Supply Chain Model in Digital for Construction Management in Higher Education Institute

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***Abstract*— The research aim to develop and to evaluate the supply chain model in digital for construction management in higher education institute. The sample groups were five experts in supply , five experts in Information and technology and five experts in construction engineering. The research sample totalling fifteen experts. The research tool was questionnaire supply chain model in digital for construction management in higher education institute comprises six main components, Many suppliers, manufacturer, distributors, retailers, customer. The data analyzed by using arithmetic mean and standard deviation. The assessment of supply chain model in digital for construction management in higher education institute. The results showed that the model was validated at a "high" level, suggesting that supply chain model in digital for construction management in higher education institute could be used to develop digital.**

Keywords— *supply chain model in digitak,construction management in higher education institute*

1. Introduction

Managing the supply chain involves understanding the breakdown and traceability of products and services, organisations, logistics, people, activities, information and resources that transform raw materials into a finished product that is fit for its purpose. Buildings are becoming increasingly complex, and require more design input by specialist suppliers. At the same time there is increasing fragmentation of the industry as can be seen from the growth of specialist suppliers/contractors, the proliferation of products and the fragmentation of design and control activities. The supply chain is relatively unstable, and the industry is project-based with defined start and end points, and a traditional separation between design and construction. Demand is treated as a series of competitively tendered prototypes constructed by temporary coalitions. This all has an impact on organisational relationships. Project relationships are short term and have defined start and end points, they are usually informal/ad-hoc and focused on the project not the business. Relationships between competencies vary from project to project. The resulting lack of continuity prevents the innovation and improvement of process as well as the development of more complex relationships. The client may also have an impact on the procurement route and choice of strategic suppliers. On large or complex projects, responsibility and performance generally cascades down the supply chain to a plethora of suppliers sometimes unknown at the top of the chain. The first and second tier of the supply chain may sign up to fairly onerous agreements but as the chain develops, so the contractual liabilities decrease until suppliers at the end of the chain are often not locked in at all. Changing the perspective from delivery of a 'project' to the process of 'project delivery' requires the building of long-term relationships (formal and informal), partnering, and alliancing. The agency offering continuity in construction have taken an increasing interest in establishing relationships beyond direct, first tier suppliers. Framework contracts and partnering agreements have pioneered this approach, encouraging the involvement of selected suppliers at relatively early stages of projects while offering continuity of work. This has led to greater collaboration between lead designers and product designers to the advantage of all parties. The Government Construction Strategy, recommended three different procurement routes that aimed to improve the supply chain management process; private finance initiative (PFI), prime contracting and design and build. With each of these, the client enters into a relationship with a single integrated supply team, which may include the main contractor, designers, sub-contractors, suppliers, facilities managers.[9]

Management of materials and information flows are key strategic priorities for construction University. A good performance in these areas can provide them with significant benefits and allow the adding of greater value for clients. Supply Chain and digital can be a very useful approach for construction University on the regard. This is especially attractive if we consider that the construction activity is a process characterized by high levels of fragmentation and where the effective integration, coordination and management of supply chain and digital, from suppliers to final clients, is a necessary condition to obtain good results. [13] It enables the organization to promptly check digital

system to ensure that the organization operates smoothly and effectively based on the determined strategies. [3],[4] The research articles presents the main results of supply chain model in digital for construction management in higher education institute for application to increase values of enterprises and educational institutions and increase satisfaction of consumers.

2. Literature Review

Gazette.(1979.) said that Building control Act,B.E. 1979 about Building means a town house, house, home, hall, shop, raft, warehouse, office and other construction which people may live or utilize, and shall also include: (1) a grandstand, or other construction for public assembly; (2) a dam, bridge, tunnel, waterway or drain, dockyard, waterside pavilion, pier, fence, wall or gate built next to or near public place or construction for general public use; (3) a signboard or the construction for fixing or holding signboard: (a) on or standing on a public land with more than one square meter size, or weigh, including its structure, of exceeding ten kilogram; (b) on or standing near public land, which horizontal distance from public land is less than the height of such signboard measuring from ground level, and with the size or weight exceeding those prescribed in the Ministerial Regulation; (4) an area or construction for used as car parking space, car reversing space, and car entrance and exit for the building prescribed under section 8 (9); (5) other construction prescribed in the Ministerial Regulation.

