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Impact of Fragmentation Issue in Construction Industry: An Overview

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Abstract. In general, fragmentation within the construction industry arises from two areas within the traditional construction process; the construction work process where the most significant division is in the separation of the design and construction phase, and the construction structure itself. The fragmentation process in traditional contracting practice further hinders the integration of construction knowledge among contractors, diminishing the opportunity for them to influence design decisions. When design professionals fail to consider as to how a contractor would construct the designed project results in scheduling problems, delays, and disputes during the construction process. Moving towards team integration is considered a significant strategy for overcoming the issue. Accordingly, this paper discusses the fragmentation issue in more detail including its definition, and causes and effects to the construction projects. It also explores that the team integration strategy alleviates scheduling problems, and helps avoid delays and disputes during the construction process, preventing harm to overall project performance.

1 Introduction

The construction industry is a complex and dynamic industrial sector. The construction industry entails many players at various stages; the construction organisation, primarily, encompassing functions such as planning, design, construction, and maintenance. The stakeholders mainly including client, designer, contractor, and manufacturer are involved from the start till completion of the project.Previous researchers revealed that traditional construction project delivery practice generated many problems associated with fragmentation, such as; isolation of professionals, lack of co-ordination between design and construction, and as it is carried out in a sequential manner. Typically, the separation of the design and construction process in traditional contracting practice (design-bid-build) further hinders the integration of construction knowledge among contractors, diminishing the opportunity for them to influence design decisions [1]. Failure of design professionals to consider how a contractor will construct the design can result in scheduling problems, delays and disputes during the construction process [2]. More importantly however, opportunities to reduce the schedule failings, improve the functionality of the final product, and reduce costs are missed when construction is separated from planning and engineering [3]. Therefore, how to effectively incorporate construction requirements and knowledge at an early stage of the project (design process) is paramount and undoubtedly leads to an overall improvement in project performance [4, 5].

Modern problems of economic security are associated with the emergence of its new challenges and threats [6]. Several researchers consider economic security as a system that reflects basic conditions and factors of economic development in its structure [7, 8]. Many researchers [9, 10, 11] noted that the aim of integration in the construction is to promote a working environment where information is freely exchanged between the different participants. Although this issue is critical and significantly affects the efficiency and effectiveness of project performance; however it still has a limitation of particular research that focuses on this issue.

Even though the construction sector continues to play an essential commercial role in the Malaysian economy, where it lends strength and capability to a host of economic activities, whilst supporting the social development of the country through the provision of basic infrastructure, such as the booming hospitality sector constructions that can be seen from the number of hotel establishments in Malaysia which has increased from 1492 units in 2000 to 2724 units in 2012 [12]. Fragmentation is a formidable barrier to improved return on investment. In addition various influencing economic determinants have presented sizeable challenges to the Malaysian construction industry, especially in the enhancement of productivity on the low and unreliable rate of profitability. Though, the traditional management, key indicators are sales (product profitability) and market share [13]. Companies are conscious and constantly monitoring their 'Liquidity Ratios' as well. It takes a special assessment of the profitability of various customer groups on the basis of accumulated statistics on the relationship with them and the specific conditions of contracting [14]. The main problems of customer directed business are connected, firstly, with the change of understanding of the value of the client (customer) for the company and secondly, with change in understanding the value of marketing to the business itself [15]. Customers are represented as company's assets and studies show that expenses for customer retention have stronger impact on the financial value of the company than the actual financial instruments (such as the cost of capital) [16]. Since value of customers for the company, can greatly differ among different groups, specifically the definition of a combination of loyalty and customer profitability for the company in the long run allows you to mark out the so-called golden customers; and vice versa – to identify such customers, to maximize the satisfaction of who is not necessary because their yield is low for the company [17]. Furthermore the construction industry has become very complicated given the political and business trends that are exerting additional economic pressure [18]. Accordingly, this paper explores and discusses the issue of fragmentation comprehensively.

2 Methodology

Wisconsin [58] has aptly opined that a thorough literature review is a “critical analysis of a segment of a published body of knowledge through summary, classification, and comparison of prior research studies, reviews of literature, and theoretical articles.” This is precisely what this paper intends to present.

