

**SIMULATION MODEL OF CONCRETE BATCHING
PLANT FOR ASSESSMENT AND JOB
SCHEDULING PURPOSES IN SAUDI ARABIA**

BY

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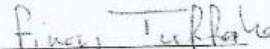
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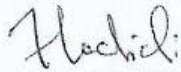
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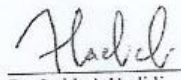
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ABSTRACT

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Ready Mix concrete Batch plants plays a vital role towards the success of the construction industry. Batch plants have the following as their main resources: mixers, pumps, and the production facility. Orders are received at the production facility with various types and various quantities, and these orders have to be delivered on time to the pertaining customers with the required quantities. In this work, a real case ready mix concrete batch plant is considered. The batch plant is located in the eastern province and it is supposed to serve customers within 50 km away from its current location. The investigated batch plant had some deficiencies regarding meeting customer requirements. We used Any logic (PLE) to simulate the batch plant performance, and the results indicated that one of the main resources of the batch plant is over utilized. In particular, with four pumps being used, the pumps utilization rate was 95%, which hindered the plant from being able to serve other customers. And hence, the plant capacity was impacted. To overcome this issue, an additional pump was added. And the plant performance was simulated again. The results indicate that the batch plant capacity have improved while maintaining all resources utilization rate within acceptable limits.

ملخص الرسالة

الاسم الكامل: مصطفى وائل النجار

عنوان الرسالة: نموذج محاكاة لمحطة خلط خرسانه جاهزه للمساعدة في التقييم و جدولة الأعمال في المملكة العربية السعودية

التخصص: ماجستير العلوم في هندسة وإدارة التشييد

تاريخ الدرجة العلمية: صفر ١٤٤٣

تلعب مصانع خلط الخرسانة الجاهزة دوراً حيوياً نحو نجاح صناعة البناء والتشييد. تحتوي مصانع الخرسانة الجاهزة على ما يلي كمصادر رئيسية: الخلطات والمضخات ومنشأة الإنتاج. يتم استلام الطلبات في منشأة الإنتاج بأنواع وكميات مختلفة، ويجب تسليم هذه الطلبات في الوقت المحدد للعملاء المعنيين وبالكميات المطلوبة. في هذا العمل، يتم النظر في حالة واقعية لمصنع خلط خرسانة الجاهزة. حيث يقع مصنع في المنطقة الشرقية ومن المفترض أن يخدم العملاء ضمن مسافة 50 كم من موقعه الحالي. كان لدى المصنع المعني بعض أوجه القصور فيما يتعلق بتلبية متطلبات العملاء. استخدمنا برنامج محاكاة (ANY LOGIC - PLE) لمحاكاة أداء المصنع، وأشارت النتائج إلى أن أحد المصادر الرئيسية في المصنع قد تم استخدامه بشكل مفرط. على وجه الخصوص، مع استخدام أربع مضخات، بلغ معدل استخدام المضخات 95%، مما أعاق المصنع من القدرة على خدمة العملاء الآخرين. وبالتالي، تأثرت قدرة المحطة. للتغلب على هذه المشكلة، تمت إضافة مضخة إضافية. وتم محاكاة أداء المصنع مرة أخرى. وتشير النتائج إلى أن قدرة المحطة قد تحسنت مع الحفاظ على معدل استخدام جميع الموارد ضمن الحدود المقبولة.

في الختام، فإن توريد الخرسانة الجاهزة في المملكة العربية السعودية لديه مجالاً للتحسين. يظهر نموذج المحاكاة مستقبلاً واعدًا في مساعدة صناعة الخرسانة الجاهزة على تحسين الفعالية في تخطيط وجدولة الخرسانة الجاهزة مما ينعكس على قطاع التشييد.

CHAPTER 1

INTRODUCTION

1.1 Overview

The use of ready-mixed concrete primarily involves two parties, the supplier and the customer (who is usually a construction contractor), although others may be involved. Ready-mixed concrete is not only a product, but also a service. This implies that the supply of ready-mixed concrete should satisfy the customers' needs in relation to both quality and supply. To satisfy quality requirements, ready-mixed concrete must contain suitable materials, and be produced under conditions of quality control by experienced staff using reliable equipment to meet the supply requirement, it must be delivered at the required time and rate. Concrete scheduling is vital for the success of providing sufficient service that would satisfy the contractor's requirements and increase the efficiency of the Ready-Mix Concrete (RMC) batching plant. It could lead to schedule delays and deterioration of the quality of concrete if not performed properly. A Conflict of interest always arises between clients and manufacturers. The client -could be the owner, the contractor, or subcontractor- wants the concrete to be delivered once he finishes the reinforcements or whenever the site is ready for pouring. While the plant manager focuses on efficient scheduling that maximizes his profit. Yet similar to any other industry, the loyal customer contributes to the majority of the work. Hence, building and enhancing the base of loyal customers requires meeting customer demands despite their quantities and irrespective of the timing of delivery which puts more pressure on the production schedules. All the time required from batching then delivering the concrete to the site and pouring of concrete is usually estimated by shippers' experience. In the traditional way contractors book concrete from the batching plant and the shipper prepare the

schedule for the next day. When the schedule is ready the batching plant's manager adds his touch on the schedule depending on his experience. Numerous uncertain factors regarding the project environment influence the scheduling process. The results of the traditional process and depending on managers' experience are bad service, low concrete quality, and an increase of the cost on the batching plant.

1.2 Problem Statement

Concrete is a major material in construction that can handle compression forces in structures. It is second most usable material in the world after water [1]. Concrete is a sensitive material that many factors could effect on its quality, and due to the complex physical characteristics of concrete which has shelf life of only a few hours and uncertainty nature of the operation environment, the planning and scheduling problems of production and delivery activities are usually unstructured and complex. Usually, concrete companies relay on their shipper's personal experience to take planning and scheduling decisions.

From interviews of ready-mixed company staff and contractors in Saudi Arabia, it seems that no computer-based planning tool is available or used for scheduling and planning of concrete supplies. There are a lot of factors effected due to wrong schedule, among those factors is the time between batching and pouring. Therefore, having the mixer waiting in queue for pouring will increase the number of truck mixers revolutions, and hence affecting the quality of delivered concrete. On the other way around, having the mixer being away when pouring is needed will create a cold joint between old and new concrete putting the contractor under the mercy of the batching plant dispatcher. Moreover, finding the optimum number of the mixers and pumps is a critical issue. The quantity of concrete produced is depending on the number of mixtures, pumps, and the capacity of concrete batching plant. In general, the

shipper and factory manager determine the quantity of concrete produced every day according to their experience and relying over the number of mixers and pumps they have.

Because of the nature of concrete and the nature of the existing supplying system, this adjusting between the two gatherings can't generally be accomplished. The balance also includes onsite crews, in addition to contractors and batch plants, who erect framework and tie reinforcing bars in preparation for concrete placement, raw materials suppliers to the batch plant, as well as others [2].

The essence of their industry is delivering the product on time. The objective of this work is to study the concrete batching plant and scheduling of the operations of ready-mix concrete batch plant with assistance of simulation software. This study will be initiated by looking into the important factors affecting concrete ready-mix plants. Data will be gathered regarding the various activates we have. A simulation model will be built to simulate the current batching processes. The model will be used to investigate various strategies that can be invoked. The best strategy that has the highest effect over the cost and plant KPI's will be recommended.

1.3 Goals

To study the operations of ready-mix concrete batching plant and develop a simulation model to enhance production process and reach the optimum number of concrete mixtures and pumps with maintaining high level of quality for ready-mix concrete company service in Saudi-Arabia.

1.4 Objectives

1. To simulate the current performance of a real case ready mix concrete batch plant located in the eastern province.
2. To identify the bottlenecks encountered by the production office.
3. To propose a proper remedy to reduce the impact of these bottlenecks or take them out.
4. To address the validity of the solution
5. To determine the optimal number of batching units, truck mixers and concrete pumps.
6. To perform sensitivity analysis to investigate the robustness of the proposed solution

1.5 Scope and Limitation

This research will focus on assessment and develop a concrete ready-mix batching plant techniques and the factors that are pertaining to concrete dispatching from plant to contractors through build a simulation model. This model will help the factory manager optimize concrete production through determining the proper number of batching units, trucks and pumps to avoid the queuing time of the truck mixtures, and to serve the maximum possible number of clients. Hence, it will aid in increasing concrete production and maintaining the service level aspired by the management. The work will be limited to the works of an RMC facility currently located in Saudi Arabia.

1.6 Structure of the Thesis

1. First Chapter (Introduction): Provides an introduction and background to the concrete industry and mention of the motivation of this research through problem statement and determining the research goal, objectives and limitations.
2. Second Chapter (Literature Review): Introduces previous studies about the simulation in construction industry and focus on what is done, how is done and what is the result in these studies.
3. Third Chapter (Background to the concrete ready-mix): brief on concrete and the ready-mix operations and steps to produce this product.
4. Fourth Chapter (Methodology): data gathering, then show the process used in the research finally the outputs.
5. Fifth Chapter (Data Collection and Analysis): collecting data from concrete batching plant and the analysis done using @Risk software.
6. Sixth Chapter (Simulation Model): in this chapter, the data collected from the previous chapter will be used to build the model and verification and validation at the end of this chapter.
7. Seventh Chapter (Results and Discussion): This chapter focuses on the presentation, discussion, findings, and analysis of the data according to research objectives.
8. Eighth Chapter (Conclusion and recommendations): This chapter will present the conclusion of the research and the recommendation and future studies.

CHAPTER 2

LITERATURE REVIEW

2.1 Literature review

Management of the operations of Ready-mix concrete batching plants is a challenging task. The challenge starts the moment an order has been placed and accepted. It encompasses the provision of material, the planning for the job, and the final delivery to the customer site. Numerous techniques are proposed to properly handle the planning and scheduling problem any typical Ready-mix company faces. Solutions varied from quite analytical as for integer /linear programming to simulation. The focus of this work is simulation and therefore the literature related to simulation will be examined.

Zayed applied simulation to concrete batching operation to analyze various solutions and for better resource management. They collected data to define the duration of different concrete batching activities. Then a simulation model was developed using Micro CYCLONE simulation system. After carrying sensitivity analysis, management tools were developed to guide the production manager to make informed decisions. These tools included time-cost-quantity chart, contour line chart, and feasible region analysis. According to their work, unit prices can be set more accurately if the distance –concrete mix combination were used rather than the common practice relying on the concrete mix alone [3]. Anson studied the operations activities of a Ready-mix concrete batching plant in Hong Kong. They developed and used HKCONSIM computer software that was built in-house to simulate the Ready-mix concrete production operations. Their simulation model covers the operations from the provision of resources phase through production planning to meet the daily demand for various sites. Their objective is to improve service levels and the utilization of resources. Upon working over their

model, they restricted the application of the model to specifying the attributes for each pour and site and left the practitioner the flexibility to study demand patterns, resources available, and the service levels achieved along with utilization levels of different resources. The software was validated over a real-life situation data [4]. In a further attempt Lu & Lam studied the optimization of concrete delivery scheduling and resource provisions for ready mixed concrete Ready-mix concrete batching plants using a simulation model they developed earlier. In their attempt this time they combined genetic algorithms (GA) with discrete event simulation to optimize the operations at Ready-mix concrete batching plant in Hong Kong. They demonstrated the potential of their work through a case study based on the daily data operations. Their results indicate that using GA with the aid of simulation have enhanced scheduling delivery efficacy, and thus had great effect on improving productivity, resource utilization and the supply process on a daily wise [5]. Another attempt, to introduce simulation via evolutionary techniques is by Cheng who developed a framework that integrates discrete event simulation and multi objective differential evolution to determine the solutions for Ready-mix concrete truck dispatch scheduling. The model takes into consideration uncertainties as well as unexpected situations such as truck breakdowns during delivery. The multi objective differential evolution algorithm is used to optimize the dispatching schedule, which minimizes the total waiting duration both of Ready-mix concrete trucks at construction sites and of construction sites for trucks. A batch plant case study is used to illustrate the capability of the new algorithm, with results showing that the generated non-dominated solutions can assist batch plant managers to set efficient truck dispatch schedules in a timely manner [6].

Tang used a simulation program called RMCSIM to simulate the daily activities for Ready-mix concrete facility. The facility in question has N mixing bays and N truck mixers and serve several sites at various distances, where each site has its own quantities to be delivered with different placing methods to be used. The data had been assumed from another earlier published paper. Their results indicated that the optimal volume of concrete a truck mixer can carry per day is 27 m^3 according to Hong Kong situation. Besides that, they found that having two mixing bay plants is always better than having only one. Also, having 5 m^3 and 7 m^3 mixers within the fleet showed no significant effect on service performance. One last remark coming out of their work indicated that bad concrete delivery performance is mostly attributed site manager's bad planning rather than scheduling [7].

Ashplat production and delivery is another variant of batching plants operation. AbouRizk developed and applied a simulation-based planning approach that manages batch plants supply chain. They applied their model to an asphalt real case production operation where the randomness of demand affects the service level of the production facility. This makes planning and inventory management hard. Their model studies the effects of various parameters on the production process and aids in determining the optimal configurations for the plant's production, inventory, and distribution processes [8]. Park and others developed a dynamic simulation model for a RMC operation using system dynamics. Their model considered a generic RMC production process where the model structure and parameters can be customized for various operational conditions. Through simulation, the RMC process is analyzed. The focus was set on the trade-off between the truck mixer dispatching interval and the queuing time on site. Their results indicated that an economical RMC supply can be achieved by maintaining the number of queuing truck mixers at the desired level, while satisfying the needs

of the customer. They sought that their model can be used as an automated tool to aid RMC planners in satisfying demand. RMC daily operations relies heavily on expert's ability [9]. An attempt to introduce expert's feedback was reported by Maghrebi who proposed a decision tree coupled with induction learning approach as a mean to reconstruct the experts' decision logic. Their method focuses on the expert's prioritization of customer orders. They tested their model through simulation of an RMC plant with one batching unit and three customers per day. Scenarios were generated by the simulation model are passed to the dispatcher who was asked to prioritize the orders given to him per day. The scenarios and the dispatcher feedback were then fed to machine learning program that created generalizations of the expert's decisions. Their results showed that decision trees and rules matched the human performance 80% of the time. Logistics and truck mixers fleet management plays an important role in the supply chain for RMC plants [10]. Zekavat presented a logistic control model for truck mixers fleet at an RMC plant. They used simulation to model the production and supply chain. They proposed two alternatives for concrete delivery, with and without an off- site waiting queue. Besides that, they studied the effect of introducing GPS tracking system providing real travel time data, which reduces the uncertainty of traveling time. Their results show that combination of GPS information with off -site queuing enhances productivity and reduces concrete waste during placement. Also, it reduces the idleness of supply trucks whenever crew or pump experience unexpected stoppage [11].

Also, Semaan studied RMC operations in Lebanon and analyzed the production of activities of a batch plant using two stochastic models: a queuing model, and a simulation model. The queuing model is based on both the Queuing Theory with the aid of Markov Chains. Whereas

the simulation model is based on the Monte Carlo simulation. A real-life case study was used to illustrate the results [12].

Most of the previous works related to concrete dispatching are in East Asian countries. The current study will develop a simulation model that will be used to optimize amount of jobs/number of mixers on a daily basis, while guaranteeing the best quality service with the highest daily production. The results will be validated and implemented with the aid of a case study to test the simulation model in Saudi Arabia.

2.2 Summary

Concrete delivery process is complicated, and inefficient scheduling will cause delay in construction and hence lead to the loss of reputation and market share. There are many studies in the literature concerning concrete dispatching and scheduling in RMC plants. Heuristic algorithms have been proposed. Simulation models were also reported. Some were coupled with genetic algorithms. The objective is always to aid in production and delivery scheduling that enhances the productivity and resource utilization per day in RMC plants. Most of the work cited in the literature is conducted in East Asian countries. None have been reported in KSA before.

In this research a simulation model will be developed to simulate the daily concrete delivery scheduling at an RMC plant in KSA. The model will facilitate concrete dispatching and scheduling by examining the efficiency of various techniques and scenarios over the RMC performance factors.

CHAPTER 3

Background to Ready-Mix Concrete

3.1 Background to Ready-Mix Concrete Production

The precise birth of the ready-mixed concrete remains uncertain. Two German authors credit the first plant to London about 1880 followed by others in Hamburg and New York before the end of the nineteenth century (Crowther, 1975). However, there were others who reported that the concept of ready-mixed concrete was developed in Scandinavia and the USA and was first introduced in Britain in 1931 when the Danish pioneer, Kjarl Ammentorp, set up a ready-mixed concrete plant (ICC Business Ratios Ltd, 1990; Dewar, et al., 1988).

Each project will use the concrete in the construction processes will pass through the following ten steps in order to obtain the finished concrete product (Woods, 1977).

Steps	Operations
1.	Designing the concrete mix
2.	Obtaining the raw materials
3.	Storing and batching the raw materials
4.	Mixing
5.	Delivering to the construction site
6.	Forming into required shape
7.	Handling and placing of the concrete
8.	Finishing the surface
9.	Curing
10.	Stripping the forms

In a construction project, if the concrete is to be supplied by a ready-mixed concrete company, it usually means that the concrete supplier will carry out operations from step 1 to step 5 in the

production and leave the remaining 5 steps to be performed by the contractor. In other words, the concrete supplier completes the part of the contract having produced the concrete and delivered it but has no control over how the concrete is placed, compacted, finished, cured or protected.

Generally, when using ready-mixed concrete, a fixed price is being paid for concrete delivered to site and the fixed price paid covers the materials cost, production cost and cost of delivery to the construction site. However, there are occasions when pan-load is involved, or the truck-mixer due to some reasons has to be retained on site longer than the allowable limit which is usually 25 minutes (Dewar, et al., 1988), additional charges may be imposed.

3.1.1 Designing the Concrete Mix

The design of a concrete mix involves determination of the proper proportions of cement, aggregates, and water, plus any admixtures, to produce a concrete having the desired properties. The basic requirements from a concrete mix are governed by the following considerations, strength, workability, durability, weight, and exterior appearance.

3.1.1.1 Strength

The target strength for design is the 28-day compressive strength of a cube or cylinder specimen. The 28-day strength of concrete with a given type of cement is determined mainly by the water/cement (w/c) ratio in the mix. It is also affected by the type of cement used and by the quantity and composition of the aggregates.

3.1.1.2 Workability

The ease with which concrete can be placed and compacted with a defined compacting method is measured through the slump test and compacting factor test. The workability for a

specific compaction is determined by the amounts of water and cement used and by the composition of aggregates - coarse versus fine - in the mix.

3.1.1.3 Durability

This is reflected in the resistance capacity of hardened concrete to ambient conditions - heat, cold, wetness, mechanical effects, and chemical attack. A very important factor governing durability is the w/c ratio. It is also affected by selection of appropriate aggregates, cement, and admixtures and curing.

3.1.1.3 Weight

The density of concrete varies between 500 - 2400 kg/cum depending on whether lightweight or normal-density aggregates are used.

3.1.1.4 Exterior appearance

This is affected by the choice of cement and aggregates of appropriate shape, texture, color and special admixtures.

3.1.2 Obtaining the raw material

Raw materials refer to cement, aggregates, water, and admixtures.

3.1.2.1 Cement

Portland cement is the name of the manufactured material used in making concrete and is mainly responsible for its properties of strength and hardness. Portland cements are made from a mixture of clay and chalk (or limestone) which is grouped up and heated to a clinker in a rotary kiln, and this clinker is ground to a fine powder, a small quantity of gypsum being added at the final grinding stage.

Cement is supplied either in 50 kg paper bags or in bulk. Cement supplied in bulk is transported by means of cement tanker and stored in cement silo.

3.1.2.2 Aggregate

The most common types are the coarse aggregates and fine aggregates derived from natural rock i.e., Crushed rock, gravel, and sand.

3.1.2.3 Water

The water used for mixing with cement should always be clean. Certain dissolved chemicals and organic matter in dirty water may interfere with the hydration process, but generally, if water is fit for drinking, it will be quite suitable for concrete.

3.1.2.4 Admixtures

Admixtures are materials added to concrete mix to improve some attributes of its performance.

3.1.3 Storing and Batching the Raw Materials

Firstly, the amount of storage must be adequate to ensure that delays are unlikely to occur through lack of supplies. Secondly, the storage arrangements must ensure that no deterioration of the materials can occur while they are on the sites.

In order to produce concrete having the required properties, it is necessary to control the quantity of each material that goes into a batch. This is referred to as batching the materials. Measurement of materials may be done either by volume or by weight. However, batching by volume is not so reliable as compared to weigh-batching.

3.1.4 Mixing

Mixing is the process of mixing the raw materials together. It can be done either by hand or by machine. Hand mixing is very hard and only could be used in a very small job. For machinery mixing there are many types of concrete mixer available, but whatever type is used, machine mixing involves three operations steps: Firstly, the materials must be moved into the mixing drums. Secondly, they must be mixed in the drum. Thirdly, the concrete must be discharged from the batching plant mixer.

3.1.5 Delivery of Concrete

Nowadays, truck-mixer is commonly used to deliver the freshly mixed concrete from the batching plant or mixer to the construction site.

3.1.6 Forming

Concrete, when initially mixed and placed, has a fluidity that will cause it to be workable and spread. Therefore, it is essential to have a constraining formwork into which the concrete is placed. This formwork consists of the surface against which the concrete rests as well as the supporting members, braces, and hardware necessary to hold the structure together.

3.1.7 Handling and Placing of the Concrete

In the case where freshly mixed concrete cannot be discharged directly into the forms from the truck-mixer, a secondary method will be used, usually concrete pump truck or pocket and crane used to elevate the concrete to the high-rise building. More efficient way for high-rise building is to use a stationary pump connected with pipes leads to the placing boom.

Once the concrete has been placed, and before it is finished, it should be consolidated to eliminate voids within the mass. Vibrators are the most common means of consolidation.

3.1.8 Finishing the Surface

The concrete surface, which will be exposed to use, must be properly finished to produce a surface that will produce the required wear, a texture to provide the degree desired of smoothness or roughness and a satisfactory appearance.

3.1.9 Curing

If concrete is to attain its maximum strength and other desirable properties, it should be cured with adequate moisture and at a favorable temperature. Curing is preventing the loss of moisture of the concrete and keep the concrete hydrated.

3.1.10 Stripping the Forms

After the concrete harden and reach the required strength to handle the self-load and additional loads formwork can be removed.

3.2 Ready-mix Concrete plant

The most common construction material is concrete it used from the small villa to the Highrise building. The nature of concrete as a perishable material consists of cement, coarse-aggregate, fine aggregate, admixture, and water. Once the water mixed to the dry concrete the mixture has only one and half or two hours- depending on the chemical admixture that is added to the mix - to expire and start the hydration process [2]. Concrete can either be mixed on-site or off-site. The former is known as the site-mixed concrete, while the latter ready-mixed concrete. Ready-mixed concrete is widely and increasingly used as an alternative to site mixing. Technical as

well as economic considerations influence the choice of alternatives. This is a broad definition of the term "ready-mixed concrete". A more elaborate definition of the term is "The supply of concrete specified to a given site in a premixed condition from a source extraneous to the site and supplied in vehicles called concrete truck mixtures" [13].

Ready-mixed concrete suppliers usually own a fleet of delivery trucks, or "truck-mixers", and several batching plants. The concrete produced is loaded into the truck-mixers for delivery to the customers' sites [13].

The consistency of batching equipment is normally controlled by a hopper and other equipment's that is loaded and charged from overhead bins (silos) using gravity force, which fill up from the truck bulker or onto a belt that goes to the mixer. The cements materials should be weighted separately. When producing concrete, charging and discharging will controlled by electronic gates connected with computer panel. The weigh hopper should be shut via operating interlocks see Figure 1. Cement weigh hoppers must inspect the interior by having an access port to facilitate the inspection. The weighing accuracy must not be affected by the dust seal between weighing hopper and the storage bin. The weighing hopper has a coned bottom and also has a vibrator to ensure complete discharge. Before mixing, the mixer has to be carefully tested with many trails mix to assure the mix will meets the specifications for the project. The batching plant mixer will produce concrete in many batches to fell the mixture truck or the required quantity, which is smaller. Usually in Saudi Arabia we use 3 m³ patch plant mixer capacity that require automatic timers set in accordance with specification prior to any mixing operations.



Figure 1 Gates of discharging materials

The mixing period begins when the last portion of the materials enter the batching plant mixer drum and ends when it loads to the concrete truck mixer. To meet mixing time, other factors have to be considered such as charging and discharging time during the total operating cycle.

There are three batching equipment usually used, which are Manual, Semi-Automatic, and Automatic as defined below:

- **Manual**

Manually the batching equipment will be charged, the accuracy of the weighing operation is dependent upon the operator's visual observation of the scale. The charging device is actuated by either hand or through power assists.

- **Semi-Automatic**

Batching equipment is charged by gadgets, which are manually and independently activated for every material to permit weighing of the material. They are activated sequentially to achieve the designated mass (weight) of every material.

- **Automatic**

Batching equipment is charged by gadgets which upon inciting by a solitary starter switch, will naturally begin the weighing operation of all materials successively and stop consequently whenever the designated mass (weight) of every material is achieved.

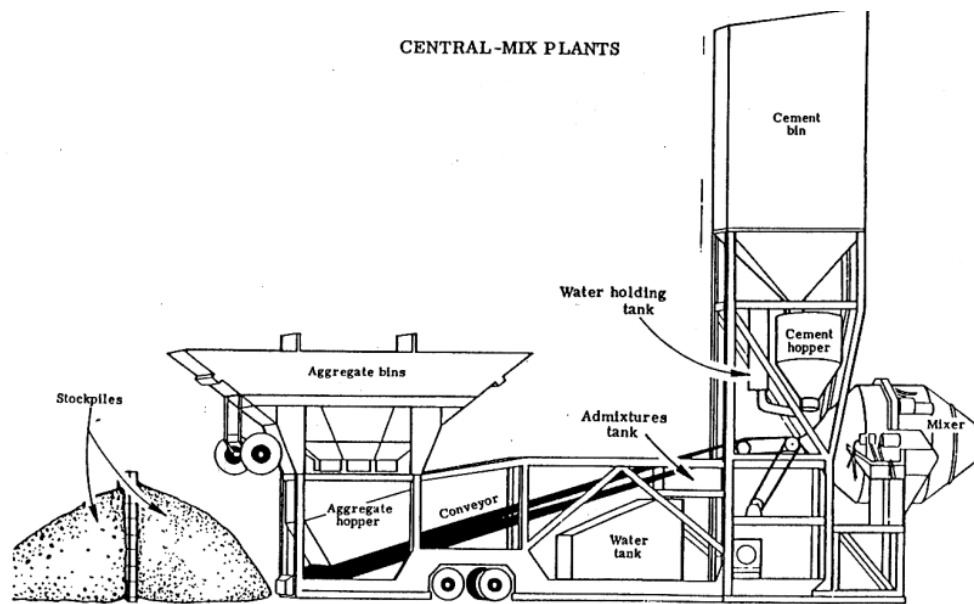


Figure 2 Batch plant component

The batch plant should also have a computer-generated batching ticket to be patched on the mixture truck (Figure 3). Every delivery ticket shows the quantity of concrete loaded to the truck mixture and time of batching and other information for the mix and delivery.



