RELATIONALLY INTEGRATED VALUE NETWORKS FOR SUSTAINABLE PROCUREMENT

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ABSTRACT

Relationally integrated value networks (RIVANS) aim to boost collaboration in built infrastructure supply chains, thereby improving both efficiencies and value creation. However, in widely practiced traditional procurement modes, transactional forces are still complex and short-sighted, resulting in weak collaborative supply chain networks, while potentially beneficial relational forces remain untapped and/or fragmented, lacking well-defined common goals among stakeholders. RIVANS have been proposed to provide a holistic conceptual framework for relational integration towards the concept to all stakeholders in the built asset lifecycle, by engaging them in cross linked value networks. The ultimate goal is for sustainable procurement through RIVANS, by developing collaborating practices and overall value focus across the entire network and through the whole built asset life cycle. A questionnaire survey was carried out to elicit relevant opinions from industry professionals. The survey led to identifying eight potential synergies/better values by linking supply chains in Infrastructure Project Management (IPM) with Infrastructure Asset Management (IAM). Functional and relational integration were identified as an appropriate mechanism to achieving value through integration. The degree of importance of eleven common goals was identified in achieving 'better value'. The key stakeholders of D&C and O&M value networks were also identified.

Keywords: *Asset Management; Procurement; Project Management; Relationally Integrated Value Networks; Supply Chain Management.*

1. INTRODUCTION

Infrastructure Project Management (IPM) teams engaged in planning, design and construction up until the delivery of a built asset, often work independently from the Infrastructure Asset Management (IAM) teams which are responsible for its operation, maintenance, usage facilities and material recycling (Kumaraswamy *et al.*, 2004). Kumaraswamy *et al*. (2004) further highlighted, interaction and communication between these two teams are usually limited in the traditional procurement approaches where transactional force are very limited, resulting in weak collaborative supply chain networks. Therefore, managing client requirements becomes a complex process which is crucial to the successful delivery of construction projects. Therefore, problems such as unrealistic expectations, incomplete requirements, insufficient resources/schedule, lack of management support, poor planning, changing requirements, and lack of users' involvement are common in the traditional procurement systems (Yu *et al.*, 2013). However, with increased attention on customer satisfaction, sustainable buildings, life cycle cost, durable designs, designing and constructing for maintainability, interaction and working relationship between IPM and IAM has also become increasingly important. Thus, value networks with common values shared among project participants focus on optimising relational integration of project stakeholders through integrated processes that generate synergies, were

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identified as a better approach. These strengthen relational forces within client - led supply chain networks in IPM and IAM to achieve higher performance (Segerstedt *et al*., 2010).

Relationally Integrated Value Networks (RIVANS) have been proposed as a holistic conceptual framework for ‘relational' integration, where project participants are engaged in cross-linked value networks (Kumaraswamy *et al*., 2010). Further, RIVANS framework extends beyond the typical structural integration approaches such as in procurement modes like Design - Build (DB) or Design Build-Operate (DBO) (Kumaraswamy *et al.*, 2010). RIVANS based on identifying common best value objectives of the entire stakeholders/network (including the client, consultants, contractors and suppliers in the supply chain), and building better relationships - mostly by jointly focusing on, and working towards such common shared values. Thus, RIVANS envisions an ensuing spiral of improving value and strengthening relationships that continue to mutually reinforce and “feed” one another. The basic concept of RIVANS is illustrated in Figure 1 (Anvuur *et al*., 2011).

The objective of the paper is to discuss potential efficiencies from RIVANS and improved practices that bridge the current divides between IPM and IAM.

