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Study & Analysis of Subcontracting Practices in Infrastructure Projects - State of Art

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Abstract: **There has been increasing concern on excessive subcontracting. This study reviews the case of India, in particular the consequence of high & growing rate of subcontracting and what project managers can do. Based on statistics and elemental cost analyses, we find that as much as 80% of the value of building works is undertaken by small subcontractors. Whilst subcontracting provides the industry with specialized services as well as organizational and managerial flexibility, it has also been attributed to the labour intensity and the lackluster performance of the industry. It relies on project manages to make the best use of what subcontracting has to offer, whilst avoiding its pitfalls. An assessment of the extent and issues of subcontracting helps us understand how project management could enhance the performance of the projects and then the industry.**

1. INTRODUCTION

In India perhaps as elsewhere, there is a large presence of building subcontractors. They are typically very small firms but collectively undertake most of the works. The extent of subcontracting is even larger when ‘‘latent” subcontracting is taken into account: the further subcontracting down the stream by subcontractors with or without the knowledge or consent of the contractors or the clients. The proliferation of subcontracting and contractors’ exploitation of small craft-based subcontractors are believed to be partly, if not mostly, responsible for the fragmentation of the industry and the persistent problems of quality, productivity, non-payments and safety. The Construction Industry Review Committee expressed its concern about excessive subcontracting. Subcontractors’ performance, or rather non-performance, inevitably impacts on the performance of the industry as a whole.

Meanwhile, subcontracting is a double-edged sword. If managed effectively, subcontractors help their contractors achieve market leadership by providing specialist construction services and absorbing contractors’ erratic workloads. Especially, when bank loans are cheap and accessible, contractors can, in assembling their project portfolios to diversify idiosyncratic project risks, treat individual projects basically as investment assets, each with its own risk and expected return. Many larger contractors have thus maintained long-term relationship with their subcontractors, when they manage to consistently secure a portfolio of works large enough to sustain the relationship.

There is a causal relationship between market penetration and competitive advantage in cost leadership that relies heavily on subcontracting. Having accumulated a critical volume of market share, contractors attain economy of scale and buying power over their subcontractors and suppliers. More importantly, with more jobs comes more opportunities for contractors and their subcontractors to learn from each other. Thus, in moving up the experience curve, contractors benefit from their subcontractors and learn to manage their supply chains in the most possible efficient manner. As observes, specialist subcontractors are often the ones who implement technological change. Indeed the economic development of owns much to the adaptive entrepreneurship of small firms. Besides, as argue network is a potential source of construction innovation. Eventually contractors attain cost leadership and consequently the capacity to offer competitive tenders to capture even more market shares, thus completing the virtuous circle of market shares and cost leadership.

In the learning process to become cost competitive, the knowledge that is valuable to contractors is often tacit in nature, and could be acquired only through long-term relationship with their subcontractors and suppliers. As observes, the efficient market hypothesis implies that transactions based on contracts are unlikely to be source of competitive advantage, because opportunities for making better contracts than others cannot last for long. Instead, it is through developing a unique set of firm-specific, trust-building and value enhancing relationships with their suppliers and subcontractors that a firm creates and sustains their competitive advantages that are difficult to imitate. Through adopting the strategy contractors have in-house like services from these subcontractors, but meanwhile keeping them at arm’s length thus relieving themselves of the overhead costs. Perhaps as elsewhere, this network is important because of the large extent of subcontracting in the building industry. Indeed it is the lack of long-term inter-firm relationship that has hampered construction innovation.

It is imperative therefore that project managers acquire the competence to harness the advantages and benefits of subcontracting, whilst keeping the problems at bay. Quoting precedent studies, argues that as companies grow, diseconomies of scale set in and problems of site supervision of subcontractors increase, thus requiring better project management. Project managers are the linking pins that integrate the otherwise fragmented stakeholders, each having their own objectives that could be conflicting with others’. Yet, first and foremost, they must acknowledge and understand the pitfalls and potential problems of subcontracting, which this paper will focus on.

We focus on the building industry. Technology requirements in typical building construction are generally less demanding than civil engineering. Due to its lower

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technological and financial barriers of entry, the building sectors in India had a lower market concentration than the civil engineering one. It should also have a larger extent of subcontracting. The more technologically complex the construction is the less subcontracting there will be, because core activities require core workforce and technology. Quality and safety problems have thus been more frequent and serious in the building than the civil engineering sector. The rest of the paper will be organized into: (i) subcontract and the case in India, (ii) increasing extent of subcontracting, (iii) subcontracting in the building elements, (iv) small firms, (v) the ramifications, (vi) the road ahead: technology development, and finally (vii) conclusion.

2. LITERATURE REVIEW

2.1.1. Sadi A. Assaf, Member, ASCE, Mohammed AI-Khalil And Muhammad AI-Hazmi, "CAUSES OF DELAY IN LARGE BUILDING CONSTRUCTION PROJECTS", J. Manage. Eng., Vol. 11, Pp. No. 45-50, 1995.

The present paper outlines the main causes of delay in large building projects in Saudi Arabia and their relative importance. A survey of a randomly selected sample of 24 contractors, 15 architectural engineering firms (AlE), and nine owners from the Eastern Province of Saudi Arabia was undertaken. The survey included 56 causes of delay, and the respondents were asked to indicate their degree of importance. The delay factors were grouped into nine major groups. The level of importance of the causes and the groups were measured and ranked by their importance index for contractors, owners and AlEs. It was found that contractors, AlEs, and owners generally agree on the ranking of the individual delay factors. It was also shown that contractors and AlEs substantially agree on the ranking of the groups of delay factors, whereas contractors and owners, and AlEs and owners do not agree. It was also shown that the financing group of delay factors was ranked the highest by all three parties and that environment was ranked the lowest.