Through the literature review, the definition relating to fragmentation, categories, causes and implication of this issue to the Industrialised Building System (IBS) in the construction industry is examined and highlighted. All the data and information gathered directly from libraries, books, articles and other printed materials searched in the international and national journals, proceeding and bulletin. This literature review is very important and helpful in the process of developing for the theoretical sections of the actual research.

3 Discussions: Fragmentation Issue

*Definition and Clarification of Fragmentation***:** The term fragmentation can be defined in terms of the number of firms/ specialists involved in construction projects, and in terms of its effects on the multiple processes in construction projects. In the context of the construction industry, [19] defined

fragmentation as: "the division resulting from the increasing number of both professions (i.e. architect, engineer) and organizations involved in all processes of a building project. This has been caused by the growing demand for differentiation and specialization as building projects increase in both size and complexity." There are two main forms of fragmentation in the construction industry; internal fragmentation and external fragmentation [19]. Internal fragmentation refers to the problem of integration and coordination between different alliance organizations (e.g. client, consultant) while external fragmentation refers to the involvement of non-alliance organization (e.g. local authority) at different stages of the design process. The following section will discuss the cause factors of fragmentation in greater detail.

The Impact of Fragmentation Issue - Separation of Design and Construction: Fundamentally, fragmentation is inherent in the traditional contract strategy (procurement) that is characterized by a lack of a sense of identity, promoting a confrontational culture and a lack of feedback loops or co-ordination between the design and construction [19, 20, 21, 22, 23, 24, 25]. Furthermore, the traditional design and construction process is conducted in a sequential manner and is constructed of segregated professionals (lack of interaction between contractors and designers) during the design and construction phase. This scenario often results in inefficiencies during the construction phase such as increased project complexity, rework, increasing costs and longer construction duration [26]. This type of approach has resulted in the construction industry being labeled as having a lack of continuity, thus hindering the formation of effective teams which then resulted in inefficiencies in the project delivery process [27, 28, 29, 20, 30, 31]. An example fragmentation practice in the current traditional construction design practice is shown in Figure 1.

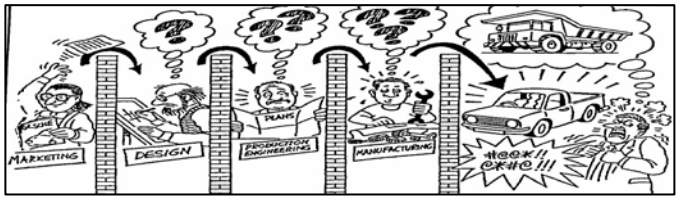

Figure 1: Traditional Design Fragmentation Practice [59]

Furthermore, the sequential nature of construction activities is highly embedded in construction processes and seems to override itself in all new procurement methods e.g. strategic alliances and new methods of team working such as virtual teams [19]. For example, design partners within project alliances are restricted to take part in the design unless they are commissioned by the client.

The Egan Report [22] was highly critical of the sequential nature of construction processes which often acts as an effective barrier to using the skills and knowledge of all project partners effectively in the design and planning of the project. Previous reports [31, 33] argued that input from other experts, such as mechanical and engineering design/construction professionals, as well as facility management expertise was needed during the early stage of a project. In addition, the gap between design and construction processes also contributes to 'major behavioural, cultural and organisational differences between project individuals and groups [28].

For example, the current industry structure has the potential for conflict when participants try to pass on the risk to others within the work [34]. During the design and construction stage for example, it is clearly shown in the diversification of the goals of the designers and builders where "the designer wants a functional design that reflects his philosophy and the builder wants a buildable product within reasonable risk limitations" [35].

In an organisational context, this separation system extends into the various sub construction processes especially affecting relationships in large construction projects [36]. Fragmentation of organisation interface, this happens frequently and is considered to be one of the weaknesses of current procurement processes especially in the traditional method [28]. This fragmentation of organisation interface occurring within the traditional procurement method (design-bid-build) has been revealed as having a tendency towards adversarial relationships [37, 28] and it could be viewed

as one of the 'fragmentation, friction and mistrust' circumstances [38]. This fragmented traditional approach will also create some related problems such as inadequate capture, structuring, prioritization and implementation of client needs; occurrence of late and costly design changes and unnecessary liability claims, occurring as a result of the above; and characterization of the design process with a rigid sequence of activity [11, 26, 39, 42].

