise from overlapping Supply Chain Networks delivering 'D&C' and 'O&M' | | | | | |
| 6. Better Value/ Synergies arise from arranging for some common/ linked resource pools and requirements (e.g. in material types, human resources) between 'D&C' & 'O&M' | | | | | |
| 7. Better Value / Synergies arise from expanded long term business opportunities | | | | | |
| 8. Better Value / Synergies arise from integrated team building (Human resource capacity improvement) | | | | | |
| 9. Better Value / Synergies arise from joint use of ICT tools (e.g. in BIM – Building Information Modeling) | | | | | |
| 10. Better Value / Synergies arise from integrated 'business continuity management' opportunities | | | | | |
| Others (Please Specify): …… | | | | | |

**Section 2: Achieving 'Value' through Integration**

**Notes**: 'Functional' integration' indicates merging functions (like 'design' and 'construction' in D&B) under one organisation. 'Relational' integration' indicates organisations (e.g. in a supply chain) collaborating well through co-operative relationships built on shared goals and values. 'Transactional' integration' indicates linking organisations for specific transactions through formal means e.g. Joint Venture or Alliancing or PPP-type formal contract agreements.

| ***2.1 Please indicate which one of the three integration types (Functional, Relational, Transactional – as defined above) can potentially BEST achieve 'better value' from the following exploitable synergies between 'D&C' and 'O&M'*** **Note: 'better value' implies 'better Overall project whole life cycle value for all stakeholders'** ***[i.e. please TICK only ONE of the three boxes in each row – for the BEST approach for each item]*** | Functional | Relational | Transactional |
|---|---|---|---|
| 1. Better Value / Synergies from sharing relevant information (e.g. building specs, as-built drawings, construction records, **O & M (Operation & Maintenance)** performance data, etc.) – *between* 'D & C' (Design & Construction) *and* 'O & M' teams | | | |
| 2. Better Value / Synergies to address Sustainability issues more effectively through above sharing of relevant information | | | |
| 3. Better Value / Synergies from similar Procurement protocols between 'D & C' and 'O & M' | | | |
| 4. Better Value / Synergies from better (integrated) 'life cycle optimization' options/ opportunities e.g. when Designers have more knowledge of O&M (and other Sustainability-impacting) issues *and* Asset Managers have better understanding of design intent and material/ equipment choices | | | |
| 5. Better Value / Synergies from overlapping Supply Chain Networks delivering 'D & C' and 'O & M' | | | |
| 6. Better Value / Synergies from arranging for some common/ linked resource pools and requirements (e.g. in material types, human resources) between 'D&C' & 'O&M' | | | |
| 7. Better Value / Synergies from expanded long term business opportunities | | | |

| ***2.1 (continued) Please indicate which ONE of the three integration types (Functional, Relational, Transactional - as defined above) can potentially achieve 'better value' from the following exploitable synergies between 'D&C' and 'O&M'***<br>**Note: 'better value' implies 'better Overall project whole life cycle value for all stakeholders'** | Functional | Relational | Transactional |
|---|---|---|---|
| 8. Better Value / Synergies from integrated team building (Human resource capacity improvement) | | | |
| 9. Better Value / Synergies from joint use of ICT tools (e.g. in BIM - Building Information Modeling) | | | |
| 10. Better Value / Synergies from integrated 'business continuity management' opportunities | | | |
| Others (Please Specify): …….. | | | |

| ***2.2 Please indicate your opinion of the degree of importance of the following common goals in achieving 'better value' through above synergies***<br>NOTE: '**better value**' implying 'better Overall project whole life cycle value' (for all stakeholders'); and '**synergies**': 'Whole (both working together)' > sum of the two separate parts | Very Important | Important | Neutral | Not So Important | Not Important At All |
|---|---|---|---|---|---|
| Common project goals such as cost, quality, time, safety | | | | | |
| Effective and efficient information sharing | | | | | |
| Lifecycle oriented project drivers, including overall sustainability concerns | | | | | |
| Lifecycle oriented project outcomes, including life cycle benefit-cost profiles | | | | | |
| Efficient resource utilization & management | | | | | |
| Expanded business opportunities | | | | | |
| Long term network building | | | | | |
| Relationship building and management | | | | | |
| Dispute minimization, management & resolution | | | | | |
| Organisational capacity building | | | | | |
| Shared corporate social responsibility | | | | | |
| Others (Please Specify): …….. | | | | | |

