BETTER VALUES AND CHARACTERISTICS IN RELATIONALLY INTEGRATED VALUE NETWORKS TO ENHANCE TOTAL ASSET MANAGEMENT

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ABSTRACT

Construction contract types span a wide spectrum ranging from traditional contracting to relational contracting modes. Although weak collaborative supply chain networks exist even in widely practiced traditional contract modes, the potentially beneficial strong relational forces remain untapped and/or fragmented, lacking well-defined common goals among stakeholders. Apart from addressing this shortfall in the built asset planning, design and construction (project management) phase, relational contracts (RC) can also be extended to total asset management (TAM) by aiming at the relational integration of all stakeholders throughout the built asset lifecycle, by engaging them in cross linked value networks'. Such integrated networks were called 'relationally integrated value networks' (RIVANS) when initially proposed for the project management phase. 'RIVANS for TAM' were next proposed to provide a holistic approach to bridge the project management phase and the asset management phase in the lifecycle of assets. The study reported in this paper, contributes to knowledge by identifying better values through adapting RIVANS as a holistic beneficial approach to the whole built environment.

A questionnaire survey was conducted to identify common better values in RIVANS. These identified better values were then clustered to form similar groups using factor analysis to establish synergetic characteristics of RIVANS. Four characteristics were extracted to identify and target embedded synergies in RIVANS, for enhanced total asset management.

Keywords: *Better Values; Characteristics; Relational Contracts; Relationally Integrated Value Networks; Total Asset Management.*

1. INTRODUCTION

Successful implementation of relational contracts requires strong commitment and continuous understanding at all levels. The trend towards consideration of relational contracts, alliance-type contracts has encouraged increased focus on the collaborative elements of design and construction (DC) of infrastructure project management (IPM) phase and operation and maintenance (OM) of infrastructure asset management (IAM) phase. Kumaraswamy *et al*. (2004) further highlighted, that interaction and communication between these two phases are usually limited in the traditional procurement approaches where transactional force are very limited, resulting in weak collaborative supply chain networks. 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 approaches (Yu and Shen, 2013). However, with increased attention on customer satisfaction, sustainable buildings, life cycle cost, flexible designs, designing and constructing for maintainability, interaction and working relationship between IPM and IAM has also become increasingly important. Thus, value networks with common goals shared among project

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teams focus on optimising relational integration of these teams through integrated processes that generate synergies, were identified as a better approach (Kumaraswamy *et al*., 2010; Famakin *et al*., 2012; Ling *et al*., 2014). These strengthen relational forces within client - led supply chain networks in IPM and IAM to achieve higher performance (Segerstedt and Olofsson, 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*., 2011). 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 is based on identifying common better values of the entire relational network (including the client, consultants, contractors and suppliers in the supply chain), 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. Thus, the objective of the paper is to discuss applying RIVANS to target potential better values and improved practices that bridge the current divides between IPM and IAM. The following section discusses common values of relationally integrated value networks highlighted in the literature.

2. Potential Better Value by Linking Usual Supply Chains in IPM with IAM

Functional integration implied consensus across functions and merged in to a single entity (Karlsson *et al.*, 2010). Literature highlighted that (Weerapperuma *et al*., 2013; Ling *et al*., 2014), exploitable synergies between DandC and OandM 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.

2.1. Sharing Relevant Information

Sharing relevant information is very critical for project management; uncertainty management and risk analysis that have an effect on the project's achievement of quality, budget and schedule requirements (Karlsen, 2010). Further, sharing information can be modelled as mechanism to prevent problems such as asymmetry and mistrust among the project stakeholders. It can also formulate to make node enterprises of supply chains to achieve order form strategy, construction capacity allocation, resource allocation and etc. (Zhang and Ng, 2012). As such, the influence of information flow on supply chains is a long and dynamic process related to functional coordination of project supply chains (Fox, 2009).

2.2. Addressing Sustainability Issue

As a whole, sustainability covers the entire cycle of a project and hence, sustainable infrastructure project is drive inception through delivery to life cycle use and finally disposal (Ugwu and Haupt, 2005). Therefore, it would enable stakeholders (specifically designers) to take appropriate proactive measures to ensure sustainable and maintainable design and construction as part of innovative infrastructure delivery (Lam *et al.*, 2011). Optimised energy use, operation cots, safety in use, need for maintenance are some benefiting traces in addressing sustainability issues at early stages such as planning and development.