Figure 3 computerized system for batching

3.2 Concrete Delivery System

Customers are usually required to place their orders in advance. However, there will be occasions where orders are received or cancelled in a short notice. Also, demand fluctuates from day to day. On a busy day, total demand may exceed the plant capacity, while on another day, the batching plant and truck-mixers can be idle most of the time. Most ready-mix plant

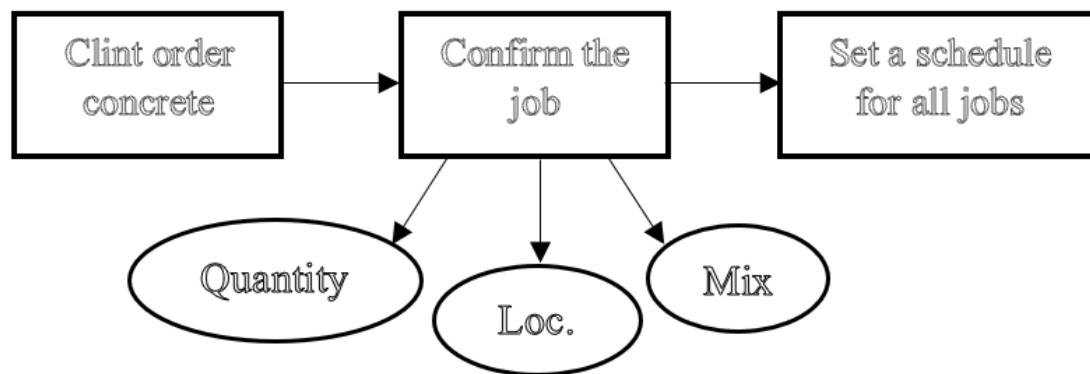


Figure 4 Process for setting a schedule

uses similar processes to deliver concrete to customers. The contractor will sign a contract with concrete Ready-mix supplier with the required mixes as shown in Figure 4. The production of concrete relies on the plant available equipment, available raw materials, contractor method of concrete placement, and the schedule between the contractor and the batching plant. Each batch plant has a capacity which is controlled by either batching capacity or delivery capacity. Batching capacity relates to the plant production capacity, the type of the mix and their ingredients and additives, workability of concrete preproduction process and the capacity of the mixture. It can be determined by the time needed to measure, and mix ingredients, and load them into a truck.

Number of trucks and drivers that service the batch plant will determine the delivery capacity. A plant's batching capacity is always larger than its delivery capacity [2].

Demand for concrete fluctuates throughout the day, week, and year. Even when the total amount of concrete for a specific placement or a project can be assessed sensibly. The timing of the required delivery is often not known precisely because the estimation of the finishing times for various activities at site is always not reliable. Besides that, concrete is not ought to set no later than an hour and a half otherwise hydration process starts, or more water has to be added. Therefore, more pressure on mixers scheduling and dispatching has to be emphasized while taking into consideration that the travel time should not exceed the limit of the hydration, and not more than half an hour. A plant's operating radius therefore tends to be limited based on the nature and condition of haul roads. The contractor should be ready and has plan to prepare for the arrival of the ready-mix truck mixtures. When a contractor requests a concrete, he needs to be ready to place that concrete once it arrives. The delivery of concrete is essential to be on time for the contractor. If a truck arrives early and the concrete placement crew are not

yet ready, in that case trucks will spend some extra time on site during off loading, and the contractor will be penalized and charged for the extra time. Usually the contractor will request concrete three days before the day of placement. The plant need time to procure materials, reserve batching capacity. And the most important is the ordered quantity which should be accurate. Because the concrete ready-mix company will charge the contractor for everything, this includes the excess concrete remaining in trucks that return to the plant once a placement has been completed [2].

Production process of concrete ready-mix starts when the customer order concrete at least before one day. The shipper takes the required quantity, mix design and the day for pouring. If the ingredients are available, the shipper will schedule the job for production in the subsequent day.

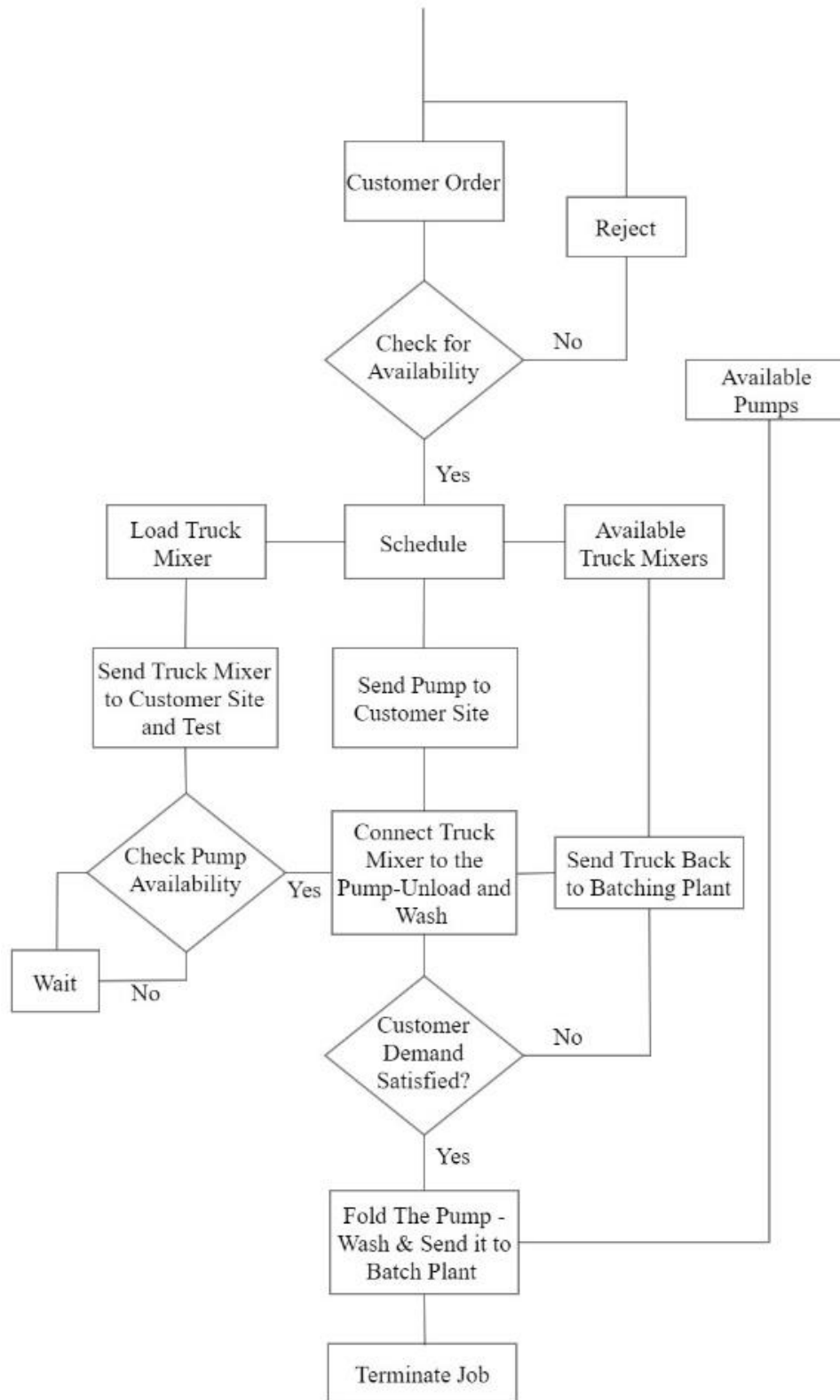


Figure 5 Flow chart of the concrete delivery process

Raw material will be requested from the suppliers, and once the needed material is delivered to the batch plant, it will be weighted and stored on the silo cementitious materials or put in the warehouse for fine/coarse aggregates. At the pouring day, the dispatcher will call the customer and inform him that the pump is on the way. When the pump reach to the site the contractor will inform the batch plant to start patching concrete. The raw material will be hauled by the loader to the hoppers that is connected to the batch plant mixer.

The mixer will mix the concrete and then load it to the mixer truck for delivery. Once concrete arrives at site, customer will check the concrete ready-mix by fresh concrete testing, which include temperature measurement, workability, collecting samples from the truck. For unloading, the truck mixer will be attached to the concrete pump and the pouring of concrete starts. The speed of pouring depends on the worker's skills, element of pouring, workability, height, and weather. When unloading is finished, the truck mixer will move to washing to clean the truck drum. Then it will return to the batch plant to reload again. If this was the last batch, the pump had to be cleaned and fold back on the truck pump and then the return back to the batch plant. Figure 5 depicts a flow chart of the concrete delivery process.

When an order is transmitted to the batching plant. the batching plant operator allocates a truck-mixer to the order. If a truck-mixer is available. the order is then loaded at a suitable time for delivery. If no truck-mixer is available. the batching plant must stop operation and wait for truck-mixers to return before production can continue. The batching plant is therefore idle while waiting for the truck-mixer to return. On other occasions several truck-mixers may return simultaneously to the plant for loading. Therefore. a large part of the potential operational time of the vehicles may be spent waiting in queue at the batching plant. The truck-mixers upon arrival at the sites, will unload the concrete provided that the work has been approved and the

handling resources are available. However, for various reasons, it is not uncommon that truck-mixers have to queue to wait for their turn to unload their concrete, or on the other hand, for the concreting work to wait for the arrival of the next truck-mixer [13]. The continuous concrete supply will affect not only the level of service provided to the customers but sometimes, the quality of the concrete structure too. Idling of the batching plant and the time the truck-mixers spend waiting in queue at the batching plant and/or sites will affect the utilization of the ready-mixed concrete supplier's resources. Thus, effective planning and scheduling will provide economic benefits to all those involved. Scheduling involves the allocation of time and resources to activities within a predetermined plan. This allocation has to avoid the introduction of inconsistencies or conflicts between activities, particularly with respect to the use of resources (Currie, 1989). If planning requirements or decision data are not fully known or change with time, a planner must be flexible and opportunistic. Since planning always involves a certain amount of prediction, it has the requirements of that task as well (Stefik, et al., 1983).

3.3 Factors effecting the ready-mix scheduling

When more than one customer require concrete at around the same time, shippers will have to decide the dispatch sequence of these orders. Sequencing defines the process of arranging the order in which tasks are to be performed.

The quantity, timing, and frequency of delivery of concrete are dependent on the demand of work sites. The demand is mainly determined by the size of their concreting work, conditions of the job and the methods of unloading. The production capacity of the batching plant and the size of the fleet of truck-mixers are usually fixed in the short term. Its actual production and

quantity of concrete that can be delivered are affected by many factors. Some of them are (Anson, et al., 1988; Dewar, et al., 1988; Newman, 1975):

1. The distance of the batching plant from the site.
2. The traffic conditions in route.
3. Method of unloading.
4. Weather conditions.
5. Breakdown of plants/truck-mixers/handling resources.
6. Demand changes dynamically during the day in question.
7. Demand is fragmented into small pours on many sites.

However, the final decision at the batching plant in Saudi Arabia to approve a production and delivery schedule is still made by the shipper. It is noted that the shippers might also explore other alternatives.

CHAPTER 4

Research Methodology

4.1 Introduction

The overall methodology is shown in the Figure 6.

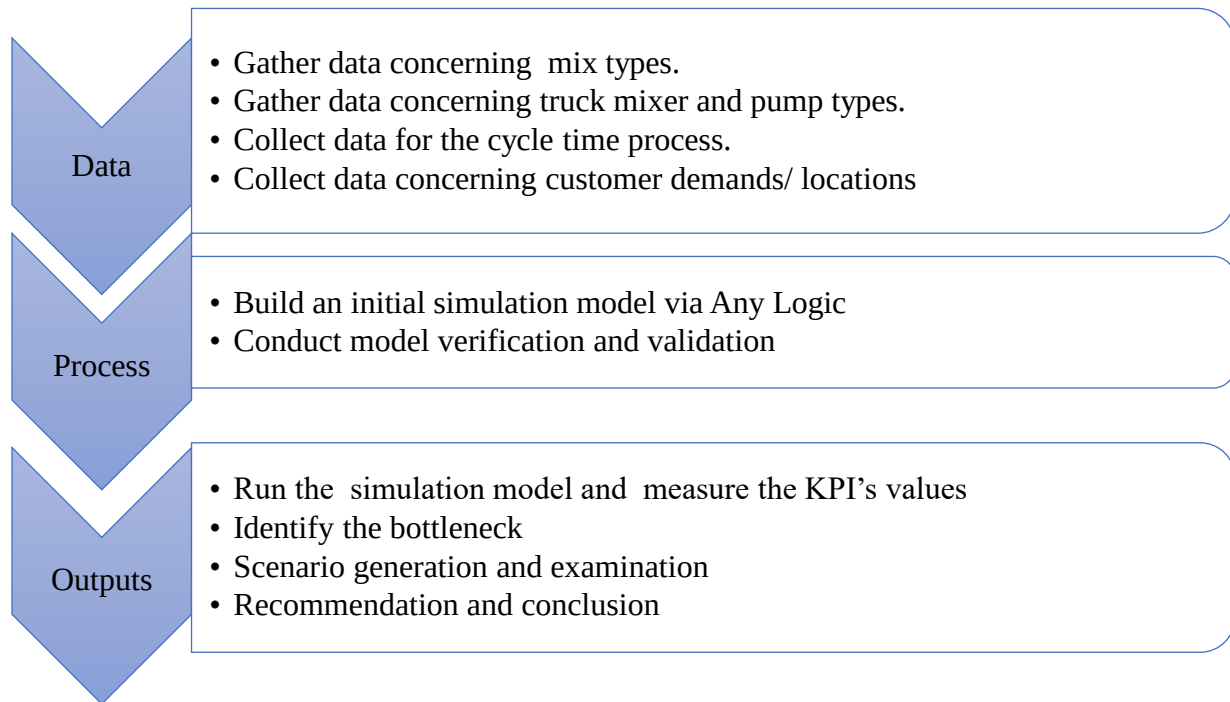


Figure 6 Input, Process and Output flowchart

As shown in Figure 6, the researcher will Identify the keys performance index (KPI) that the patching plant in Saudi Arabi follow to achieve their- targets and satisfy their clients though making an interview with batching plant managers. Then gathering data for truck - mixtures, pumps, and requited mixes from the clients. Then collect data to calculate the cycle time. The second step is developing a model and validate the model. The outputs will be performance analysis, scenario generation and examination finally the Recommendation conclusion

As shown in the flow chart we need to collect data from a ready-mix batching plant. The researcher will take the customer orders from the shippers for the entire week to study the time between two orders and check their statistical distribution in order to use it in the simulation by using at-risk software.

4.2 Data Collection from Batching Plant

The researcher will consider the time between orders, loading time, travel time, unloading time, and return time as showing in the below table.

Table 1 The schedule of the date collected from the batching plant

Trip.	Trip	Mixing Time	Ex-Plant	On-Site	St. Unloading	Fn. Unloading	Time Between two Trucks.	Unloading Time	Return	Trip Hrs.
No.	Qty m ³	min.	Time	Time	Time	Time	min.	min.	Time	hr.
1	9	6.75	6:55	7:30	7:39	7:51		0:13	8:24	1:29
2	9	6.75	7:02	7:40	7:52	8:03	0:01	0:12	8:38	1:36
3	9	6.75	7:20	8:00	8:04	8:15	0:01	0:12	8:52	1:32
4	11	8.25	8:06	8:50	8:51	9:04	0:36	0:14	9:45	1:39
5	9	6.75	8:13	9:00	9:05	9:16	0:01	0:12	10:03	1:50
6	9	6.75	8:22	9:12	9:17	9:28	0:01	0:12	10:17	1:55
7	11	8.25	9:07	10:00	10:01	10:14	0:33	0:14	11:07	2:00
8	11	8.25	10:17	11:01	11:02	11:15	0:48	0:14	11:57	1:40
9	11	8.25	11:11	11:49	11:50	12:03	0:35	0:14	12:38	1:27
10	9	6.75	12:49	13:23	13:24	13:35	1:21	0:12	14:08	1:19
Trips: 10		98 m ³								

The first column shows the trip numbers, and it is a series from one to the last trip. Second column shows the quantity of concrete that truck-mixer has been loaded. Then mixing time shows in the third column. It depends on the capacity and the type of the batching plant. Fourth column shows, the exact time when the dispatcher prints the delivery ticket to travel to the

customer site. The quality control on-site will receive the truck -mixer and he will write the arrival time and start time and finish unloading time for the truck -mixer as shown in the next three columns. Finally, when the truck-mixer returned to the batching plant the researcher assigns the security to take the arrival time. The cycle time will be calculated from subtracting the time exit from the plant and the arrival time to the batching plant.

4.3 Simulation of Concrete Ready-mix Delivery

The simulation will be based on the analysis of the collected data for a concrete batching plant located in Saudi Arabia, eastern province, Al-Khobar. The used simulation software will be AnyLogic®. The researcher will make verify the simulation model to be used in the future in the batching plant as a tool for scheduling the daily jobs.

CHAPTER 5

DATA COLLECTION AND ANALYSIS

In this chapter, the data will be collected from the concrete batching plant in Saudi Arabia located at Khobar. The following is a summary of the results extracted from the researcher survey and experts' meetings. The most common method of producing ready-mix concrete is to mix all raw materials then load into a truck mixer, and to maintain the workability of the concrete, the truck mixer will keep mixing while it is reached the customer site.

The average number of truck-mixer for one batching plant is 14 truck-mixers. Table 2 shows the daily production for one week.

5.1 Customer Order / Demand

This data was collected in Saudi Arabia in the Eastern province. The annual output of a ready mixed concrete of the mentioned batching plant almost 100,000 m³. This gave an average of 8,300 m³ per month. The below table 2 shows the ordered quantities from the customers for one week.

Table 2 Daily production for one-week in Saudi Arabia

Daily Batch Plant Production	
Day	QYT. M ³
1st Day	389
2nd Day	526
3rd Day	409
4th Day	431
5th Day	572
6th Day	505

Table 3 shows the daily schedule demand for one week with the associated quantity, element and the respective booked date and time.

Table 3 daily schedule demand for one week

Demand Schedule			
Saturday, Feb. 8, '20	QYT	Element	Time
	m3		
Job. 1	55	Slab	4:00
Job. 2	36	Slab	8:00
Job. 3	91	Column	9:00
Job. 4	160	Beam	12:00
Job. 5	37	Column	13:00
Job. 6	10	Column	14:00
Sunday, Feb. 9, '20			
Job. 7	35	Beam	4:00
Job. 8	15	Beam	5:00
Job. 9	30	Foundation	6:00
Job. 10	16	Column	8:00
Job. 11	50	Slab	9:00
Job. 12	130	Foundation	10:00
Job. 13	40	Slab	11:00
Job. 14	160	Beam	12:00
Job. 15	50	Slab	13:00
Demand Schedule			
Monday, Feb. 10, '20	QYT	Element	Time
	m3		
Job. 16	60	Foundation	5:00
Job. 17	60	Column	8:00
Job. 18	120	Foundation	8:30
Job. 19	110	Foundation	9:00
Job. 20	10	Column	12:00
Job. 21	25	Slab	13:00
Job. 22	24	Beam	14:00
Tuesday, Feb. 11, '20			
Job. 23	20	Column	4:00
Job. 24	45	Slab	5:00
Job. 25	120	Foundation	6:00
Job. 26	15	Beam	8:00
Job. 27	50	Slab	10:00
Job. 28	30	Slab	13:00

Job. 29	101	Foundation	13:30
Job. 30	30	Beam	14:00
Job. 31	20	Beam	14:30
Demand Schedule			
Feb. 11, '20	QYT	Element	Time
	m3		
Job. 32	100	Beam	5:00
Job. 33	21	Beam	5:30
Job. 34	100	Beam	6:00
Job. 35	295	Slab	6:30
Job. 36	41	Foundation	8:00
Job. 37	15	Beam	13:00
Feb. 12, '20			
Job. 38	28	Beam	4:00
Job. 39	90	Slab	4:30
Job. 40	40	Slab	5:00
Job. 41	160	Column	5:30
Job. 42	17	Beam	8:00
Job. 43	50	Slab	13:00
Job. 44	80	Foundation	14:00
Job. 45	40	Foundation	17:00

Average daily output of the plant was 472 cu m. Variations in the daily demands were great from only 8.5 cu m to 314.2 cu m. Table 6.4 shows the average daily output of the plant with 14 or more tuck-mixers. About 86% of the orders were placed one day before the pour and most of them were placed in the late afternoon of that day. The remaining 14% of the orders were ordered on the day when the pours were carried out. Customers who placed orders in advance may cancel the order later and the cancellation rate was about 10%.

5.2.1 The Time Between Orders

The time between orders is varying from day to day. If the batch plant has large order quantities, it will stop taking more orders until the customer satisfied and the plant capacity can handle other jobs. The simulation will help the decision-maker in the batching plant

when he should open another job to increase production or fulfill the current customers. The below schedule shows the time between job orders for one week. The distribution in the Figure 7 shows a sample of the gathered data.

Table 4 Difference time between orders

Time Between Orders			
4.00	1.00	1.00	0.50
1.00	1.00	1.00	1.50
3.00	1.00	2.00	5.00
1.00	16.00	2.00	15.00
1.00	3.00	3.00	0.50
14.00	0.50	0.50	0.50
1.00	0.50	0.50	0.50
1.00	3.00	0.50	2.50
2.00	1.00	14.50	5.00
1.00	1.00	0.50	1.00
1.00	14.00	0.50	3.00

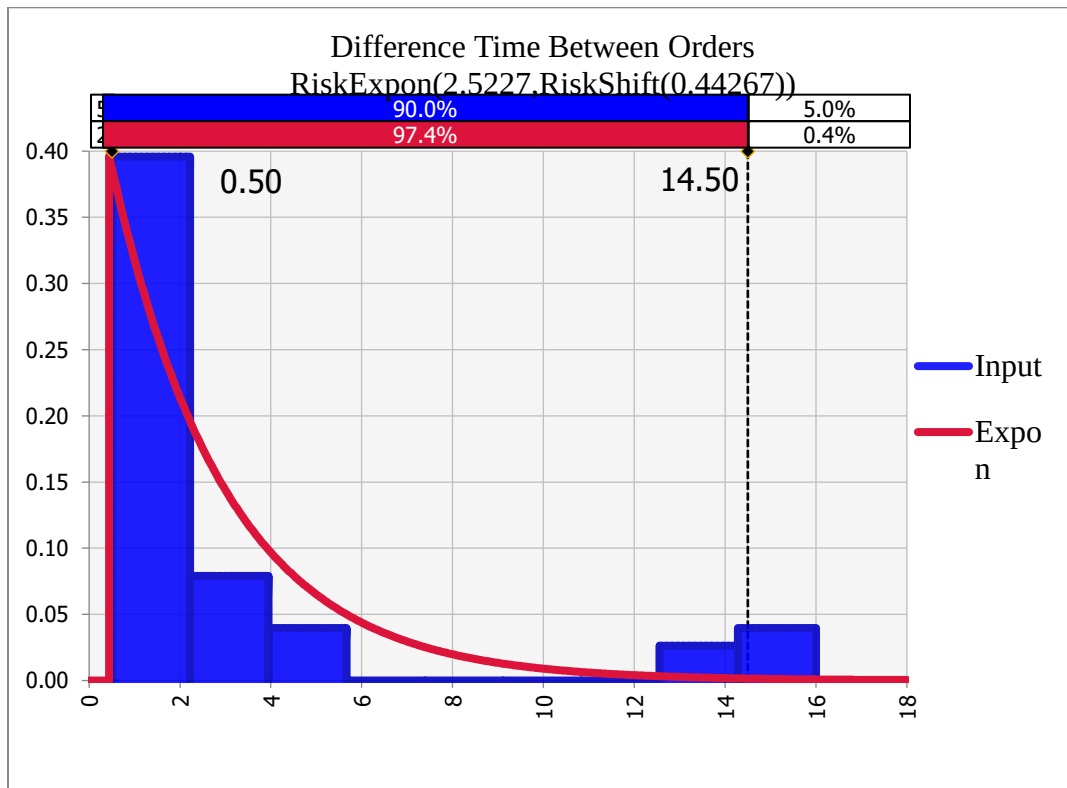


Figure 7 Distribution for Time between orders

Figure 7 shows the distribution taken from table 4, and it shows 97% of the time between orders are varying between half-hour to 14.5 hours for the big orders.

5.2.2 The distribution of the Structure Element Orders

When the customer requests a concrete, the batch plan's shipper will consider three main inquiries to estimate the required time and schedule the job. One of these inquiries is the structure element type that will be cast. The below schedule shows the orders and the element that will be cast. For the sake of simplicity, a symbol was placed for each element, slab (0), column (1), beam (2), and foundation (3). The order's element was requested is shown below in discrete distribution in Figure 8.

Table 5 Pattern of Structure Element Orders

Pattern of Structure Element Orders				
Slab (0)	Column (1)	Foundation	Slab (0)	Beam (2)
Slab (0)	Slab (0)	Column (1)	Foundation (2)	Beam (2)
Column (1)	Foundation	Slab (0)	Beam (2)	Slab (0)
Beam (2)	Slab (0)	Beam (2)	Beam (2)	Slab (0)
Column (1)	Beam (2)	Column (1)	Beam (2)	Column (1)
Column (1)	Slab (0)	Slab (0)	Beam (2)	Beam (2)
Beam (2)	Foundation	Foundation	Beam (2)	Slab (0)
Beam (2)	Column (1)	Beam (2)	Slab (0)	Foundation (3)
Foundation (3)	Foundation (3)	Slab (0)	Foundation (3)	Foundation (3)

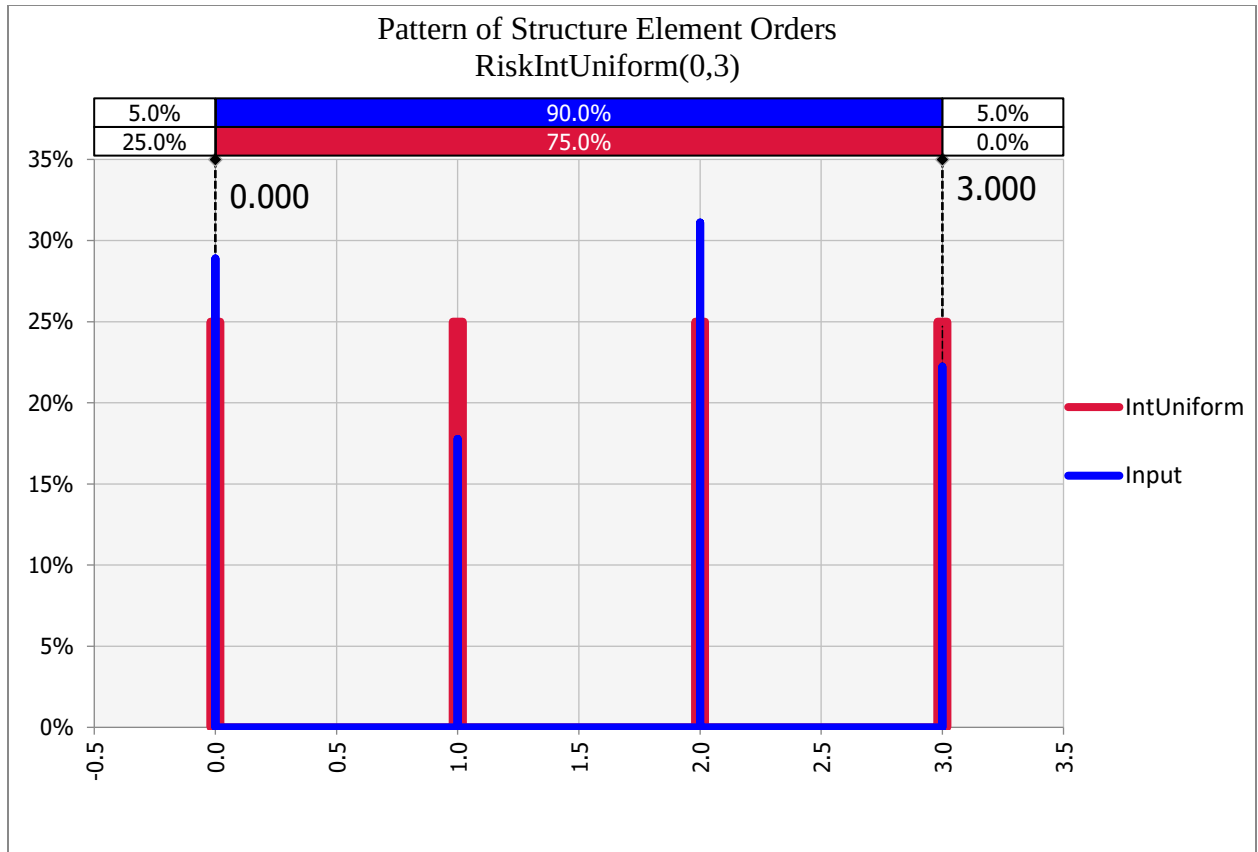


Figure 8 Uniform distribution for the pattern of the orders of the structure elements

Figure 8 shows 75% of the uniform distribution for the structure element ordered from construction sites, however, in actual it shows more orders for slabs and foundations, where these elements increase the batching plant profits due to large quantities.

