CONTRIBUTION OF COLLABORATIVE PROJECT PERFORMANCE TO CORPORATE PERFORMANCE IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION (EPC) COMPANIES

ICHSAN SYARIFUDIN, DERMAWAN WIBISONO
School of Business and Management, Bandung Institute of Technology

ABSTRACT

Main purpose of this study is to explore relationships between collaborative supply chain to project performance measures and the contribution of these measures to corporate performance measures in engineering, procurement, and construction (EPC) industry. Collaborative supply chain is useful due to the fact that EPC projects require multidiscipline capabilities, but it is also challenging because of the short term contractual relationships among parties in the collaboration. The existence of EPC contracting companies is important to support the development of infrastructure projects in developing countries. Integrated scope and concurrent project cycle development within EPC contract enable the projects to be developed in a more timely and efficient manner. Contribution of project performance to corporate performance in this industry plays a critical role to maintain sustainable capabilities and growth of an EPC company. A series of interview and survey will be undertaken to acquire information from executives in EPC companies regarding their perception on performance measures of projects and how these measures may support the corporate performance. Constructs emerge from the interviews, will be compared with a predetermined conceptual constructs based on previous research and references.

Result of this research may be used as the basis for defining the EPC companies' corporate performance objectives as a function of collaborative project performance measures. The finding may also be used in assessing the capability of EPC companies to cope with the challenge of accelerated infrastructure development in developing countries. Although a considerable number of construction companies have been developing an EPC division or subsidiary in the past five years, the number of established EPC contractors operating in Indonesia is very limited (less than twenty companies). This limited number of EPC companies implies that data collection activity in this research should consider the ability to represent the industry characteristics.

Keywords: Supply Chain Collaboration; Project Performance; Corporate Performance; EPC Projects

INTRODUCTION

This research will investigate relationship between degrees of supply chain collaboration with project performance, in engineering-procurement-construction-installation (EPC/EPCI) projects. Project performance in this study is defined as the ability to achieve functionality, quality, cost and schedule performance which is higher than specified in the contract between project owner and project contractor.

The reason behind the selection of these performance measures as the main measures in project performance is because in the industries which are familiarly served by EPC contractors, investment effectiveness is determined by the ability of the constructed facilities to function according to its purpose. In order to function properly, compliance with specification is the basic requirement. Concerning the time value and the amount of investment needed in industries served by EPC companies, the ability to design, procure, and construct the project in timely and efficient manner is valuable for the whole project stakeholders. Ability to achieve the performance measures mentioned above will lead to efficient manner in running business in EPC industries. Lam, Chan, and Chan (2007) proposed that functionality, time and costs are defined as very important measures in design and build projects.

The importance of relating project performance to corporate performance is based on the needs to ensure sustainable success of project based operations companies. Construction industry, as one of the country's economic development enablers, shares a significant positive contribution to Indonesia's gross domestic product (GDP). Accelerated development after 1998's monetary crisis has not yet been supported by a significant improvement in construction industry supply chain management. Fragmented industry and project based, short-term relationships among parties still dominates transaction pattern in construction industry.

In Asia Construct 2008 conference, data from Institute for Construction Service Development (Lembaga Pengembangan Jasa Konstruksi / LPJK) described that until 2010, Indonesia' has the second largest construction industry in Asia, right after People Republic of China. Contribution of this sector to Indonesia's GDP also increases from 8.17% in 2004 up to 8.9% in 2007.

This significant contribution is due to the fact that construction service industry is basically acting as facilitator to other industries' investment activities. Oil-and-gas or energy-related sectors is one of examples for industries whose performance relies heavily on the construction stage of their business. Another significant contribution can be derived from the fact that availability and reliability of infrastructure is one the main consideration for direct foreign investment in a developing country.

The opportunity to improve supply chain performance of construction industry through collaborative arrangement should be supported by improvement in relationships arrangement among parties involved in the projects, stated in the scope of project contract. An integrated contract may enable project implementation performance improvement through more synchronous and synergized information, decisions, and material flow. Humphrey, et.al (2003) proposed that transition from traditional approach characterized by partial scope of contract to project partnership and strategic partnership characterized by integrated-long term contract, is the path to a successful collaborative relationship.