2.3. Integrated Business Continuity Management

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). BCM has reduced losses from the interaction of the equity, flexibility and alignment goals of management, workers and society (Low *et al.,* 2010).

2.4. 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 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). 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).

2.5. Life Cycle Optimisation Options/Opportunities

When designers have more knowledge of operational and maintenance issues and asset managers have better understanding of design intent and material equipment choices, it could create better opportunities to achieve life cycle optimisation options (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 and Risku, 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.

2.6. Integrated Team Building (ITB)

Clients and other stakeholders working together as a team can enhance whole-life value through reducing total cost and improving performance, to deliver a project effectively than in a traditional fragmented relationship that is often adversarial. Collaborative working is the underline core requirement for integrating teams. Thus, Team-working is characterised by mutual trust and openness, where problems and risks are shared and resolved collectively by the integrated project team. ITB balances three competing quality targets; equity, flexibility and alignment of cooperate objectives (Aghazadeh, 2003). However, the benefits of this would rely on team’s ability of meeting customer’s expectation (Langbert and Friedman, 2002).

2.7. Common Linked Resource Pool

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 and Sherif, 2012). Further, this ensures the maximum use of resources. Thus, IPM team and IAM team are encouraged to integrate to make use of common resource pools. Ultimately, this grants and ensures smooth functionality between DandC and OandM stages.

2.8. Expanded Long Term Business Opportunities

Fuelled by collaborative technologies that allow new ways of organising and changing from a process-centric view of work to human-centric view of project due to its value creative networks (Alee, 2008). The impact of the long term business opportunities is likely to be significant and to generate shareholders’ capital gains (Hughes, 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. 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.

3.1. *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 organisation, 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 minimised by selecting key persons from large projects and asset management organisations.

3.2. *QUESTIONNAIRE DESIGN AND QUESTIONNAIRE SURVEY*

Led by the third author, a multi-country research project was undertaken in Hong Kong, Singapore, Sri Lanka and the UK to investigate ways to integrate PM and AM supply chains to achieve better value. The survey questionnaire developed for above purpose is used to investigate the situation in Sri Lanka.

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) (refer Table 1). 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 and C" and "O and M" value networks. Therefore, 11 of stakeholders were listed and respondents were asked to rank using the same five point Likert scale. The data for this paper was taken from the first section of the questionnaire (Table 1).

Table 1: Questions Used for Studying Potential Better Value / Synergies by Linking the Usual Supply Chains in IPM with the Usual Supply Chains in IAM

Better Value / Synergies
1. Better Value / Synergies arise from sharing relevant information (e.g. building specs, as-built drawings, construction records, O and M (Operation and Maintenance) performance data, etc.) - *between* 'D and C' (Design and Construction) *and* 'O and 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 'DandC' and 'O and M'
4. Better Value / Synergies arise from better (integrated) 'life cycle optimisation' options/ opportunities e.g. when Designers have more knowledge of OandM 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 'DandC' and 'OandM'
6. Better Value/ Synergies arise from arranging for some common/ linked resource pools and requirements (e.g. in material types, human resources) between 'DandC' and 'OandM'
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

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.

4. RESULTS AND DISCUSSIONS

Potential better values by linking usual supply chains in design and construction (DC) and operation and maintenance (OM) was established using t-test and were discussed in a previously published paper from this research (Weerappuruma *et al*., 2013). Further, factor analysis (FA) was carried out to identify leading characteristics of RIVANS, through identifying dominating factors. FA is a statistical tool to identify if there is any further relationship among the measures. FA was conducted using the Statistical Package for Social Science (SPSS). Table 2 shows all possible number of factors extractable and the loadings after rotation. The important factors are those whose eigenvalues are greater than or equal to 1, since an eigenvalue is a measure of how a standard variable contributes to the principal components. A component with an eigenvalue of less than 1 is considered as less important and can therefore be ignored and omitted. The eigenvalues corresponding to the each factor are shown below to the factor number in the table. The table also shows the rotated factor loadings and commonalities (h^2). Simply, a factor loading can be expressed as a correlation coefficient between an original variable and an extracted factor. Commonality is a measure of variance in the variable that has been accounted for its factor extraction. To minimise the number of factors and increase the factor loadings, factor rotation is carried out with "varimax" rotation.