5.2.3 The distribution of the order size

The quantity is varying from one structure element to another. Usually, foundations and slabs consume more quantity than the column and beam. The below tables shows a sample of the order quantities within one week of production.

Table 6 Quantities Orders Pattern

Quantities Orders Pattern of Columns for one week		
91	20	16
37	160	60
10	10	10
Quantities Orders Pattern of Beams for one week		
160	160	30
35	24	20
15	15	100
21	100	15
28	17	
Quantities Orders Pattern of Slabs for one week		
55	36	50
40	50	25
45	50	30
295	90	40
	50	
Quantities Orders Pattern of Foundations for one week		
30	130	60
120	110	120
101	41	80
	40	

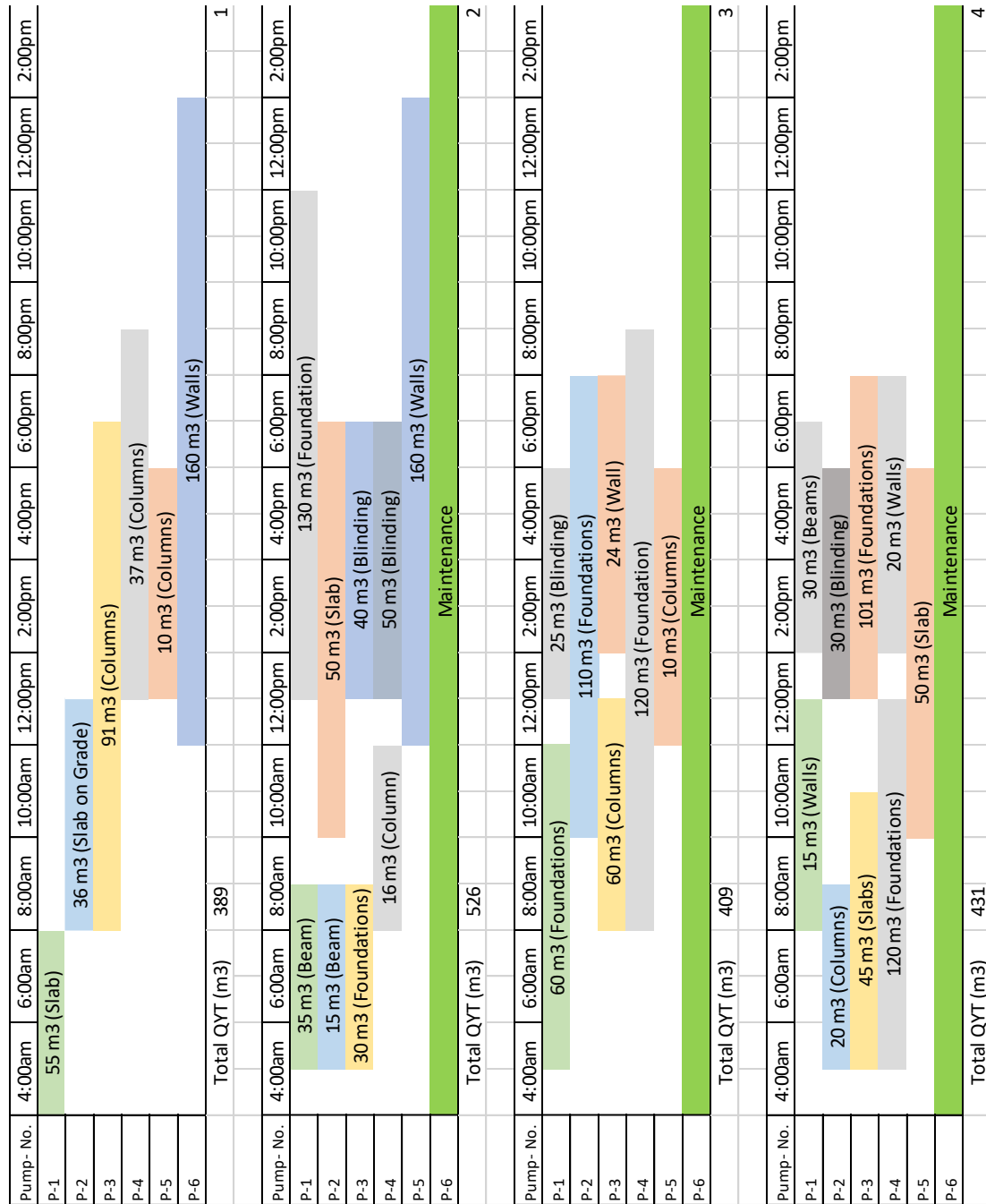


Figure 9 Daily concrete schedule per one week

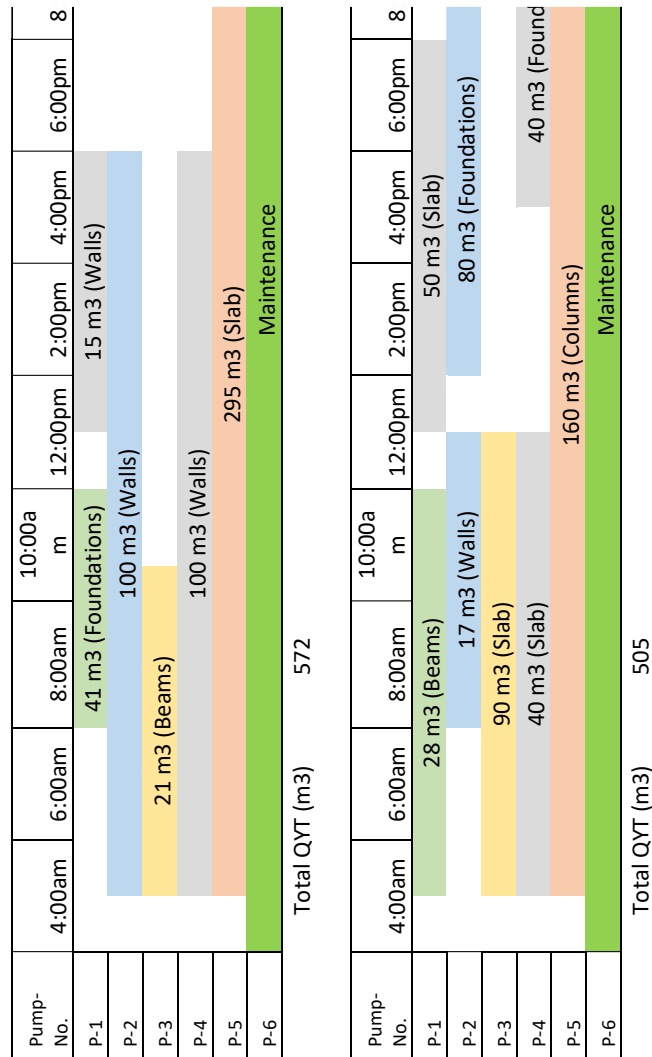


Figure 10 Daily concrete schedule per one week

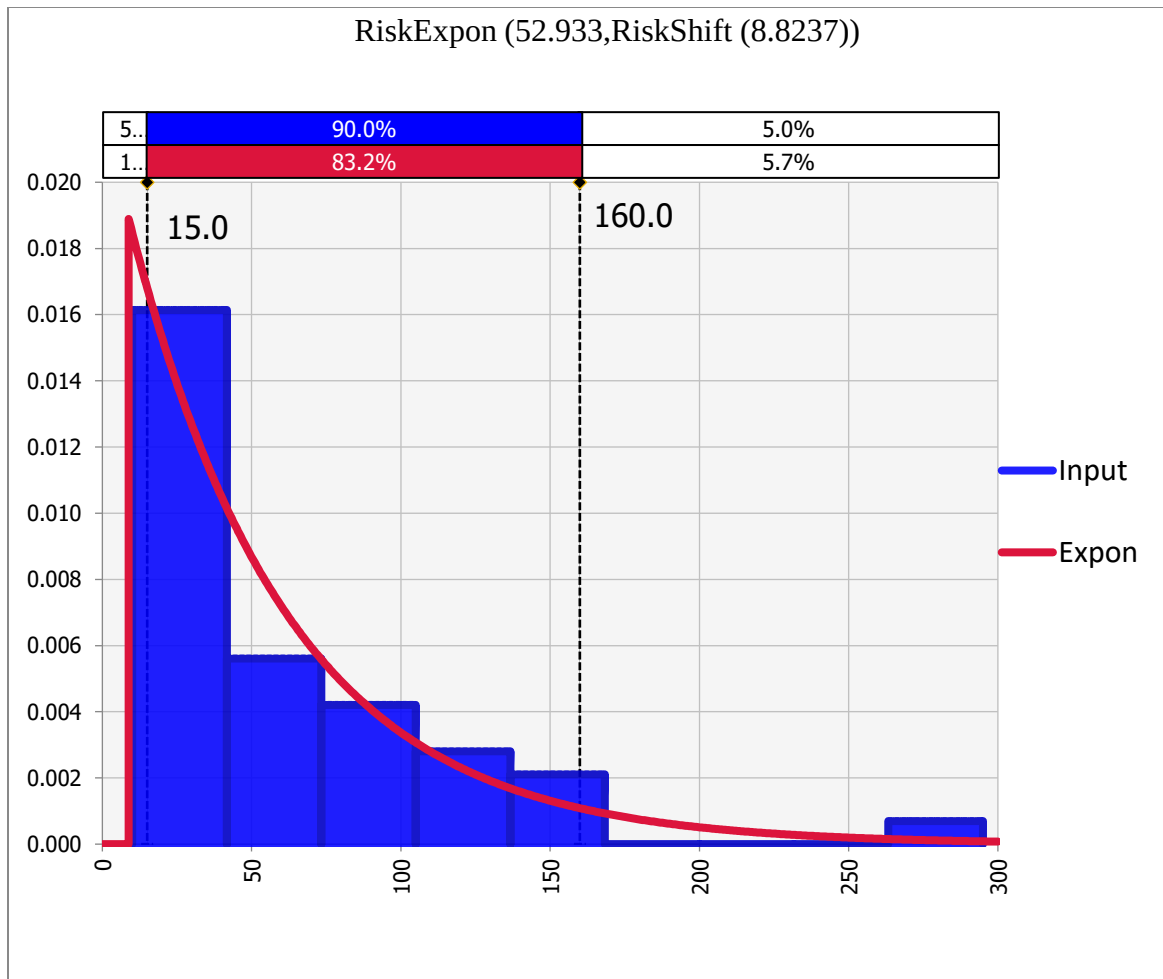


Figure 11 Quantities order pattern for all elements

The quantity of concrete is also another parameter that will affect the job duration, figure 11 shows 83% of the orders are between 15 m³ to 160 m³ with exponential distribution, however, there are almost 6% more than 160 m³. Usually, if the order is more than the capacity of the batching plant it will share the quantities with another batching plant to fulfill the construction site requirements.

5.3 Loading Time distribution of Truck-Mixers

In the ready-mix concrete batching plant, the time required to load the mixer is mainly dependent on the batching plant capacity per hour and the truck-mixer capacity. The following formula is usually used to estimate the truck-mixer loading time;

$$\text{Mixing Time for a Truckmixer (packing)} = \frac{\text{Truckmixer Capacity (m}^3\text{)} \times 60(\text{min})}{\text{Batching Plant Capacity /hr}}$$

5.4 Traveling Time distribution of Truck-Mixers

For estimating the required travel time of the truck-mixer, the researcher divides the territory that is served by the batching plant to ranges as showing in the table below. The ranges are depending on the distances measured by kilometer. The traveling time mainly depends on any factors, as for; the distance, the used routs, and traffic jams...etc.

Table 7 Construction sites ranges



Distance	Mean	Std Dev	Minimum	Maximum
km	Min.	Min.	Min.	Min.
6-12	31.6	4.3	22	40
13-18	35.4	4.7	28	52
19-30	45	5.5	32	60

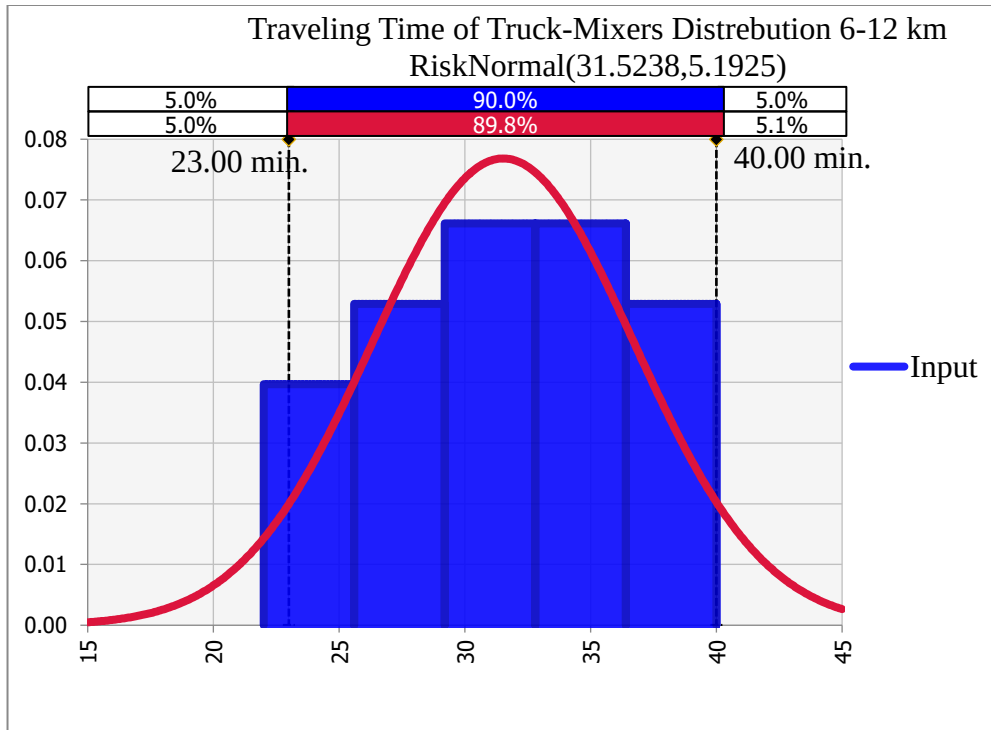


Figure 12 Distribution of traveling time of Truck-Mixers 6-12 km

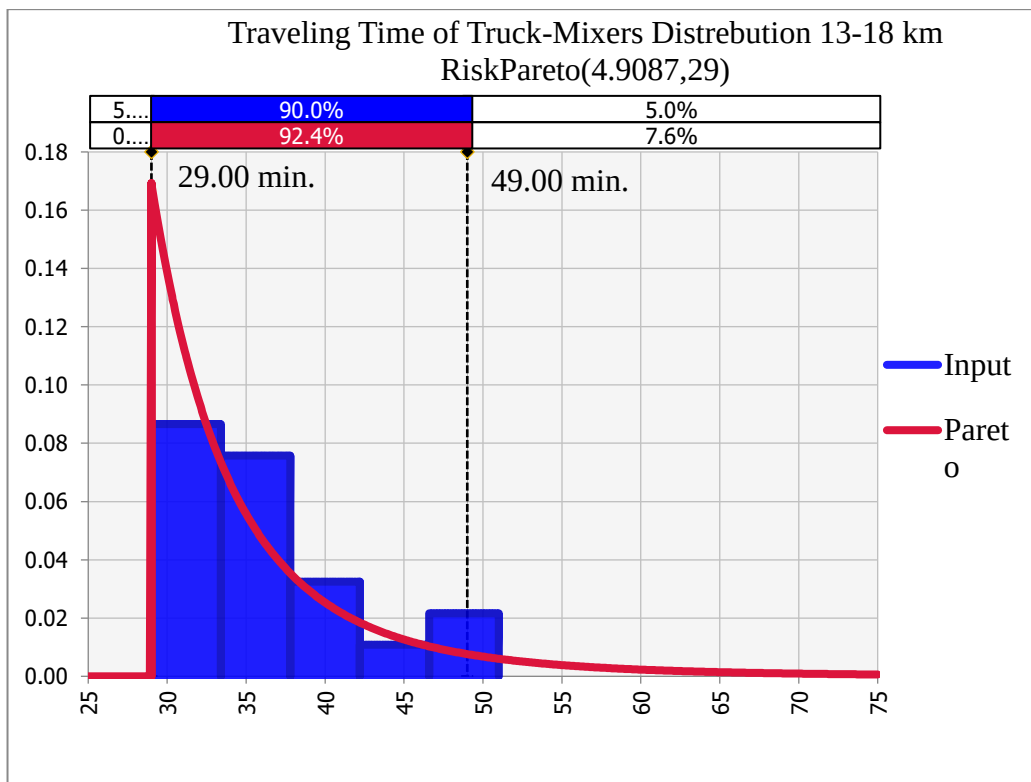


Figure 13 Distribution of travel time of the truck-mixers 13-18 km

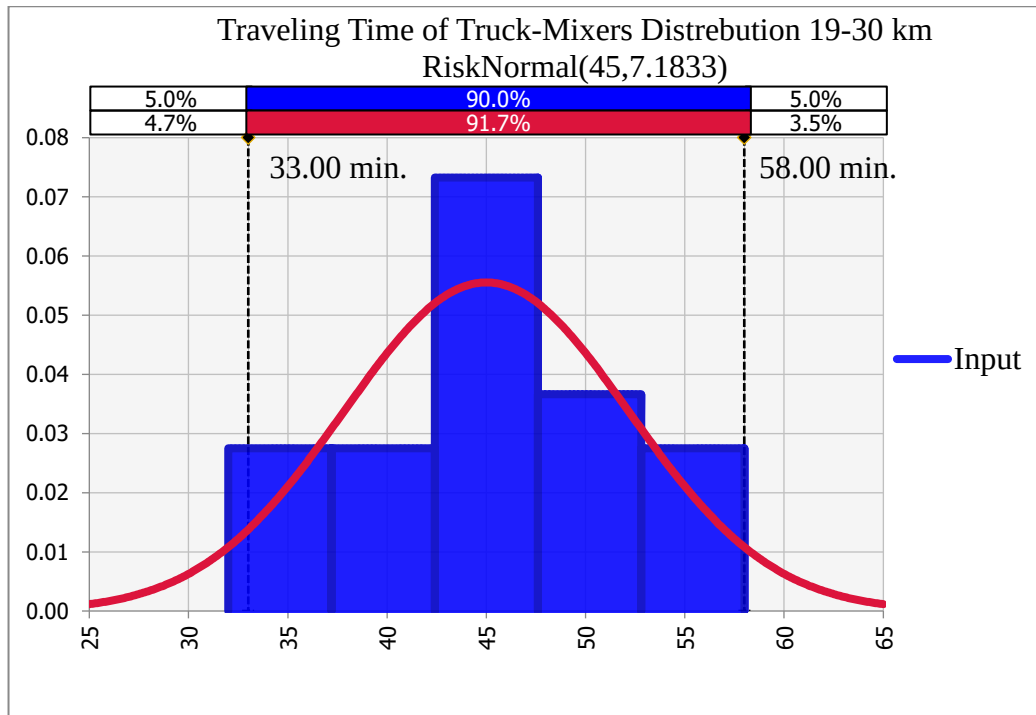


Figure 14 Distribution of travel time of the truck-mixers 19-30 km

Figures 12, 13, and 14 show the traveling time required for a concrete truck mixer to the construction site. The service area was divided into three areas to simplify the data collection. However, this data was not used at AnyLogic® where the software using GPS for defining the distance and time.

5.5 Unloading Time distribution of Truck-Mixers

The rate of supply of ready-mixed concrete depends largely on the speed of unloading which is in turn affected by the method, capacity, and number of unloading resources used. However, it is not necessary for the speed of unloading and hence the rate of concrete supply to be the same when the same handling equipment with the same arrangement is employed. In fact, the speed

of unloading not only varies from job to job due mainly to different site conditions and constraints, even for the same job, but the speed can also vary considerably when different structure element is to be cast. For example, casting a thick slab is usually faster than casting small size columns, beams, or walls. In other words, assuming traveling time is constant, the rate of supply is determined by the methods of unloading, placing, and compacting operations on site. The following tables show the required time for the truck-mixers to unload the concrete from the truck mixer to the structure element. The observations were considering the structural element and the concrete truck-mixer capacity. The capacity of the truck mixtures that are usually used and allowed by the government in Saudi Arabia is varying from 9 m³, 10 m³, and 11 m³ and it is possible to load less than the maximum capacity of the truck mixture. While the structural element can be classified into vertical elements like columns, beams, and walls. And horizontal like foundation, slab, slab on grad ...etc. For every schedule below the researcher used @Risk software to assist in selecting the proper distribution of the unloading observations.

5.5.1 Unloading Time distribution for 9 m³ - Column

Table 8 Unloading Time for 9 m³ – Column (n = 30)

Unloading Time for 9 m ³ – Column (n = 30)				
13.25	15.50	16.50	17.00	18.00
13.50	16.00	16.50	17.00	18.75
14.75	16.00	16.50	17.50	19.75
15.00	16.25	16.75	17.50	20.75

15.00	16.25	16.75	17.50	21.25
15.25	16.50	17.00	17.75	25.75
Mean	Std Dev	Minimum	Maximum	
Min.	Min.	Min.	Min.	
17.06	2.42	13.25	25.75	

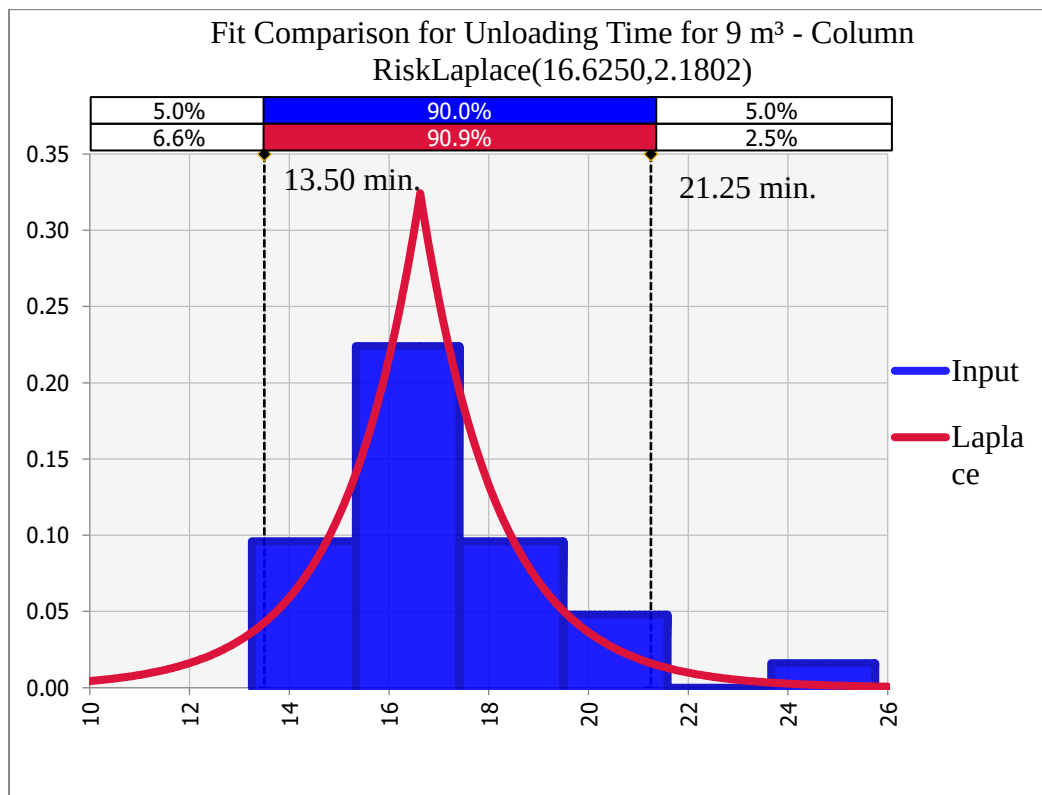


Figure 15 Unloading Time for 9 m³ - Column

5.5.2 Unloading Time for 10 m³ - Column

Table 9 Unloading Time distribution for 10 m³ - Column

Unloading Time for 10 m ³ - Column (n = 30)				
14.75	16.00	17.00	17.75	18.75

15.00	16.00	17.25	18.00	19.00
15.25	16.25	17.25	18.25	19.25
15.50	16.50	17.50	18.25	19.50
15.75	16.75	17.50	18.25	21.75
15.75	16.75	17.75	18.75	26.50
Mean	Std Dev		Minimum	Maximum
Min.	Min.		Min.	Min.
17.53	2.24		14.75	26.5