Evaluation of collaborative supply chain performance improvement requires identification of key performance indicators and key success factors of supply chain collaboration in this sector of construction industry.

Even though the integrated scheme (EPC) contract is more popular in oil and gas or energy related sector, due to their complex interfaces among project stages, it might be useful to explore the opportunity to apply some of the principles in other sectors, such as infrastructure or property sectors of construction industry.

Comprehensive studies have been undertaken to explore unique characteristics of construction supply chain. Its project based relationships and contractual agreement among parties involved in the projects are among the factors considered in those studies. Abduh, Soemardi, and Wirahadikusumah (2009) mention that supply chain management in project delivery settings is unique, due to the fact that many project supply chains are relatively short-lived, but yet, they must be established, configured rapidly, and remain flexible to match demands that vary over the course of project execution. The possibility to build collaborative supply chain in construction projects has also been studied in previous researches. Benefit and consequences of the collaborative arrangement have been discussed in several related studies.

Although the number is limited, studies on engineering, procurement, and construction projects have also been conducted, regarding the benefit of integrated scheme compared to the traditional partial scheme of contract (Ballard, 1993; Kumar Dey, 2002; Michelli et al, 2008). Support of this integrated scheme in undertaking supply risk management is one of topics discussed in previous researches.

Considering that EPC project contract requires multidiscipline competencies, which may not be owned internally by a contractor's own resources, EPC project usually involves collaboration in its project supply chain to achieve high project performance (Kumar Dey, 2002). Performance measures of integrated engineering (design), procurement, and construction (build) type of project includes time, cost, quality and functionality as the principal success criteria for design and builds projects (Lam and Chan, 2007).

However, relationships between collaborative projects supply chain and project performance in terms of functionality, quality, cost and schedule performance; and the effect of project scope integration (EPC or EPCI scheme) to these performance measures has not been explored yet. This study would be beneficial considering that in most of sectors served by construction industry, there are still various interpretations on the benefit and consequences of EPC contract scheme.

Expected results from this research is the development of model relating supply chain collaboration in project environment, project performance, and the effect of integrated scope of projects (EPC scheme) to project success. This expected results lead to the formulation of research questions which includes:

- What are the benefits of having supply chain collaboration to project performance?
- In what condition does project performance will lead to corporate performance?
- What are the contributions of integrated EPC contract to the success of collaborative project supply chain?

LITERATURE REVIEW

Suradji and Kusnandar (2008) from the Institute for Construction Service Development (Lembaga Pengembangan Jasa Konstruksi / LPJK), divided construction industry into 15 groups which consist of: (1) residential; (2) non-residential; (3) electrical installation; (4) gas and water facilities installation; (5) sanitation facilities; (6) foundation; (7) sound system and air conditioning; (8) water supply network; (9) gas and oil pipe network; (10) electricity network; (11) irrigation and drainage; (12) electric power generator and telecommunication network; (14) port, air port, and terminal; (15) other construction works.

Suprapto (2007) from Indonesian Association of Project Management (Ikatan Ahli Manajemen Proyek Indonesia / IAMPI), classified construction industry based on construction types, which includes: (1) housing construction; (2) non-residential or non-housing construction; (3) heavy construction; (4) industrial building construction.

A more common classification used by construction practitioners is grouping between property and infrastructure construction. Property construction can later be grouped into: (1) residential; (2) commercial; (3) office; (4) industrial; (5) and public facilities. Infrastructure construction can be grouped into: (1) transportation facilities; (2) electricity; (3) telecommunication; (4) water; (5) oil and gas sectors.

Other grouping is based on the ownership of the facilities. This type of classification groups construction into government institution projects and non-government or private sector projects. This classification is based on a significant difference in goods and service procurement process, communication patterns, and decision making process related with project contracts in those two groups. Supply chain collaboration is defined as two or more independent firms jointly working to align their supply chain processes so as to create value to end customers and stakeholders with greater success than working alone (Simatupang and Sridharan, 2002).

