An Innovative of Simul Model for Ready-Mix Concretes in the Concept of Third-Party Logistics and Supply Chain Management in Malaysia and Thailand

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***Abstract*— The research discusses on issues in an order fulfilment for sustainable ready-mix concrete as desired for an eco-friendly choice of integration in the concept of third-party logistics and supply chain management. There are insufficient and inappropriate means in concrete industry which has contributed to un-environmentally friendly especially in Malaysia and Thailand. The supply management and logistics are the factors in designing of product which influence on the environmental, safety and health. It also involves on costs of energy, effectiveness, economic certainty, businesses and other related issues. Through the current practices with relevant factors, the analysis of model is no longer realistic. The sustainable of simulation in logistics model should relate to descriptive approaches. Through the less numbers of movements and reduction on carbon dioxide are significant for the simulation. In some developing countries, the involvements of commercial players and government bodies have their responsibility in controlling, simulating economic and business development. Relation to this fundamental deficiency, this paper utilized SIMUL model in the logistics for sustainable ready mixed concrete, eco-friendly and to meet on the order fulfilments. The result clearly indicates that the eco-friendly SIMUL model can be more sustainable, cost efficient and time effective in fulfilling orders for the operational of ready-mix concrete in future.**

Keywords*—SIMUL model, Sustainable ready-mix concrete, eco–friendly, sustainable Logistics and Supply chain management, Order fulfilment*

1. Introduction

Ready Mixed Concrete (RMC) is a construction material which prepared and delivered comprehensively in ready to use. It was prepared through the combination of a mix with aggregates such as gravel, sand, mix Portland cement or crushed stone. Through the latest technology the RMC is more advanced as compared to site mixed concrete. Benefit of RMC such as quality, speed, lifecycle, costs, environmentally friendly. The advantages as compared with site ready mixed processes are quality, speed, no storage, low labor, leans, life cycle, cost saving and eco-friendly. Concrete ready-mix is a perishable items and essential material in the construction industry with a usable time of less than 2 hours. Through limited usable times, the essential commodity is required to be batched out with specifications through an appropriate timing in delivery. The majority of the ready-mix concrete orders are necessary with the timing and staggered operation of several trucks. The most important and significant issue is the control the contractors' desires in terms of on-time site delivery of concrete products. The supplies of ready-mix concrete should be resourceful with the materials through economical values and justify with the distance between the site location and the plants. Ready-mix concrete is a type of batch process with appropriate specifications as suggested by the customers from the sites. Similar studies conducted on the ready-mix concrete in several cities and must be batched with appropriate processes. Upon ordering the scheduling had been made and through the processes are similar in contact of third-party logistics as practiced in transportation industry.

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2. Purpose of Study

The purpose of the study is to look into an innovative of new Simul model for ready mix concretes in the concepts of third-party logistics and supply chain management in several construction industries in Malaysia and Thailand. The study was conducted in two cities in Malaysia i.e. Kuala Lumpur and Penang, the Thailand counterparts at Bangkok and Hadyai. Sustainable ready-mix concrete is specifically produced for delivery to construction site through order fulfilment procedures. Ready mix concretes industry is a challenging part in construction, production, logistics and transport businesses. The revealed that the ready-mix concrete operators are actually involved in logistical businesses which practicing on the system of supply chain management concepts. It also involved in planning, organizing, leading and controlling in the whole business activities. Avoid further loses in the whole operations, timing in this business is very essential and well-coordinated. Most of the construction sites were located at the town areas and some involved the delays due to unforeseen circumstances. Transport supervisor form ready-mix operators had been notified on the demand from construction site engineer from the schedule as planned earlier. The preparation on the mixing had been made accordingly.

Considering on traffic delays, various time of transits, modifications, cancellations, variance of orders amount, breakdown of plants, due to mechanical faults and accidents. The ready concrete needs to assess with other available means in the decision of the certain truck for the delivery until completion. Sustainability in third party logistics towards the supply chain management in concrete industry is based on the better technique in managing the environment and other factors related to the delays. The collective advantage of sustainable in supply chain management and logistics are on environmental aspects, reduction on raw materials, waste reduction and high degree of pollution. This study expressed on third party logistics and supply chain management as the system of integration which influencing on its perspective into industry especially on the related problems as mentioned. This also involves product design, selection, material sourcing, processes of manufacturing, end products delivery to final users and life cycle monitoring of products' life span