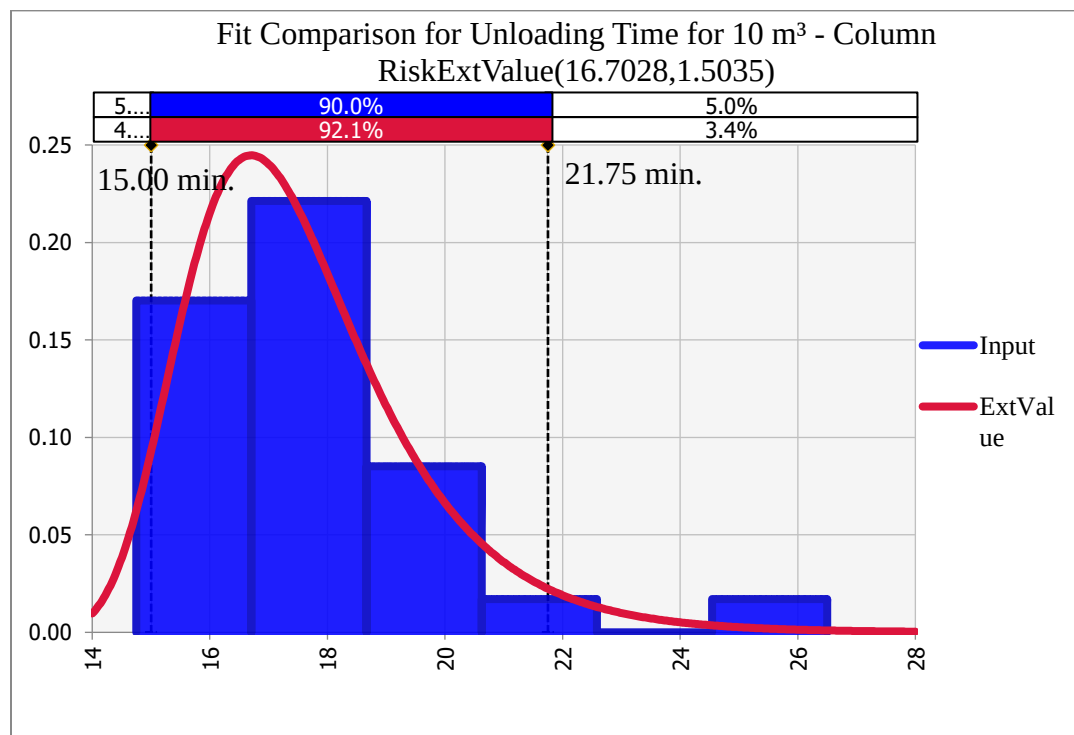


Figure 16 Unloading time for 10 m³ - Column

5.5.3 Unloading Time for 11 m³ - Column

Table 10 Unloading Time for 11 m³ - Column

Unloading Time for 11 m ³ - Column (n = 30)				
14.50	19.00	20.00	20.50	22.50

15.50	19.25	20.25	20.00	22.75
16.75	19.50	20.25	20.75	23.50
17.75	19.75	20.25	20.75	25.75
18.00	19.75	20.50	21.75	26.00
18.75	20.00	20.50	22.25	27.50
Mean	Std Dev	Minimum	Maximum	
Min.	Min.	Min.	Min.	
20.48	2.81	14.5	27.5	

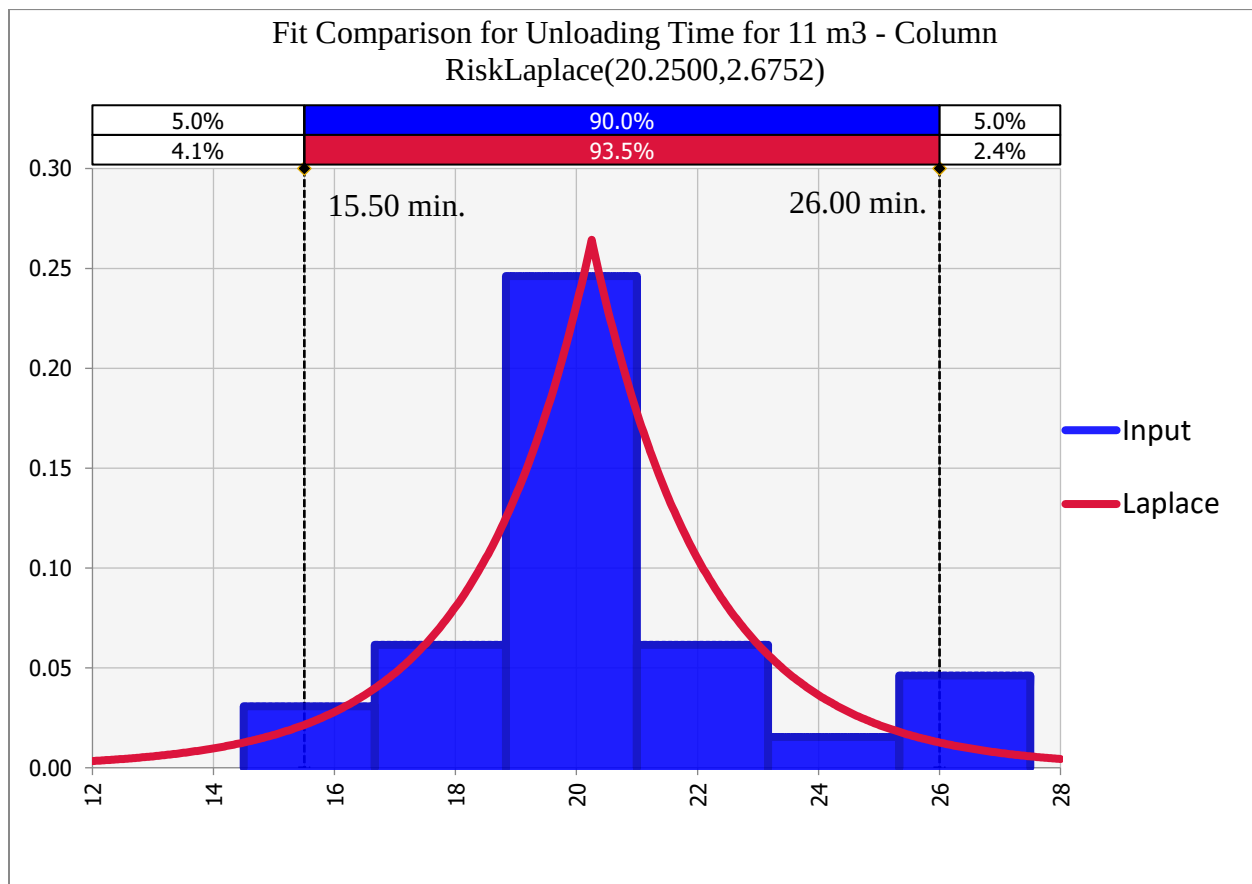


Figure 17 Distribution of Unloading Time for 9, 10,11 m³ - Column

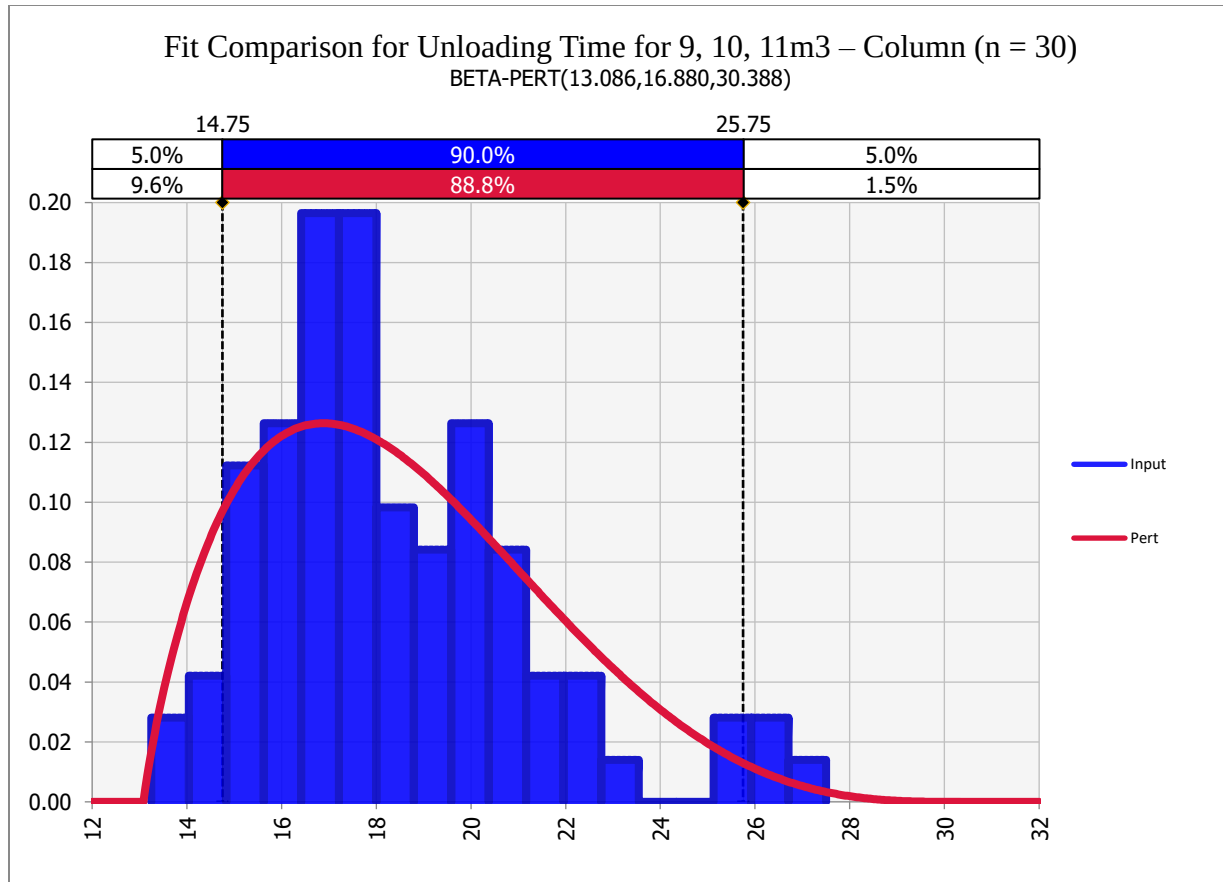


Figure 18 Unloading Time for 9, 10, 11m3 – Column (n = 30)

Figures 15, 16, and 17 show the distribution for unloading time of concrete for each truck capacity used in the batching plant to cast columns. In the simulation, the distribution for the three capacities is used as shown in figure 18, where shows the unloading time of the ready-mix concrete to cast a column is a Beta distribution. Where 88% of the casting will take from 14.75 to 25.75 minutes and rarely extends beyond this time.

5.5.5 Unloading Time for 9 m³ - Beam

Table 11 Unloading Time for 9 m³ - Beam

Unloading Time for 9 m ³ – Beam (n = 30)				
10.75	13.75	15.50	16.25	17.50
12.75	14.75	15.75	16.50	17.50
12.75	15.00	15.75	16.75	17.75
12.75	15.25	16.00	16.75	18.00
13.00	15.25	16.00	17.00	18.85
13.75	15.50	16.25	17.25	19.75
Mean	Std Dev	Minimum	Maximum	
Min.	Min.	Min.	Min.	
15.68	2.01	10.75	19.75	

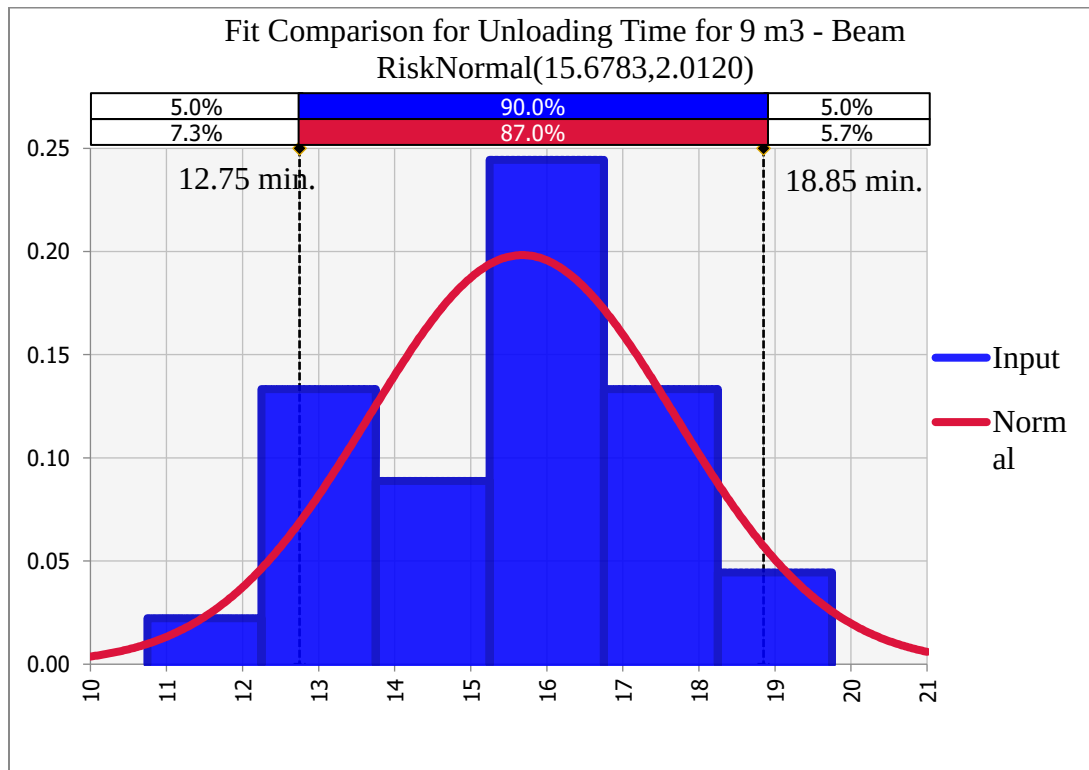


Figure 19 Unloading Time for 9 m³ - Beam

5.5.6 Unloading Time for 10 m³ - Beam

Table 12 Unloading Time for 10 m³ - Beam

Unloading Time for 10 m ³ – Beam (n = 30)				
12.75	14.75	16.75	17.75	19.50
13.00	14.75	16.75	18.25	20.50
13.75	15.00	17.00	18.50	21.50
14.00	15.25	17.50	18.75	22.75
14.25	15.50	17.50	19.00	23.75
14.50	16.00	17.50	19.50	24.00
Mean	Std Dev	Minimum	Maximum	
Min.	Min.	Min.	Min.	
17.34	3.04	12.75	24	

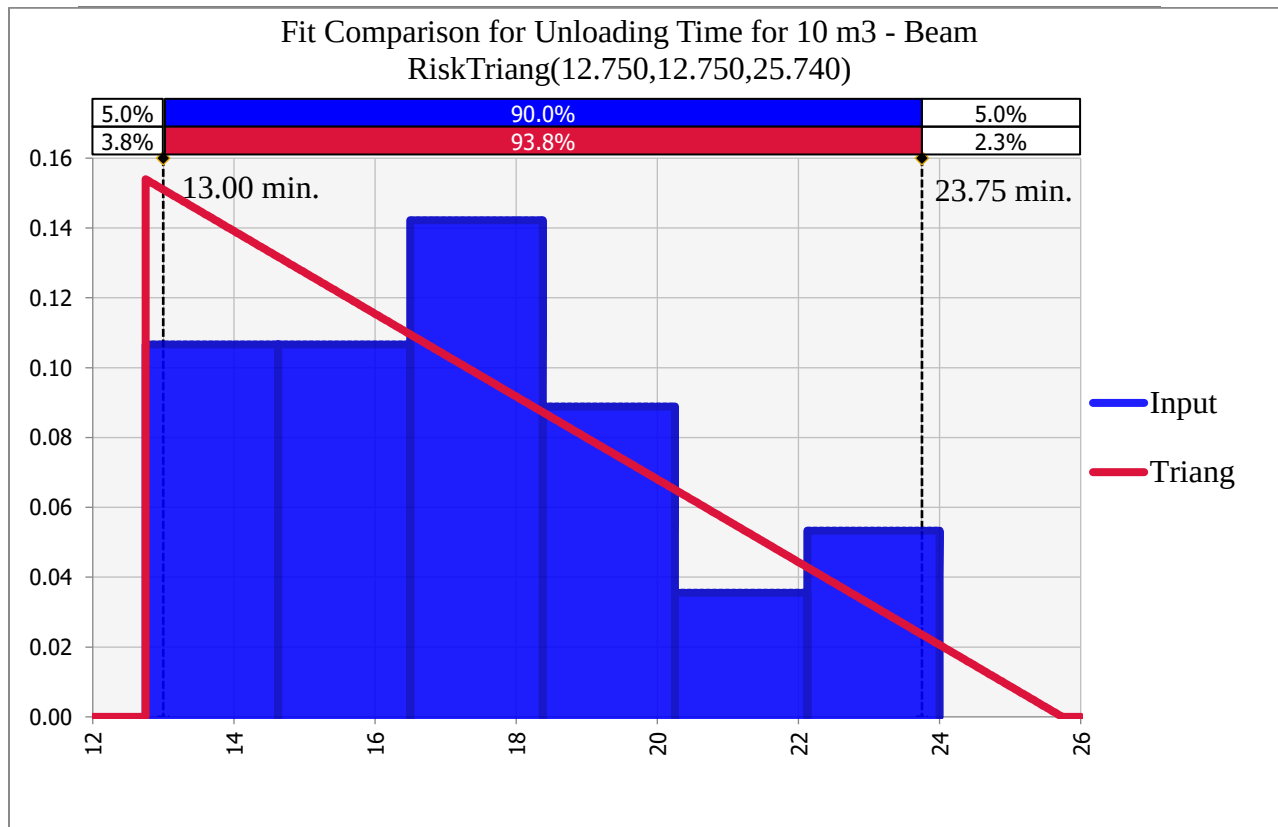


Figure 20 Unloading Time for 10 m³ – Beam

5.5.7 Unloading Time for 11 m³ - Beam

Table 13 Unloading Time for 11 m³ – Beam (n = 30)

Unloading Time for 11 m ³ – Beam (n = 30)				
13.75	16.50	19.50	20.50	22.25
14.00	16.75	19.75	20.75	22.25
14.50	17.25	19.75	21.00	22.50
15.50	18.50	20.00	21.50	22.75
15.75	19.25	20.00	21.50	23.25
16.00	19.50	20.50	21.50	23.75
Mean	Std Dev	Minimum	Maximum	
Min.	Min.	Min.	Min.	
19.34	2.85	13.75	23.75	

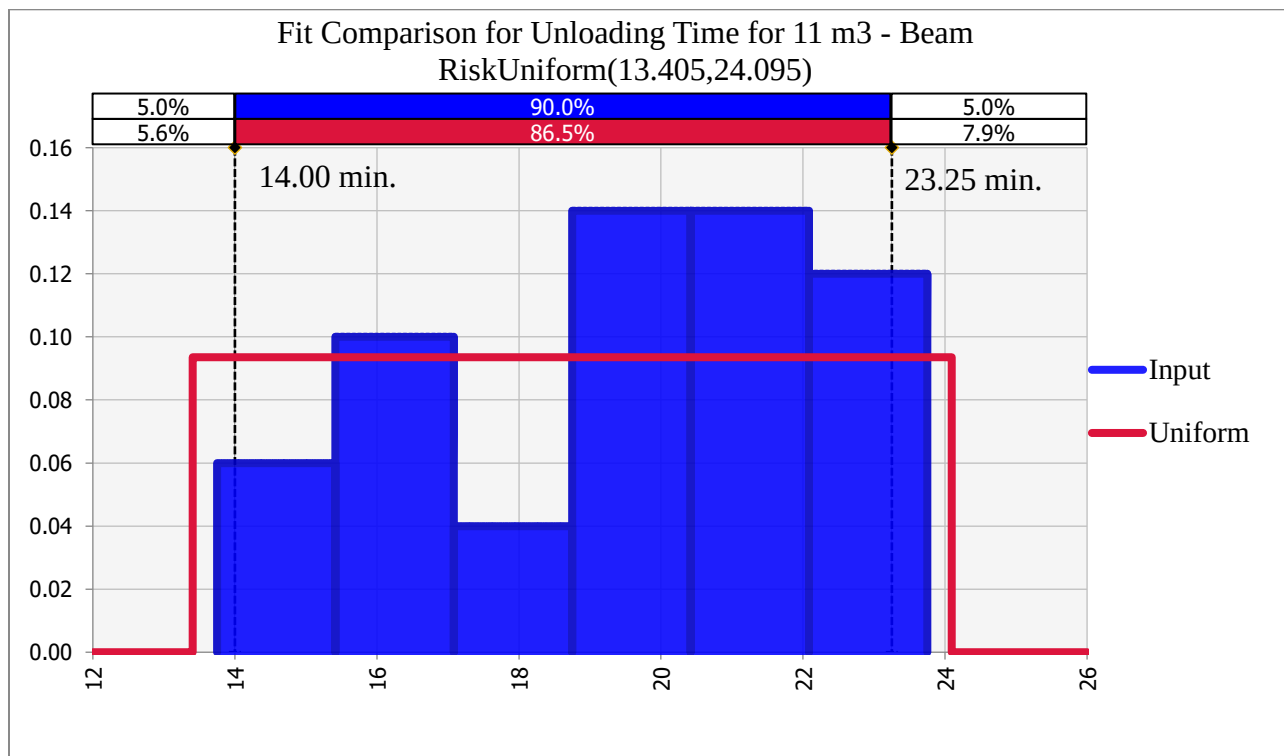


Figure 21 Unloading Time for 11 m³ - Beam

5.5.4 Distribution of Unloading Time for 9, 10, 11 m³ - Beam

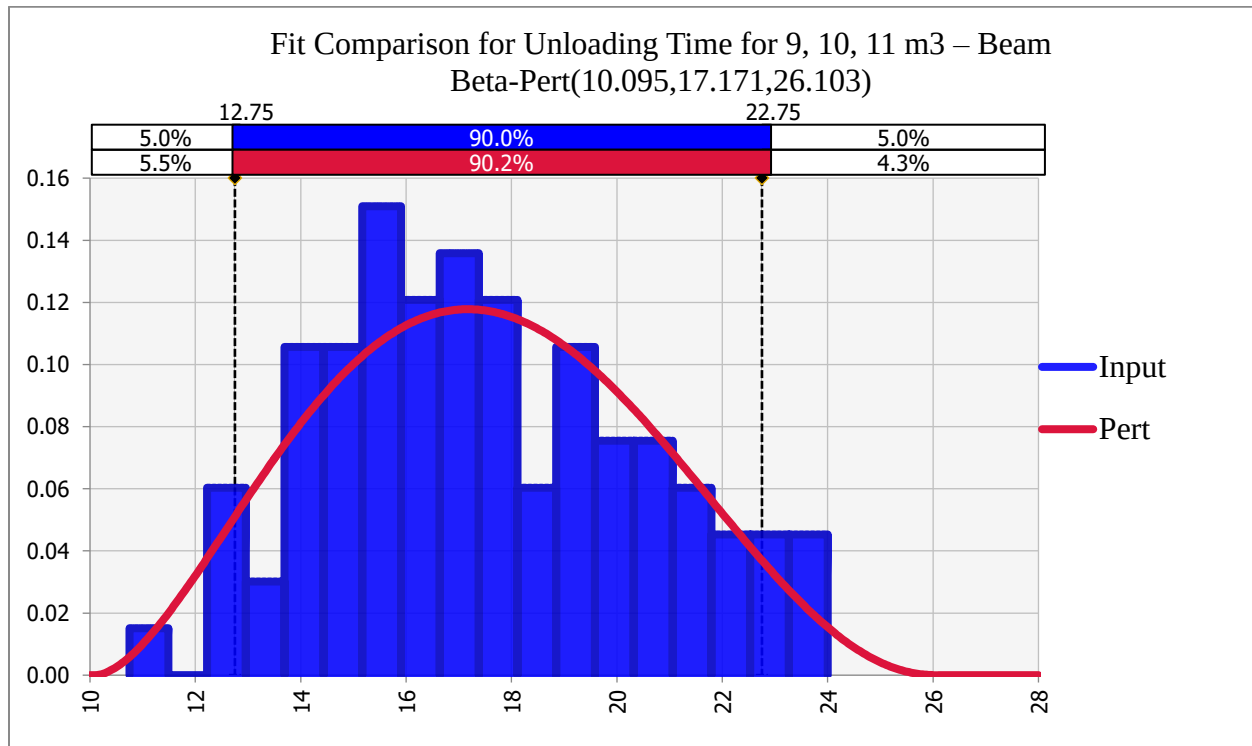


Figure 22 Unloading Time for 9, 10, 11 m³ – Beam

Figures 19, 20, and 21 show the distribution for unloading time of concrete for each truck capacity used in the batching plant to cast beams. In the simulation, the distribution for the three capacities is used as shown in figure 22, where shows the unloading time of the ready-mix concrete to cast a beam is a Beta distribution. Where 90% of the casting will take from 12.75 to 22.75 minutes and rarely extends beyond this time.