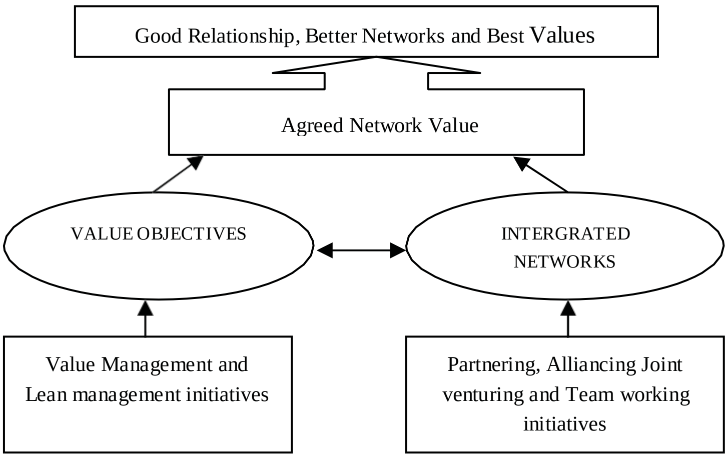

Figure 11: The Basic Concept of RIVANS (Anvuur *et al.*, 2011)

2. RESEARCH DESIGN

Research was designed to identify its objectives through an industry-wide questionnaire survey. Since client, consultant, contractor, sub-contractor, supplier, academia and developer are the main parties dominating the project management and asset management industry and its practices; it was decided to elicit their knowledge as experts' views to explore the research objectives.

2.1. SAMPLE SELECTION

The survey sample was selected randomly (using simple sampling methods). The contact list of leading clients, consultant, contractor, sub-contractor, supplier and developer of the infrastructure sector was taken from the Institute for Construction Training and Development (ICTAD) registry, telephone directory, leading organization, respective professional institutions. However, due to the limited time and other several constrains, number of questionnaires were limited to 35. The vacuum in the knowledge extraction due to number of questionnaires of the survey was minimized by selecting key persons from large projects and asset management organizations.

2.2. QUESTIONNAIRE DESIGN AND QUESTIONNAIRE SURVEY

The questionnaire was developed into three sections. Several important questions were grouped under section one to identify the potential better value/synergies by linking the usual supply chains in IPM and IAM. Ten such factors were given in this section and responses were asked to rank on a five-point Likert scale (1= Strongly Disagree, 2=disagree, 3=Neutral, 4= Agree and 5=Strongly Agree). Section two was focused to identify achieving value through integration under three categories "Functional Integration", "Relational Integration", and "Transactional Integration". Further eleven common goals were listed in this section to seek the respondents' opinions on the importance, in achieving "better value through above synergies. They were asked to rank the importance of listed common goals using a five point Likert scale where, 1= Not important at all, 2=Not so important, 3=Neutral, 4= Important and 5=Very important. Section three was focused to identify key stakeholders of "D & C" and "O & M" value networks. Therefore, 11 of stakeholders were listed and respondents were asked to rank using the same five point Likert scale.

The questionnaire survey was started from a pilot survey which was carried out to ensure the reliability of the survey. Three experts were involved in this task and their feedbacks were used to fine-tune the format of the questionnaire. The improved version of the questionnaires was used to collect data, through a web-based survey.

3. RESULTS AND DISCUSSION

T-test, which is one of analysis procedures for Likert scale data, was used as a tool to establish potential better value/synergies, common goals and key stakeholders. Evaluation was carried out by using "Statistical Package for Social Science" (SPSS) software. To test the null hypothesis Ho: $\mu = \mu o$ against the alternative hypothesis H1: $\mu < \mu o$, where μo is the population mean. μo is the critical rating above which the issue was considered agreeable or ineffective. In this analysis, μo was fixed at 3 because, by definition, given in the rating scale, 3 is neutral.

3.1. POTENTIAL BETTER VALUE BY LINKING USUAL SUPPLY CHAINS IN IPM WITH IAM

Results showed that the appropriate integration activities/items between 'Design & Construction (D&C)' and 'Operation & Maintenance (O&M)', when appropriately mobilised, can be yielded better value/synergies by linking the usual supply chains in IPM with the usual supply chains in IAM. Eight better value/synergies were identified among the ten activities by the t-test (i.e. significance <0.05) (Table 1). Further, two activities/items such as similar procurement protocol and, overlapping supply chain networks were not significant.

Table 1 show all significant better value/synergies which are ranked according to their t-values. Further it shows their mean values and standard deviations to indicate the respondents' mean average and the deviation among the responses.