A survey of contractors, owners, and AlEs was conducted on the causes of delay factors in large building projects in Saudi Arabia. The survey showed that all three groups generally agree on the ranking of individual delay factors. The factors were categorized into nine major groups and were ranked. It was shown that the contractors and AlEs substantially agree on the ranking of the groups of delay factors, whereas contractors and owners, and AlEs and owners do not agree. It was also shown that the financing group of delay factor was ranked the highest by all three parties and that the environment group was ranked the lowest.

The most important delay factors according to contractors were preparation and approval of shop drawings, delays in contractors' progress, payment by owners, and design changes by owners. The most important delay factors according to AlEs were cash problems during construction, the relationships between different subcontractors' schedules in the execution of the project, and the slowness of the owners' decision-making process. The most important delay factors according to owners were design errors, excessive bureaucracy in project-owner organization, labor shortages, and inadequate labor skills.

2.1.2. F.T. Edum-Fotwe, A. Thorpe, R. Mccaffer, "INFORMATION PROCUREMENT PRACTICES OF KEY ACTORS IN CONSTRUCTION SUPPLY CHAINS", European Journal Of Purchasing & Supply Management, Vol. 7, Pp. No. 155-164, 2001.

This paper presents a survey on the practices associated with the acquisition, use, storage and transfer of information by a sample of professionals (actors) within the construction supply chain. The role of information in construction supply chains witnessed a shift from its passive function in decision-making from the 1990s, to a strategic resource that drives both the processes and competitiveness of companies. This change presents challenges for organisations that participate in the construction supply chain. The way organisations involved in the construction supply chain manage this resource will have direct impact on their competitiveness. This is influenced by the information acquisition, processing, utilization and transfer practices of their professional sat! (Actors) involved in the processes of the construction supply chain. The paper presents results from a survey that looks at some aspects of how key actors in the construction supply chain address these information-related issues.

The construction supply chain is essentially an information transaction process. This paper has argued that the role of information in the supply chain needs to be broadened from its current passive status to encompass its active management as a strategic resource. Treating information as a resource should enable the parties in the construction supply chain to plan and ascertain optimum levels of its utilization for projects and thereby achieve productivity improvements. For this to be a reality, the way information is utilised by actors in the supply chain has to be understood. A survey that focuses on some aspects of the way professionals in construction utilize information shows that there is a propensity to utilize paper-based options in procuring, processing and transferring this resource. The productive time involved coupled with the medium of transfer makes information supply chain in construction a potential avenue for productivity improvement. The current growth in sources of information and availability of technology for ease of access implies that the management of information as a resource in the construction supply chain can be a reality.

A significant proportion of actors in the respondent group considered their current information requirements as being relatively stable (subject to annual changes). However, the current trend of technological development and its concomitant economic competition that it will generate from productivity improvements and shorter operational times imply that such stability may no longer exist within the foreseeable future. The potential impact of considering information as such a resource in the construction supply chain can be useful in this direction. It will call for the development of appropriate procedures, protocols and mechanisms for evaluating information along the same basis as other construction tangible inputs and outputs.

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2.1.3. Sadi A. Assaf & Sadiq Al-Hejji, "CAUSES OF DELAY IN LARGE CONSTRUCTION PROJECTS", International Journal Of Project Management, Vol. 24, Pp. No. 349–357, 2006.

A survey on time performance of different types of construction projects in Saudi Arabia was conducted to determine the causes of delay and their importance according to each of the project participants, i.e., the owner, consultant and the contractor. The field survey conducted included 23 contractors, 19 consultants, and 15 owners. Seventy-three causes of delay were identified during the research. 76% of the contractors and 56% of the consultants indicated that average of time overrun is between 10% and 30% of the original duration. The most common cause of delay identified by all the three parties is ''change order''. Surveys concluded that 70% of projects experienced time overrun and found that 45 out of 76 projects considered were delayed.

The delay in construction projects in Saudi Arabia is discussed in a field survey. It studied frequency, severity and importance of the causes of delay. The importance index of each cause is calculated as a product of both frequency and severity indices of each cause. 73 causes of delay were identified through research. The identified causes are combined into nine groups. The field survey included 23 contractors, 19 consultants, and 15 owners. Data collected were analyzed by frequency, severity and importance.

76% of the contractors have indicated that average of time overrun is between 10% and 30% of original duration, while about 56% of the consultants specified the same percentage. 25% of the consultants have indicated from 30% to 50% average time overrun. Owners specified that causes of delay are related to contractor and labours. Study indicated that owners and consultants realize that awarding to the lowest bidder is the highest frequent factor of delay, while, contractors considered severe causes of delay are related to owners.

Only one cause of delay is common between all parties, which is ''change orders by owner during construction''. Many causes are common between two parties, such as delay in progress payments, ineffective planning and scheduling by contractor, poor site management and supervision by contractor, shortage of labors and difficulties in financing by contractor. All parties agree that the following causes are the least important: changes in government regulations, traffic control and restrictions at site, effect of social and cultural factors and accidents during construction.

Both owners and consultants specify labor and contractor related causes as the severe and important sources of delay, while, contractors indicate that the important sources of delay in construction projects are owners and consultants. The values of the Spearman's rank correlation

Coefficients show that there is relative good agreement between each two groups of parties in ranking of the importance of delay causes. The highest degree of agreement is 72.4% between owners and consultants, while the lowest is 56.8% between owners and contractors.

2.1.4. Peter F. Kaming,1 Paul O. Olomolaiye, Et. Al., "FACTORS INFLUENCING CONSTRUCTION TIME AND COST OVERRUNS ON HIGH-RISE PROJECTS IN INDONESIA", Construction Management And Economics, Vol. 15, Pp. No. 83- 94, 2010.