5.5.8 Unloading Time for 9 m³ - Foundation

Table 14 Unloading Time for 9 m³ - Foundation (n = 78)

Unloading Time for 9 m ³ - Foundation (n = 78)					
7.50	10.00	10.25	10.50	10.50	11.00

7.50	10.00	10.25	10.50	10.50	11.25
8.75	10.00	10.25	10.50	10.50	11.75
9.25	10.00	10.25	10.50	10.50	11.75
9.75	10.00	10.25	10.50	10.50	11.75
9.75	10.00	10.25	10.50	10.75	12.00
9.75	10.00	10.25	10.50	10.75	12.25
9.75	10.00	10.25	10.50	10.75	12.50
9.75	10.00	10.25	10.50	10.75	12.50
9.75	10.00	10.25	10.50	10.75	13.25
9.75	10.00	10.25	10.50	10.75	15.75
9.75	10.00	10.50	10.50	10.75	18.75
10.00	10.25	10.50	10.50	10.75	23.25
Mean	Std Dev	Minimum	Maximum		
Min.	Min.	Min.	Min.		
10.74	2.01	7.5	23.25		

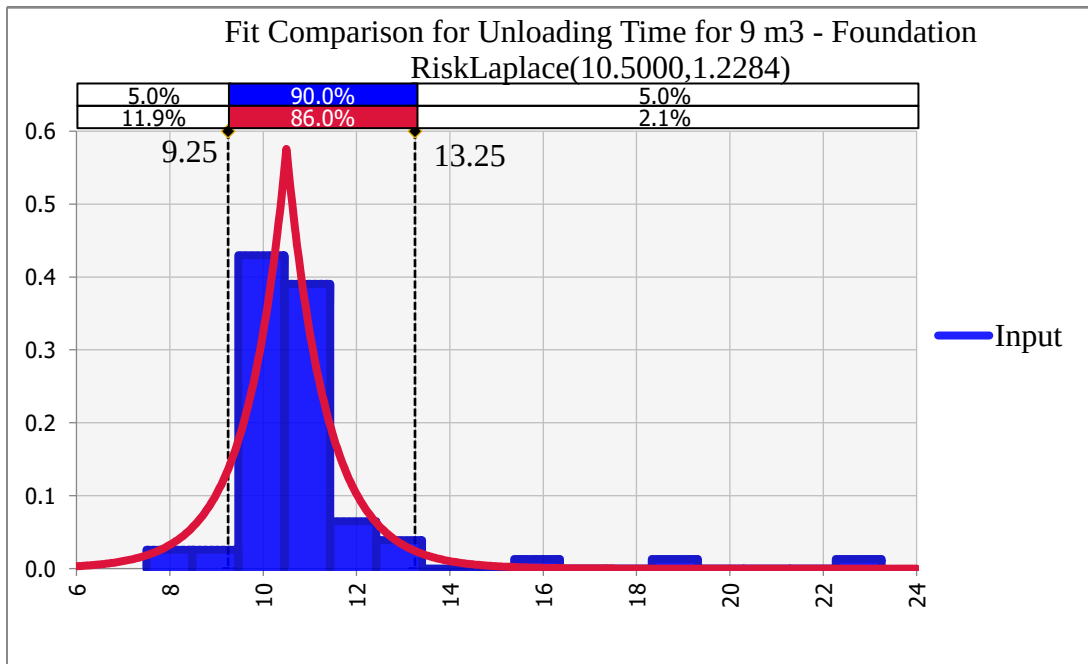


Figure 23 Unloading Time for 9 m3 – Foundation

5.5.7 Unloading Time for 10 m³ - Foundation

Table 15 Unloading Time for 10 m³ - Foundation

Unloading Time for 10 m ³ - Foundation (n = 49)						
7.50	10.75	10.75	11.00	11.25	11.50	11.75
7.75	10.75	10.75	11.00	11.50	11.50	11.75
8.75	10.75	10.75	11.25	11.50	11.50	12.00
9.25	10.75	10.75	11.25	11.50	11.75	12.50
9.50	10.75	10.75	11.25	11.50	11.75	12.75
9.75	10.75	10.75	11.25	11.50	11.75	14.75
10.00	10.75	10.75	11.25	11.50	11.75	15.75
Mean	Std Dev		Minimum		Maximum	
Min.	Min.		Min.		Min.	
11.10	1.33		7.5		15.75	

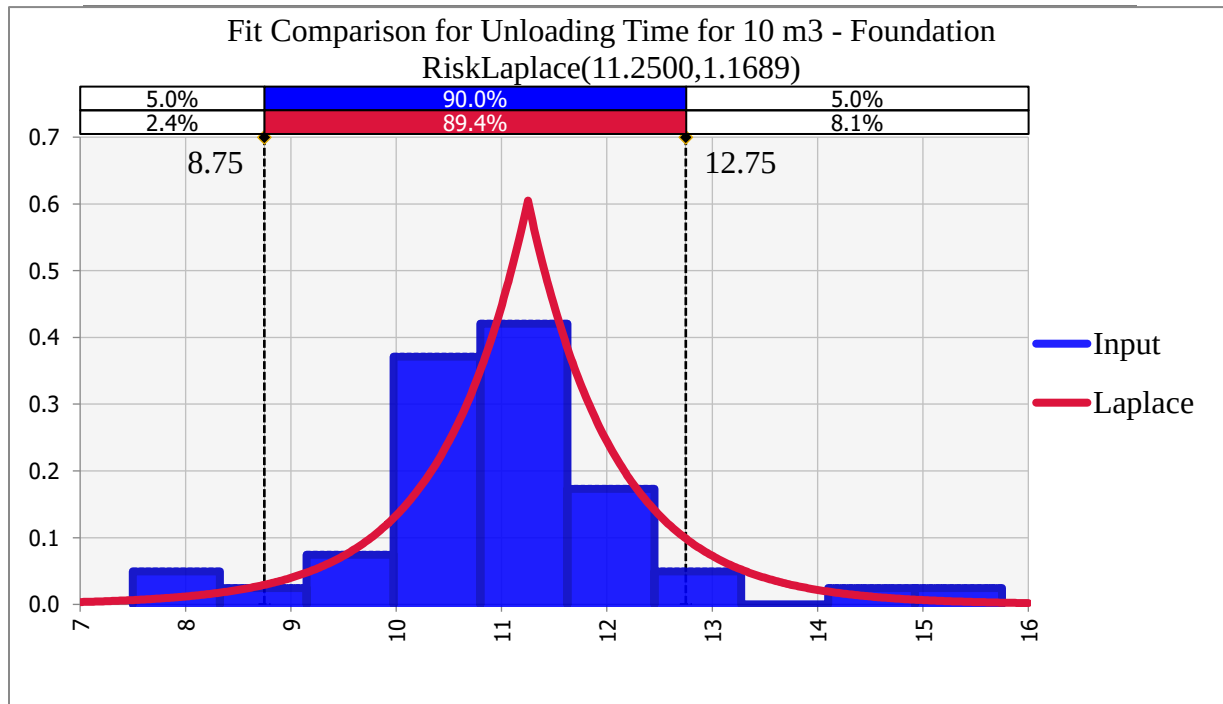


Figure 24 Unloading Time for 10 m³ - Foundation

5.5.8 Unloading Time for 11 m³ - Foundation

Table 16 Unloading Time for 11 m³ - Foundation

Unloading Time for 11 m ³ - Foundation (n = 55)				
8.75	11.75	12.50	12.50	12.75
9.75	12.00	12.50	12.50	12.75
9.75	12.00	12.50	12.50	12.75
10.00	12.00	12.50	12.50	12.75
10.25	12.25	12.50	12.50	12.75
10.75	12.25	12.50	12.50	12.75
11.25	12.25	12.50	12.75	12.75
11.75	12.25	12.50	12.75	12.75
11.75	12.25	12.50	12.75	13.25
11.75	12.25	12.50	12.75	14.00
11.75	12.50	12.50	12.75	15.75
Mean	Std Dev	Minimum	Maximum	
Min.	Min.	Min.	Min.	
12.23	1.05	8.75	15.75	

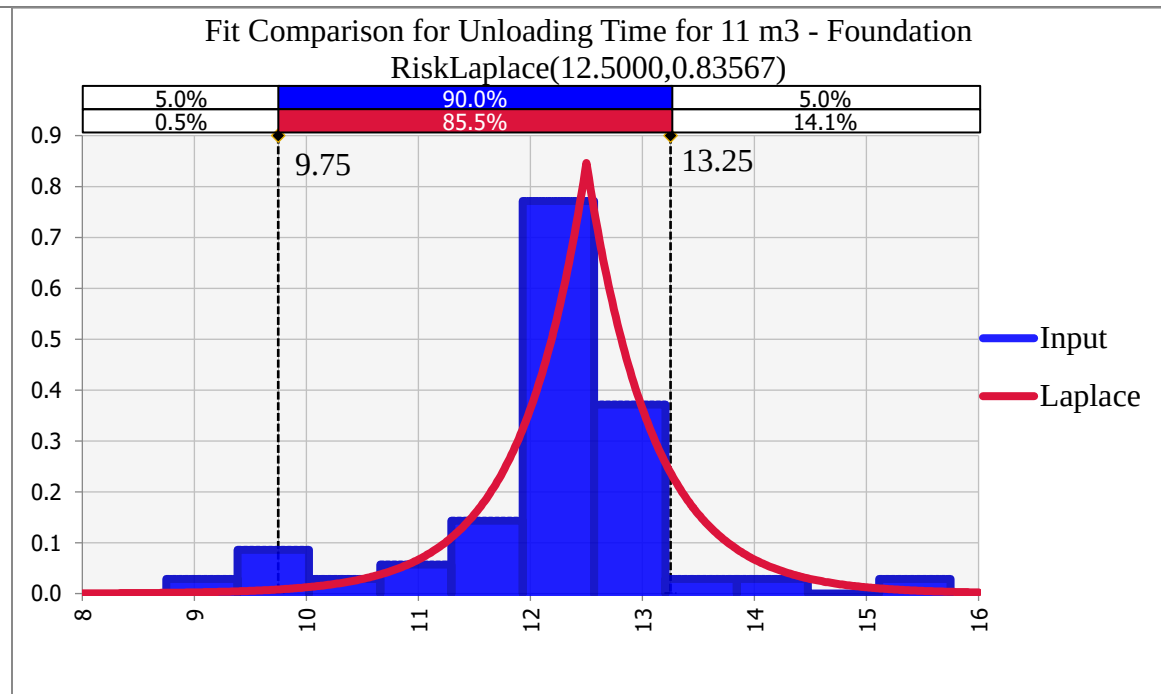


Figure 25 Unloading Time for 11 m³ - Foundation

5.5.4 Distribution of Unloading Time for 9, 10, 11 m³ - Foundation

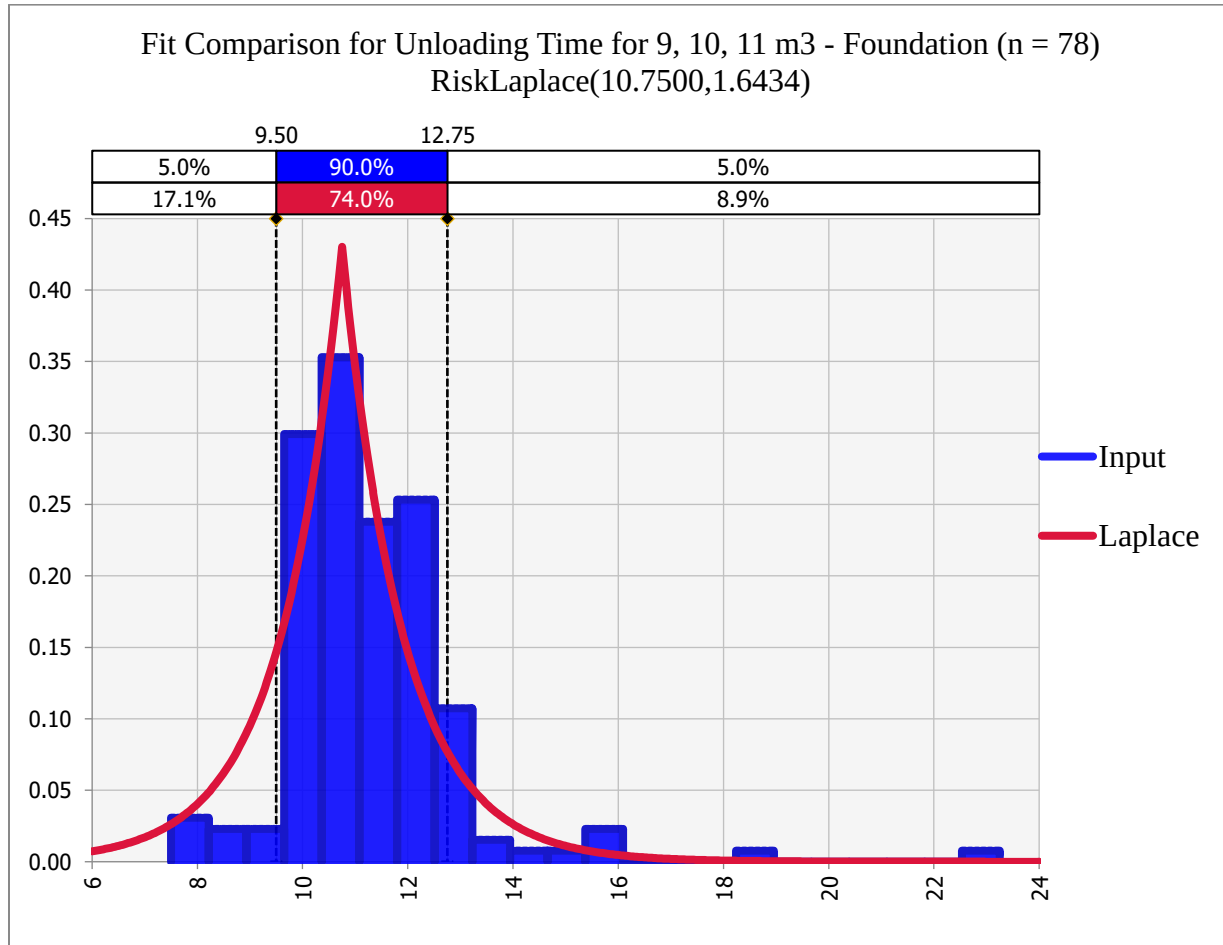


Figure 26 Unloading Time for 9, 10, 11 m³ - Foundation (n = 78)

Figures 23, 24, and 25 show the distribution for unloading time of concrete for each truck capacity used in the batching plant to cast foundations. In the simulation, the distribution for the three capacities is used as shown in figure 26, where shows the unloading time of the ready-mix concrete to cast a foundation is a laplace distribution. Where 74% of the casting will take from 9.5 to 12.75 minutes.

5.5.9 Unloading Time for 9 m³ - Slab

Table 17 Unloading Time for 9 m³ - Slab

Unloading Time for 9 m ³ – Slab (n = 40)			
8.00	10.25	12.00	12.50
8.25	10.25	12.00	12.50
8.75	10.50	12.25	12.50
9.50	10.50	12.25	12.50
9.75	10.50	12.25	12.75
9.75	10.75	12.25	13.25
9.75	11.00	12.50	13.25
10.00	11.75	12.50	13.50
10.00	11.75	12.50	14.75
10.25	12.00	12.50	17.75
Mean	Std Dev	Minimum	Maximum
Min.	Min.	Min.	Min.
11.54	1.82	8	17.75

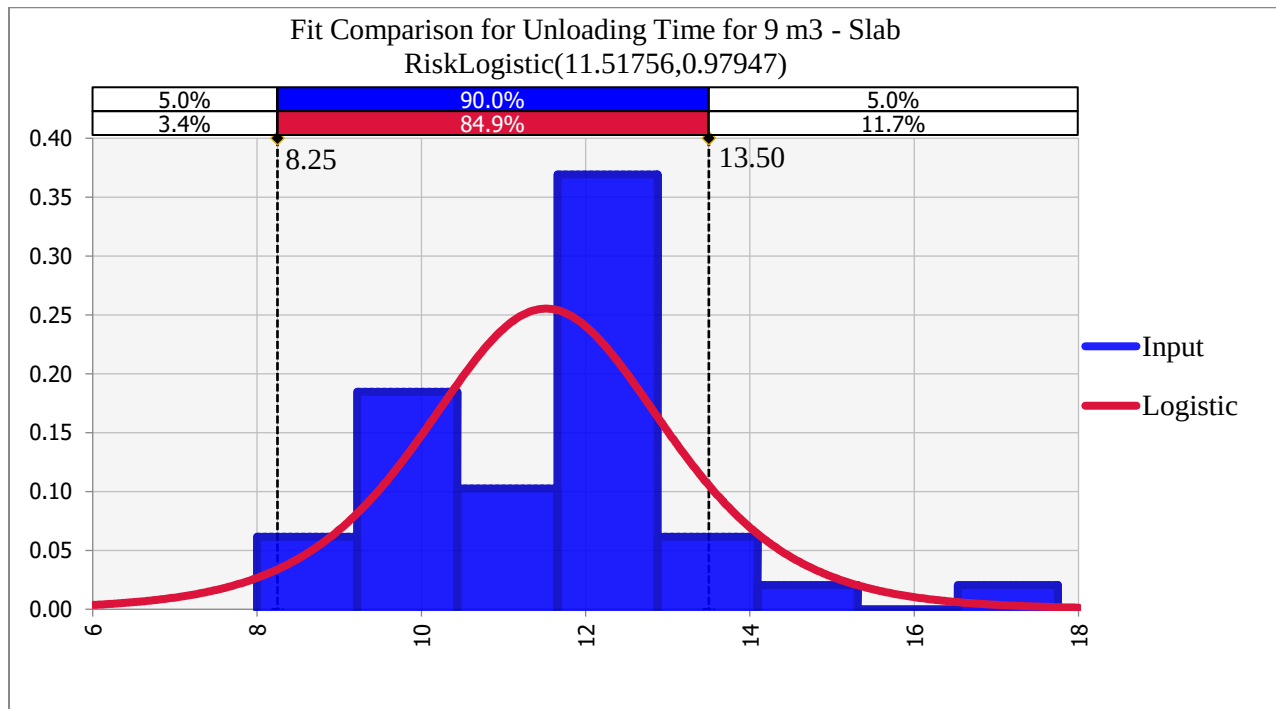


Figure 27 Unloading Time for 9 m³ - Slab

5.5.10 Unloading Time for 10 m³ - Slab

Table 18 Unloading Time for 10 m³ - Slab

Unloading Time for 10 m ³ – Slab (n = 40)			
8.75	11.25	12.00	15.25
10.75	11.25	12.50	15.50
10.75	11.50	12.75	15.50
11.00	11.50	13.25	15.50
11.00	11.50	13.50	15.75
11.00	11.50	13.50	16.75
11.25	11.50	13.50	17.00
11.25	11.75	14.00	18.75
11.25	11.75	14.00	19.75
11.25	12.00	15.25	21.75
Mean	Std Dev	Minimum	Maximum
Min.	Min.	Min.	Min.
13.24	2.76	8.75	21.75

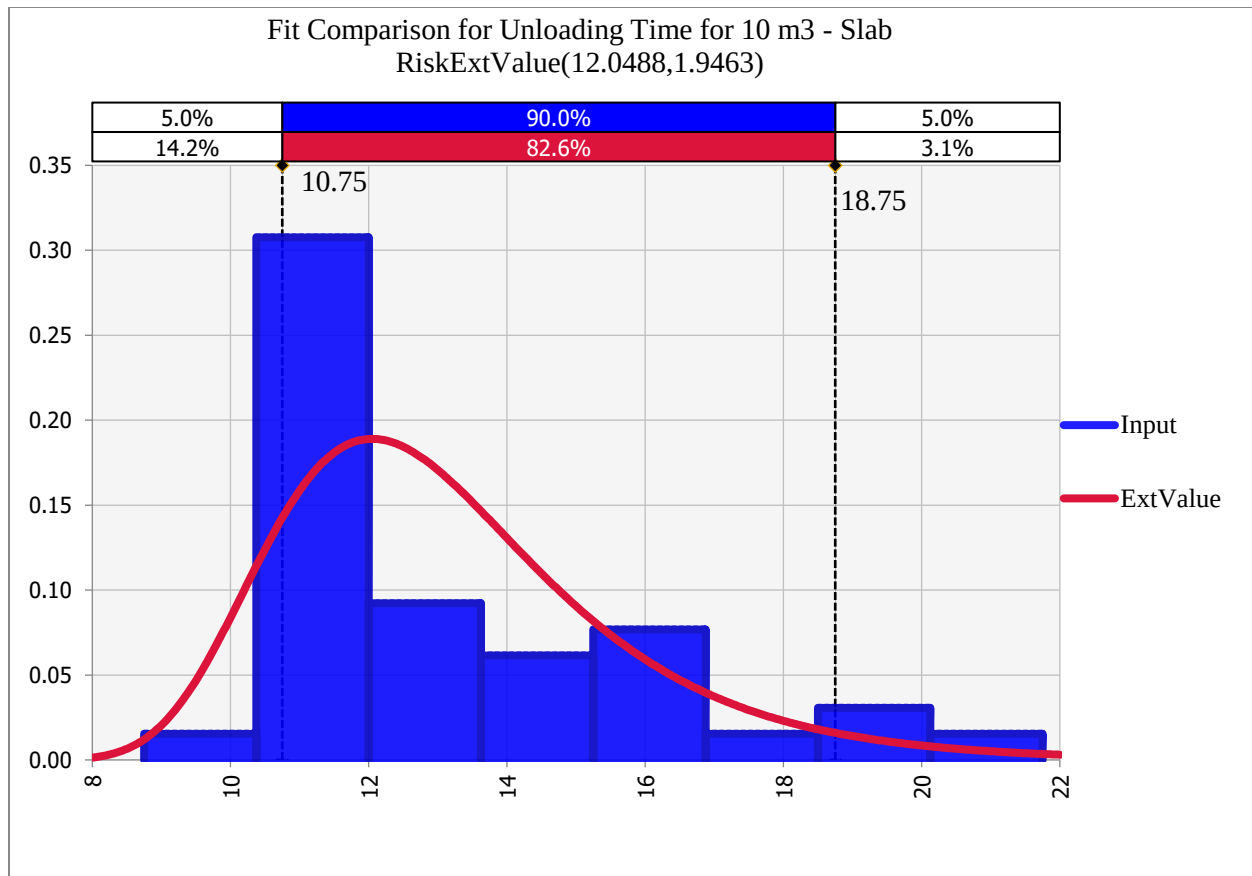


Figure 28 Unloading Time for 10 m3 – Slab

5.5.11 Unloading Time for 11 m³ - Slab

Table 19 Unloading Time for 11 m3 – Slab (n = 44)

Unloading Time for 11 m3 – Slab (n = 44)			
10.75	12.25	13.00	14.50
10.75	12.25	13.75	14.75
11.00	12.25	13.75	15.25
11.75	12.50	14.00	15.75
11.75	12.50	14.25	16.00
11.75	12.50	14.25	16.50
12.00	12.50	14.25	16.75
12.00	12.50	14.25	17.00
12.00	12.50	14.50	17.50

12.25	12.75	14.50	22.75
12.25	13.00	14.50	24.75
Mean	Std Dev	Minimum	Maximum
Min.	Min.	Min.	Min.
13.80	2.81	11	25

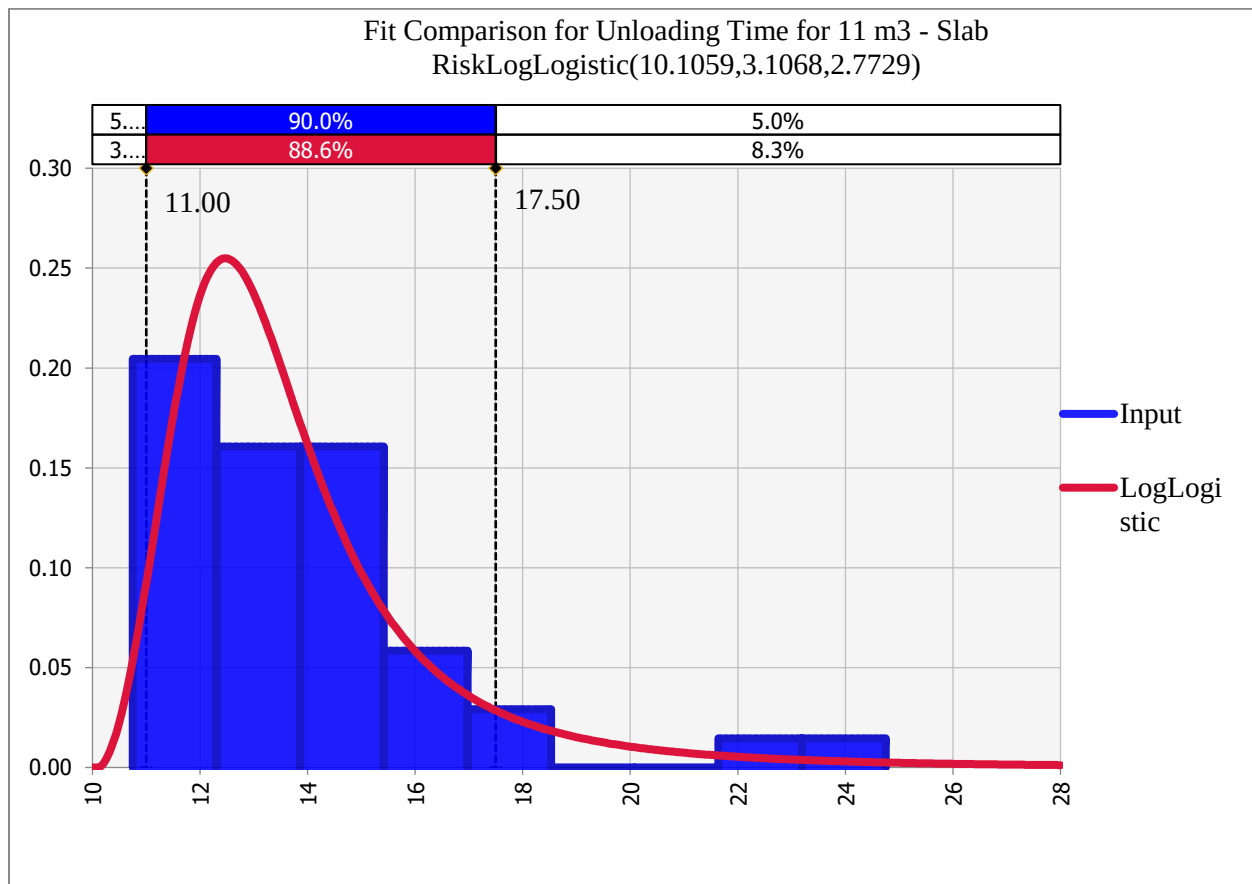


Figure 29 Unloading Time for 11 m3 - Slab

5.5.4 Distribution of Unloading Time for 9, 10, 11 m³ - Slab

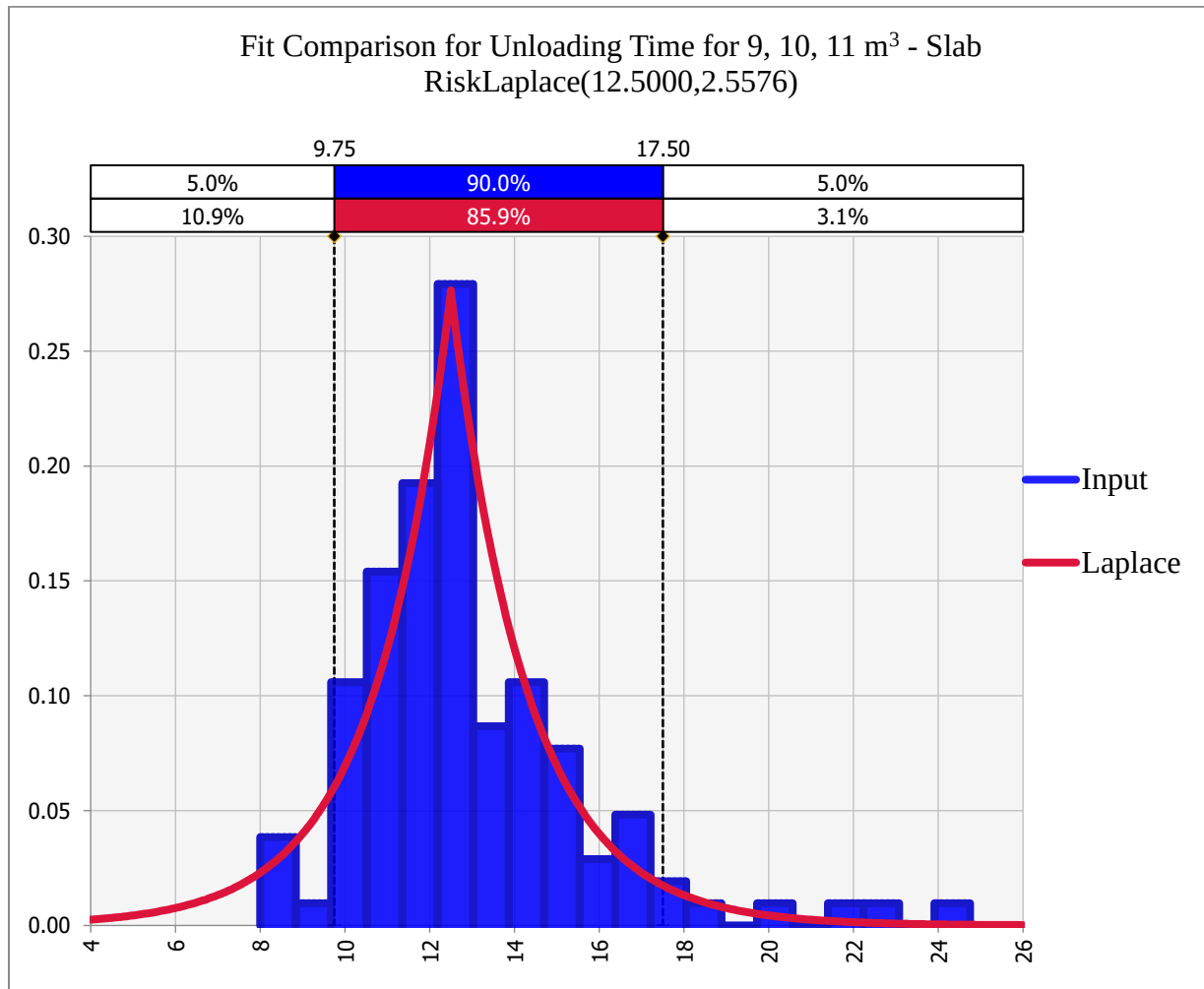


Figure 30 Unloading Time for 9, 10, 11 m³ - Slab

Figures 27, 28, and 29 show the distribution for unloading time of concrete for each truck capacity used in the batching plant to cast slabs. In the simulation, the distribution for the three capacities is used as shown in figure 30, where shows the unloading time of the ready-mix concrete to cast a foundation is a Laplace distribution. Where 85.9% of the casting will take from 9.75 to 17.5 minutes.