Lack of Communication in the Supply Chain: Poor communication has been widely recognized as a major problem faced by the construction industry [40]. As has been observed by many researchers, this problem arises from the fragmented nature of the industry during design and is exacerbated by differences in language or the communicating culture itself [41]. Communication problems arise typically at the contractor-subcontractor-architect design interfaces [43]. The flow of essential information between the relevant parties is very limited. Furthermore, [44] identified that the level of communication between the main contractor and sub-contractors and interaction between the specialists within traditional project delivery procurement is extremely low especially during the design phase. As stated by [45], successful design performance of large multi-disciplinary projects requires substantial co-ordination to ensure that all cross discipline interactions between architects, engineers and quality surveyors are facilitated and all parties are constantly aware of the ever changing state of the project. Due to this limitation, most of the decisions within the supply chain are made on an ad-hoc basis rather than systematically [40].

Ad-hoc based decision making can lead to two problems [46]. First, some of the materials are purchased during construction immediately prior to their being required and this can result in delay or interruption to the schedule. The second problem is dealing with materials procured in large quantities without considering the actual production requirements at site. For example, this practice has much potential for wastage and inventory problem especially when the building component at site cannot be kept and managed adequately. Other than being inefficient in the project delivery process [47], this practice is also considered to be a lack of communication of design intent and rationale for example between designer and builder [26]. Consequently, these problems lead to design inefficiency, unnecessary liability claims, increases in design time and cost variations, and inadequate pre- and post-design specifications which will ultimately affect the project coordination and schedule [48, 49, 26]. In the case of projects that do not meet the owner's expectations because of low quality productivity, the process of redesign by the consultant (designer) will occur, thus delaying the completion of work by the contractor. Lack of appropriate communication or poorly communicated design changes among design team members is a major reason for the failure of many projects that do not meet the set expectations [44,50].

Lack of Client Focus: In general, the management of design and engineering is felt to be problematic in construction projects [19]. This problem could be seen clearly from the separation of design and construction process through traditional contracting practice. Many clients have the wrong justification or misconception of the traditional construction process namely, 'if clients accept design and construction as two separate independent functions, this will raise the quality of the work.' This type of working environment will limit clients to actively get involved in the whole thus prevent from optimising full co-operation and teamwork during the design solution process. This leads to a lack of continuity and ineffective responses to changes in the delivery process [9]. In addition, the traditional design and construction process hinders design and construction knowledge integration besides diminishing the opportunity for professionals or contractors to influence design decisions [1]. It is because each project participant in this traditional practice is a separate entity and, therefore, there is no overall management and coordination in the procurement process [51].

Adversarial Culture: The construction industry is well-known as a complex business, with its very essence based on one-off projects and temporary relationships. As highlighted earlier, the problem of fragmentation not only exists in project relationships, but also in the project process whether conventional (i.e. mortar and brick system) or modern methods of construction (i.e. precast technology, etc) are used [53, 52]. For example, current industry structure has many potential points of conflict where participants attempt to pass on the risk to others. It is clearly present in the diversification of the goals of the designer and builder, where "the designer wants a functional design

that reflects his philosophy and the builder wants a buildable product within reasonable risk limitations" [35].This situation clearly shows 'conflicts, inconsistencies and mismatches' between all of project team members [54] which is possibly due to simple misunderstandings or assumptions mainly caused by the current traditional design and construction practice [55]. Construction industry, in general, is fragmented and uncoordinated [56], riddled with a lack of trust, non-client focused, inefficient and expensive; it has no effective forum where all the constituent parts come together to thrash out issues of the day. The industry needs an effective forum where all stakeholders can come together to discuss the important issues of the day and then communicate with the government and its regulatory bodies. A study in Singapore [57], 'Re-inventing Construction', criticized the performance of the industry and identified fragmentation and segregation of design and construction activities as the main barriers to improved investment and development. In order improve business and market conditions that meet customer demands and expectations, the study identified that the construction industry needs further integration and greater innovation effort [57].