Table 1: Better Value/ Synergies by Linking the Usual Supply Chains in IPM with IAM

Better Value/Synergies	Mean	Std. Deviation	Sig (2 tailed)	t-value
1.Sharing relevant information	4.56	0.51	0.000	15.40
2.Addressing sustainability issue	4.44	0.51	0.000	14.21
3.Integrated business continuity management opportunities	3.92	0.49	0.000	9.32
4.Joint use of ICT tools (BIM -Building Information Modeling)	4.20	0.91	0.000	6.57
5.Integrated life cycle optimization options/opportunities	4.00	0.93	0.000	5.25
6. Integrated team building (Human Resource Capacity Improvements)	3.88	0.99	0.000	4.32
7.Arranging for some common /linked resource pool and requirements	3.72	1.06	0.002	3.39
8.Expanded long term business opportunities	3.75	1.15	0.004	3.19

Sharing Relevant Information

Results indicated that the sharing information and its communication is the most significant activity to yield better values/synergies. Sharing relevant information is very critical for the project management; uncertainty management and risk analysis have long been regarded as an internal project process to manage events that have an effect on the project's achievement of quality, budget and schedule requirements (Karlsen, 2010). Information can be practiced and thus prevent problems such as asymmetry and mistrust among the project stakeholders. Further, it can make node enterprises of supply chains to achieve order form strategy, construction capacity allocation, resource allocation and etc. (Zhang et al., 2012). The influence of information flow on supply chains is a long and dynamic process and its vital role related to functional coordination of project supply chains (Fox, 2009). Therefore, sharing relevant information flow enhances achieving the integration of project key stakeholders.

Addressing Sustainability Issue

Better value/synergies arise from addressing sustainability issue more effectively is a vital requirement as viewed by stakeholders. Sustainability has become an important issue in recent decades because it is a much more powerful rhetoric than simply being environment friendly. This is further underpinned by the development of methods, techniques and decision support tools that would facilitate sustainable appraisal and decision-making at the various project level interfaces (either from conceptualisation to design, construction, operation and decommissioning). As a whole, sustainability covers the entire project cycle of a project; sustainable infrastructure project is drive inception through delivery to life cycle use and finally disposal (Ugwu *et al*., 2005). Therefore, it would enable stakeholders (specifically designers) to take appropriate proactive measures to ensure sustainable design and construction as part of innovative infrastructure delivery (Lam *et al*., 2011).

Integrated Business Continuity Management

This is identified as the third significant activity for potential better values/synergies. Business Continuity Management (BCM) and Continuity of Operations (COOP) is a multi-dimensional practice requiring a balance of investment against risk to the enterprise. Business continuity planning is however more than just a simple task of setting out certain contingency plans and avoiding risks. It hence, refers to its ability to have a focused response management to deal with the situation once the consequences are known (Iyer *et al*., 2000). Thus integrated BCM initiatives typically focus on the continuous assessment of business needs, acceptable levels of risks in infrastructure projects to optimize operational availability. Further, BCM has reduced losses from the interaction of the equity, flexibility and alignment goals of management, workers and society (Low *et al*., 2010).

Joint Use of ICT Tools

Infrastructure projects involve collaborative working among multiple enterprises. Project managers are required to facilitate the integration of work of all the stakeholders, while project team may be geographically separated beyond national boundaries or, in the different context of countries (Adriaanse *et al*., 2010). The effective communications between project stakeholders is being important for the project success and it can be achieved through Information Communication Technologies (ICT). As per the questionnaire survey, the project organizations more perceive the ICT in grant. Currently, ICT is commonly used for many standalone applications for book keeping and two-dimensional drawings. However, more advanced applications such as three and four dimensional modelling, Building Information Management (BIM) applications global positioning systems and internet technology are still at their adolescent stages (Ahuja *et al*., 2010).