Provided that the parts of those buildings shall also be included therein. “High building”4 means the building where people may live in or use with more than twenty three meters high measuring from building surface level to rooftop; as regard the gable roof or hip roof building the height shall be measured from building surface level to the topmost ceiling; “Edifice”5 means the building constructed for use of the whole or any part of floor areas for residing, or operating one or more categories of activities, having the whole space area of every ground floor of the same building of more than ten thousand square meters; “Public assembly building”6 means a building or any part of the building where people may enter for assembly, having space area of ten thousand square meters or more, or may assemble more than five hundred people; “Entertainment hall”7 means a building or any part of the building for use as a cinema, theatre, music hall, or other entertainment, having the objective of regularly opening for public participation, notwithstanding for reward or not; “Public land” means the space opening for or allowing people to enter or pass, notwithstanding for reward or not; “Layout plan” means a map showing the nature, situation, and boundary of the land and building constructed, modified, demolished, moved, used or changed the use, as well as sketching the nature, situation, and boundary of the public land and building in the vicinity; “Drawing plan” means a drawing for the purpose of construction, modification, demolition, move, use, or change of use, having picture showing the important details, size, signs, materials, and various usages of a building which is clearly enough for operation.

Specification means the statement of detailed description concerning quality, and kind of materials, as well as method and procedure for construction, modification, removal, move, use, or change of use of the building in accordance with the drawing plan; “Calculation sheet” means a sheet showing method of calculation on strength of material, loading weight, and resistance weight of various parts of the building; “Construct” means construction of a new building, even though it is constructed in place of the former one; “Modify” means to change, extend, add, reduce, or expand the nature, boundary, form, shape, proportion, weight, space area of the structure of building or various part of the building already constructed to be different from the former nature, and it is not the reparation or modification prescribed in the Ministerial Regulation; “Repair” means to renovate or change various part of the building to be maintained in the former nature; “Demolish” means to remove the structure part or the building such as the pillar, beam, joist, or other part of the building prescribed in the Ministerial Regulation; “Conflagration area” means the boundary suffering conflagration of thirty or more buildings or within the area of one thousand and six hundred square meters or more, including the vicinity area within the boundary of thirty meters around the conflagration area; “Superintendent” means the person responsible for the direction or supervision of construction, modification, removal, move of building; “Operator” means the owner or occupier of the building who operates the construction, modification, removal, move of building by himself or herself, and includes the person who agrees to operate such act, no matter with or without reward, and a subcontractor; “Building occupier”8 includes the manager of the condominium juristic person in respect of the common property under the law on condominium.

Examiner 9 means the licensee for professional engineer or licensee for professional architect under such respective law, as the case may be, which has been registered under this Act; “Inspector” means the person appointed by the local competent official as an inspector; “Technician”10 means an official or local government employee appointed by the local competent official as a technician, or an engineer or architect appointed by the Director-General of the Public Works and Town Planning Department as a technician; “Local government

administration" means a municipal, sanitary district, provincial administrative organization, Bangkok Metropolitan Administration, Pattaya City, and other local government organization prescribed by the Minister as local government administration under this Act; "Bylaw" means a regulation issued by local legislative power of a local administrative organization, such as municipal law, sanitary regulation, Changwat bylaw, Bangkok Metropolitan bylaw, or Pattaya bylaw, etc.

'Supply' is the flow of resources used to satisfy a demand, such as materials, labour, information, skills, and so on. It can also refer to competencies, and represent combinations of resources. Commodity suppliers tend to be more price focused, whilst strategic suppliers are more quality/delivery focused.

'Chains' represents the notion of links within and between both resources and competencies. They are based upon relationships between people and organisations, and processes within and between organisations.

'Management' is the exercise of formal authority within a structured organisational setting that is directed towards aims and objectives through the efforts of other people using systems and procedures.