3. Literature Review

There were few research studies on the production and delivery in ready mixed concrete. The articles are focusing on the challenges and solution methods connected to the delivery of ready mixed concrete which utilised JIT models of purchasing threshold [22]. While the using of special genetic algorithms-based models and a simulation to highlight the option means of dispatch schedule that could minimised the time of waiting of trucks as construction sites [6]. The scope, definition and contents of sustainable supply management varies from sustainable purchasing to the innovated supply chain management that is sustainable moving from manufacturer to supplier to end user and retailers [10,27]. Meanwhile performance [3] created a model to enhance organisation' financial performance whereby the production cost and the delivery of ready-mix concrete is estimated with consideration of cost connected with traffic, distance and late delivery. In another development [12] revealed on the systematic and dynamic routing for different types of vehicles for the distribution of ready-mixed concrete on daily basis of multi-plant with time settings. A tool was development by [5] to back up decision making in connection with concrete delivery and scheduling on the basis time space network with numeral side constraints. Therefore, concrete suppliers have to find out on how the materials able to be distributed based on the geographical areas through plants capacity in meeting the demand [26].

The truck mixer scheduling and management of the logistics of raw material within batches are important to ensure cost and time [23]. Optimization of scheduling of concrete delivery and resources production at a plant with numerous locations and depending on the modelling of validation stimulation, which is usually referred to as HKCONSIM was conducted by [11]. The authors used total operations inefficiency (TOI) as measurement tools for assessing the outputs. [13] Evolved a model to organise production and transportation of JIT at a group of plants that is partially independent to ensure delivery of concrete is timely by means of a meta-heuristic. [25] Observed the Ready-Mix concrete production challenges and came up with the model for production panning and truck scheduling with travel time. A solution for the delivery challenges of ready-mixed concrete with multiple plants was

evolved by [17] and [16]. The authors include multiple construction sites, several types of vehicles which includes different capacities trucks that has unique equipment such as pumps, integration of production scheduling and pumps delivery. The practical experiences were the focus in the research study. The research considers waiting time between different vehicles, continuity of sites construction work, the location of the construction sites, an efficient method to enhance the effectiveness and costs saving techniques. A review of delivery challenges of concrete and its solution was conducted by [8].

[1] Introduced a mixed delivery using liner programming model with main aim of maximizing the sum of the costs of transport and consequences for not fulfilling the order contract. Based on the complexity of the model, it can't be resolved generally, and the authors decided to their own made meta-heuristics algorithm and evaluate its effectiveness. [14] Improved on the supplies' plants with aggregates and cement. The model was modified with continuation dynamic system with simulation and software which is enable the operational changed and was tested in a Singapore's' plant. Simulations by computer were usually utilized in the concrete mix batching through analysis.

[21] Used the Microcyclone network of Petri, while [26] also utilized same model. In the two cases, the models were simulated using several combinations of resources to assess productivity of concrete plant and equipment utilized. Meanwhile [18] made use of simulation to revegetated batching plant operations. The objectives of the research were to enhance the management of the mix production by minimizing activities that do not improve the value of the service, from the perception of customers. Majority of the research articles put forward one-plant-multiple site method and travel times' design that depend on method of determinist. But this paper considers a simul model based on batching schedule.

4. Procedure of Ready Mixed Concreate Transportation

The period for the timely delivery from the point of mixing of concrete to the time of placing should not be longer than the setting time of the concrete in particular condition. For the delivery of concrete mix, there should be a good plan of the vehicle's routes and production schedule in other that when the concrete is fresh and wet, a ready truck for the quick delivery of the concrete is available. This is because breaks and delay may result to wasting of the whole batch of mix. On the other hand, the system of having several trucks on the queuing waiting and idle away is not economical. The concrete mix is a custom- made product whereby each batch is prepared according to specification and order of client. Hence, as the batch is loaded, immediately, the truck must be led to the certain site that the concreate is needed.

The dispatcher has no right or discretion of his own change its direction of destination. Moreover, in some cases, the construction sites to be served by a plant may be jammed or of restricted unloading capabilities and may not be able to receive two or more trucks at particular time. Therefore, to ensure concreting works continuity, the production of the mix and schedule of the deliveries is necessary with utmost care. In the research work conducted by [6] categorized orders of concrete mix in twos parts, which are those place on the day the concrete work is to be done. Daily concrete mix demand is not distributed uniformly. The authors observed that there are usually peak hours between 9:30am and 11:30am and also between 14:30 and 7:30, although Matsatsinis (2004) and Naso et al. (2007) were of the opinion that the demand is higher in clear way between 7:00am and 9:00am and later between the hour of 13:00 and 15:00. In the production process, the peak hour is specially challenging for the plants company that handle the production, dispatch as well as the transport screws. Therefore, it is not only focusing on environmentally friendly but also business value [7] and [24].