Life Cycle Optimization Options/Opportunities

Results showed that the life cycle optimization is more dominant driver in infrastructure project to boost interaction and working relationship between IPM and IAM. Further designers have more knowledge of operational and maintenance issues and asset managers have better understanding of design intent and material equipment choices (Yang *et al*., 2011). Life cycle optimisation is focuses on the total costs that occur during a project life cycle in two dimensions; estimating costs on a whole life basis and monitoring the cost incurred throughout the project life (Korpi *et al*., 2008). Therefore, it is necessary to comprehend the interaction of the cost items that accumulate among the relevant stakeholders during the different stages of project life cycle. The life cycle relationship between the design and construction and operation and maintenance of infrastructure project is driven by different factors such as environment and technology (Pelzeter, 2007). It drives comparing of actual and budgeted costs, which facilitate of better pricing decisions, improved profitability assessment, enhanced understanding of project environmental effects, and focusing on the costs incurred after construction or development (Korpi *et al*., 2008).

Integrated Team Building (Human Resource Capacity Improvements)

Results showed that integrated team building (ITB) is significant for potential better values/synergies of infrastructure projects. ITB balances three competing quality targets; equity, flexibility and alignment (Aghazadeh, 2003). The competing values over time is directed towards the continuous improvement and it depends on infrastructure project management and infrastructure project employees' ability of meeting customer's expectation (Langbert *et al*., 2002). Thus, ITB has reduced losses from the interaction of the equity, flexibility and alignment goals of management, workers and society. It has also helped to improve integrated values of infrastructure projects.

Common Linked Resource Pool

The common linked resource pool is yielded potential synergy by linking usual supply chains in IPM with IAM. This encompasses people skills, technologies, applications, and business processes to make better strategic and tactical decisions in infrastructure projects. Thus, it plays a crucial role in achieving competitive advantages (Kapoor *et al*., 2012). Further, this ensures the maximum use of resources. Thus, IPM team and IAM team are encouraged to integrate to make use of resource pools. Ultimately, this grants and ensures smooth functionality between D&C and O&M stages.

Expanded Long Term Business Opportunities

Fueled by collaborative technologies that allow new ways of organizing and changing from a process-centric view of work to human-centric view of project due to its value creative networks (Alee, 2008). Thus impact of the long term business opportunities is likely to be significant and to generate shareholders' capital gains (Hughes *et al.,* 1995). Therefore, this better value/synergies directs purposeful group of people who come together to take action in project and strengthen powerful new practices and merits for managing collaborative works through human interactions (Jarvealainen, 2012).

3.2. ACHIEVING BETTER 'VALUE' THROUGH INTEGRATION

The appropriate types of integration of eight exploitable synergies between D&C and O&M identified through percentage calculation (Table 2). Five synergies were shown, functional integration as the best appropriate type whereas three synergies were shown relational integration as the appropriate integration. However, none of exploitable synergies were indicated transactional integration as the best approach.

Table 2: Achieving 'Value' through Integration

Better Value /Synergies	Functional	Relational	Transactional
1.Sharing relevant information between Design and Construction (D&C) and Operation and Maintenance (O&M) teams	**64%**	28%	8%
2.Joint use of ICT tools	**60**%	24%	16%

3. Integrated team building (Human Resource Capacity Building)	**56%**	32%	12%
4.Arranging common/linked resource pool ands and requirement	**48%**	28%	24%
5.Integrated "Business Continuity management"	**40%**	36%	24%
6. Expanded long term business opportunities	24%	**56%**	20%
7. To address sustainability issue	32%	**48%**	20%
8. 'Life cycle optimization' option/opportunities	36%	**44%**	20%

Functional Integration (Merging Functions)

Functional integration indicates merging functions (like 'design' and Construction' in D&B) under one organization and it tends to invoke positive connotations. Results showed that exploitable synergies between D&C and O&M such as sharing relevant information, joint use of ICT tools, integrated team building, arranging common linked resource pool and requirement and integrated business continuity management can potentially best achieve 'better value' through functional integration than other integration types. Functional integration implied consensus across functions and merged in to a single entity (Karlsson *et al.*, 2010).The achieved integration denoted that the highest significance of sharing relevant information between D&C and O&M. Further, functional integration can be granted with appropriate used of ICT tools such as BIM that can integrate stakeholders of infrastructure projects through sharing information. Integrated team building arranging common linked resource pool and requirement and integrated business continuity management can also be originated and improved functional integration as it automatically forms long term cross-networks with various stakeholders.