CHAPTER 6

SIMULATION MODEL

The simulation model will be built according to the actual situation, considering the quantity of the requested concrete from the client and the structural element used for casting the concrete, while the distance will be controlled via the GPS feature that is included in AnyLogic® software. The data used in the model was gathered from a local concrete batching plant to build the model and the current performance will be measured. Thereafter, the suggestion will add to improve the production process and increase the batching plant performance. The output of the simulation model could be used in the batching plant to support the decision making for planning and scheduling processes.

6.2 The simulation Model Process Map using Any-Logic®

The process map used at Any-Logic® is divided into four sections according to the orders that can be handled simultaneously which is determined by the available numbers of pumps at the batching plant as shown in Figure 31.

When the order is generated by the model it will go into a queue to be assigned any available pumps as shown in Figure 32. Then the concrete pump will start handling the job and move to the site as shown in Figure 33. Parallel to the order initiation, there is another process to release the truck as shown in Figures 34 and 35.

The batching plant will continue sending trucks until satisfying the quantity which has been ordered before.

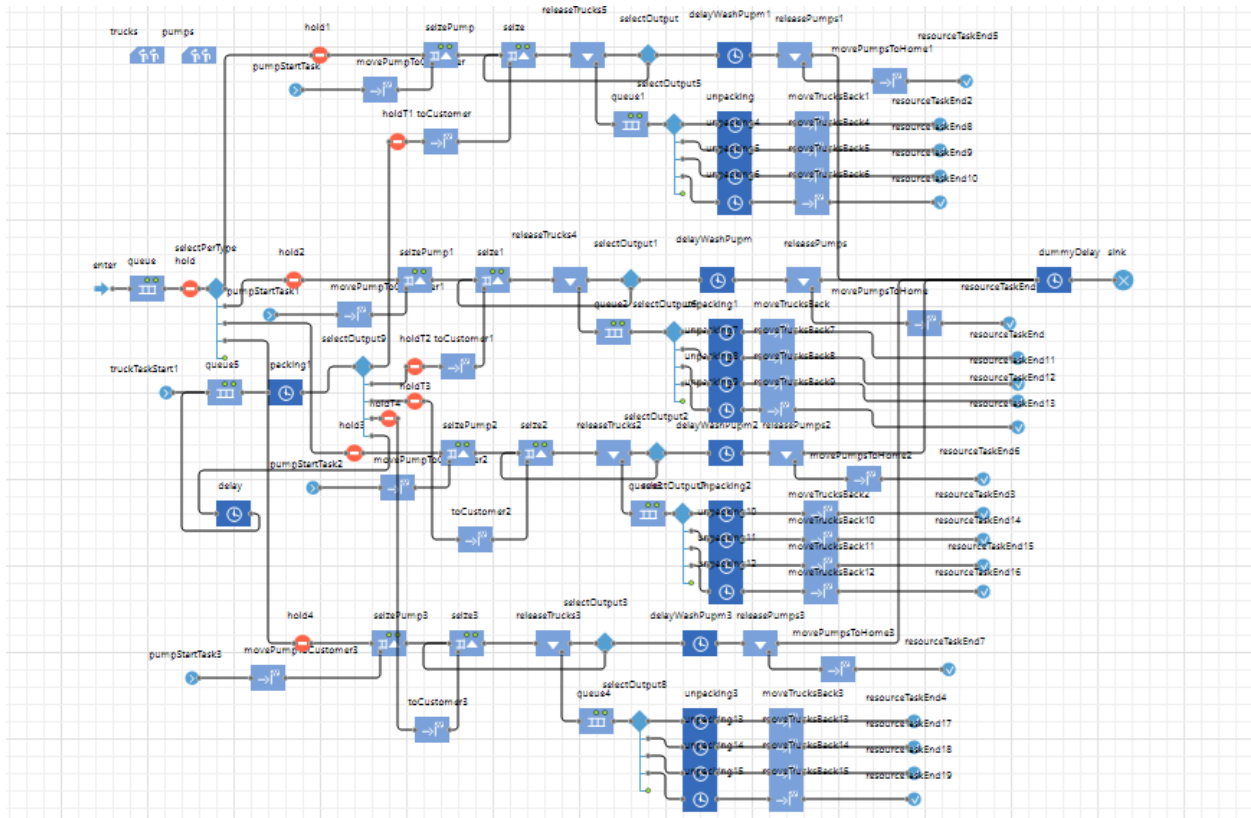


Figure 31 Main Process map

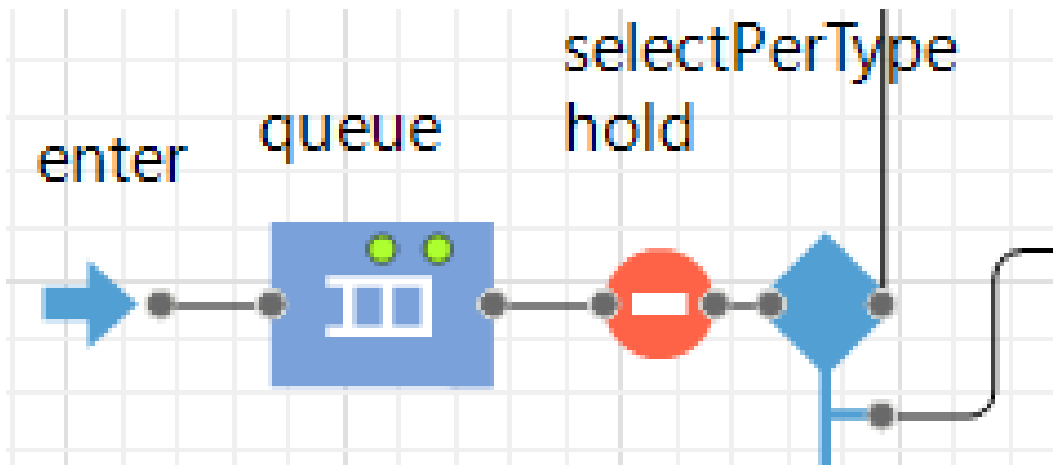


Figure 32 First step in the process map is receiving the order

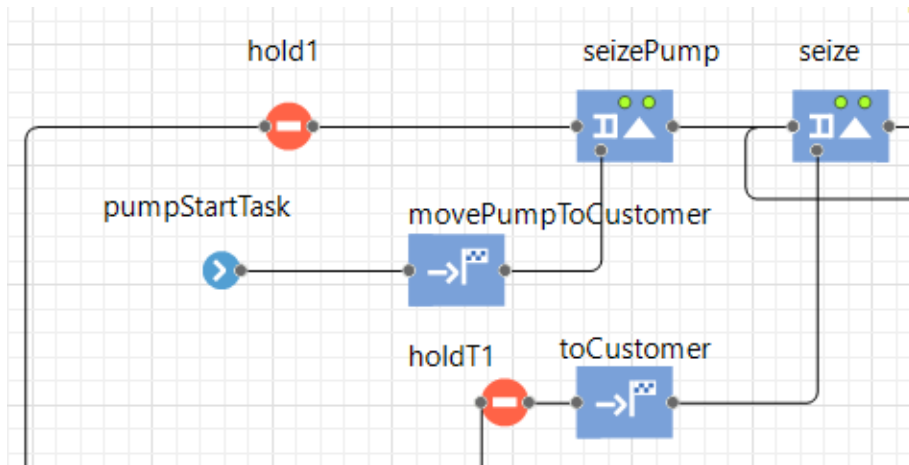


Figure 33 Second step in the process map for each concrete pump

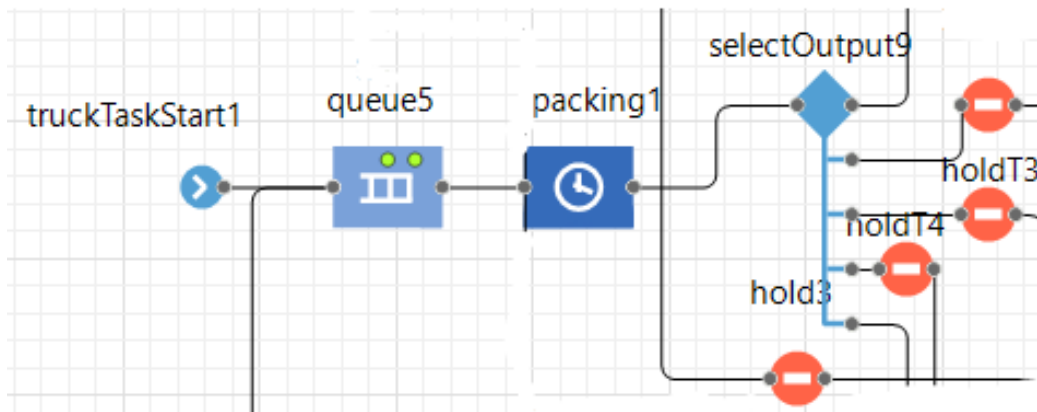


Figure 34 Third step in the process map the release of the concrete mixer and attach to the process map

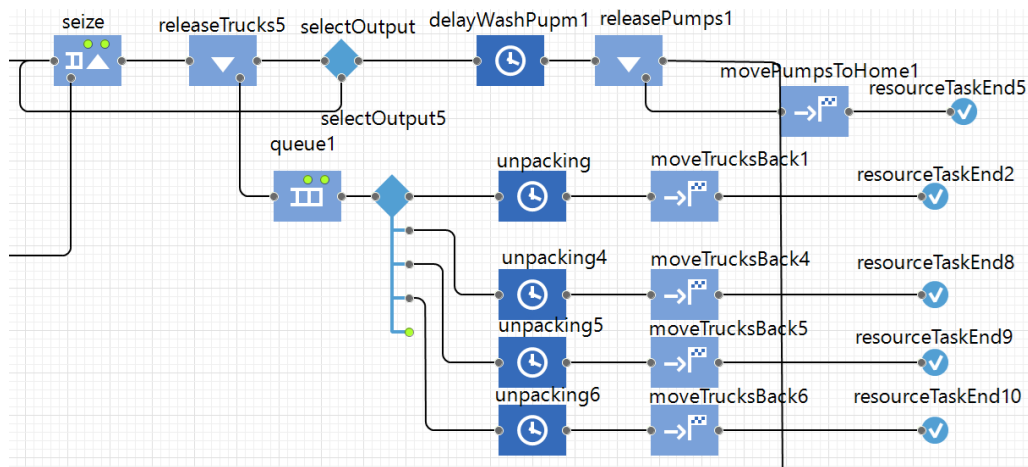


Figure 35 After the pump and the mixer attached to the process

The unloading time is different between the structural elements and as has been discussed previously. This is conveyed on the process map as shown in Figure 35, where the first line shows the required time for unloading of the column, then the beams show at the second line, while the slab and foundations follow them. The Figure 36 shows the end of the job.

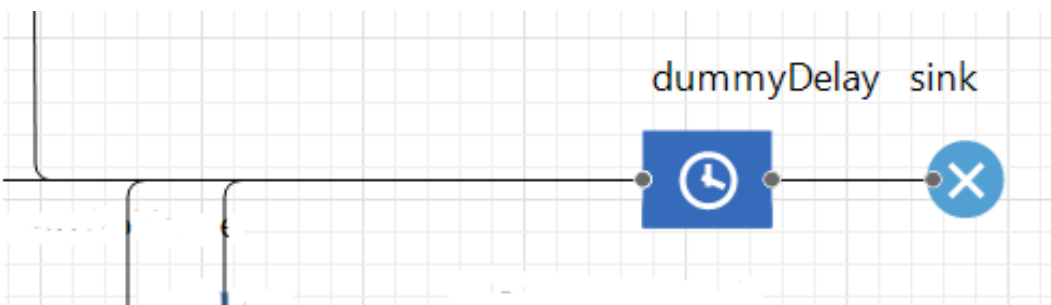


Figure 36 Release the Pump and end of the job

6.3 Agents on the model

The agents were added to the simulation model as shown in figure 37. The process map of the model is existing at the batching plant agent. The customer agent shows the distribution of the order initiation and state chart were used in the client agent to the batching plant and also for each structure element as shown in Figure 38.

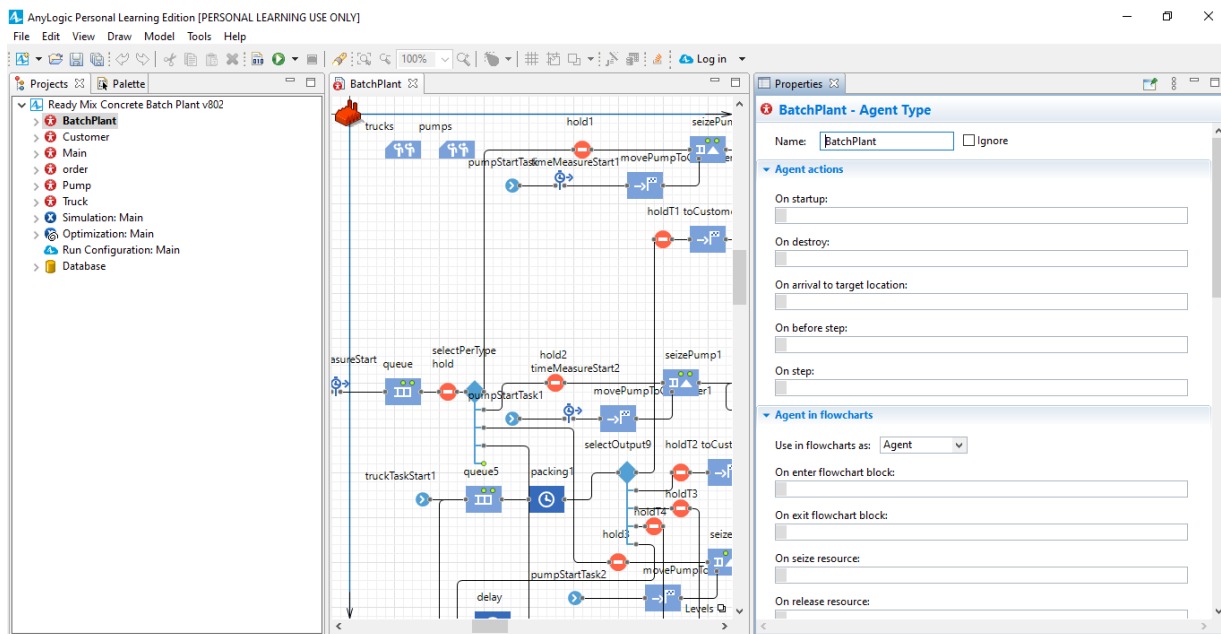


Figure 37 The main window of the model



Figure 38 Customer agent and the distributions for each structure element

The GIS map shown in Main Agent, where it shows the area where the batching plant is located and the areas that served by the batching plant as shown in Figure 39.

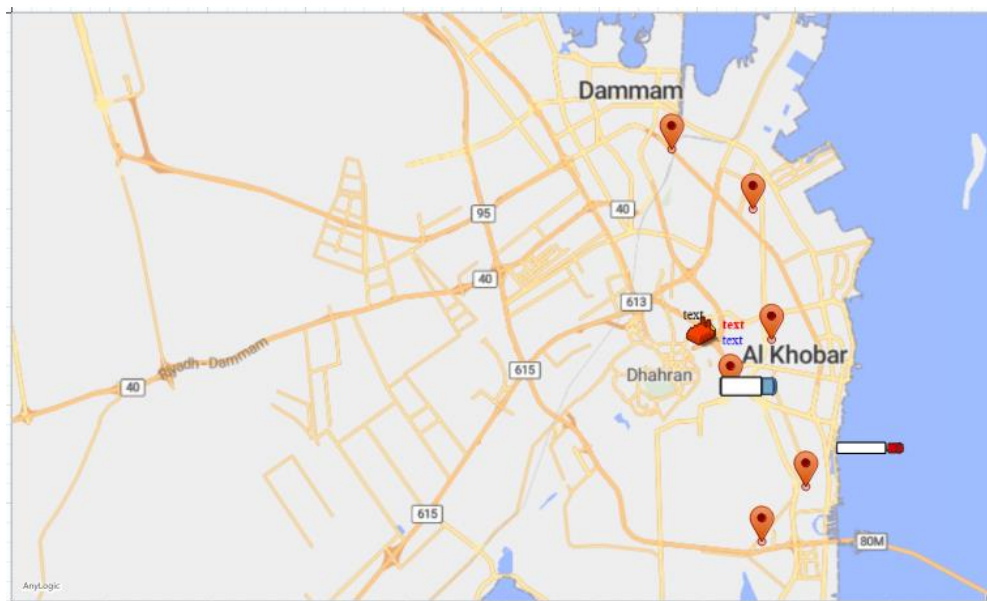


Figure 39 GIS map used at the model

6.4 Running the simulation model

During model execution, the customer agent makes an order with the type of structure element and the required quantity as shown in the Figure 40. The Batching plant will release the concrete pumps and after a while the concrete mixtures will be called to customer respective site. When the concrete mixer reaches the site it will attach to the pump and unload the concrete. The unloading time will be varying according to structure type. After the unloading is finished the truck mixer will do a clean up and head back to the batching plant to take another job. After all, when the customer required order is fulfilled, the customer agent will send a signal to the batching plant to stop sending more trucks. Then the pump will fold the boom and return to the batching plant to get another job.

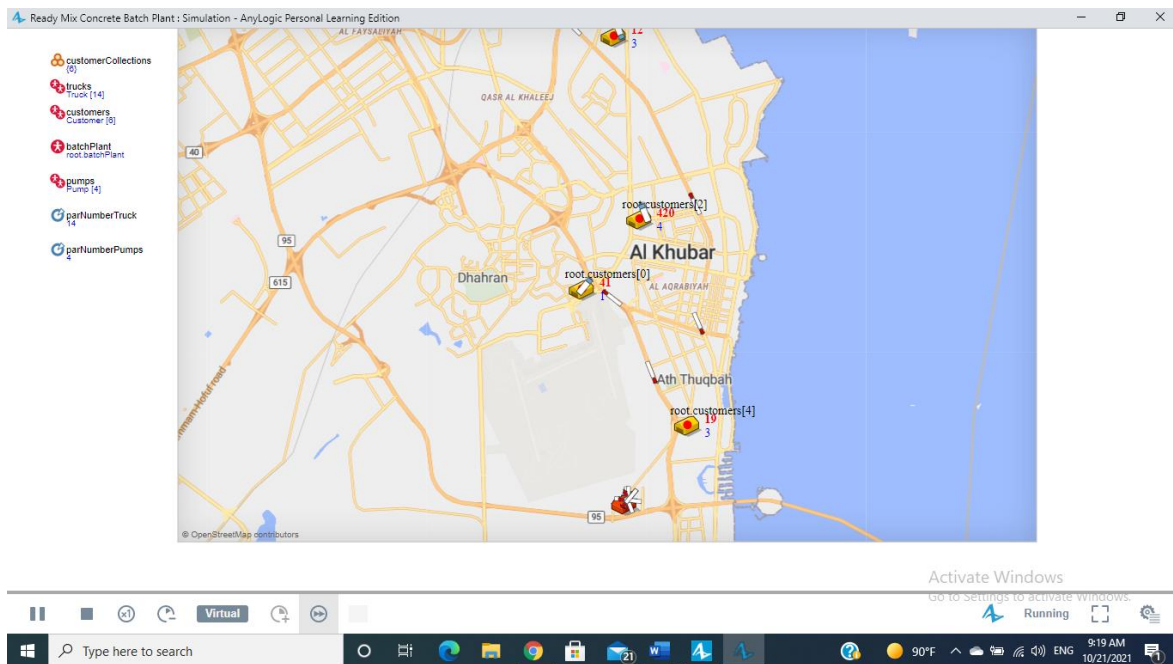


Figure 40 Shows the customer sites and the batching plant location during the model is working.

6.5 Model verification

From the database after running the model, the sample has been taken to verify the simulated job durations. As shown below in the table, the job duration for a pump is somehow comparable to the real-time for job completion in the batching plant.

Agent		Start the job	End the Job	Time to complete the job
Customer	waitingDetails	12/01/2020 19:17:02	13/01/2020 2:00:44	6.7
Customer	waitingDetails	13/01/2020 5:27:09	13/01/2020 10:25:30	5.0
Customer	waitingDetails	13/01/2020 16:10:20	13/01/2020 23:24:41	7.2
Customer	waitingDetails	14/01/2020 3:19:37	14/01/2020 12:16:06	8.9
Customer	waitingDetails	14/01/2020 20:20:42	15/01/2020 5:10:29	8.8
Customer	waitingDetails	15/01/2020 5:15:50	15/01/2020 16:15:18	11.0
Customer	waitingDetails	15/01/2020 18:13:57	16/01/2020 9:45:52	15.5
Customer	waitingDetails	16/01/2020 10:54:44	17/01/2020 13:27:06	26.5
Customer	waitingDetails	17/01/2020 15:01:10	17/01/2020 19:14:26	4.2
Customer	waitingDetails	18/01/2020 0:53:29	18/01/2020 10:59:15	10.1
Customer	waitingDetails	18/01/2020 20:25:02	19/01/2020 9:05:55	12.7
Customer	waitingDetails	19/01/2020 10:09:55	19/01/2020 13:10:36	3.0
Customer	waitingDetails	19/01/2020 13:44:51	19/01/2020 21:28:25	7.7
Customer	waitingDetails	20/01/2020 3:28:59	20/01/2020 13:29:46	10.0
Customer	waitingDetails	21/01/2020 4:53:12	21/01/2020 11:04:49	6.2
Customer	waitingDetails	21/01/2020 11:53:14	21/01/2020 22:10:07	10.3
Customer	waitingDetails	21/01/2020 23:20:29	22/01/2020 21:04:15	21.7
Customer	waitingDetails	22/01/2020	23/01/2020	9.6

		21:05:41	6:39:12	
Customer	waitingDetails	23/01/2020 14:38:55	23/01/2020 18:59:44	4.3
Customer	waitingDetails	23/01/2020 20:34:21	24/01/2020 5:08:27	8.6
Customer	waitingDetails	24/01/2020 5:44:07	24/01/2020 14:57:26	9.2
Customer	waitingDetails	24/01/2020 17:24:33	24/01/2020 23:42:00	6.3
Customer	waitingDetails	25/01/2020 15:39:05	26/01/2020 16:35:19	24.9
Customer	waitingDetails	26/01/2020 19:03:22	27/01/2020 4:42:08	9.6
Customer	waitingDetails	27/01/2020 7:05:24	28/01/2020 3:20:56	20.3
Customer	waitingDetails	29/01/2020 4:03:57	29/01/2020 16:56:57	12.9
Customer	waitingDetails	29/01/2020 17:30:47	30/01/2020 3:27:17	9.9
Customer	waitingDetails	30/01/2020 3:36:14	30/01/2020 17:11:56	13.6
Customer	waitingDetails	30/01/2020 18:21:38	31/01/2020 11:13:16	16.9
Customer	waitingDetails	31/01/2020 16:35:37	01/02/2020 2:55:11	10.3
Customer	waitingDetails	01/02/2020 6:59:34	01/02/2020 13:19:39	6.3

CHAPTER 7

RESULT AND DISCUSSION

This chapter focuses on the presentation, discussion, findings, and analysis of the data according to research objectives. The field research was conducted with respect to the objectives of the research. The obtained data were analyzed with the aid of @RISK® Software. For modeling, the AnyLogic® software was used. Charts and summary tables were used to present the result of the model and data from the field.

7.2 Evaluation of the Current Situation

The concrete delivery can be evaluated from two perspectives. The concrete ready-mix company wants to serve more customers in the meanwhile reduce the idle time of their truck-mixer on the customer sites and cast as much as possible to increase the daily production. Increasing the production led to reducing the unit cost. When the unit cost reduces the company can increase their profits and allow the company to reduce their price and increase their market share. To do that concrete ready mix companies always give priority to the customers with large quantities and maintain the customer satisfy forced to cast his small quantity on the other days.

On the other hand, the customer wants concrete available on his site with high quality whenever he needs it with no consideration of the time the truck-mixer is spending on his site if it is not affected by the quality of concrete. In that regard, we can extract two numbers that can represent and evaluate the concrete batching plant performance and customer satisfaction.

The below chart in Figure 41 shows how many trucks waiting on sites. As we can see more than 25% wait only one minute which is usually the truck maneuver time to connect the truck mixer to the pump. While there is one percent of truck mixers are waiting up to 25 minutes.

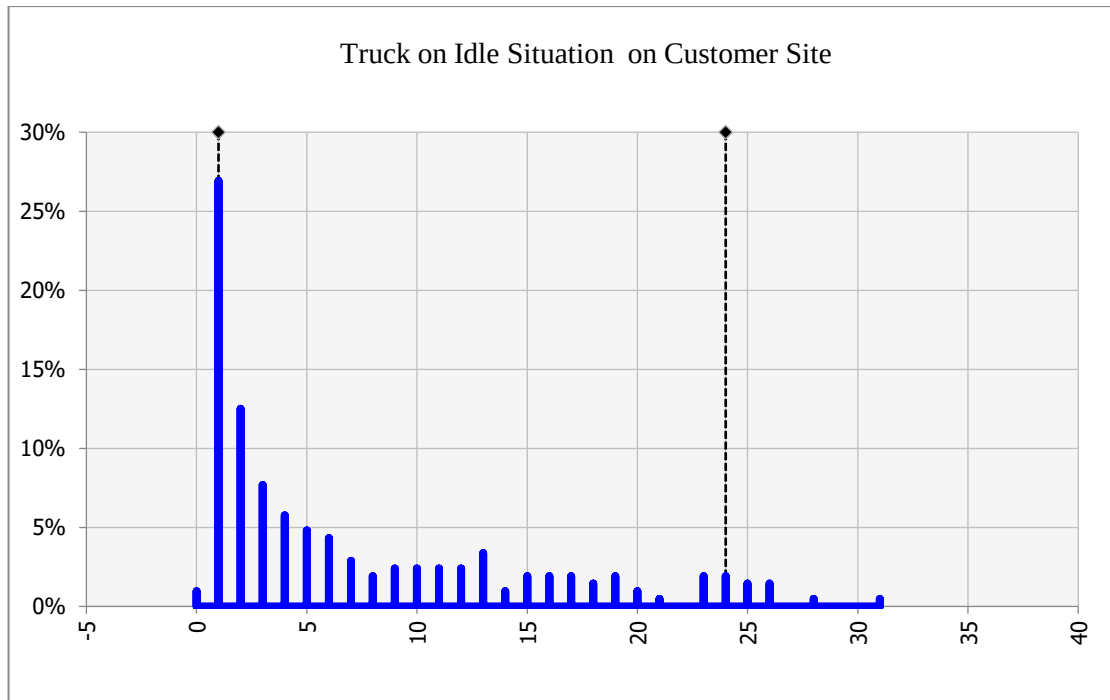


Figure 41 Idle truck in the customer site

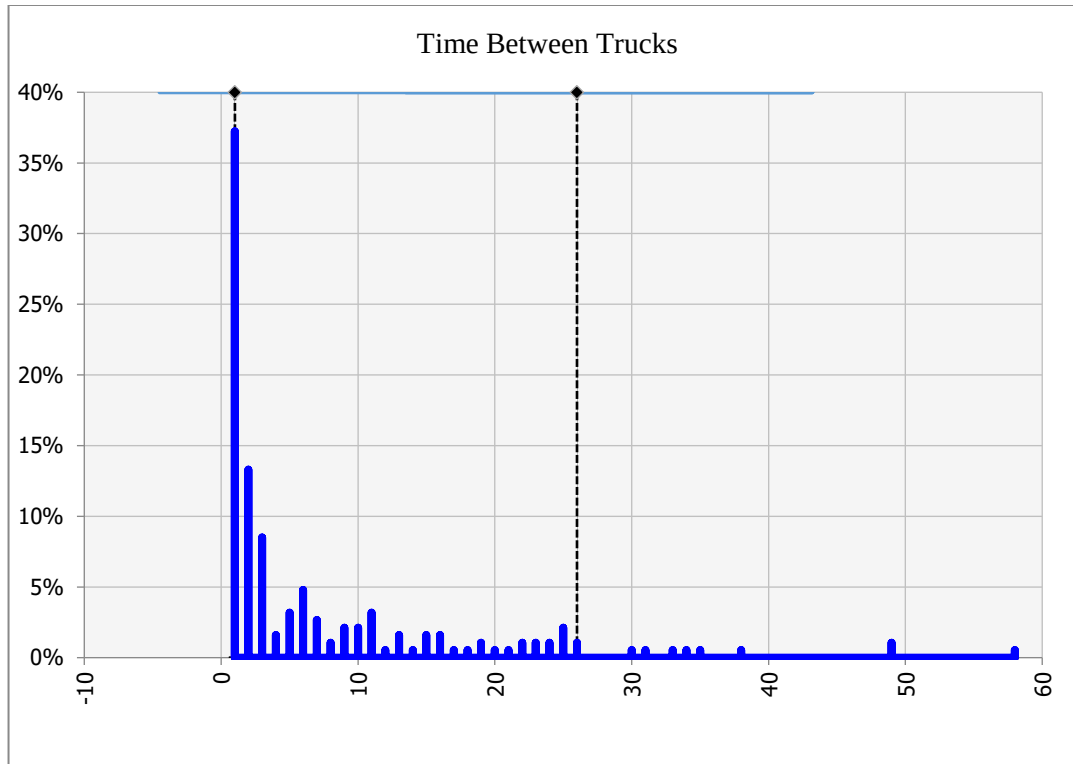


Figure 42 Time Between Trucks

The second chart, Figure 42, shows the time between two trucks which can present customer satisfaction. More than 35% of the time of the truck mixers is one minute, **however**, sometimes reaches 20 minutes. When the time between two mixers is more than 20 minutes it will affect the structure quality and it could lead to concrete cold joints and concrete repair works. When the time between two trucks is increasing, customer satisfaction is decreasing.