4 Conclusions

Based on the discussion above, it shows that, typically, fragmentation within the construction industry arises from two areas within the traditional construction process; the construction work process where the most significant division is in the separation of the design and construction phase, and the construction structure itself. However, it shows that more studies are required to be focused on fragmentation of the design and construction work process as this best reflects the current demand by the industry. This initiative is also a response to the proposal by Lathan [31] that challenged the construction industry to work towards more collaborative and integrated delivery approaches. It is also supported by the reports Egan [10] by suggesting that process and team integration are key drivers of change necessary for the industry to become more successful. In addition, the recent report by Malaysian Construction Industry Development Board revealed that the integration of design, manufacturing and construction process, especially in the Industrialized Building System (IBS) projects, is extremely important. The report also suggested that by implementing an integrated approach in design and construction process, the fragmentation gaps could be minimized. Therefore, it is recommended that for the future study should focus towards the development of best practice or approach of integrated procurement, concepts, principles etc. in more detail in order for overcoming the issues of fragmentation in effectively.

References

1. Song, L. Mohamed, Y. and AbouRizk, S. M., 2006. Evaluating Contractor's Early Involvement in Design, AACE International Transactions.
2. Arditi, D., Elhassan, A., and Toklu, Y. C., 2002. Constructability analysis in the design firm.J. Constr. Eng. Manage., **128**(2): 117-126.
3. Construction Industry Institute (CII), 1996. The partnering process-Its benefits, implementation and measurement. Publication 102-11, Austin, Tex.
4. Pocock, J. B., Kuennen, S. T., Gambatese, J., and Rauschkolb, J., 2006. Constructability state of practice report Constr. Eng. Manage., **132**(4): 373–383.
5. Khalfan, M. M.A., Anumba, C. J. and Carrillo P. M., 2001. Development of a readiness assessment model for concurrent engineering in construction. Int. Journal, **8**(3): 223-239.
6. Popkova, E.G., Akopova, E.S., Alekhina, Yu. I., Dubova, J. N., Popova, I. A., Avdeeva and I. Yu. Proskurina, 2013. Methodology of Development of Strategy of Development of Economic Systems. World Applied Sciences Journal, **26**(4): 489-493.
7. Kupreschenko, N.P., 2005. Economic security.World Applied Sciences Journal **31** (6): 1033-1038
8. Tumin, V.M., A.G. Koryakov and E.P. Nikiforova, 2013. The Main Factors of Socio-Ecological-Economic Stability and Development of IndustrialEnterprises. World Applied Sciences Journal, **25**(6): 945-949.