Barrat (2004) describes that supply chain collaboration may not only exist between adjacent stage of supply chain, but also between parties at the same chain in a supply chain. This is explained by the existence of vertical collaboration and horizontal collaboration. Vertical

collaboration is defined as collaboration between parties in successive stages or chain in a supply chain (EPC contractor with its subcontractors, suppliers, or clients), while horizontal collaboration is defined as collaboration between parties at the same stage or chain in a supply chain (in this case, collaboration between EPC contractors). This collaboration involves collaborative culture, joint decision making, SC metrics, and cross functional activities which leads to process alignment. Collaboration is supported by cultural elements which involve collaborative culture, supported by trust, mutuality, information exchange, and openness & communication. Successful collaboration needs to be aligned with strategic elements which consist of: resource commitment, technology, business case, and corporate focus (Barrat, 2004).

Simatupang and Sridharan (2004) propose an integrative framework for supply chain collaboration based on reciprocal approach. According to this integrative framework, a collaborative SC collaboration is composed of five connecting features of collaboration which includes: collaborative performance system; information sharing; decision synchronization; incentive alignment; and integrated supply chain processes. Successful implementation of SCM in manufacturing based industries inspires practitioners and researchers to implement and study the implementation of SCM in construction sectors. Despite the constraints and problems limiting the implementation, SCM offers beneficial and valuable changes to construction industry (Dainty et al, 2001; Vrijhoef et al, 2001; Cox and Ireland, 2002; Briscoe and Dainty, 2005; Marosszecky, 2005; Fearnie and Thorpe, 2007).

Vrijhoef, et.al (2001) stated that major part of ineffective condition and inefficiency in construction is due to supply chain problems, originating from the interfaces of different parties. A large share of this supply chain problems are caused by poor articulation and communication of commitments.To build a comprehensive supply chain in construction industry, Kumar Dey (2002) underline the importance to classify two main supply chains, which includes local supply chain and global supply chain.

Childerhouse, et.al (2003) proposed the significance of material flow improvement in construction supply chain. They emphasized the role of business process reengineering (BPR) implementation in reducing lead times, through cellular manufacturing and lean process flow of material.

Humphrey, et.al (2003) stated that major requirement to a successful collaborative relationship in construction supply chain is trust among parties involved in the projects. This relationship is becoming more important considering the use of subcontracting within construction industry has become a common practice, especially when the main contractor only undertakes the management and coordination activities. Humphrey also mentioned that to overcome increasing tension in relationships between main contractor and subcontractor, it is important to reconsider the balance of power and domination between them.

Despite the benefit of having standardized products and process in lean supply chain, Capo, et.al (2003) reminded that in construction industry, certain clients may not be looking for standardized or low cost products, but high quality and personalized (specifically designed) products that adapt to their specific needs. This requirement leads to the needs of collaboration in project development, even if it means that they have to bear higher costs.

Considering the lean or regularity in project environment, Ireland (2004) reminded that power regime exists in construction supply chain may create resistance to lean and partnership development. Ireland stated that only in supply chain with high level of extended buyer domination or interdependence and with regular volumes, is a lean or partnering approach feasible.

Other mode to build collaborative relationship, as proposed by Maturana, et.al (2004) is buy onsite subcontractors' evaluation. This type of evaluation enables fast responsive proactive

performance attitude, which in the long run, will develop the collaboration between main contractor and subcontractors.

Khalfan, et.al (2005) mentioned that construction industry is moving from traditional procurement toward innovative procurement method. This transformation into a more integrated supply chain requires equal power and dependency between transacting parties. Trust in partnering development, is also a prerequisite to sustaining multi project procurement and repetitive contracting. The authors also mentioned that early involvement of subcontractors and suppliers create opportunity for downstream participants to offer their expertise in advance which could result in potential cost saving.

This early involvement is related to the concept of innovation friendly climate which will contribute to supply chain performance improvement proposed by Eriksson, et.al (2007); and relationship marketing proposed by Davis (2008) which mentioned that it could create more value for customers and all stakeholders in the long term.