Many variables have an impact upon construction time and cost overruns in Indonesia. A questionnaire survey was undertaken of project managers working on high-rise construction projects in two Indonesian cities: Jakarta and Yogyakarta. The variables identified were ranked according to their perceived importance and frequencies of occurrence. Inflationary increases in material cost, inaccurate material estimating and project complexity are the main causes of cost overruns. The predominant causes of delay are design changes, poor labour productivity and inadequate planning. Using factor analysis techniques, delay and cost overrun variables were grouped into factors, and their relationships analysed. Although Indonesia specific, the results reflect construction management problems common to developing countries.

From the projects and project managers surveyed, it would seem that cost overruns occur more frequently and are thus a more severe problem than time overruns on high-rise construction in Indonesia. The predominant factors influencing time overruns/delays are design changes, poor labour productivity, inadequate planning and resource shortages. In the case of cost overruns, the most important factors are material cost increases due to inflation, inaccurate materials estimating and degree of project complexity. Considering both time and cost overruns together, the most important factors that influence them are: materials cost increases due to inflation, inaccuracy of estimates, and lack of experience of project type.

While the data on which these findings are based are specific to Indonesia, the results generally agree with earlier studies in developing countries, and confirm the reasons underpinning recent studies on build ability /constructability in both the UK and the USA. By reducing the influences of the identified factors, time and cost overruns on high-rise construction projects in developing countries can be carefully controlled.

While conceding that the experience of project managers should not be discounted, labour outputs need not remain in the realm of guesswork; they can be determined through time study techniques. However, it would be quite expensive for each contractor to carry out separate time studies on different construction operations. A way out, as suggested by Olomolaiye and Ogunalana (1989) for Nigeria, would be for the Association of Contractors in Indonesia, or other interested bodies in Indonesia, to sponsor further research to establish output figures on various construction sites. The research should be done with particular reference to methods and equipments that have been found to have a significant influence on production outputs. There is a need for method studies and dissemination of research results, to both large and small firms, so that the most productive working methods can be adopted by all operatives, with resultant increases in output, without necessarily exerting more physical effort.

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2.1.5. M. Haseeb, Xinhai-Lu, Et. Al., "PROBLEMS OF PROJECTS AND EFFECTS OF DELAYS IN THE CONSTRUCTION INDUSTRY OF PAKISTAN", Vol.1, Pp. No. 41-50, 2011.

The problem of project delays is a fact that occurs mostly in construction industry of Pakistan. Delays are always measured as expensive to all parties concerned in the projects and very often it will result in clash, claims, total desertion and much difficult for the feasibility and it slows the growth of construction sector. For analyzing the causes of delay, an appraisal on construction project's time performance was conducted.

The main objective of this study is the identification of factors of delay and their effects on the success and completion of project. The most common factor of delay are natural disaster in Pakistan like flood and earthquake and some others like financial and payment problems, improper planning, poor site management, insufficient experience, shortage of materials and equipment etc. This paper covers the delay factors and causes of delay and some suggestion for reducing these delays in large construction projects in Pakistan.

The survey results indicated that the majority of delay factors are relevant to client factor. It is concluded from survey for dipping in delay client must have strong economical ability and financial arrangement for project, correctly time decision. He must give proper time and priority on his construction project and tacking appropriately time verdict. Most factors related to consultant it is due to not understanding the client necessities, not having proper project information, absence of some detail in drawing etc. It is examine from survey due to contractor that mostly delay occur because of deficient in obtaining up-to-date equipments, unwarranted material used in construction.

Due to which cause of dispute occur in construction so it is necessary that excellent material is used in construction. Providence of material is also most significant causes due to which delay occur in construction so it is essential that material supply must be in time. From survey it is predicted that some delay occur in projects due to shortage of labors. There may be variation among labors, injuries, and low yield of work. In other factors due to which delay occurs are project conditions like site, complexity, complication in work due to weather. Delay also occurs due to external factor like change in government, regulation and location etc. Client must be mentally and financially strong for starting a new project due to which we can reduce delay in projects.

2.1.6. Nenad Cus-Babic, Danijel Rebolj, Et. Al., "SUPPLY-CHAIN TRANSPARENCY WITHIN INDUSTRIALIZED CONSTRUCTION PROJECTS", Computers In Industry, Vol. 65, Pp.No.345–353, 2014.

This paper addresses those issues relating to the integration of information flows in relation to material management throughout the construction industry supply-chain. Based on a case study, it shows how to bridge any gaps between those information systems used within the design, prefabrication, and on-site construction processes.

The information requirements of the aforementioned three key processes are analysed regarding an industrialized construction project, and any gaps identified between their three sets of requirements. A theoretical model for information mapping is proposed using these requirements. The solution is then verified through a case study, performed within the operational environment of a construction company. This case study represents one approach for applying the proposed information mapping model, and possible benefits for the industry.

The information analysis highlights significant distinctions among particular views on the information required for supporting the tasks during the three above-mentioned processes. The main difference lies in the levels of data granularity important for particular tasks. Building Information Modelling based construction (BIM-based construction) proved itself to be an adequate context for bridging the information gaps. BIM-based construction can accommodate the proposed model for information mapping across the processes. Within this context it is possible to separate the identities of physical building elements from those of designed building elements, which is required when mapping.

This study shows that it is feasible to automate the proposed information mapping in the form of a computer algorithm. It explains the value and necessity of building information model (BIM) usage, in order to provide the context for information mapping. The integration of design, manufacturing, and construction processes, and a transparency of information about material resources across these processes, would bring significant benefits for all stakeholders within the supply-chain. In the case study, the architecture and a prototype of the software system were developed in order to implement the proposed idea. Specifically, the case study showed that the proposed information mapping improved the project's progress monitoring, detailed planning, and management of material flows, across the construction supply-chain.