Table 2: Rotated Factor Matrix

Better Values	**Factor 1 (2.9)**	**Factor 2 (2.0)**	**Factor 3 (1.4)**	**Factor 4 (1.2)**	h^2
Integrated team building	0.929				0.866
Joint use of ICT tools	0.927				0.583
Expanded long term business opportunities	0.525				0.731
Overlapping supply chain networks delivering DC *and* OM teams		0.842			0.693
Arranging for some common/ linked resource pools and requirements between DC *and* OM		0.836			0.839
(integrated) 'life cycle optimisation' options/ opportunities		0.700			0.772
Integrated 'business continuity management' opportunities			0.819		0.407
Addressing sustainability and maintainability issues more effectively through sharing of relevant information			0.754		0.928
Sharing information between DC *and* OM teams				0.908	0.873
Similar procurement protocols between DC and OM teams				0.619	0.803

Next section of this paper discusses characteristics of RIVANS extracted through factors analysis. These factors are labelled as:

Factor 1: Building long term integrated networks
Factor 2: Setting a common pool linking DC and OM
Factor 3: Enhancing sustainability of TAM
Factor 4: Developing a similar protocol between DC and OM

4.1. BUILDING LONG TERM INTEGRATED NETWORKS

The most important characteristic (i.e. first factor) in RIVANS, with an eigenvalue of 2.9 is labelled as "building long term integrated networks". This factor consists of three better values (refer Table 2). Integrated team building (ITB) is a potential better values/synergies that could build a long term integrated network among teams in DC and OM. Integrated team building aligns goals of management; employees and society and thus meets the customers' satisfaction (Langbert and Friedman, 2002; Aghazadeh, 2003). Therefore, it is important that the teams to work together to strengthen powerful new practices and merits for managing collaborative works through human interactions (Jarvealainen, 2012).

In building integrated networks, it involves collaborative working among multiple enterprises (Adriaanse *et al*., 2010). For instance at the PM phase, project managers are required to facilitate the integration of work of all the stakeholders. Thus, effective communications between these teams is important for the success and joint use of Information Communication Technology (ICT) tools are highlighted as effective (Ling *et al*., 2014). However, ICT is commonly used for many standalone applications for book keeping and two-dimensional drawings during both IPM and IAM phases in the local practices. Further, practising of more advanced applications such as three and four dimensional modelling, Building Information Management (BIM) applications, global positioning systems and internet technology are still at a primitive level.

Further, creating long term business opportunities is a significant benefit in these integrated networks (Hughes *et al*., 1995; Alee, 2008). Moreover, successful outcome is achievable in terms of time, cost and quality and also it leads to establish stronger commitments and closer bonds (Palaneeswaran *et al*., 2003). However, local expert mentioned that creating a "monopoly" along with these long-term business relationships could be a latent risk in these expanded long terms business opportunities.

4.2. SETTING A COMMON POOL LINKING DC AND OM

The second characteristic identified by the factor analysis is setting a common pool linking DC and OM. The eigenvalue obtained for this factor is 2.0. This factor has three better values that are positively correlated (refer Table 2). Overlapping supply chain networks in DC and OM may eventually form a common pool where material, information and services can be pooled. In general, relational contracts allow teams to pool their resources including financial resources, knowledge, expertise, technology and skills for joint management (Carrillo, 1996; Walker and Johannes, 2003). For instance in the local practice, joint ventures which is the most common relational contracting approach in Sri Lanka, are formed in situations where the resources of one contracting company are not enough to carry out a certain project and further companies seek new business opportunities through the strengths of the other partners such as reputation, stable position, business relationships etc. Thus, there is an avenue created for setting a common pool under current practices. However, it is at its adolescent stage in the local industry.