Complex engineering based interfaces in oil and gas or energy related sector projects leads to the significance of EPC contract arrangement. Micheli, et.al (2008) stated that this EPC scheme also contributes to the implementation of supply risk management (SRM) which includes demand, product, information, and supply management. The authors also mentioned that a thorough supplier selection (SS) process will support SRM in construction projects.

Azambuja and O'Brien (2009) emphasize the needs of integrating strategic and operational decisions in three main stages in project implementation to increase efficiency and reduce project costs. These three stages includes: (1) pre-project planning/detail design/engineering; (2) procurement; and (3) construction.

Integration of these three main stages is needed to anticipate complexities in demand and supply decisions due to: (1) lack of reliability of site production system; (2) insufficient information flow regarding material requirement changes; (3) subcontractors' and suppliers' capability to support multiple projects; (4) project owners' and engineers' requirement changes and approval process. They also summarized seven distinction of construction or project based supply chain, compared to manufacturing based supply chain, which include: (1) structure; (2) information flow; (3) collaboration; (4) product demand; (5) production variability; (6) buffering; and (7) capacity planning characteristics. List of explanation that differentiates construction based supply chain from manufacturing based supply chain is provided in table 1.

Table 1.Manufacturing vs. Construction Characteristics (Azambuja and O'Brien, 2009)

Characteristics	Manufacturing SC's	Construction SC's
structure	Highly consolidated; high barriers to entry; fixed locations; high interdependency; predominantly global markets	Highly fragmented; low barriers to entry; transient locations; low interdependency; predominantly local markets
information flow	Highly integrated, fast, and shared; high availability of supporting SCM tools	Recreated several times between trades; lack of sharing; slow flow; lack of IT tools
collaboration	Long-term relationships; shared benefits and incentives	Adversarial practices
product demand	Uncertain due to seasonality, competition, and innovation; advanced forecasting method	Less uncertain due to pre-described contract or specification
production variability	Highly automated and low variability environment	Labor productivity and availability; tools; open environment; lack of standardization; high complexity and variability in material flow and trades

buffering	Inventory models (economics of order, safety stock, etc)	No models; inventory to reduce risks; time float (slack) as buffer
capacity planning characteristics	Aggregate planning; optimizing models	Independent planning; infinite capacity assumptions; reactive approach

METHODOLOGY

Preliminary studies regarding the characteristics of construction industry, especially in sectors familiar with integrated (EPC) contracts (ex: energy and oil & gas sectors) was conducted, to capture the uniqueness of integrated contract projects environment.

In depth interview and survey with decision makers in EPC contractors operating in Indonesia was conducted to acquire the information collected by the above questions. Decision makers whom are interviewed include those who are involved in collaboration development and project performance evaluation decisions. Profile of the respondents include: (1) Responsible for middle to long term planning of the company; (2) Possess the capability and authority to control technical and commercial performance of the project; (3) Has the access and knowledge to company's past experience related with supply chain collaboration.

EPC contractors which are studied include those which serve sectors familiar with integrated contract (energy and oil & gas sectors) and have been conducting relatively the same size of projects, in terms of values and complexity. These companies include national and multinational EPC companies. Four major questions used in the interview, the purpose, and the relevancy to research questions is provided in table 2.

The reason why the first question asks whether the company that the respondent works for engaged in a collaborative supply chain is to determine whether the respondent gives the answer based on experience or based on expectation.

The use of open question for the remaining questions will allow the respondent to share his/her opinion regarding the topics using his/her own framework and constructs.

Table 2.List of Questions

	Interview Questions	**Purpose**	**Relevancy to Research Questions**
1	Does your company have the experience of building supply chain collaboration among contractors? If your company doesn't have experience in building collaboration, is there any plan or intention to build collaboration?	To identify whether the company is engaged in a collaborative supply chain or not. To identify the potential of building collaborative supply chain.	To determine whether the respondents answer interview questions number one based on their experience or based on their expectation/requirement
2	What are the benefits of having supply chain collaborations on your company's project performance?	To explore the respondent's opinion about the impact of collaborative supply chain to the projects being carried out.	The answer may provide useful information to measure the positive impact of supply chain collaboration to project performance.
3	How does the achievement of your project performance contribute to the corporate performance objectives?	To identify the alignment of project performance to corporate performance measurements.	This question will identify the synchronization between project performance with corporate performance and among project performance measures.
4	What are the contributions of the integrated EPC contract in supporting	To explore the respondent's opinion about the benefit of	To identify the contributions of integrated EPC contract to

	performance of collaborative supply chain built in your projects?	having integrated contract to achieve project objectives.	the performance of collaborative supply chain.