From the literature review and our own experiences, we have identified an opportunity for enhancing construction project planning, execution, and control via the integration of software tools for design within construction (CAD tools) and ERP systems. The problem that prevented seamless integration of these systems in the past lay in the incompatible data structures used during particular phases of a construction project. On the other hand, building information modelling (BIM) is used in the construction industry with the aim of overcoming problems of interoperability among different software tools. By our efforts, we have introduced BIM as a basis for integrating the CAD and ERP systems. Within the building information model, a complete building is encoded as a hierarchy of the building elements.

In order to bring data structures from both types of tools onto common ground within an integrated model, there is a need for a mapping algorithm. This algorithm solves the problem of building element identity, because the identity of a physically built element is handled differently during the stages of detailed building design, the manufacturing of building elements, and at the construction site. A useful case study was performed containing several pilot projects using CAD tools and ERP systems, and where software tools and

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systems were integrated by the system architecture proposed in this paper. This case study serves as a 'proof of concept'. During the piloted projects, we identified benefits within the process of construction project planning in terms of more accurate scheduling and proactive change management due to transparency of material flows throughout the project supply-chain.

The manufacturing and distribution of prefabricated building elements can also be optimized because of integrating prefabrication with the design and construction processes. Both the short-term goals set at the beginning of the project were achieved, which were the improvement of project progress monitoring and an improved transparency regarding the statuses of building elements throughout the construction supply-chain. Therefore, we can conclude that this work provides a contribution to better transparency of information flows within construction processes and brings added-value to the broader context of a construction supply-chain.

2.1.7. Samad M E Sepasgozar, Mohamad Ahmadzade Razkenari & Khalegh Barati, "THE IMPORTANCE OF NEW TECHNOLOGY FOR DELAY MITIGATION IN CONSTRUCTION PROJECTS", American Journal Of Civil Engineering And Architecture, Vol. 3, Pp.No. 15-20, 2015.

Construction technology has a great potential to improve productivity and decrease project duration. Delay happens in many construction projects, although the priority of delay causes is different in various countries due to environmental effects. Delays can lead to considerable negative effects such as lawsuits between owners and contractors, loss of productivity and revenue, and contract termination. This paper presents key sources of construction projects delay in Iran, following a review of publications related to delay. In addition, the paper presents the relationship between new technology and time overrun in those projects. One of the main causes of delay in many projects is that they use an old generation of construction technologies; however, the role of technology adoption in delay is ignored. In order to collect first-hand data to explore the delay sources, experienced project managers of the residential and industrial projects were recruited. Experienced professionals from twenty six companies participated in this study. Seventy-three delay causes were identified in the sample projects, in which 25 factors were related to the new technology restriction. The result of the study assists policy makers and practitioners to understand the actual factors causing delay. The value of the study is that it investigates three main issues such as frequency of occurrence, degree of severity, and importance of each factor. Different than other studies, the paper focuses on technology attributes that may affect the project scheduling and time.

This study aimed to investigate main causes of delay in the construction projects. Particularly, the purpose of the study was to understand the priority of causes affecting time and the project duration focusing on technology attributes. Top ten factors were identified as main causes of delay: (1) contractor organization attributes, (2) labor shortness, (3) external factors, (4) material deficiency, (5) design issues, (6) owner attributes, (7) technology restriction, (8) consultant attributes and (9) project attributes. As the result shows, technology restriction is one of the top ten most important factors out of seventy-three affecting delay in construction projects. Most of previous publications investigated overall factors affecting time. However, fewer publications focused on a particular attribute such as technology to measure the exact impact of technology on delay. This study is a step forward to understand how construction technology (new crane, loader, and dozer) restriction may affect the project time.

In particular, participants from contractor companies reported that monthly payment's difficulties from agencies or owners were the most important cause of delay. While the results show poor contractor management is generally the most important factor. Despite some differences in the viewpoint held by contractors, owners and consultants in this survey, there is a considerable degree of agreement among most of them regarding their ranking of the factors, and pointing that construction technology has an important impact on delay. The overall ranking results indicate that the major ten attributes such as new technology restriction can cause excessive project overruns in developing countries.

The exact role of new construction technologies such as tools, equipment and machinery in the duration of construction projects still remains unknown. Future studies should focus on construction technology attributes. In addition, similar studies should be separately performed in different kinds of construction projects such as: tunneling, bridge, high-rise building and dams.

2.1.8. Prakash Kumar & Piush Raj, "DELAY ANALYSIS OF PROJECTS AND EFFECTS OF DELAYS IN THE MINING/ MANUFACTURING INDUSTRIES", Vol. 12, Pp.No. 61-71, 2015.

Delays are unique and one of the largest issues mining/manufacturing companies is facing today. Delays in mining/manufacturing projects have become a major concern across all parts of the world. Substantial value is destroyed and companies face significant corporate risk if these delays occur during project execution. However, despite the concern regarding the project delays, there has been very limited research conducted in this area.

Delay in the completion of a project can be a major problem for contractor companies leading to costly disputes and adverse relationships amongst project participants. Projects can be delayed for a large number of reasons. The reasons are related to the various types of uncertainty associated with activities during the mining/manufacturing processes. The most common factor of delay are natural disaster like flood, earthquake etc. and some others like financial and payment problems, improper planning, poor site management, insufficient experience, shortage of materials and equipment etc. Delays will also result in several negative effects like lawsuits between house owners and contractors, exaggerated prices, loss of productivity and revenue, and contract termination. So, comprehensive study on these delays is important.

Present study works on identification of causes of delay in mining/manufacturing projects in Indian context. An approach is suggested to carry out ranking of these causes by

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two different techniques: Relative importance index and Importance index based on degree of severity and degree of frequency.

In most of the cases schedule delays also appear in these projects and result in delay claim progressively. Several studies have proposed various schedule delay analysis methodologies; however, most of the studies focus on the analysis of surface data (as-planned and as-built schedules), few of them on evaluating the effect of root causes, such as the problem of lost productivity. Lost productivity, one essential delay cause, is usually experienced by a contractor while accomplishing its works less than planned rate of production. We analyze the situations of schedule impacts caused by loss of productivity through the case study. In this study, it has been proposed to calculate the schedule impact from lost productivity. The study results will be a basis for developing comprehensive delay analysis methodologies for different mining/manufacturing Projects. It is hoped that the findings of the paper will help the stakeholders to act on critical causes and further try to reduce delay of their projects.