Relational Integration (Coorporative Relationship Built On Shared Goals)

Relational integration indicates organizations (e.g. in a supply chain) collaborating well through corporative relationship built on shared goals and values. When project participants are engaged in cross-linked value networks, with overall common values shared among project participants focus on relational integration of project teams through integrated process that generate synergies (Kumaraswamy *et al*., 2010). This strengthens relational forces within client led supply chains in IPM to achieve higher performance. Relational integration is mechanism to manage resources shared among the organization (Anvuur *et al*, 2011). Results showed that the highest percentage against expanded long term business opportunities, address sustainability issue and life cycle options/opportunities are ranked under relational integration where basic trust on this research was empowering relational integration towards the sustainable procurement. Thus, it indicates that the network created through relational integrations is long-term and can utilize the entire life cycle of a project.

3.2.2. COMMON GOALS IN ACHIEVING 'BETTER VALUE'

Eleven common goals in achieving 'better value' through above synergies were identified and are listed in Table 3. "Relationally Integrated Value Networks" (RIVANS), based on identifying common goals of the entire team/networks (including the client, consultants, contractors and suppliers in the supply chains), and building better relationships - mostly by jointly focusing on, and working towards such common goals which were highlighted in achieving better values, in the literature (Kumaraswamy *et al.*, 2010). In this research, common project goals such as cost, quality, time and safety were identified as most significant. Relationship building and management, efficient and effective communication, dispute minimization and management are also common goals in achieving better value. Further both life cycle oriented project outcomes (life cycle benefits and cost profiles) and life cycle oriented project drivers (overall sustainability concerns) were ranked as common goals. The efficient resource utilization and management, organization capacity building, long term network building, shared corporate social responsibility and expanded business opportunities are ranked as common goals. However, as highlighted in the literature, a relational network such as RIVANS can create a momentum in the construction industry.

Table 3: Degree of Importance of Common Goals in Achieving 'Better Value'

Common Goals	**Mean**	**Std. Deviation**	**Sig (2 tailed)**	**t - Value**
1.Common project goals such as cost, quality, time, safety	4.76	0.52	0.000	16.83
2. Relationship building and management	4.16	0.37	0.000	15.50
3.Effective and efficient communication	4.6	0.58	0.000	13.86
4. Dispute minimization , management & resolution	4.24	0.66	0.000	9.35
5. Lifecycle oriented project outcomes , including life cycle benefit-cost profiles	4.12	0.67	0.000	8.41
6. Lifecycle oriented project drivers , including overall sustainability concerns	4.36	0.81	0.000	8.39
7. Efficient resource utilization & management	4.32	0.85	0.000	7.74
8.Organizational capacity building	4.04	0.81	0.000	6.33
9.Long term network building	3.96	0.81	0.000	5.82
10.Shared corporate social responsibility	4.04	1.02	0.000	5.10
11. Expanded business opportunities	3.52	0.71	0.000	3.64