FINDING AND DISCUSSION

EPC companies, or recently known as EPCI (engineering, procurement, construction, and installation) contractors play important role on many infrastructure development supply chain, especially in energy-related or oil-and-gas sectors. These contractors, supplied by goods and services by engineering companies, procurement agent, construction (or fabrication) companies, and installation companies, basically serve the owner and operator of large industrial facilities such as energy and oil and gas companies.

As described by Barrat (2004) that there are two kind of collaboration which may exist in a supply chain (vertical and horizontal collaboration), the same thing also exists in EPC projects supply chain. An EPC company (or contractor) may not only build supply chain collaboration with its sub-contractors or suppliers, but also with other EPC contractor. Policy to enhance the use of local products and services, enforced by regulation to comply with minimum local content applied by countries where the EPC projects are located, drive the needs to build these kinds of collaboration.

A schematic diagram describing the potential collaboration which can be developed in EPC projects supply chain can be seen in figure 1 below. Red-dashed circle represents collaborative supply chain between EPC contractor with its sub-contractors, suppliers, and other EPC contractor. The blue dashed circle represents collaborative supply chain with project owner and/or other EPC contractor.

Figure 1.Potential collaboration in EPC project supply chain

Benefits of supply chain collaboration to project performance include risk minimization, through cost reduction; quality assurance; optimize utilization of expertise; and timeliness of the

project execution. All respondents agree that long term commitment with suppliers or subcontractors will give higher level of certainty in demand to their suppliers and subcontractors. This certainty enables the EPCI companies to have more competitive offers for their outsourced services or goods. This higher level of demand certainty also contributes to the willingness of suppliers and subcontractors to do significant investment to support their EPCI customers. Relatively large proportion of costs in procurement part of EPC or EPCI projects (40%-55%) is also one of the considerations for developing long-term relationships. For local EPC companies, collaborative supply chain also enables them to have strong support and trust from their suppliers, which later allows more efficient project cash flow and working capital.

Contribution of project performance to corporate performance is considered to be very positive related, due to the fact that project activities are the EPCI companies' core activities. Cross subsidy among projects and support to long-term beneficial investment such as research and development are among the contributions of project success to corporate performance. This contribution can be utilized under certain condition that the proportion of invested fund has been carefully analyzed to prevent unexpected losses and risks.

EPC and EPCI contracts are considered to be very beneficial to EPC companies, considering that this integrated scheme of contract allows an integrated and comprehensive control to all project activities. This comprehensive control is mandatory since in energy related or oil and gas sectors development, many decisions are interrelated and have complex dependencies. Higher level of technology adaption and lower level of interchangeability of goods and services are main reasons for this interrelated decisions condition. This integrated scheme of contract also allows the EPC companies to have access to resources and expertise available around the world.

Explorative interview with project managers and directors of EPC companies operating in Indonesia proposes that EPC project performance consists of (starting from the highest priority): functionality, quality, time and cost performance measures. Functionality represents the ability of the designed, procured, and constructed project to solve the clients' needs regarding the function of newly built facilities or specific technical challenge of the project. Quality reflects not only the ability to comply with the specification of work results, but also the specification of process / methods, and qualification of resources utilized in the project. Time and cost performance are closely related, since most of EPC projects require utilization of relatively high cost resources, any delay in the project execution will affect project costs severely.