**Section 3: Key Stakeholders of 'D&C' and 'O & M' Value Networks**

| *Please rate to what extent you believe the following stakeholders are important for deriving **'better value'** by mobilising/ exploiting **'synergies'** between 'D&C' and 'O & M' supply chains (value networks).* | Design & Construction (D & C) | | | | | Operations & Maintenance (O & M) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Very Important | Important | Neutral | Not So Important | Not Important At All | Very Important | Important | Neutral | Not So Important | Not Important At All |
| Clients | | | | | | | | | | |
| Main Contractors | | | | | | | | | | |
| Sub-Contractors | | | | | | | | | | |
| Designers and Principal Consultants | | | | | | | | | | |
| Other (Specialist / Sub-) Consultants | | | | | | | | | | |
| Suppliers | | | | | | | | | | |
| Users | | | | | | | | | | |
| General Public | | | | | | | | | | |
| Relevant non-governmental organisations | | | | | | | | | | |
| Relevant Statutory bodies | | | | | | | | | | |
| Other relevant Government organisations | | | | | | | | | | |
| Project financiers | | | | | | | | | | |
| Others (Please Specify): …… | | | | | | | | | | |

**Section 4: Demographic Characteristics**

**(a) Organisation type that you are currently employed in:**

☐ Client ☐ Consultant ☐ Contractor ☐ Sub-contractor

☐ Supplier ☐ Academia ☐ Others (Pls. Specify): ……

**(b) Type of work you are predominantly experienced in:**

☐ Design & Construction ☐ Operations & Maintenance ☐ Other

**(c) Your supply chain size**: ☐ 1 to 2 layers ☐ 3 layers ☐ > 3 layers

**(d) Your experience in the industry (no. of years)**: _____ years.

**Your Name** (***Optional***): ……..

**Your Designation / Position**: ……

**Your email address** (***Optional*** – and tick, if you like to receive a research summary): …… ☐

**Returning the questionnaire** - Please return the completed questionnaire by any of the following means:

**By mail:** Please return the completed questionnaire by mailing it in the addressed 'freepost' envelope enclosed. No postage is required if mailed from Hong Kong.

**By email:** Please return a scanned copy of the filled in questionnaire to Mr. Kelwin Wong at kelwin.wong@hku.hk

**By fax:** Please fax with a cover page addressed to Prof. Mohan Kumaraswamy to (852) 2559 5337.

**----------Thank You----------**

**Appendix 2 – Profiles of Case Study Interviewees**

| Interviewee | Position | Division |
|---|---|---|
| 1 | Project Manager | Projects |
| 2 | Planning & Development Manager | Special Team Connecting Projects and Operations |
| 3 | Engineering Planning Manager | Special Team Connecting Projects and Operations |
| 4 | Operations Planning Manager | Special Team Connecting Projects and Operations |
| 5 | Manager - Knowledge Management | Projects |
| 6 | Manager - Knowledge Management | Operations |
| 7 | Group Depot Manager | Operations |
| 8 | Chief Architect | Projects |
| 9 | Chief of E&M Engineering | Operations |
| 10 | Senior Engineer | Operations |
| 11 | Liaison Engineer | Projects |
| 12 | Engineer | Projects |
| 13 | Technical Officer | Projects |

**Appendix 3 – Profiles of General Industry Interviewees**

| Interviewee | Position | Organization |
|---|---|---|
| 14 | Engineer | Consultant |
| 15 | Director | Estates Office of Tertiary Institution |
| 16 | Engineer | Government |
| 17 | Planning Manager | Public Transportation Organization |
| 18 | Senior Architect | Government |
| 19 | Architect | Government |

**Appendix 4 – Workshop Participants**

| Participant | Position | Type of Organization |
|---|---|---|
| 1 | Senior Commercial Manager | Consultancy Firm |
| 2 | Head of Project Engineering | Public Transport Company |
| 3 | Course Instructor | Tertiary Education Institution |
| 4 | CEO | Information Technology and Services |
| 5 | Engineer | Consultant |
| 6 | Executive Engineer | Consultant |
| 7 | Researcher | Tertiary Education Institution |
| 8 | Director | Consultant |
| 9 | Assistant Professor | Tertiary Education Institution |
| 10 | Deputy Director | Government |
| 11 | Associate | Consultant |
| 12 | Associate | Consultant |
| 13 | Project Manager | Contractor |
| 14 | Principal | Consultant |
| 15 | Assistant Professor | Tertiary Education Institution |
| 16 | Chief Civil Construction Engineer | Public Transport Company |
| 17 | Associate Professor | Tertiary Education Institution |
| 18 | Deputy director of Campus Development | Tertiary Education Institution |
| 19 | Director | Consultant |
| 20 | Associate | Legal Firm |
| 21 | General Manager | Supplier / Specialist Sub- Contractor |
| 22 | Project Director | Consultant |
| 23 | Assistant Director | Government |
| 24 | Teaching Consultant | Tertiary Education Institution |
| 25 | Manager | Construction Industry Body |
| 26 | Assistant General Manager | Property Developer |
| 27 | Engineer | Consultant |
| 28 | Partner | Consultant |
| 29 | Project Director | Contractor |
| 30 | Construction Engineer | Public Transport Company |
| 31 | Engineering Planning Manager | Public Transport Company |
| 32 | Associate Professor | Tertiary Education Institution |
| 33 | Engineer | Government |