9. Baiden, B. K., Price A. D. F., and Dainty A. R. J., 2006. The extent of team integration within construction projects. International Journal of Project Management, **24**(1):13-23.
10. Egan, J., 2002. Accelerating Change, Strategic Forum for Construction, London.
11. Anumba, C.J., Baugh, C., Khalfan, M. M.A., 2002. Organisation Structure to Support Concurrent Engineering to Construction, Industrial Management and Data Systems, 102/5:260-270.
12. Suan, C. L., and Mohd Nasurdin, A., Do Human Resource Management Practices Affect Employees' Service-Oriented Organizational Citizenship Behavior? Evidence from the Malaysian Hotel Industry, World Applied Sciences Journal **31** (2): 253-266, 2014
13. Komarov, S. V., 2014, Management of Enterprise Based on Matrix of Profitability and Customer Loyalty, World Applied Sciences Journal **31** (6): 1033-1038, 2014. ISSN 1818-4952
14. Ferris, P.U., T. Bendl Neil and Philip J. Pfeiffer, 2009. In: Market Indicators: Over 50 indicators those are important to know each manager Balance Business. World Applied Sciences Journal **31** (6): 1033-1038, 2014.
15. Komarov, S.W., 2011. Schlusselprobleme Des Produktinnovationsmarketing, In: Anforderung an Strukturen und Instrumente in der Wirtschaft vor dem Hintergrund Globalisierung: Internationale wissenschaftliche Tagunden 26 und 27.05.2011 in Bernburg-Strenzfeld: Bernburg-Strenzfeld, 2011. S.8. Cited in World Applied Sciences Journal **31** (6): 1033-1038, 2014. ISSN 1818-4952
16. Gupta, S. and D. Lehmann, 2007. "Gold" customers. Are the clients of the money that you spend on them ? / Per. from English. St. Petersburg: Peter, S. 112-113. World Applied Sciences Journal **31** (6): 1033-1038, 2014.
17. Gupta, S., Donald R. Lehmann, 2005. Managing Customers as Investments. The Strategic Value of Customers in the Long Run. N.Y. Pearsom Education Inc., Wharton School Publishing. R. 206. World Applied Sciences Journal **31** (6): 1033-1038, 2014. ISSN 1818-4952
18. Schellekens, P., 2009, "Reposition for Growth", Malaysia Economic Monitor
19. Abadi, M., 2005. Issues and Challenges in Communication within Design Teams in the Construction Industry. PhD Thesis, University of Manchester, UK.
20. Dainty, A. R.J., Briscoe, G.H. and Millett, S.J., 2001. Subcontractor perspectives on supply chain alliances. Construction Management and Economics, **19**(8): 841-848.
21. Rowlinson, S.,1999. A definition of Procurement systems- A guide to Best Practice in Construction, Rowlinson, S., McDermott, P., (eds) -E& FN Spon.
22. Egan, J., 1998. Rethinking construction, report of the construction task force on the scope for improving the quality and efficiency of UK construction industry, Department of the Environment, Transport and the Regions, London.
23. Anumba, CA, Kamara, J. M. and Evbuomwan, N. F. O., 1997. Construction in the UK Petrochemical Industry- Aspects of Concurrent Engineering Practice in Adams T. M (Editor). Proceedings of Fourth Congress Computing in Civil Engineering, June 16-18, Philadelphia, Pennsylvania,114-121.
24. Orr, A.J. and McKenzie, P., 1992. Programme and project management in BT. British Telecommunication Engineering, (January), 10.
25. Russell, Jeffrey S., 1994. Comparative analysis of Three Constructability Approaches. ASCE Journal of Construction Engineering & Management, Vol. **120**. No 1 Mar.
26. Evbuomwan, N.F.O., and Anumba, C.J., 1998. An integrated framework for concurrent life-cycle design and construction, Advances in Engineering Software, Vol. **29**(7-9).
27. Jha, K.N. and Iyer, K.C., 2006. Critical determinants of project coordination, International Journal of Project Management, Publisher Elsevier UK 24(4).
28. Love, P.E.D. Irani, Z. Edwards, D.J., 2004. A seamless supply chain management model for construction, Supply Chain Management: An International Journal, Vol. **9**(1): 43-56.
29. Pardu, W., 1996. Managing change in a project environment, CMI, Volume 6.
30. Gunasekaran, A. and Love, P.E.D., 1998. Concurrent engineering: a multi-disciplinary approach for construction. Logistics Information Management **11**(5):295-300.
31. Latham, M., 1994. Constructing the Team, Final report on joint review of procurement and contractual agreements in the UK construction industry. HMSO, London.