7.3 Using Simulation to Support Decision Making

As mentioned previously, ready-mixed concrete is both a product and a service. In providing the product, a ready-mixed concrete supplier must deliver the freshly mixed concrete of the workability required by the contractor and having potential qualities in the hardened state which satisfies the engineer's specification. In providing a service, the supplier must

deliver the product in the quantities required and at a rate to suit the contractor's handling and placing requirements (Newman, 1975).

This research proposes to integrate the simulation software as a tool in the batching plant system to support the decision-making process which will furnish pertinent information to the shippers. It is aimed to enhance the effectiveness of shippers' decision-making abilities. The proposed system gives a better understanding and preparation of the tasks leading towards an appropriate evaluation and selection of alternatives.

7.4 Comparison Between the Actual and the Simulation Model Results

The data was collected from the concrete batching plant having fourteen concrete truck mixtures and four concrete pumps, where the below chart shows the idle concrete truck mixtures at the site waiting their turn to start casting. On average the concrete truck mixers wait for 4 minutes on the construction site, where on some jobs the concrete mixtures are on queue reached almost to 25 and 30 minutes of waiting at the site and usually, those trucks will not be able to cast the concrete, and it will return to the batching plant.

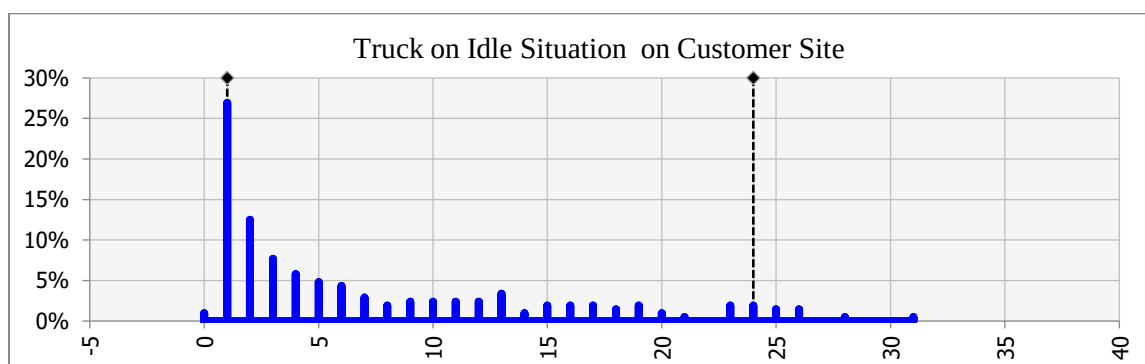


Figure 43 Truck on Idle Situation on Customer Site

Similarly, when we run the model with the same date used to draw the previous chart which is in Figure 43, the simulation shows almost zero hours waiting at the site as shown in the below

chart in Figure 44, as the model simulate the reality and make better decisions on the truck mixtures distribution than the man-made decisions where it shows the room for improvement of the concrete delivery process.

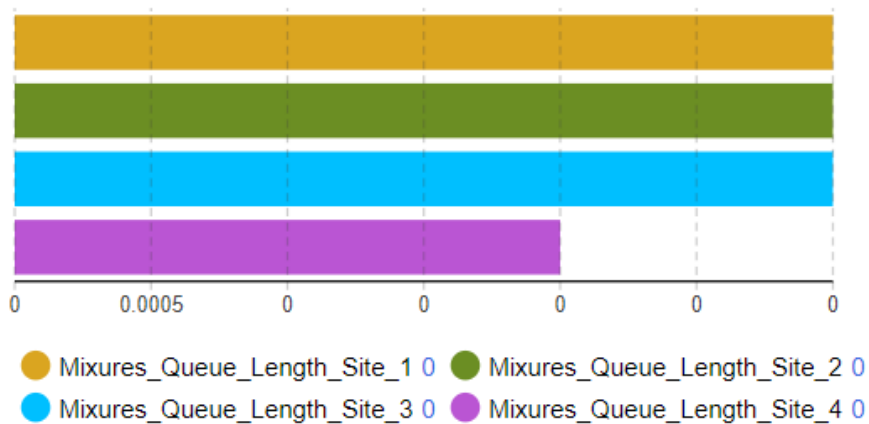


Figure 44 Mixture's queue length at sites

After running the model for a while and exceeding 60,000 hr. the average queue length of the orders waiting at the batching plant is 0.81 order and the queue length of the truck-mixers is 0.26 truck as shown in Figure 46. That means the opportunity to see a truck waiting at the batching plant is low and most of the truck is at the customers' sites. Figure 47 shows the utilization factors for the batching plant, pumps, and truck mixtures. The utilization factor for the pumps is the highest at 95% while the truck utilization factor is the lowest at 46%. The batching plant utilization factor is 67%. These factors show the opportunity to increase the number of concrete pumps to increase production in the concrete batching plant.

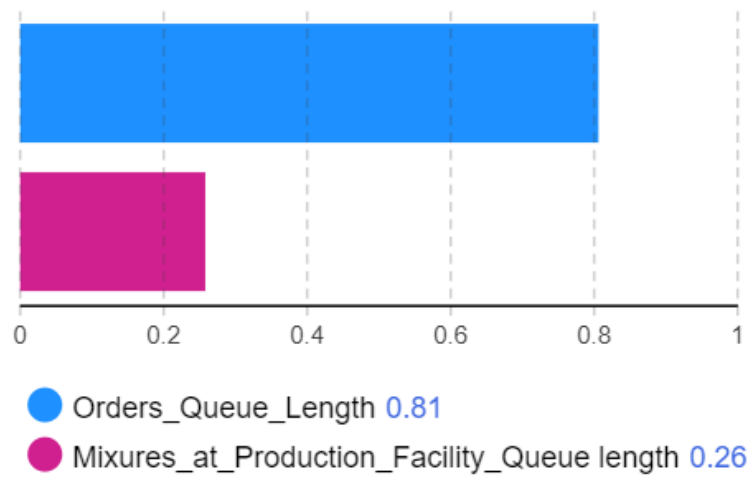


Figure 45 Queue length for the orders and the concrete mixtures at the batching plant

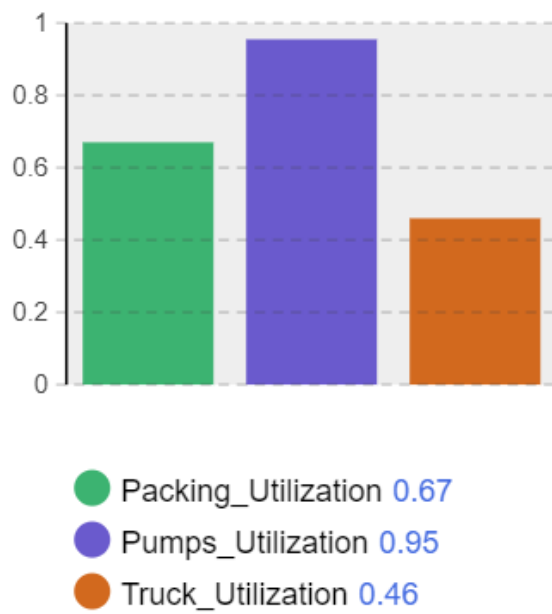


Figure 46 Utilization factor for the batching plant, pumps, and trucks

The average time of the total order duration when the construction team at the site requests the concrete to complete the concrete pouring was 7.37 hours as shown in Figure 47. Occasionally, the job extends more than 35 hr. when the concrete quantity is high, and casting conditions are difficult like walls and massive concrete tanks.

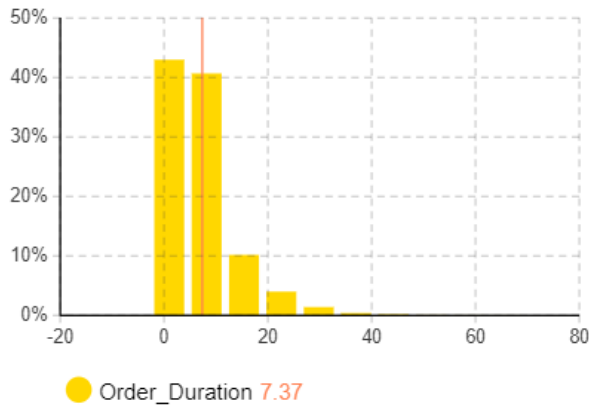


Figure 47 The total job duration.

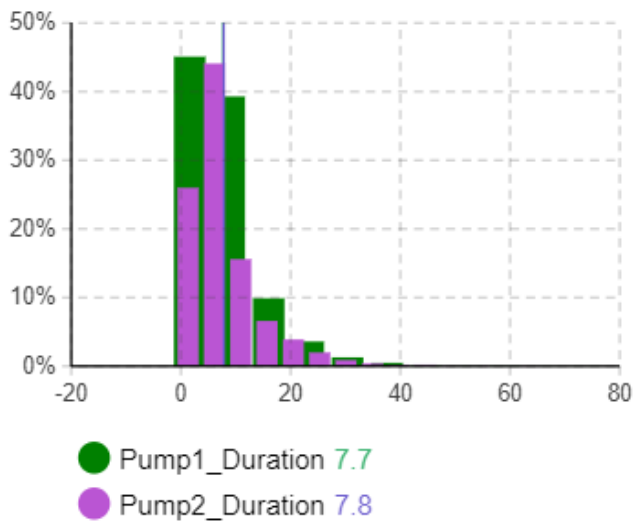


Figure 48 The concrete pump travel duration from the release to the construction site and returns to the batching plant.

The pump average trip duration will be more than the order duration thus the pump will release from the construction site whenever the casting is finished and the job is completed, therefore, the average duration is 7.75 hr. and like the order duration, some concrete pumps will take more than 35 hours.

The waiting time at the construction site till the pump is reached usually varies, in some cases, it could reach 6 hours waiting to release the pumps, however, the average time is one and half hours until releasing the pump as shown in Figure 49 and more than 55% less than one hour.

There are 7% of the sites will wait 5 hours until they receive a pump.

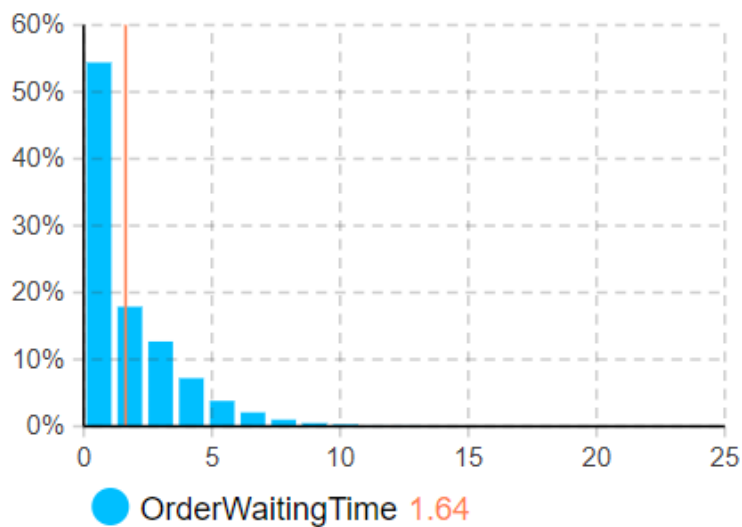


Figure 49 Order waiting time

Figures 50, and 51, 52, and 53 below show the required average time for one truck mixture to cast the different structural elements and return to the concrete batching plant. The average time for the column is 1.3 hours, while the beams take 1.28 hours. The column and beam show almost Comparable numbers, thus the average time required of the truck mixtures to complete the job and return to the batching plant are almost the same.

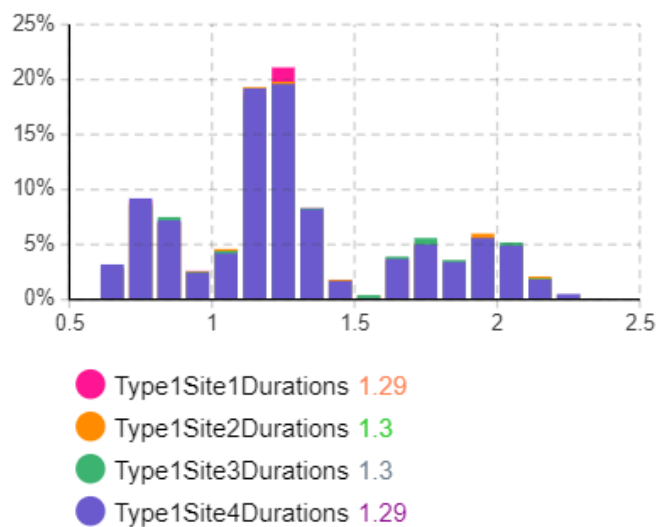


Figure 50 The average time for one truck mixture to cast columns and return to the concrete batching plant

However, the slabs and foundations are exhibits lower cycle time than those reported for the columns and beams. This can be attributed to the fact that slabs and foundations are usually open spaces, thus, the concrete pumps are casting faster. Figure 52 shows 1.16 hours for a truck to cast a slab whereas Figure 53 shows 1.14 hours to complete the job of the truck to cast a foundation.

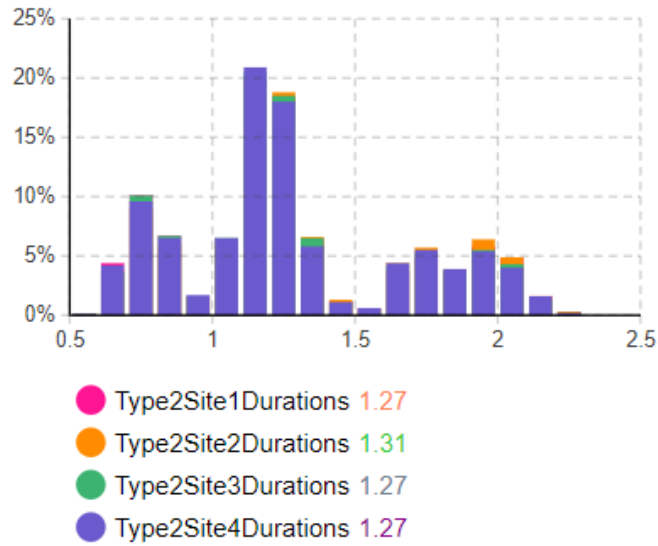


Figure 51 The required average time for one truck mixture to cast beams and return to the concrete batching plant

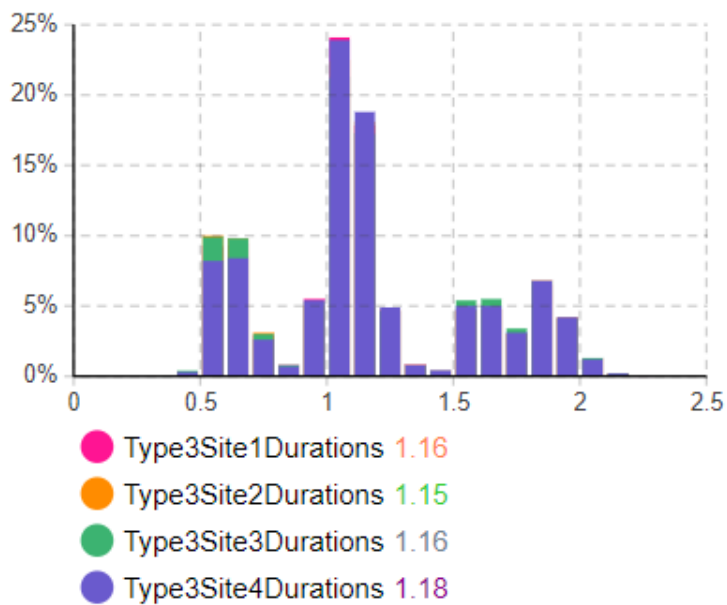


Figure 52 The required average time for one truck mixture to cast slab and return to the concrete batching plant

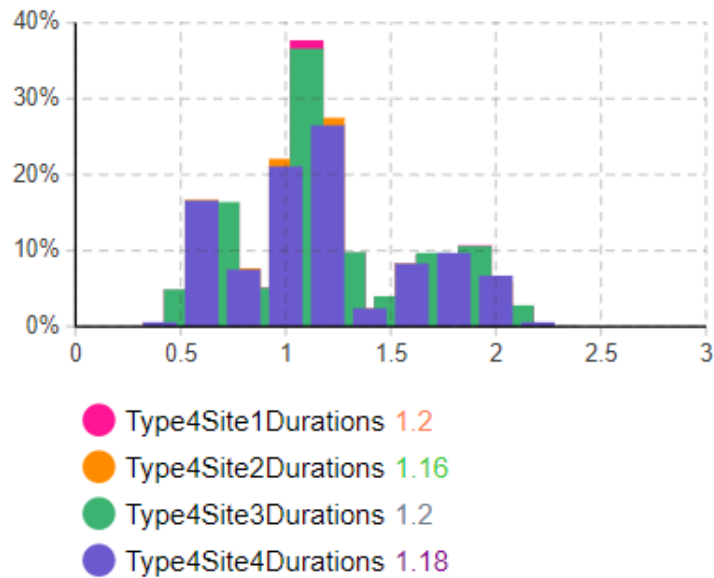


Figure 53 The required average time for one truck mixture to cast foundations and return to the concrete batching plant

7.5 Simulation with five pumps

As per the first simulation attempt, which simulates the real situation encountered in the batching plant with four pumps and fourteen trucks. The simulation run indicated the existence of a bottle neck, the bottleneck is seen in the high utilization rate of the pumps, utilization factor more than 95%, thus limiting the ability of the patching plant to accommodate more customer orders. Hence, adding more additional pump will elevate the pressure over this resource, and can facilitate handling more demand, which will in turn improve the overall productivity of the batch plant.

In the following, the result of the simulation is reported after adding the extra pump; i.e. with five pumps; The queue length of the concrete mixtures trucks in the construction sites is zero as shown in the below Figure 54 therefore, the simulation model arranges the trucks ideally with a corporation with the GIS that is attached in the simulation software.

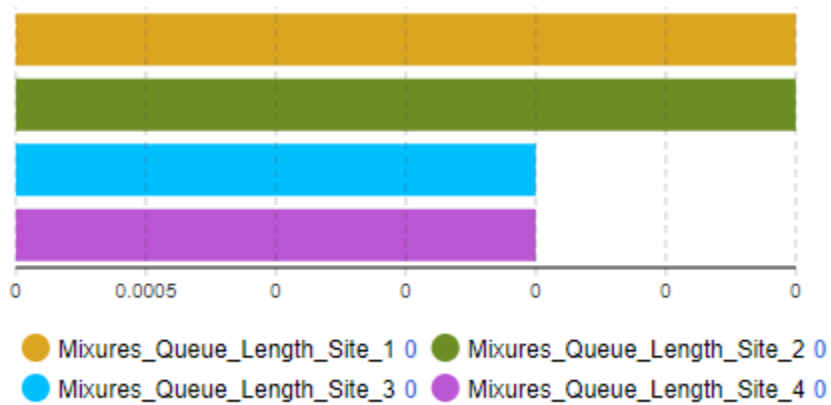


Figure 54 Mixture’s queue length at sites, for five pumps.

The average order queue length is 0.19 order awaiting at the batching plant while in the four pumps was 0.81 order and the queue length of the truck-mixers is 0.42 truck as shown in Figure 55.

Figure 56 shows the utilization factors for the batching plant, pumps, and truck mixtures. The utilization factor for the pumps is still the highest but reduced from 95% to 86%, while the truck utilization factor is still the lowest at 51%, however, there is an increase of 6% when there is an additional pump. The batching plant utilization factor increased by 7% to reach 74% with 5 pumps.

This increment in the patching plant utilization is an indication of better resource utilization, meeting more customer demand, and enjoying higher productivity.

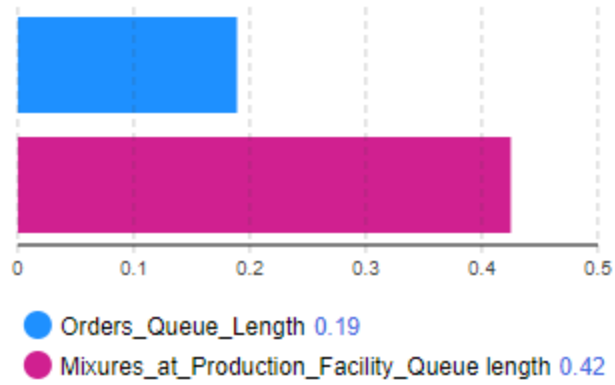


Figure 55 Queue length for the orders and the concrete mixtures at the batching plant, for five pumps.

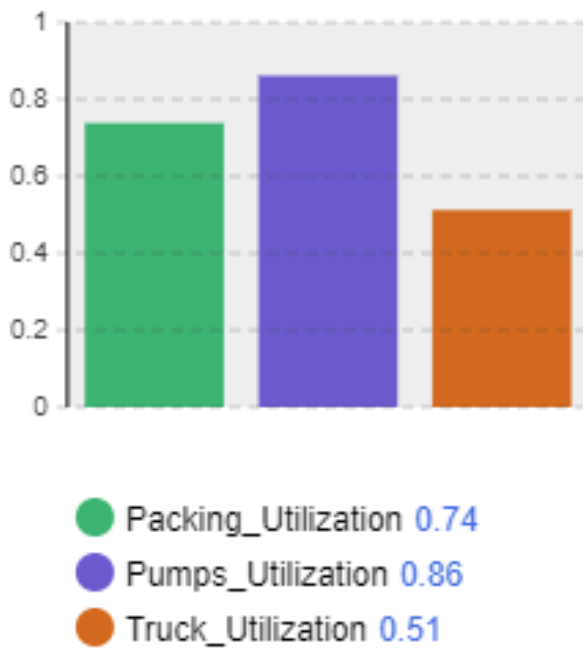


Figure 56 Utilization factor for the batching plant, pumps, and trucks, for five pumps.

The average time of the total order and the duration of the pump until finish the job is almost the same and has no effect when the additional pump is added to the simulation as shown in Figures 57 and 58.

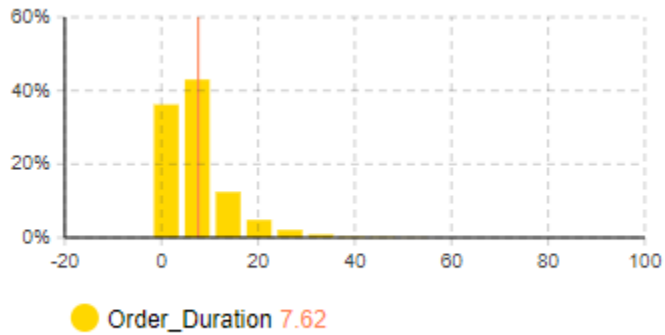


Figure 57 The total job duration, for five pumps.

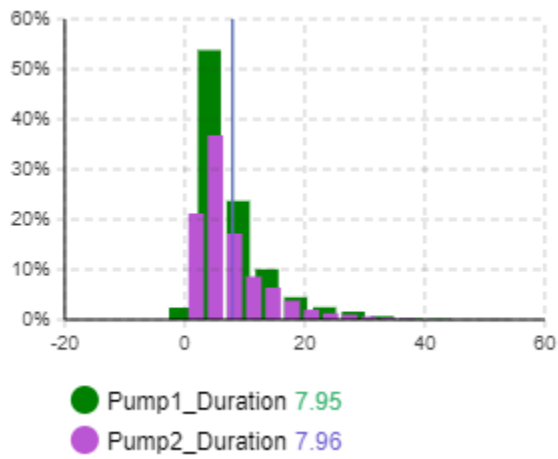


Figure 58 The concrete pump travel duration, for five pumps.

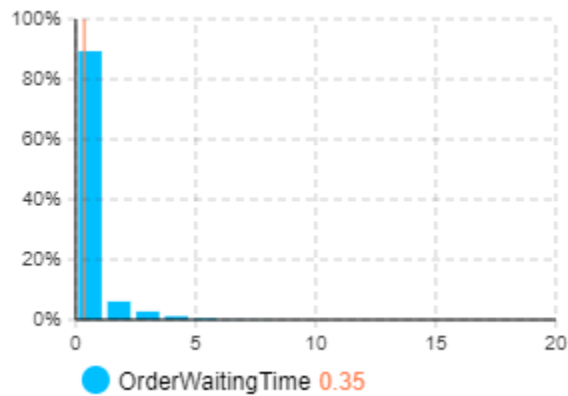


Figure 59:- Order waiting time for five pumps

Another indication of the improved productivity is seen in Fig.59 The waiting time for the customer until the pump is released to his site is reduced, while it was 1.5 hours it reaches to 20 minutes, and 90% within one hour as shown in Figure 59. Hence more customers are being served.

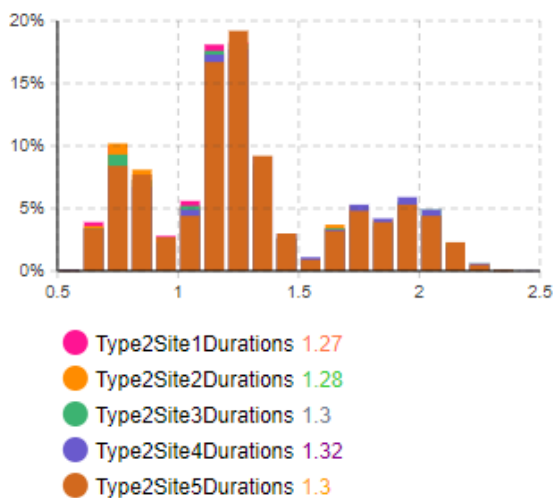


Figure 60 The average time for one truck mixture to cast columns and return to the concrete batching plant, for five pumps.