5. Methodology

The objective of this article is to identify the fundamental works on sustainability related to supply chain management whereby environmental issues are incorporated into batching of ready-mix concrete with several ready-mix concrete operations. Discrete event simulation models have been recommended whereby all stated variables are modernised at a discrete set of points and with each point referred to as event time devoid of action in-between consistent times of event [26] even though, the arrangement looks like valuable and resourceful to tackle some pressing issues and result to maximise dispatching intervals, there is no actual integration of environmental health factors and responses and the management. Hence, this article engaged case study analysis of the focus of the article. Also, descriptively, the order fulfilment

factor in the perception of supply chain management sustainability. The various information were received during the visits at sites in Kuala Lumpur and Penang at the construction industry to UEM Group Berhad, YTL Corporation Berhad and in the Thailand counterpart at Dpt International Co. Pte Ltd and Areeya Property Public Company Limited .While the mixture companies were visited at Malaysia is Unipati Concrete Sdn Bhd (UPC) in Petaling Jaya and Hanson Malaysia in Penang. While in Thailand Holcim Bangkok and Heidelberg Cement in Hat Yai.

Case Study- Supply chain management of concrete in the Traditional batching system.

Traditional batching process and sustainable supply chain management of concrete in ready-mix plants are served not only through mixing but in ready-mix and transporting to the site location as requested by the customers. It is called a pull method in which practices are involved with mixing, scheduling, coordinating, transporting by professional persons [15]). The concrete is produced and dispatch to the site as ordered to meet the demand. Contrary to that, the concrete products can be produced in order to meeting an order whether is urgent or less and this is based on the needs that had been forecasted. The batching and delivery methods of ready-mix concrete are also known as supply chain management. Figure 1 shows typical example of ready-mix concrete batching by traditional method as practiced by concrete-mix industry at present. Figure 2 shows example of a batch method.

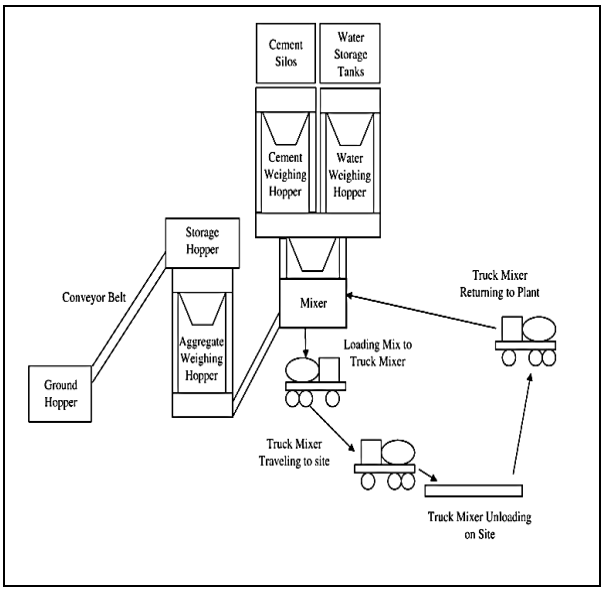

Figure 1 Traditional batching and delivery Method of ready mix concrete (Zayed and Halpin, 2001).

In the traditional method of batching, the concrete production and batching consists labour and plants material deployment, handling raw materials of concrete to the batching plant and the storage of the concrete product at the plant. There are two hoppers, one is ground hopper while the second one is storage hopper, cement silo, weight hopper, water storage and cement silo, mixer and truck mixer in the factory visited. The batching procedures' performance is authorised by the procedure that confirm the weight aggregates and discharge the raw material of the concrete to the mixer. This is based on the aggregates loading and sand from the ground hopper is self-control as the operator basically fills the storage hopper regardless of plant is in operational or not. There was the estimation of time value taken to affirm the aggregates weight to the time of discharging the materials into the mixer and it was 5.31 minutes and 8.22 minutes respectively.

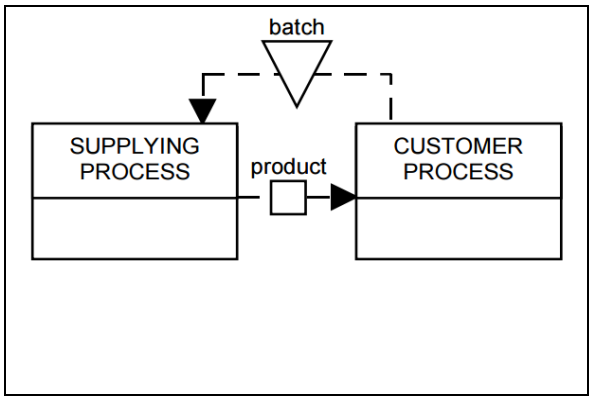

Figure 2 The traditional batching process of ready mix concrete (Tommelein and Li, 1999).

In same manner, the performance of the truck mixer was experimented, even though, the truck mixers performance differs, and it relies on the methods of concrete placement that is used on construction site.