The study was carried out to investigate various reasons of delay in execution of a mining/manufacturing project. Results show that less than 50% delay is attributable to customer and client and more than 50% of problems are attributable to contractor. Also this study helps in identifying various reasons and factors causing delay from customer, consultant and contractor‘s end. Also it helps in highlighting flaws of contract.

The importance of delay causes in mining/manufacturing project in India has been identified clearly. Although this research was conducted in the commercial sector in India, the results may also be applicable for similar projects in other developing countries. The identification of important delay causes helps a contractor in seeking extra time for completion from the customer. If the contractor wins in explaining the reasons of delay and gets a contractual extension of time than the customer is bound to pay extra claim to contractor. The contractor gain or loss is huge in terms of its credential in the market in terms of a successful presentation of delay analysis.

Further methodology is suggested to work out critical causes from available ones by two techniques: Relative importance index and Importance index as a function of severity index and frequency index. Survey questionnaire must be prepared based on these techniques. It is proposed to carry out ranking of causes of delay from two different techniques in the next phase of research.

2.1.9. Alexandre Pinheiro De Barrosa, Celia Satiko Ishikiriyama, Et. Al., "PROCESSES AND BENEFITS OF THE APPLICATION OF INFORMATION TECHNOLOGY IN SUPPLY CHAIN MANAGEMENT: AN ANALYSIS OF THE LITERATURE", Procedia Computer Science, Vol. 55, Pp.No. 698 – 705, 2015.

The growth in the use and application of information technology (IT) in supply chain management (SCM) can be attributed to the performance improvements and value creation in organizations. In this sense, there has been a considerable evolution of scientific investigations into this integration over the past few years. This paper seeks to review, in a comprehensive and updated manner, the available scientific literature on business processes benefiting from the application of IT in SCM between the years of 2009 and 2014. The study identifies and analyzes the benefiting processes, and the benefits obtained in SCM. The paper concludes that there is a window of opportunity for advances in processes related to the production and development of products or services.

The objective of this paper was to use scientific articles published in a horizon of five years to identify and analyze the benefiting processes and the respective benefits obtained with the application of IT in the supply chain management of organizations. The paper answered questions related to: (i) the business processes that benefited most by such adoptions; and (ii) the main benefits obtained by these applications in SCM.

Regarding the benefiting processes with the adoption, one can also see that there is a higher concentration of articles with analyses and citations of processes related to the planning macro-process, to the quality of information and the improvement of the management processes, and to the services rendered to all the actors in the supply chain. This analysis was confirmed with the presentation of the results on the main benefits obtained by organizations, according to the assessment model proposed by the authors, with an emphasis on the quality of information, process improvements and the collaboration between the actors.

This paper concludes that in terms of citations and analyses of recent scientific articles, there is a window of opportunity for IT advances in the context of SCM, especially regarding production processes (manufacturing) and the development of products or services.

The study was limited to the existing databases of the CAPES Journal Portal, and also to a specific horizon of analysis. For future studies on the subject of integration between IT and SCM, the authors suggest new research databases, a greater number of combinations of search terms, and an extension of the horizon of analysis.

2.1.10. Ke Xing, Wei Qian & Atiq Uz Zaman, "DEVELOPMENT OF A CLOUD-BASED PLATFORM FOR FOOTPRINT ASSESSMENT IN GREEN SUPPLY CHAIN MANAGEMENT", Journal Of Cleaner Production, Vol. 139, Pp.No. 191-203, 2016.

Managing life-cycle information presents a critical challenge for footprint assessment and performance measurement in supply chains. Extant literature and supply chain collaboration models fall short in providing an interactive platform to enable cross-organisational life-cycle information gathering, sharing and management. This paper proposes a cloud-based life-cycle assessment (LCA) platform that enables dynamic life-cycle data collection and exchange, and supports supply chain collaboration for environmental footprint assessment. Using green supply chain management of cotton T-shirts as an example, the paper further illustrates the potential of the proposed cloud-based model in helping supply chain stakeholders to address the implications of managing life-cycle information and to improve the timeliness of their carbon footprint assessment.

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Based on the Cloud Manufacturing paradigm and web-based technology applications, this paper proposes a multimodal and multilevel cloud-based model to support collaborative LCA. The architecture and data exchange mechanisms used for this hybrid cloud model provide a technological platform to support dynamic life-cycle information sharing and real-time footprint assessment in supply chains. The GSCC platform can be implemented by either the champion of the supply chain or a third-party business intelligence service provider to set and maintain protocols for life-cycle data collection and communication, to check LCI data quality and consistency, to ensure system accessibility, reliability and security, to conduct data synthesis and the whole-of-supply-chain environmental footprint evaluation, and to produce LCA report for the supply chain as well as external stakeholders.

However, despite the usefulness of this platform in the case example, the efficacy of the platform and the potential of extending its application to other GSCM contexts need to be tested and validated through further model evaluations and case studies. Also, the Cloud-based model is still at an early stage of development with few empirical studies and anecdotal cases. A detailed model construct and operational mechanisms to support data conversion, data exchange and data synthesis within and across the Clouds (i.e. LCAC, GSCC, and ECIs) need to be further developed. In addition, like many other Cloud-based systems and applications, the costs of investing in developing in-house IT capabilities and maintaining operations of hardware and software systems could be high if business entities operate their own private Clouds. For most supply chain members, especially SMEs, it is more viable to subscribe Cloud data or platform services provided by third parties on a pay per- use basis. Meanwhile, the stability and quality of mission critical Cloud services for life-cycle process-flow data gathering, management and exchange need to be addressed and guaranteed through Service Level Agreements with Cloud service providers.