32. Kwakye A, .A., 1997. Fast tracking construction, Occasional Paper, **4**(6), UK CIOB.
33. Nelson, M.L., 2004 The Applicability of the Integrate to Innovate (i2i) model in Supply Chain Management (SCM) in Facilities Management (FM).PhD Thesis, University of Salford, UK.
34. Cox, A. and Townsend, M., 1997. Latham as Half-Way House: A Relational Competence Approach to Better Practice in Construction Procurement. Engineering, Construction and Architectural Management, **4**(2):143-158.
35. Mendelsohn, P., 1998. Teamwork-The Key to Productivity Journal of Management in Engineering, Vol. **14**(l):22-25.
36. Harmon, K. M. J., 2003. Conflicts between Owner and Contractors: Proposed Intervention Process. Journal of Management in Engineering, **19** (3): 121-125.
37. Nawi, M.N.M., Lee, A. and Nor, K.M., 2011. Barriers to the implementation of Industrialiased Building System (IBS) in Malaysia. The Built and Human Environment Review: online journal, Volume 4, University of Salford, United Kingdom.
38. Newcombe, R., 1997. Procurement Paths – a Cultural/ Political Perspective. In Procurement – A Key to Innovation, 523-534. Canada: CIB Proceeding.
39. Clarke, A., 1999. A practical use of key success factors to improve the effectiveness of project management. International Journal of Project Management, **17**(3):139-145.
40. Mohamad, I. M., 1999. The Application of Concurrent Engineering Philosophy to the Construction Industry. Thesis PhD, Loughborough University.
41. Ngowi, A. B., 2000. Construction procurement based on concurrent engineering.Logistics Information Management, vol. **13**(6): 361-368.
42. Kong, A.T. and Gray, J., 2006. Problems with Traditional Procurement in the Malaysian Construction Industry – A Survey, In Runeson, Goran and Best, Rick, Eds. Proceedings Australasian Universities Building Educators Association Annual Conference, pp. 1-21, University of Technology, Sydney.
43. Muya, M., Price, A.D.F., and Thorpe, A., 1999. Contractor's supplier management, In Bowen, P. and Kindle, R., eds. Proceedings of CIB W55165 Joint Triennial Symposium, Customer Satisfaction: A Focus for Research and Practice in Construction. 5-10 September, Cape Town.
44. Konchar M. and Sanvido, V., 1998. Comparisions of US. Project Delivery Systems. Journal of Construction Engineering and Management Vol. **124**(6), pp 435-444
45. Newton, A. J., 1995.The planning and management of detailed building design. Ph.D thesis, Department of Civil and Building Engineering, Loughborough University, Loughborough, UK.
46. Agapiou, A., Flanagan, R., Norman, G. and Notman, D., 1998. The changing role of builders merchants in the construction supply chain. Construction Management and Economics, 16:351-361.
47. Luiten, G. T. and Tolman, F. P., 1997. Automating Communication in Civil Engineering Journal of Construction Engineering and Management, Vol. **123**(2):113-120.
48. Chan, D. W. M. and Kumaraswamy, M. M., 1997. A comparative study of causes of time overruns in Hong Kong construction projects, International Journal of ProjectManagement, **15**, (1):55-63.
49. Zaneldin, E., Hegazy, T. and Grierson, D., 2001. Improving Design Coordination for Building Projects, 11: A Collaborative System.Journal of Construction Engineering and Management **127**(4): 330-336.
50. Hartman, F., 2000. Don't park your brain outside, PMI, Newtown Square, Pa.
51. Tenah, K. A., 2001. Cost Engineering, **43**(1): 30-36.
52. Smith, J., O'Keffle, N., Georgiou, J., Love, P.E.D., 2004. procurement of Construction Facilities; A case study of design management within a design and construct organisation.Journal of facilities, Vol. **22**(½):26-34.
53. Nawi, M.N.M., Lee, A., Kamar, K.A.M.; and Hamid, Z.A., 2012. Critical Success Factors for Improving Team Integration in IBS Construction Projects: The Malaysian Case. Malaysia Construction Research Journal (MCRJ), **10**(1), 44-62.

54. Hegazy, T., Zaneldin, E., and Grierson, D., 2001. Improving Design Coordination for Building Projects, I: Information Model. Journal of Construction Engineering and Management **127**(4), July/ August, pp. 322-329.
55. Gardiner, P. D. and Simmons, J. E. L., 1998. Conflict in Small and Medium-Sized Projects: Case of Partnering to the Rescue. Journal of Management in Engineering, **14**(1): 35-40.
56. Alashwal, M. A., Abdul Rahman, H., & Abdul Mutalib Beksin, A. M., 2011. Knowledge sharing in a fragmented construction industry: On the hindsight, Scientific Research and Essays, Vol. **6**(7), pp. 1530–1536.
57. Dulaimia, M. F., Linga, F. Y. Y., Oforia, G., & De Silvaa, N., 2006. Enhancing integration and innovation in construction, Building Research & Information Volume **30**, Issue 4, pp. 237-247,
58. Wisconsin, 2008. 'Literature Review', Writing Studio, Duke University
59. Nawi, M. N. M., Lee, A., Azman, M.N.A., and Kamar, K.A.M., 2014. Fragmentation Issue in Malaysian Industrialised Building System (IBS) Projects. Journal of Engineering Science & Technology (JESTEC), Vol. **9**(1), 97-106.