Further, life cycle optimisation is a value addition of forming a common pool for proper assembling of information and material in an integrated way. This could provide an immense opportunity for effective decision making, when designers have more knowledge of operation and maintenance issues and facilities managers have better understanding of design intent and material/ equipment choices through sharing of relevant information through interaction and working relationship between DC and OM phases. For instance, the life cycle relationship between these phases of infrastructure projects gives better valuing decisions, focusing on the costs incurred after construction or development (Pelzeter, 2007; Korpi and Risku, 2008).

4.3. ENHANCING SUSTAINABILITY OF TAM

Enhancing sustainability of TAM is the third characteristic comprising a 1.4 eigenvalue. Continuity management of business opportunities in relational contracts yields long-term sustainability of TAM. Business Continuity Management (BCM) and Continuity of Operations (COOP) is a multi-dimensional practice cooperates with sustainability objectives (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 optimise operational availability in the lifecycle (Low *et al*., 2010). This pave the way to address the important issues immediately and motivate the recovery of lags in sustainability and maintainability of infrastructure projects with no delay before propagating into an unrecoverable failure (Bennett and Jayes, 1995; Thomas and Thomas, 2005).

Further, efficient sharing of relevant information would address sustainability and maintainability issues more effectively at early stages of TAM. Sustainability is further underpinned by sharing development methods, techniques and decision support tools that would facilitate sustainable appraisal and decision-making at various project level interfaces (either from conceptualisation to design, construction, operation and decommissioning (Ugwu and Haupt, 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).

4.4. DEVELOPING A SIMILAR PROTOCOL BETWEEN DC AND OM

Fourth important characteristic (i.e. fourth factor) in RIVANS, with an eigenvalue of 1.2 is labelled as "developing a similar protocol between DC and OM. This factor consists of two better values (refer Table 2). Sharing information between DC and OM enables to provide the foundation for development of a similar protocol between DC and OM phases of infrastructure assets. Sharing relevant information is very critical for the project management; uncertainty management and risk analysis (Karlsen, 2010). Information in supply chains can be properly integrated to prevent problems such as asymmetry and mistrust among the stakeholders. Thus, strong cross-links through effective information sharing is critical in RIVANS where more than one party work for the same goal, to prevent conflicts and confusions (Chan *et al*., 2006; Cheng *et al*., 2001; Chan and Kumaraswamy, 1997). For instance, when work done in one phase or one party provides inputs to the other phase or party hence if not communicated properly conflicts and confusions occur impeding the total asset management.

Further, the cross links formed between DC and OM through efficient information sharing can be standardised by adopting similar procurement protocols between these two phases. However, considering for such an attempt is almost neglected in current practices. Further industry experts have lesser faith in developing a similar protocol under local context.

5. CONCLUSIONS

The purpose of this research was to investigate better values in mobilising synergies between DC and OM supply chains and important characteristics in RIVANS. Four (04) characteristics from ten (10) better values (refer Table 2) were identified. They are building long term integrated networks, setting a common pool linking DC and OM, enhancing sustainability of TAM and developing a similar protocol between DC and OM. These factors were analysed in terms of the better values and there inter-relationship with the characteristics.

The most important characteristic in RIVANS, is labelled as "building long term integrated networks". Therefore, it is important to work together to strengthen powerful new practices and merits for managing collaborative works through human interactions. However, local expert mentioned that creating a "monopoly" along with these long-term business relationships could be a latent risk in these expanded long terms business opportunities.

Overlapping supply chain networks in DC and OM may eventually form a common pool where material, information and services can be pooled. Further, life cycle optimisation is a value addition of forming a common pool for proper assembling of information in an integrated way which provide an immense opportunity for effective decision making, when designers have more knowledge of operation and maintenance issues and facilities managers have better understanding of design intent and material/ equipment choices through sharing of relevant information through interaction and working relationship between DC and OM phases.

Continuity management of business opportunities in relational contracts yields long-term sustainability of TAM. Further, efficient sharing of relevant information would address sustainability and maintainability issues more effectively at early stages of TAM. Sustainability is further underpinned by sharing development methods, techniques and decision support tools that would facilitate sustainable appraisal and decision-making at the various project level interfaces. Sharing information between DC and OM enables to provide the foundation for development of a similar protocol between DC and OM phases of infrastructure assets.

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