3.3. Key Stakeholders of "D&C" and "O&M" Value Networks

The importance of key stakeholders for delivering 'better value' by mobilizing /exploiting 'synergies' between D&C and O&M supply chains are shown in Table 4. Twelve key stakeholders of 'D&C' value networks are identified through the t-test and ten key stakeholders of 'O&M' value networks are identified through the t-test. Stakeholders have varying levels of responsibility and authority when participating in a project and these can change over the course of the project's life cycle, occasional of contributions (Othman, 2011). Thus, according to their varying levels of responsibility and authority, results showed that client is the most important key stakeholder during IPM whereas second important stakeholder during IAM. This may be due to lack of integration between IPM and IAM phases of projects. However, the client has a greater responsibility for engaging stakeholders in framing of individual service specification (Heywood, 2006). Main contractor is second key stakeholder during IPM. Design and principal consultant, relevant salutatory bodies, project financiers, relevant governmental organization, and (principal/sub) consultants are identified as important. Further, sub-contractors and users are key stakeholders in IPM and they have similar weights. The relevant non-governmental organization, suppliers and general public are also key stakeholders in IPM and they have less weight compared to other stakeholders in IPM. This may be due to their lesser authority in project management. Further, results showed that the relevant governmental organization is most important key stakeholders, followed by the client, in IAM among ten identified stakeholders. Respondents may believe that relevant governmental organization is the most important as almost of the infrastructure projects such as highways owned by the local government and has more enforcing powers. Users are the third key stakeholders in IAM. The values of infrastructure projects in IAM phase is gained by users ultimately. The smooth functionality of infrastructure projects is lead to grant benefits to the owners. Relevant statutory bodies, general public, project financiers, designers and principle consultant, (specialist/sub) consultant and main contactors are highlighted as important key stakeholders in IAM.

Table 4: Key Stakeholders of 'D&C' and 'O&M' Value Networks

Stakeholders	Design & Construction				Operation & Maintenance			
	Mean	Std. Deviation	Sig (2 Tailed)	t Value	Mean	Std. Deviation	Sig (2 Tailed)	t Value
1.Client/Owner	4.84	0.37	0.000	24.58	4.04	0.84	0.000	6.19
2.Main Contractor	4.60	0.76	0.000	10.47	3.68	0.99	0.000	3.44
3. Designer and Principle Consultant	4.48	0.71	0.000	10.36	3.92	0.95	0.000	4.82
4. Relevant Statutory Bodies	4.24	0.72	0.000	8.57	4.04	0.95	0.000	5.35
5. Project Financiers	4.28	0.94	0.000	6.84	4.16	1.14	0.000	5.07
6. Relevant Governmental Organizations	4.16	0.85	0.000	6.82	4.36	0.91	0.000	7.49
7. (Specialist/Sub) Consultant	3.96	0.79	0.000	6.08	3.88	1.09	0.000	4.03
8. Sub-Contractor	4.16	1.02	0.000	5.64				
9. Users	4.16	1.03	0.000	5.64	3.96	0.84	0.000	5.71
10.Relevent Non-Governmental Organization	3.84	0.76	0.000	5.63	3.92	0.93	0.000	4.84
11. Suppliers	3.88	0.88	0.000	4.99				
12.General Public	4.00	1.19	0.000	4.47	4.04	1.00	0.000	5.11

4. CONCLUSIONS

The findings was identified that there is shortfall traced to persisting disconnect between 'design and construction' (project management phase) and operation and maintenance (asset management phase). Further, this research has shown innovative signs for the potential application of RIVANS, which focused on developing corporative/collaborative relationship in the pursuit of overall value. The significance of eight better values/ synergies by linking the usual supply chains in IPM with usual supply chains in IAM was identified. The better value/synergies were sharing relevant information, addressing sustainability issue, life cycle optimisation options/opportunities, common/linked resource pools, expanded long term business opportunities, integrated team building, joint use of ICT tools and integrated business continuity management. Further, the research found that the value through integration is basically shaped up with functional and relational integration. Functional integration indicates merging functions (like 'design' and Construction' in D&B) under one organization and it tends to invoke positive connotations. Thus, Relational Integration indicates organizations (e.g. in a supply chain) collaborating well through corporative relationship built on shared goals and values. The basic concept/trust of this research was relational integration based on identifying common best value objectives of the entire team/network (including the client, consultants, contractors and partners in the supply chain), and building better relationships - mostly by jointly focusing on, and working towards such common shared value. Therefore, the degree of importance of eleven common goals was identified. They are common project goals such as cost, quality, time and safety, relationship building and management, effective and efficient communication, dispute minimization, management and resolution, life cycle orientation, efficient resource utilization and management, organisational capacity building, long term network building, shared corporate social responsibility and expanded business opportunities. Twelve key stakeholders of IPM and ten key stakeholders of IAM as driving forces of RIVANS were also identified. Ultimately, RIVANS is conceptualised as a viable strategy for sustained competitive advantage.

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