Supply chain management requires a holistic perspective and a view of organisations as parts of a process. It requires the ability to look beyond organisational boundaries, and a recognition of the interdependence of organisations **[**9]

Construction supply chains can be very complex particularly in large projects. This complexity, one of the main characteristics, can be attributed to the variety of site materials and parties (suppliers and sub-contractors) required for a construction project. The project can become more complex as more people get involved. i.e. first tier, second tier suppliers and other tiers of sub-contractors etc. Moreover, there is a correlation between the increase of the scope of the project and the complexity of the supply chain as more manpower, parties and materials are necessary for the completion of the project. This requires a great deal of planning, organising and collaboration between supply chain partners which may cause the complexity. A large construction company may interact with hundreds or thousands of suppliers and sub-contractors per a year in order to deliver a project. For example, in 1999 the Wates Construction Company paid more than 3000 suppliers and sub-contractors that were involved in projects they delivered [14]

Vrijhoef carried out research on residential building and contributed that Construction supply chains are normally converging, make to order, fragmented and temporary, as described below: 1. Converging supply chain. Normally in construction projects, operation capacity, documents, materials and so on, are to be assembled and delivered to site by subcontractors and suppliers under supervision of the main contractor. Usually, the end user is one or a limited number of people. As a consequence, the Construction supply chains is converging in nature unlike the manufacturing supply chain, which is most likely to be diverging. 2. Make to order supply chain. Clients drive the creation of construction projects. This can be the result of the end user's tradition to take the initiative and start a construction project. Therefore, end user becomes involved in the whole production process. 3. Fragmented supply chain. This characteristic is the main feature within this industry. Construction contractors, suppliers and other participants are active in different stages, and the distribution of responsibility and authority changes during the project.. 4. Temporary supply chain. For any construction project, on completion, all participants and companies involved are normally dismissed and this can be traced to the project based nature of construction. Consequently, all participants in the project must finish their roles and duties. This short-term partnership with different members may cause problems and fluctuations in performance and productivity[14]

Muya et al. pointed out other Construction supply chains features as follows: 1. The primary supply chain. This delivers the materials that are incorporated in the final stage of the construction process, such as: sub-assemblies, components, raw materials and electrical and mechanical equipment. 2. The support chain. This chain is responsible for providing expertise and equipment that smooth and facilitate the construction process such as: scaffolding and excavation supports. 3. The human resource supply chain. This is responsible for the supply of supervisory staff and labour as inputs to the construction process. Given the uniqueness of the construction industry characteristics this differentiates the Construction supply chains from other industries, such as manufacturing. To sum up, the Construction supply chains consists of the human resource supply chain, the support chain and the primary chain, and is characterised as temporary, make to order, complex and converging supply chains. Below are further discussions regarding the complexity of supply chains and the problems associated during the construction process.

Al-Werikat, G said that supply chain management In construction; revealed. The construction supply chain plays a major role in the construction market competition. Construction supply chain management assists enterprises by helping to improve competitiveness, increase profits and have more control over the different factors and variables within the project. supply chain management provides the construction industry

with opportunities to have more control on projects, increase profits, and reduce time, cost and waste. The Construction supply chains consists of many groups, although the material and the construction chains are the largest. Integrating the construction and material chains helps in establishing more collaboration, smoother information flow and more efficient information sharing through the construction chain which assists the decision making process. supply chain management in the construction industry encounters many challenges linked to poor logistics planning, lack of partnerships and strategic alliances with suppliers, resistance to change and
communication problems. In order to establish an efficient integrated supply chain, clients, suppliers, contractors and other parties in the supply chain need to establish long term partnerships, form transparent communication channels and benefit from each other‘s experience for the greater good. The Jordanian industry should make corrective actions to allow the efficient supply chain integration to take place such as: early involvement of all parties, education of project staff, fair payment, have knowledge of the benefits of integration, be familiar with and have an understanding of new contractual documents. Should all parties within the supply chain be targeted, including the main contractor, subcontractor and suppliers, overall costs of construction would reduce. In addition, early involvement of the subcontractor and supplier is as necessary as early contractor involvement. This early involvement of all parties would allow the exchange of expertise which may help to reduce costs furthermore, early involvement integration would enable suppliers to be service providers as oppose to providers of products.