CONCLUSION

All respondents mentioned the benefit of having supply chain collaboration due to the high proportion of procurement value in EPC projects and the importance to minimize risks in time, cost, and quality of projects. Very close relationship between project performances to corporate performance can be utilized under the condition that decisions related with resource allocation and investment proportion value are conducted through careful analysis. The significance of having EPC contract to support project success is based on the unique characteristics of specific location of every projects and close interrelated decision in EPC projects.
The needs to combine and synergy resources and capabilities trigger the needs to build collaboration in EPC project supply chain. Willingness agreed upon collaborated parties to develop: (1) information sharing; (2) synchronous decision making; (3) integrated process; (4) incentive alignment; and (5) collaborative performance metrics is the key requirement to build the collaboration.

Closer interfaces between different stages of project activities (between engineering, procurement, and construction activities) resulted from the collaboration will lead to higher project performance. This higher project performance achievement will justify decisions to build longer term relationships among parties involved in the project and a relatively stable

performance in projects conducted by EPC companies. Successful implementation of projects undertaken by EPC companies will lead to a more sustainable companywide or corporate performance. Figure 2 below provide a schematic diagram of the above explanation.

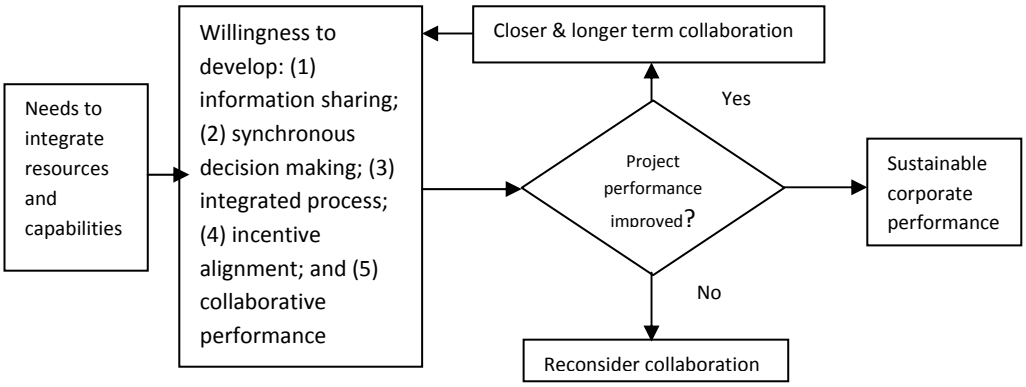

Figure 2.Benefits of Supply Chain Collaboration to Corporate Performance

Result of this research may be used as the basis for defining the EPC companies' corporate performance objectives as a function of collaborative project performance measures. The finding may also be used in assessing the capability of EPC companies to cope with the challenge of accelerated infrastructure development in developing countries.

Model developed from this research could be used as one of considerations in determining the relevance of building supply chain collaboration in construction projects. Findings of this research which is studied in oil and gas or energy related sector of construction could be used to similar outline of research studied in different sectors served by construction industry. This comparative study could be useful in proposing beneficial changes in other sectors.

Large number of previous studies related with supply chain and construction industry, will provide valuable sources for conceptual development in this research. Study exploring factors considered by practitioners in EPC companies operating in Indonesia shall give strong empirical basis in identifying factors to be measured in the core research.

Although provide considerable portion in discussing contractual aspect of relationships among parties in construction supply chain, this study will not offer detailed discussion regarding legal or regulatory aspects constraining the relationships.

REFERENCES

Barrat, Mark. Understanding the meaning of collaboration supply chain. Supply Chain Management: an International Journal, Volume 9/1, 2004, pp 30-42

Capo, Josep, Lario, Fransisco C, and Ortiz, Angel (2003). *Proposal of an Advanced Model for Supply Chain Management in Construction Industries, based on the Virtual Enterprise*. Universidad Politecnica de Valencia, Spain.

Childerhouse, Paul, Lewis, Jayne, Naim, Mohamed, and Towill, Dennis R., (2003). *Reengineering a Construction Supply Chain: a Material Flow Control Approach*. Supply Chain Management: an International Journal, Volume 8, Number 4, 2003, pp 395-406.

Dainty, Andrew R.J., Briscoe, Goefrey.H., Millett, Sarah.J. New perspective of construction supply chain integration. Supply Chain Management: an International Journal, Volume 6/4, 2001, pp 163-173.