Applying the model developed in this paper will not be feasible without establishing and developing mutual trust and partnership among supply chain members for collective GSCM benefits. In the future work, it is necessary to incorporate the Cloud-based model with a cross-organisational communication framework so as to code fine system boundary and functional units, the level of details for data sharing, and common strategies for footprint management. Future research may also benefit from incorporating other GSCM functions, such as life-cycle design and life-cycle management, into Cloud-based models. Linking Cloud technology with the ERP system to enhance business analytics is an area worth further investigation.

2.1.11. Dr. Shabbab Al Hammadi & M. Sadique Nawab, "PROJECT TIME OVERRUNS IN SAUDI ARABIAN CON-STRUCTION INDUSTRY", International Journal Of Scientific & Engineering Research, Vol 7, 2016.

Construction industry of Saudi Arabia is developing on a large scale, participating in employment and overall economic growth of country due to changes in the Kingdom's socio-economic development policies, and thereby recognizing the need for more efficient and timely completion of projects. Construction time often serves as benchmark for assessing the performance of a project and efficiency of project organization. Due to unexpected problems and change in original design during construction phase led to unwanted delay in timely completion.

The primary objective of this paper is to identify factors responsible for delay in Saudi Arabian construction industry by critically analyzing and evaluating delay factors proposed by researchers, and further determining their relative importance. This has been achieved by undertaking a critical analysis of the literature and carrying out a questionnaires survey among consultants, project managers and engineers in construction firms and collecting their responses. The importance of Project owner's role, contractor related, Financing related, Materials related, and Site management & supervision have often been cited as main delay factors.

The main delay factors that lead to Project overruns are related to "Project owner's role, contractor related, Financing related, Materials related, Design documents and Site management & supervision".

*2.1.12. **Abhijit N. Bhirud & Bhushan M. Revatkar, "EFFECTIVE IMPLEMENTATION OF ERP IN INFRASTRUCTURE CONSTRUCTION INDUSTRY", International Journal Of Technical Research And Applications Vol. 4, Pp.No. 246-249, 2016.***

ERP or Enterprise Resource Planning can enable companies to optimize their business processes and allows for necessary management .Thus, ERP can be said as system software that can integrate several activities in a project & deliver a unison result for bettering performance & increase profits. A construction ERP system provides Cost optimization, incorporate design changes, Consistent quality conformance, Reliable, Faster and on time delivery, Incorporates value engineering, Collaborative work environment, team tracking facility.

The case study relating to ERP implementation by firms operating in the Infrastructure construction industry is investigated. It is found that to ensure efficient implementation firms must first have a good reason why ERP should be implemented, determine the tradeoffs, choose an appropriate re-engineering process, identify and mitigate risks that may arise. Based on the findings, strategies for managing the implementation of ERP in the construction industry are developed.

Systematic implementation of ERP system added more benefits to infrastructure construction enterprises in various divisions i.e. integration of all business processes, fully computerized generation of reports to assist in decision making, and attainment of competitive advantage.

As Infrastructure construction is fragmented and ERP system having modest benefit helps infrastructure firms to gain more projects. The problems faced by Infrastructure construction enterprises in implementing ERP include insufficient training of employees and short software testing period. Infrastructure construction company do not rush into implementing ERP directly, but be mindful that it may be easier to change the software than change the human being one possible.

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However, it is believed that the findings of this study can still help firms to take the first step towards management of ERP implementation and earn high benefits in terms of saving cost and time for future projects.

2.1.13. Moon Jung Kang & Jongwoon Hwang, "INTERACTIONS AMONG INTER-ORGANIZATIONAL MEASURES FOR GREEN SUPPLY CHAIN MANAGEMENT", Procedia Manufacturing, Vol. 8, Pp. No. 691 – 698, 2017.

Collaboration among supply chain partners is essential to enhance environmental performance during the life cycle of a product. Inter-organizational measures for green supply chain management tend to show diverse patterns because of various requirements that emerge in a complex supply chain. However, this diversity hampers the comprehensive understanding and systematic adoption of these measures. Therefore, this paper classifies various inter-organizational measures for green supply chain management into several collaboration patterns and analyzes their structural relations through an interpretive structural modeling. The results reveal the collaboration patterns that have higher driving power and dependency than other patterns and, thus, require further attentions.

This study imposes order and direction on the complexity of relationships and analyzes the interdependencies of the various collaboration patterns for GSCM, which can provide company managers with a realistic representation of the tasks in conducting GSCM with their supply chain partners. This approach can aid the top management in prioritizing so that it can proactively take steps to improve inter-firm collaboration for GSCM. However, the ISM methodology has its own limitations. The relations of the collaboration patterns presented in this study are based only on the statistically significant relations from the previous literature with empirical evidence. However, each of the previous studies applied various terminologies, definitions, and categories. Interpreting the collected measures and classifying them into the present framework embeds the subjective bias of the person who is judging the variables because this process is affected by the person's knowledge and familiarity with the company, its operations, and its industry.

Furthermore, the ISM methodology cannot measure the relative importance of the variables because of the lack of weights associated with the variables. To overcome these limitations, structural equation modelling (SEM) can be applied in future research to test the validity of this hierarchical model. SEM can only statistically test an already developed theoretical model, whereas ISM is able to develop an initial model. Therefore, ISM can serve as a basis of forthcoming studies that employ SEM. In addition, this study can be empirically complemented with the case studies, as the GSCM collaboration in real world can be complicated which might cause difficulties in operation.

2.1.14. S.Yu. Eroshkin, N.D. Koryagin, Et.Al., "THE PARADIGM OF THE INTEGRATION OF DIFFERENT TYPES OF MANAGEMENT INFORMATION SYSTEMS IN INVESTMENT AND CONSTRUCTION COMPANY IMPLEMENTING THE PROJECT APPROACH", Procedia Computer Science, Vol. 103, Pp. No. 605 – 608, 2017.