Meriam Cherian,& Joe Arun（202）said that Digital Transformation in Supply Chain Management: A conceptual framework for construction industry. Digital technology is a powerful tool for storing, analyzing, and integrating data. Despite the construction industry contributes significantly to the economic growth of India, the industry has struggled to make effective use of tools and technology due to low productivity, lack of data, inefficient payment systems, and poor regulations. As a result, successful technology adoption leads to digital transformation in the construction sector. The sector is in an infant stage of technology adoption. Hence, the paper aims to investigate the use digital technology as an enabler to revolutionize the construction supply chain, and to identify the advanced technologies that are used in construction supply chain management. The paper also investigates the factors responsible for adoption of digital supply chain management in the construction industry using Technology, Organization and Environment theory. An in-depth interview is conducted among construction professionals to determine the adoption factors. The identified factors such as digital transformation enabler, digital infrastructure, digital expertise, Supply Chain integration, company size, security, and regulatory problems are modulated as a conceptual framework. With this study, the construction professionals and suppliers will benefit and able to get more knowledge on the adoption of digital technology in construction supply chain management. however, to implement digital supply chain management in the construction business, experts require proper coordination and training

Digital system in supply chain management for construction management help in better integration, collaboration, and communication with the stakeholders. Also, digital system in supply chain management helps in global transactions and partnership. The study addresses the factors influencing the adoption of digital system in supply chain management for construction industry, As a result, it boosts productivity by decreasing time, expenses.

3 Research Methodology

This research has 6 part

Part 1 To analyse and synthesize related documents and research to the components of supply chain model in digital for construction management in higher education institute.

Part 2 Defind research framework of supply chain model in digital for construction management in higher education institute setting.

Part 3 To design supply chain model in digital for construction management in higher education institute using data collected from studies and analysis of relevant documents.

Part 4 To propose the models to consultants for further examination and revision.

Part 5 Create a questionnaire for assessing the appropriateness of supply chain model in digital for construction management in higher education institute.

Part 6 Data collection and develop questionnaire are sent to the experts in order to ask their opinions on appropriateness of supply chain model in digital for construction management in higher education institute and analyse the data based on evaluation criteria and suitability criteria of the model.

4 Results

4.1 Research results about supply chain model in digital for construction management in higher education institute, as shown in fig 1.

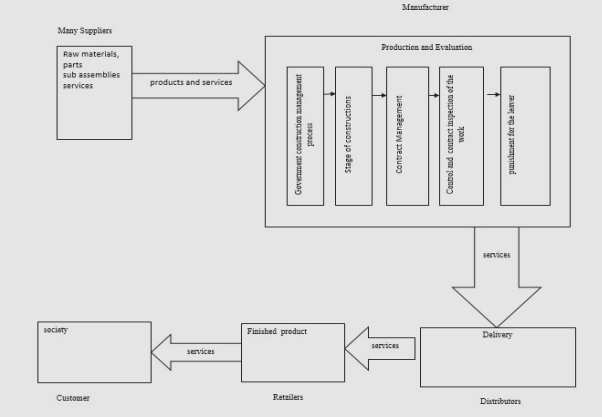

Fig. 1. Supply chain model in digital for construction management in higher education institute.

4.2 Principles of supply chain model in digital for construction management in higher education institute.

1 Many suppliers

Many suppliers mean trading inputs from vendors and multiple contractors namely Raw materials, parts, sub-assemblies and services.

2. Manufacturers

Manufacturer mean the main contractor who will be the main production business support unit for higher education institutions. The main contractor will be responsible for construction management and The Evaluation Committee will follow up to ensure compliance with the employer's agreement in each activity namely, Government construction management process, Stage of construction, contract management, Control and contract inspection of the work and punishment for the leaver.The final result is the prefabricated building for the society.

3 Distributors

Distributors mean prefabricated building delivery.

4. Retajlers

Retajlers mean prefabricated building for consumers.