Davis, Peter R., (2008). *A Relationship Approach to Construction Supply Chain*. Faculty of the Built Environment, Art, and Design, Curtin University of Technology, Perth, Australia. Industrial Management and Data System, Volume 108, Number 2, 2008.

Dey, Prasanta Kumar (2002). *Supply Chain Management in Construction through Partnership*. AACE International Transaction, 2002.

Eriksson, P.E., Dickinson, Michael, and Khalfan, Malik M.A., (2007). *The Influence of Partnering and Procurement on Subcontractors' Involvement and Innovation*. Lulea University of Technology, Sweden, and University of Salford, Greater Manchester, UK.

Humphreys, Paul, Mathews, Jason, and Kumaraswamy, Monan (2003). *Preconstruction Project Partnering: from Adversarial to Collaborative Relationships*. Supply Chain Management: an International Journal, Volume 8, Number 2, 2003, pp 166-178.

Ireland, Paul, (2004). *Managing Appropriately in Construction Power Regime: Understanding the Impact of Regularity in the Project Environment*. Supply Chain Management: an International Journal, Volume 9, Number 5, 2004, pp 372-382.

Khalfan, Malik M.A., Ericksson, P.E., Dickinson, M, and McDermott, Peter (2005). *Listening to the Voices of Suppliers and Subcontractors*. University of Salford, Greater Manchester, UK, and Lulea University of Technology, Sweden.

Khalfan, Malik M.A., McDermott, Peter, and Swan, Will (2007). *Building Trust in Construction Projects*. Supply Chain Management: an International Journal, Volume 12, Number 6, 2007, pp 385-391.

Khalfan, Malik M.A., McDermott, Peter, Vrijhoef, Ruben, and Asad, Salman (2005). *The Effect of Procurement on the Integration of the Supply Chain within Construction Industry*. University of Salford, Greater Manchester, UK, and Technische Universiteit, Delft.

Marosszecky, Marton, 2005. Best practices in the construction supply chain. University of New South Wales.

Maturana, Sergio, Alarcon, Luis, and Vrsalovic, Mladen (2004). *Achieving Collaboration in the Construction Supply Chain: an Onsite Subcontracting Evaluation Methodology*. Pontificia Universidad Catolica de Chile.

Micheli, Guido J.L., Cagno, Enrico, and Zorzini, Marta (2008). *Supply Risk Management vs. Supplier Selection to Manage the Supply Risk in the EPC Supply Chain*. Politecnico de Milano, Italy. Management Research News, Volume 31, Number 11, 2008.

Simatupang, Togar.M., Sridharan, Ramaswami. The collaboration index: a measure for supply chain collaboration. International Journal of Physical Distribution and Logistics Management, Volume 20/1, 2004.

Simatupang, Togar.M., Wright, Alan C., Sridharan, Ramaswami. Applying the Theory of Constraints to Supply Chain Collaboration. Supply Chain Management: an International Journal, Volume 9, Number 1, 2004, pp 57-70.

Soemardi, Biemo W., Wirahadikusumah, Reini D., Larasati, D, 2006. *Preliminary study on the Indonesian construction industry supply chain system*. Institut Teknologi Bandung.

Suparto, Hari G., 2007. *Industri konstruksi Indonesia*. Ikatan Ahli Manajemen Proyek Indonesia (IAMPI).

Suradji and Kusnandar (2008), *Construction Market in Asia*. Institute for Construction Service Development (Lembaga Pengembangan Jasa Konstruksi / LPJK).

Vrijhoef, Ruben, Korkela, Lauri, and Howell, Greg, (2001). *Understanding Construction Supply Chain: an Alternative Interpretation*.

Wirahadikusumah, Reini D., Abduh, Muhamad, 2003. *Metode kontrak inovatif untuk peningkatan kualitas jalan: peluang dan tantangan*. Fakultas Teknik Sipil dan Lingkungan, Institut Teknologi Bandung.

Wirahadikusumah, Reini D., Susilawati, 2006. *Pola supply chain pada proyek konstruksi bangunan gedung*. Jurnal Teknik Sipil, Vol 13 No.3.