The report examines trends in the development, construction project management systems in the overall system of the global network economy. The approaches of system developing the information tools of investment and construction project management of complex infrastructure projects is proved throughout their lifecycle from project initiation to disposal facility.

The aspiration of system using a vertical of information flow from strategic management to management of technological processes and products is becoming more apparent. Such vertical diffusion solution of the tasks in management information systems, as well as horizontal aggregation of these tasks across time reflects an important characteristic of information management in the formation of network economy.

Analytical information system for company strategic management accompany "smart" product throughout its life cycle and beyond. Classic PPM-systems are limited in time and stop information support of the product after its production. Transaction management systems, generally vary throughout the life cycle of the product. Thus, in the production process can be used in some information systems, e.g. ERP, and the process operation and product recovery more. BIM-system, by definition, accompanied by "smart" product throughout its life cycle and is increasingly involve in this process, the elements of strategic management. The ability that BIM provides to design, construct and operate a building virtually will prove to be an important instrument to increase productivity and quality. The improvement of the efficiency and transparency of the building construction will attract domestic and foreign institutional investors. This representation is conditional, but it allows qualitative assessment of the trends of development of the paradigm of management of investment-construction projects in the General system of the global information network management.

2.1.15. Jeong Hugh Han, Yingli Wang & Mohamed Naim, "RECONCEPTUALIZATION OF INFORMATION TECHNOLOGY FLEXIBILITY FOR SUPPLY CHAIN MANAGEMENT: AN EMPIRICAL STUDY", International Journal Of Production Economics, Vol. 187, Pp. No. 196–215, 2017.

IT flexibility is an increasingly important factor in today's dynamic business environment. However, earlier research lacks 1) an integrated framework that corresponds to diverse processes for supply chain management and 2) an explanation of how IT flexibility affects firms' performance in the supply chain context. To fill these gaps, our study theorised a research model by integrating disparate streams of IT flexibility research with three types of IT flexibility, namely, operational, transactional, and strategic, and tested both the direct and indirect effects of the three IT flexibility types on firm performance. Our theoretical model uses an

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extended resource based view to highlight the role of IT flexibility in managing interdependent firm relationships in supply chains.

Using a partial least squares approach to structured equation modelling analysis on 162 questionnaires from supply chain practitioners, we found two significant relationships: (1) transactional IT flexibility affects operational IT flexibility, and (2) operational IT flexibility affects strategic IT flexibility. Transactional IT flexibility also affects strategic IT flexibility, thus playing a pivotal role in the effectiveness of the other two flexibility types. In addition, it was identified that transactional and operational flexibilities affect firm performance indirectly, via process integration capability, while strategic flexibility directly affects firm performance. By classifying diverse IT flexibility attributes into three types, a comprehensive and explicit concept of IT flexibility in inter-organisational relationships is attained, which allows practitioners to target key resource investments to realize the full potential of IT in the supply chain.

The first limitation of this study is that it tested the impact of IT flexibility on firm performance at an aggregate industry level. While it determines the causal relationship between variables, it does not offer a measurement tool per se. Future research could explore ways to determine the level of inherent IT flexibility within a firm and, hence, the resulting absolute or relative impact on firm performance. The second limitation of our study is that we have adopted perception based firm performance measures in our survey. Future research should explore ways to conduct a sample check of actual performance, such as ROI and profits, against perception of performance. The third limitation of our study is our non-probability method of sampling. Though appropriate for the explorative nature of study, future research should adopt a more rigorous sampling technique in order to improve general is ability.

Our paper focuses on how IT flexibility gets executed in a supply chain, adopting the theory of extended RBV. Future research should explore how companies should adapt their IT flexibility to the supply chain context to improve firm performance. These decisions about resource and relational configurations with supply chain partners should be based on the context within which a focal company operates, as a 'one-sizes-fits-all approach' is unlike to be effective (Wong et al., 2011; Kembro et al., 2014). In this case, other theoretical lenses, such as contingency theory, would be more appropriate.

Extending the empirical testing research beyond our current scope of the dyad between the focus company and its customers/suppliers will provide further insights into how IT flexibility supports the reconfiguration of end-to-end supply chains and supply networks. Due consideration may also be given to the potential impact of technological trends, such as the greater adoption of crowd sourcing, online social media and the Internet of Things.

2.1.16. Mohammad M. Ali, Mohamed Zied Babai, et. al., "SUPPLY CHAIN FORECASTING WHEN INFORMATION IS NOT SHARED", European Journal of Operational Research, Vol. 260, Pp. No. 984–994, 2017.

The operations management literature is abundant in discussions on the benefits of information sharing in supply chains. However, there are many supply chains where information may not be shared due to constraints such as compatibility of information systems, information quality, trust and confidentiality. Furthermore, a steady stream of papers has explored a phenomenon known as Downstream Demand Inference (DDI) where the upstream member in a supply chain can infer the downstream demand without the need for a formal information sharing mechanism. Recent research has shown that, under more realistic circumstances, DDI is not possible with optimal forecasting methods or Single Exponential Smoothing but is possible when supply chains use a Simple Moving Average (SMA) method. In this paper, we evaluate a simple DDI strategy based on SMA for supply chains where information cannot be shared. This strategy allows the upstream member in the supply chain to infer the consumer demand mathematically rather than it being shared. We compare the DDI strategy with the No Information Sharing (NIS) strategy and an optimal Forecast Information Sharing (FIS) strategy in the supply chain. The comparison is made analytically and by experimentation on real sales data from a major European supermarket located in Germany. We show that using the DDI strategy improves on NIS by reducing the Mean Square Error (MSE) of the forecasts, and cutting inventory costs in the supply chain.