5. Customer

The customer mean society who receive finished product or prefabricated building Finally, the finished product will provide added value to the supply chain.[2],[3],[4],[5],[6],[7] and [11]

4.3 Results on Evaluation of supply chain model in digital for construction management in higher education institute.

Table 1: Appropriateness of main components of supply chain model in digital for construction management in higher education institute.

ITems	$\overline{X}$	S.D.	Suitability
Many suppliers	3.3.66	0.61	High
Manufacturers	3.73	0.70	High
Distributors	3.66	0.89	High
Retailers	3.73	0.70	High
Customer	3.66	0.61	High
Total	3.69	0.70	High

From Table 1, it can be seen that all of the main components of supply chain model in digital for construction management in higher education institute are rated to be appropriate at the high level. The total rating mean is 3.69, which is also at the high level.

Table 2: Appropriateness of Sub-components of the Suppliers

ITems	$\overline{X}$	S.D.	Suitability
Raw materials	3.66	0.48	High
Parts	3.66	0.72	High
Sub-assemblies	3.73	0.96	High
Service	3.73	0.70	High
Total	3.70	0.71	High

From Table 2, it can be seen that suppliers component are rated to be appropriate at the high level. The total rating mean is3.70, which is also at the high level.

Table 3: Appropriateness of Sub-components of Manufacturers

ITems	$\overline{X}$	S.D.	Suitability
Government construction management process	3.73	0.70	High
Stage of construction	3.73	0.70	High
contract management	3.66	0.72	High
Control and contract inspection of the work	3.66	0.72	High
punishment for the leaver	3.66	0.72	High
Total	3.69	0.71	High

From Table 3, it can be seen that the sub-component in terms of Manufacturers implementation and evaluation process of is rated to be appropriate at the high level, with the rating mean of 3.69.

Table 4: Appropriateness of Sub-components of the distributors

ITems	$\overline{X}$	S.D.	Suitability
Delivery	3.66	0.61	High
Total	3.66	0.61	High

From Table 4, it can be seen that distributors component are rated to be appropriate at the high level. The total rating mean is 3.66, which is also at the high level.

Table 5: Appropriateness of Sub-components of the Finished product

ITems	$\overline{X}$	S.D.	Suitability
Finished product	3.73	0.45	High
Total	3.73	0.45	High

From Table 5, it can be seen that finished product component are rated to be appropriate at the high level. The total rating mean is 3.73, which is also at the high level.

Table 6: Appropriateness of Sub-components of the society

ITems	$\overline{X}$	S.D.	Suitability
society	3.66	0.61	High
Total	3.66	0.61	High

From Table 6, it can be seen that society component are rated to be appropriate at the high level. The total rating mean is 3.66, which is also at the high level.

Table 6: Results of appropriateness evaluation of supply chain model in digital for construction management in higher education institute.

ITems	$\overline{X}$	S.D.	Suitability
Main components	3.69	0.70	High
Many suppliers	3.70	0.71	High
Manufacturers	3.69	0.71	High
Distributors	3.66	0.61	High
Retajlers	3.73	0.45	High
Customer	3.66	0.61	High
Total	3.68	0.63	High

From table 6 ,show that the fifteen experts agree the model on the list show the overall rating mean of 3.68 and standard deviation of 0.63, which means that supply chain model in digital for construction management in higher education institute. is appropriate at the high level.

5 Conclusion

From evaluation by fifteen experts, supply chain model in digital for construction management in higher education institute is considered to be high appropriate suggesting that supply chain model in digital for construction management in higher education institute could be used to develop digital.

6 Discussion

From evaluation by fifteen experts, supply chain model in digital for construction management in higher education institute is considered to be high appropriate and the design was relevant to Chansamut has studied supply chain and information system about educational ,[4],[5],[6],[7] In addition, with the study of Kaewngam, Chatwattans and Piriyasurawong and research of Chansamut recommended that supply chain and digital too.[3],[11]

7 Recommendations

Supply chain model in digital for construction management in higher education institute comprises six main components, Many suppliers, manufacturer, distributors, retailers, customer is highly appropriate Therefore, if possible it should be implemented in higher education institute.

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