Table 1; Average time of travelling by a truck mixer from batching plant to site (Park et al., 2011)

Type of unloading	Number of deliveries (truck)	Avg truck mixer dispatching interval	Avg time to position	Avg time to load mix	Avg time for slump test	Avg time to haul	Avg queuing time on-site	Avg time to unload	Avg time to return	Avg time taken for delivery
Crane and Skip	39	18.30	1.58	1.27	3.01	23.04	29.94	20.05	24.92	103.81
Wheel barrow	12	20.7	0.79	0.63	1.50	21.50	22.77	25.90	20.50	93.59
Tremie pour	16	6.30	1.84	1.55	2.95	22.31	12.01	9.50	24.44	74.60
Pump pour	9	8.10	2.11	1.04	2.76	21.33	16.96	13.85	21.67	79.72
Direct pour	24	7.50	1.50	1.33	3.07	22.21	12.06	9.24	24.67	74.08
All types[a]	100	13.15	1.55	1.23	2.81	22.38	20.76	15.91	23.96	88.60

Figure 3 Data loading process of Simul model

The time of loading for a driver of truck mixer is an average of 1.20 minutes. When the truck driver uses an average time of 1.50 minutes for position

and readjusting of the truck for loading, it takes an average of 2.75 minutes for concrete batching to be tested for workability standard by conducting slump test. This testing is important to guarantee quality and standard ready-mix concrete. A good example of average time for travelling between construction site and concrete batching plant and it is shown in Table 1.

Based on this structure, each loading details and schedule loading time are apportioned to the plants consequently. It shows the queuing scheduled time of loading, the queued time in minutes by the plant and the loading time in progress. But in a case where the loading plant is free, the truck is making available at the plant and the minute of the simulation is equal or higher than the loading minute. There is a change in the minutes of loading stock, therefore, at the same times, the truck is taking to the location of the loading. All the characteristics of all delivery that consists of the time scheduling of loading, transit time and the truck cubic meter capacity should move through the model in a concurrent mode. Considering cycle time calculation, the truck time of average cycle is calculated from the time in minute that the truck begins loading the product by the time the truck return to the plant.
A good example is by using a simulated 440 minutes time cycle in the model.
The truck journey from the plant to site = 30 minutes
The unloading time at the dispatched site= 15 minutes
The journey of the truck back to the plant=30 minutes
The overall journey of the ready-mix concrete delivery= 515 minutes.
This indicates that this type of load is 75 minutes for estimated cycle.

6. Analysis and Discussion

Using this Simul model, the placing of the ready-mixed concrete through sustainable supply chain management delivery system and if place side by side with that of traditional ready-mix concrete, it could be that there are many factors that made it more desirable
Time Cost factor **-**There is more to desire in the timely characteristics of the Simul model delivery in comparison with traditional system. Likewise, there are at least a noteworthy time saving in the total time of delivery when compared to traditional system. This is basically because of the detailed features of the Simul model sustainability. It involves the supply chain management principle that consist environmental sound choices. This declaration was observed by [4] in their research study which was focused on performance measurement of the ready-mixed concreting resources as collected data for simulation by the system. The model was also able to minimise the operation cost effectively and increase on the delivery time to the tune of 90% when it is compared with traditional system.

Reuse - The sustainability of the supply chain management Simul model was planned for reuse and in the process of manufacturing when compare to traditional system. This is also opined by [19] in their research study on making purposeful sales advantageous by remanufacturing the product both economically and environmentally. The model influences the fleet efficiency in the maintenance service level to around 10%.

Effectiveness of tool- The tool of the sustainable supply chain management is suitable to assess the efficiency of the supply regulations and policies in a good time ahead of usage. Meanwhile, in the traditional system, there is no ascertainment of the measures and assessment. This result was also corroborated by [19].

7. Conclusion

The high level of supply chain performance of the truck delivery of ready-mix concrete depends heavily on the efficiency of truck mixer raw materials, scheduling and logistics. But these have been a factor of hindrance for the suppliers of ready-mix concrete by traditional system. This may probably be as the outcome of the differences relative to viewpoint on the supply chain performance of concrete and assumption of all the stakeholders in the business sector. The end user, whom is the contractors in this case are keen in the timely delivery and waste reduction to ensure disruption in concrete placing on site. The ready-mix concrete suppliers as well are more interested in minimising the losses due to operation in such a manner of reducing the idle time of truck mixer on site. This is because they are targeting the overhead truck cost on site and time wastages. Hence, sustainable Simul model of sustainable supply chain is the panacea to wastage of time, lack of cost effective, insufficient efficiency and lack of sustainability that associated with the traditional method of batching.

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