This paper has several implications, both from academic and practitioner perspectives. Firstly, the results of this study confirm that supply chains should always strive to share information in order to be most effective. Irrespective of the forecasting method adopted, sharing information would always be beneficial as the up- stream supply chain links would be using the actual consumer demand in their planning framework.

As discussed in this paper, there are many supply chains where information sharing does not take place. If the retailer does not pass on the information upstream, the manufacturer has two options: base their planning on the orders received from the retailer or try to mathematically infer the consumer demand. Although inference is not possible in general, to date the only method that has been found that may facilitate such inference is the Simple Moving Average (SMA). There could be instances where SMA is al- ready in place e.g. there is evidence to suggest that SMA is used extensively in practice (Ali, & Boylan, 2012) and thus the manufacturer may simply ask the retailer for an identification of the SKUs for which this method is used. There is extant literature on manufacturers offering incentives to the retailer to share information e.g. price discounts (Karabati and Kouvelis, 2008 ; Aditya, Sridhar, & Sohoni, 2010), investment sharing (Cannella et al., 2015), buy- back policy (Chen, 2011), two-way coordination (Gao, 2015), revenue sharing clause (Heese, & Kemahlioglu-Ziya, 2016) and VMI (Yu et al, 2002). In capability and trust constrained situations, similar incentives could be offered to retailers for the use of SMA.

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On the other hand, if the manufacturer is the stronger player between the two, they may instruct the retailer to use SMA.

The implications, as mentioned above, are more relevant for improving the performance of supply chains where information is not shared despite the willingness of both parties to do so. However, it is also important to discuss the implications of the strategy of using SMA in supply chains where at least one partner is not willing to engage in formal information sharing practices due to lack of trust, commitment and confidentiality. An important implication for managers for such supply chains is how the initial collaboration on using a certain forecasting method may result in enhancing trust in the supply chain partners. One of the contributions of the paper is that the scope of the solution presented is not limited to situation where willingness to share information already exists, but also to situations where the parties involved do not trust each other.

Trust building is a continuous process and requires constant commitment from the parties towards the relationship (Revilla, & Knoppen, 2015; Xu et al., 2015). Amaral and Tsay (2009) report that supply chain partners will not participate in any collaborative initiative if they do not trust their partner, irrespective of the anticipated financial gains. This is because the two parties are highly conscious of the risk and vulnerability of trusting each other and this level of perceived risk acts as a threshold barrier for trust building (Mayer, Davis, & Schoolman, 1995). Forecast information sharing requires sharing the demand forecasts with the upstream link. The high risk of giving access to forecasts to the other party may prove to be a deterrent to initialise collaborations. However, if the discussions are restricted to sharing the type of forecasting method used, the probability of an initial collaboration is higher. As the relationship then further develops, the supply chain partners can better estimate the actions of the other parties and this may result in a growth of trust to higher levels. Ba (2001) argues that interacting with each other in different contexts and building upon past experience may cultivate trust from a low to high level e.g. from cognitive trust to bonding trust (Slack, & Lewis, 2010). As pointed out by Laeequddin et al. (2009) “supply chain members should strive to reduce the partnership risk levels to build trust rather than striving to build trust to reduce the risk.

”If supply chains adopt our recommendations the cost savings would initially be limited to SKUs where SMA may be used. How- ever, the benefits are expected to extend to other SKUs as well as the trust starts to build up and both parties engage in a more extensive demand information sharing process.

Before we close this paper, we would like to discuss some potential limitations and suggest an agenda for further research in this area. Firstly, the mathematical analysis of the paper is limited to an AR (1) process. Although we have checked and confirmed the consistency of our findings for MA (1) and ARMA (1, 1) processes, our mathematical analysis could be extended to a more general ARMA (p , q) model. Secondly, the empirical analysis conducted in our study was based on data from a major European superstore. Further empirical analysis should be conducted on empirical data from other industries. Finally, in this paper we recommend the use of SMA as this is the only forecasting method known to date to facilitate demand inference. An interesting avenue for further re- search would be to explore the possibility of DDI through other forecasting methods.

3. CONCLUSION

Subcontracting on construction projects is a common and well-established practice. Contractors enlist the services of subcontractors to achieve certain objectives, including obtaining cost reductions, securing access to specialized services, and risk sharing. Nonetheless, subcontracting on a project can introduce certain associated problems that can affect construction management and construction quality. This research explored exclusively the subcontracting practices in the construction industry of Pakistan, identified the main problem areas, examined the overall satisfaction with the quality of service provided by subcontractors, and focused on ways to improve the quality of construction affected by subcontracting. A questionnaire survey was conducted to investigate the extent and involvement of construction firms in subcontracting, reasons for subcontracting, and the selection criteria of subcontractors.

Additionally, interviews were conducted with researchers, professionals, and experts in the industry. The results reveal the widespread use of subcontracting and sub-subcontracting in the construction industry, primarily done to save time and money. Results show that the substandard quality of work of subcontractors is the main problem area. Conversely, the use of direct labour was found to be an unprofitable proposition because of the high degree of uncertainty, fluctuations in construction workload, and higher administrative overhead costs.

Results show that 53% of the respondents are satisfied with their current subcontracting experiences, whereas 47% of the respondents want positive changes to be made in subcontracting arrangements. To rectify flaws in the existing subcontracting system, the following remedies were noted: (1) reduce the number of layers or tiers of subcontracting to effectively manage the communication gap between prime contractor and subcontractor; (2) establish mandatory subcontractor registration, prequalification, and performance evaluations; (3) adopt a standardized form of contract between contractors and subcontractors; and (4) develop the infrastructure for the technical training of subcontractors to improve construction quality. Further insights and discussion are presented in the paper. The findings of this research will help subcontractors to improve their performance and assist stakeholders in the successful execution of a quality project through the judicious employment of subcontractors.

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