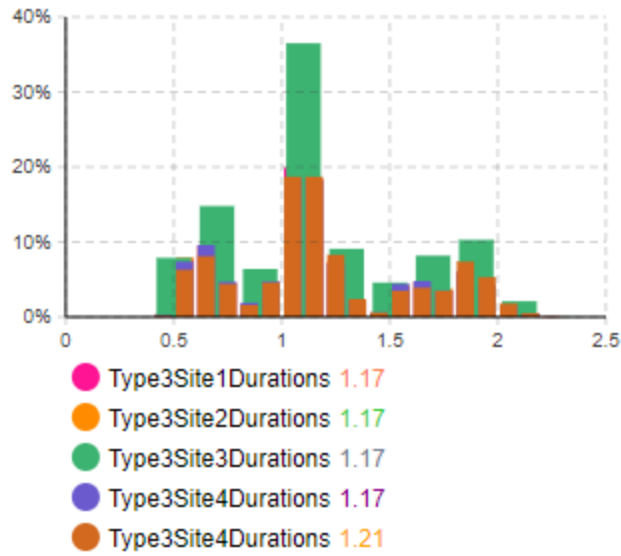


Figure 61 The required average time for one truck mixture to cast beams and return to the concrete batching plant, for five pumps.

Figures 60, 61, 62, and 63, show the required average time for one truck mixture to cast the different structural elements and return to the concrete batching plant, which is still the same as the previous case with the four pumps and didn't change.

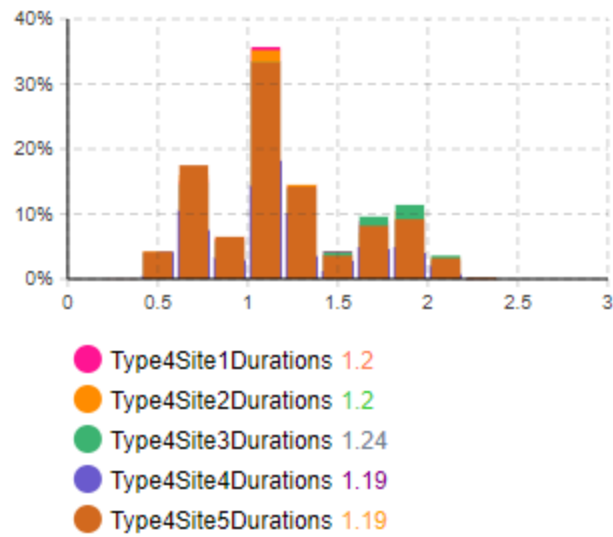


Figure 62 The required average time for one truck mixture to cast slab and return to the concrete batching plant, for five pumps.

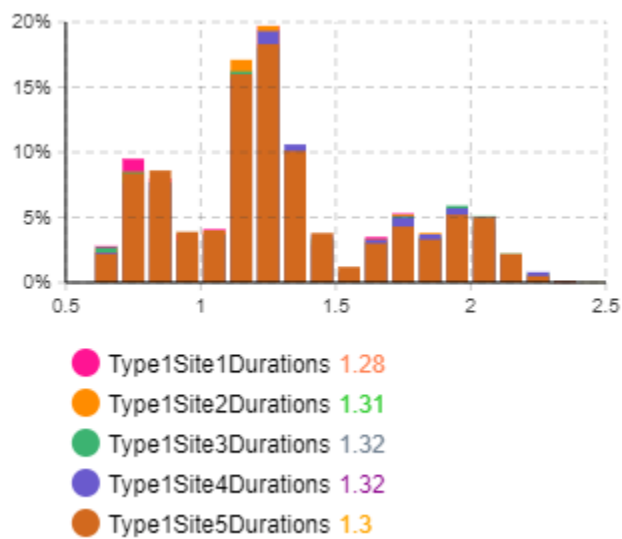


Figure 63 The required average time for one truck mixture to cast foundations and return to the concrete batching plant, for five pumps.

7.6 Optimizing number of concrete truck mixtures

After incorporating five pumps, The utilization factor of the concrete trucks reached 51%. Which is an indication that 14 truck mixer is more than needed to serve the costumer demand, in order to determine the best number of truck mixers that has to be used, along with the five pumps available, we used the optimization function at the simulation software to select the optimum number of concrete trucks. After running the optimization function at the simulation model, the optimum number of trucks that has to be used is 7 (see Figure 64).

	Current	Best
Iterations completed:	10	6
Objective: ↓	0.768	0.809
Parameters	Copy best	
parNumberTruck	9	8

▼ Parameters	
parNumberTruck:	7
parNumberPumps:	5
Paste from clipboard	

Figure 64 Optimization function in the simulation

After adding the fifth pump, the optimization function suggests reducing the number of concrete mixtures. Therefore, Figure 65 shows the average queue length of the orders and concrete mixtures with seven trucks. Compare the results with the second case, after adding the fifth pump, the average order queue length slightly increased from 0.19 to 0.24 order. However, the average concrete truck mixtures waiting at the batching plant reduced from 0.42 to 0.21 trucks when we reduce the concrete tuck mixtures.

The utilization factors of the batching plant reduced while the pumps increased as shown in Figure 66. However, the truck utilization factor reached 91%. The order duration of one hour increased as shown in Figure 67. Decreasing the number of concrete trucks will increase the load on the concrete pumps, thus, the concrete pumps will take more time to return to the batching plant as shown in Figure 68. Also, order waiting time increased by reducing the number of trucks as shown in Figure 69.

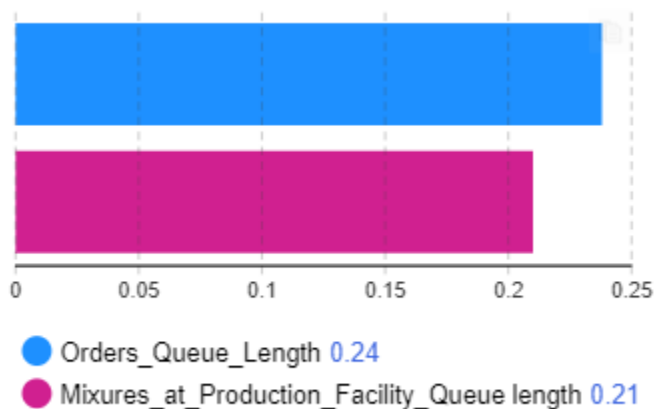


Figure 65 Queue length for the orders and seven concrete mixtures at the batching plant

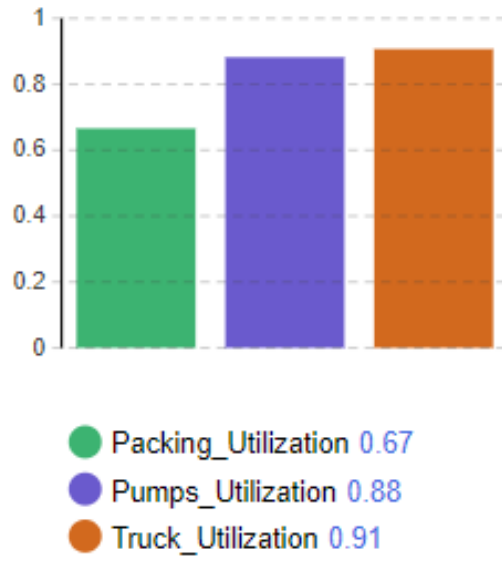


Figure 66 Utilization factor for the batching plant, pumps, and the seven trucks

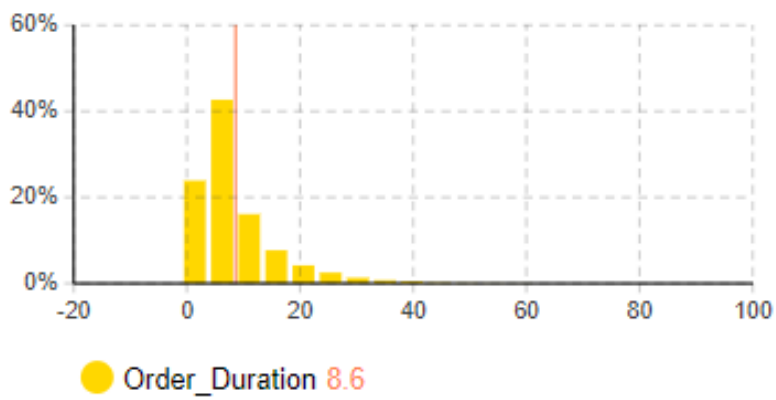


Figure 67 The total job duration with seven concrete mixtures

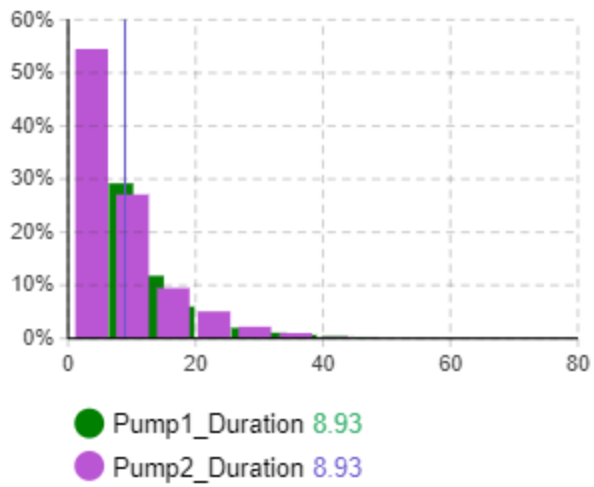


Figure 68 The concrete pump travel duration with seven concrete truck mixtures

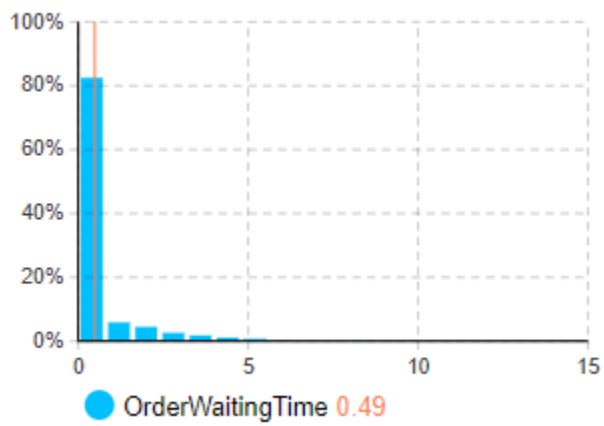


Figure 69 Order waiting time for five pumps and seven concrete truck mixtures

CHAPTER 8

CONCLUSION

8.1 Conclusion

Concrete is a major material in construction that can handle compression forces in structures. It is second most usable material in the world after water [1]. Concrete is a sensitive material that many factors could affect on its quality, and due to the complex physical characteristics of concrete which has shelf life of only a few hours and uncertainty nature of the operation environment, the planning and scheduling problems of production and delivery activities are usually unstructured and complex, and there is no computer-based planning tool is available or used for scheduling and planning of concrete supplies the

The goal of this study is to study the operation and delivery process of ready-mix concrete batching plants and develop a simulation model to enhance the production process and reach the optimum number of concrete mixtures and pumps with maintaining a high level of quality of the concrete ready-mix companies serve in Saudi-Arabia. The model has been successfully built and developed as a result of the operations of concrete production and construction as well as the delivery process and detailed collection of knowledge from a local concrete company and the bottlenecks have been identified by the production office and a proper remedy has been proposed to reduce the impact these of bottlenecks, thus, determine the optimal number of batching units, truck mixers, and concrete pumps. The sensitivity analysis was taken from the database after running the model, the sample has been taken to verify the simulated job durations and presented to the experts.

The results were abbreviated in the below table which gives a summary of the current situation and two cases that move the bottleneck from the pumps to improve the provided service, which

will enhance the quality of concrete and make work in construction sites more smoothly without a long queue of the trucks in the sites or at the batching plant.

Table 20 summary of the three cases

Parameter	Unit	Case I	Case II	Case III
		Actual situation	14 truck mixtures and 5 pumps	7 truck mixtures and 5 pumps
Average Mixtures queue length at sites	nos.,	0	0	0
Average queue length for the orders at the batching plant	nos.,	0.81	0.19	0.24
Queue length for the concrete mixtures at the batching plant	nos.,	0.26	0.42	0.21
Packing Utilization factor	%	67	74	67
Pumps utilization factor	%	95	86	88
Truck utilization factor	%	46	51	91
The total job duration	hr.	7.37	7.62	8.6

Average concrete pump travel duration	hr.	7.7	7.95	8.93
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8.2 Recommendations for future studies

This model could be the base to build a software to use the computer base in the daily concrete delivery and reduce the required decisions came from the shippers and the bathing plant managers. The dynamic simulation for a concrete batching plant also could be build based on this model.

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Appendix A: JOB DELIVERY DETAILS

Date: Tuesday, March 26, 2019

Structures: Slab

Original Order (m³): 145

Booking Date

Sunday, March 24, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty. m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10	7.5	7:15	8:10	0:55	8:14	0:04	8:25		0:12	9:17	0:52	2:02
2	2	11	8.25	7:25	8:19	0:54	8:26	0:06	8:37	0:01	0:12	9:29	0:52	2:04
3	3	11	8.25	7:38	8:26	0:48	8:38	0:11	8:49	0:01	0:12	9:34	0:45	1:56
4	4	10	7.5	8:05	9:00	0:55	9:02	0:01	9:12	0:13	0:11	10:05	0:53	1:59
5	5	9	6.75	8:22	9:05	0:43	9:13	0:08	9:22	0:01	0:10	10:00	0:38	1:38
6	6	9	6.75	9:18	9:58	0:40	10:00	0:02	10:09	0:38	0:10	10:47	0:38	1:29
7	7	10	7.5	10:15	10:57	0:42	10:59	0:01	11:09	0:50	0:11	11:48	0:39	1:32
8	8	11	8.25	10:33	11:21	0:48	11:23	0:02	11:34	0:14	0:12	12:19	0:45	1:46
1	9	11	8.25	11:05	11:54	0:49	11:56	0:02	12:07	0:22	0:12	12:53	0:46	1:48
3	10	9	6.75	11:18	12:02	0:44	12:08	0:06	12:17	0:01	0:10	12:58	0:41	1:40
5	11	9	6.75	11:38	12:21	0:42	12:22	0:01	12:31	0:05	0:10	13:13	0:41	1:34
2	12	11	8.25	11:59	12:55	0:56	12:56	0:01	13:07	0:24	0:12	14:03	0:56	2:04
6	13	10	7.5	12:28	13:14	0:46	13:15	0:01	13:25	0:07	0:11	14:08	0:43	1:40
7	14	11	8.25	12:53	13:35	0:42	13:36	0:01	13:47	0:10	0:12	14:27	0:40	1:34
8	15	4	3	13:58	14:41	0:43	14:43	0:01	14:47	0:56	0:05	15:29	0:42	1:30
Trips: 15		146 m³												

1

Date: Saturday, August 17, 2019

Structures: Slab

Original Order (m³): 105

Booking Date

Thursday, August 15, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9.00	6.75	7:15	7:43	0:28	7:45	0:02	7:56		0:12	8:21	0:25	1:06
2	2	11.00	8.25	7:25	7:50	0:25	7:57	0:06	8:08	0:01	0:12	8:31	0:23	1:06
3	3	9.00	6.75	7:38	8:04	0:26	8:09	0:04	8:18	0:01	0:10	8:41	0:23	1:03
4	4	11.00	8.25	8:05	8:30	0:25	8:32	0:01	8:43	0:14	0:12	9:06	0:23	1:00
5	5	9.00	6.75	8:22	8:54	0:32	8:55	0:01	9:04	0:12	0:10	9:31	0:27	1:09
6	6	11.00	8.25	9:18	9:47	0:29	9:48	0:01	9:59	0:44	0:12	10:26	0:27	1:08
7	7	8.00	6	10:15	10:55	0:40	10:57	0:01	11:05	0:57	0:09	11:42	0:37	1:26
1	8	10.00	7.5	10:33	11:02	0:29	11:06	0:04	11:16	0:01	0:11	11:42	0:26	1:09
8	9	11.00	8.25	11:05	11:27	0:22	11:28	0:01	11:39	0:12	0:12	11:58	0:19	0:53
4	10	12.00	9	11:18	11:52	0:34	11:54	0:01	12:06	0:14	0:13	12:37	0:31	1:18
5	11	9.00	6.75	11:38	12:06	0:27	12:07	0:01	12:16	0:01	0:10	12:42	0:26	1:04
9	12	3.00	2.25	11:59	12:29	0:30	12:30	0:00	12:33	0:13	0:08	13:03	0:30	1:04
Trips: 12		113 m³												

2

Date: Sunday, September 15, 2019

Structures: Slab

Original Order (m³): 80

Booking Date

Thursday, September 12, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9.00	6.75	9:15	9:41	0:26	9:46	0:05	9:56		0:11	10:19	0:23	1:04
2	2	11.00	8.25	9:26	9:49	0:23	9:57	0:07	10:08	0:01	0:12	10:29	0:21	1:03
3	3	10.00	7.5	9:38	10:02	0:24	10:09	0:06	10:19	0:01	0:11	10:40	0:21	1:02
4	4	11.00	8.25	10:15	10:43	0:28	10:44	0:00	10:56	0:25	0:13	11:22	0:26	1:06
5	5	10.00	7.5	10:30	10:52	0:22	10:57	0:05	11:07	0:01	0:11	11:24	0:17	0:54
6	6	11.00	8.25	11:14	11:43	0:29	11:44	0:01	11:54	0:37	0:11	12:21	0:27	1:07
7	7	10.00	7.5	11:55	12:24	0:29	12:26	0:01	12:36	0:32	0:11	13:02	0:26	1:06
1	8	8.00	6	12:33	12:58	0:25	13:00	0:02	13:08	0:24	0:09	13:30	0:22	0:57
3	9	5.00	3.75	13:20	13:44	0:24	13:46	0:01	13:51	0:38	0:10	14:15	0:24	0:55
Trips: 16		85 m³												

3

Date: Thursday, January 16,
2020

Structures: Slab

Original Order (m³): 143

Booking Date

Monday, January 13, 2020

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9	6.75	11:41	12:10	0:29	12:17	0:07	12:29		0:13	13:10	0:41	1:29
2	2	9	6.75	12:01	12:35	0:34	12:36	0:01	12:47	0:07	0:12	13:24	0:37	1:23
3	3	9	6.75	12:27	13:00	0:33	13:01	0:01	13:12	0:14	0:12	13:48	0:36	1:21
4	4	10	7.5	12:40	13:10	0:30	13:18	0:08	13:30	0:06	0:13	14:03	0:33	1:23
5	5	11	8.25	13:12	14:00	0:48	14:01	0:01	14:14	0:31	0:14	15:05	0:51	1:53
6	6	9	6.75	14:28	15:00	0:32	15:01	0:01	15:12	0:47	0:12	15:47	0:35	1:19
7	7	11	8.25	14:37	15:06	0:29	15:18	0:12	15:31	0:06	0:14	16:03	0:32	1:26
1	8	9	6.75	14:48	15:18	0:30	15:35	0:17	15:46	0:04	0:12	16:19	0:33	1:31
2	9	9	6.75	14:54	15:24	0:30	15:52	0:28	16:03	0:06	0:12	16:36	0:33	1:42
3	10	9	6.75	15:05	15:40	0:35	16:09	0:29	16:20	0:06	0:12	16:58	0:38	1:53
4	11	10	7.5	15:18	16:00	0:42	16:26	0:26	16:38	0:06	0:13	17:23	0:45	2:05
1	12	9	6.75	16:10	16:40	0:30	16:43	0:03	16:54	0:05	0:12	17:27	0:33	1:17
3	13	9	6.75	16:36	17:05	0:29	17:06	0:01	17:17	0:12	0:12	17:49	0:32	1:13
8	14	11	8.25	16:50	17:20	0:30	17:23	0:03	17:36	0:06	0:14	18:09	0:33	1:19
9	15	9	6.75	17:27	18:00	0:33	18:01	0:01	18:12	0:25	0:12	18:48	0:36	1:21
6	16	7	5.25	17:53	18:26	0:33	18:27	0:01	18:37	0:15	0:11	19:13	0:36	1:20
Trips: 16		150 m³												

4

Date: Thursday, December 12, 2019

Structures: Slab

Original Order (m³): 90

Booking Date

Tuesday, December 10, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9	6.75	6:55	7:30	0:35	7:39	0:09	7:51		0:13	8:24	0:33	1:29
2	2	9	6.75	7:02	7:40	0:38	7:52	0:12	8:03	0:01	0:12	8:38	0:35	1:36
3	3	9	6.75	7:20	8:00	0:40	8:04	0:04	8:15	0:01	0:12	8:52	0:37	1:32
4	4	11	8.25	8:06	8:50	0:44	8:51	0:01	9:04	0:36	0:14	9:45	0:41	1:39
1	5	9	6.75	8:13	9:00	0:47	9:05	0:05	9:16	0:01	0:12	10:03	0:47	1:50
5	6	9	6.75	8:22	9:12	0:50	9:17	0:05	9:28	0:01	0:12	10:17	0:49	1:55
4	7	11	8.25	9:07	10:00	0:53	10:01	0:01	10:14	0:33	0:14	11:07	0:53	2:00
6	8	11	8.25	10:17	11:01	0:44	11:02	0:01	11:15	0:48	0:14	11:57	0:42	1:40
7	9	11	8.25	11:11	11:49	0:38	11:50	0:01	12:03	0:35	0:14	12:38	0:35	1:27
3	10	9	6.75	12:49	13:23	0:34	13:24	0:01	13:35	1:21	0:12	14:08	0:33	1:19
Trips: 10		98 m³												

5

Date: Thursday, August 8, 2019

Structures: Foundations

Original Order (m³): 135

Booking Date

Monday, August 5, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	9:54	10:22	0:28	10:30	0:08	10:41		0:12	11:08	0:27	1:14
2	2	9.00	6.75	10:06	10:35	0:29	10:42	0:07	10:53	0:01	0:12	11:22	0:29	1:16
3	3	9.00	6.75	10:14	10:45	0:31	10:54	0:09	11:06	0:01	0:13	11:36	0:30	1:22
4	4	11.00	8.25	10:25	11:00	0:35	11:07	0:07	11:22	0:01	0:16	11:55	0:33	1:30
5	5	9.00	6.75	11:40	12:10	0:30	12:11	0:01	12:25	0:49	0:15	12:52	0:27	1:12
6	6	11.00	8.25	12:15	12:51	0:36	12:52	0:01	13:06	0:27	0:15	13:35	0:29	1:20
2	7	10.00	7.5	12:40	13:09	0:29	13:10	0:01	13:24	0:04	0:15	13:50	0:26	1:10
4	8	11.00	8.25	13:25	13:56	0:31	13:57	0:01	14:12	0:33	0:16	14:40	0:28	1:15
7	9	9.00	6.75	13:37	14:09	0:32	14:14	0:05	14:26	0:02	0:13	14:56	0:30	1:19
2	10	10.00	7.5	14:02	14:35	0:33	14:36	0:01	14:49	0:10	0:14	15:21	0:32	1:19
8	11	11.00	8.25	14:35	15:10	0:35	15:11	0:01	15:26	0:22	0:16	15:58	0:32	1:23
9	12	9.00	6.75	15:05	15:34	0:29	15:35	0:01	15:46	0:09	0:12	16:13	0:27	1:08
5	13	9.00	6.75	15:17	15:49	0:32	15:50	0:01	15:59	0:04	0:10	16:30	0:31	1:13
10	14	11.00	8.25	16:30	17:06	0:36	17:07	0:01	17:25	1:08	0:19	18:00	0:35	1:30
Trips: 14		139 m³												

6

Date: Saturday, May 18, 2019

Structures: Slab

Original Order (m³): 77

Booking Date

Thursday, May 16, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9	6.75	7:55	8:28	0:33	8:33	0:05	8:40		0:08	9:11	0:31	1:16
2	2	9	6.75	8:10	8:48	0:38	8:49	0:01	8:57	0:09	0:09	9:32	0:35	1:22
3	3	9	6.75	8:22	9:06	0:44	9:07	0:01	9:14	0:10	0:08	9:55	0:41	1:33
4	4	11	8.25	8:42	9:16	0:34	9:17	0:01	9:27	0:03	0:11	9:58	0:31	1:16
1	5	9	6.75	9:01	9:38	0:37	9:39	0:01	9:48	0:12	0:10	10:25	0:37	1:24
5	6	9	6.75	9:33	10:05	0:32	10:06	0:01	10:14	0:18	0:09	10:45	0:31	1:12
4	7	11	8.25	9:55	10:28	0:33	10:29	0:01	10:39	0:15	0:11	11:12	0:33	1:17
6	8	10	7.5	10:15	10:59	0:44	11:00	0:01	11:08	0:21	0:09	11:50	0:42	1:35
Trips: 8		77 m³												

7

Date: Saturday, September 14, 2019

Structures: Slab

Original Order (m³): 105

Booking Date

Thursday, September 12, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	7:54	8:23	0:29	8:28	0:05	8:38		0:11	9:06	0:28	1:12
2	2	10.00	7.5	8:06	8:34	0:28	8:39	0:05	8:49	0:01	0:11	9:17	0:28	1:11
3	3	9.00	6.75	8:14	8:45	0:31	8:50	0:05	8:59	0:01	0:10	9:29	0:30	1:15
4	4	11.00	8.25	8:25	8:58	0:33	9:00	0:02	9:11	0:01	0:12	9:42	0:31	1:17
5	5	9.00	6.75	8:40	9:12	0:32	9:12	0:00	9:22	0:01	0:11	9:51	0:29	1:11
6	6	11.00	8.25	9:15	9:48	0:33	9:49	0:01	10:01	0:27	0:13	10:27	0:26	1:12
1	7	10.00	7.5	9:40	10:17	0:37	10:18	0:01	10:29	0:17	0:12	11:03	0:34	1:23
2	8	10.00	7.5	10:25	10:59	0:34	11:00	0:01	11:11	0:31	0:12	11:42	0:31	1:17
7	9	9.00	6.75	10:37	11:16	0:39	11:17	0:01	11:26	0:06	0:10	12:03	0:37	1:26
8	10	10.00	7.5	10:50	11:28	0:38	11:29	0:01	11:40	0:03	0:12	12:17	0:37	1:27
3	11	6.00	4.5	11:50	12:21	0:31	12:22	0:01	12:29	0:42	0:08	12:57	0:28	1:07
Trips: 11		105 m³												

8

Date: Thursday, January 16, 2020

Structures: Slab

Original Order (m³): 187

Booking Date

Monday, January 13, 2020

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10	7.5	8:21	8:53	0:32	8:57	0:04	9:15		0:19	9:46	0:31	1:25
2	2	10	7.5	8:41	9:10	0:29	9:16	0:06	9:30	0:01	0:15	9:57	0:27	1:16
3	3	11	8.25	8:55	9:26	0:31	9:31	0:05	9:47	0:01	0:17	10:17	0:30	1:22
4	4	11	8.25	9:30	10:09	0:39	10:10	0:01	10:26	0:23	0:17	11:01	0:35	1:31
5	5	11	8.25	9:41	10:15	0:34	10:27	0:12	10:40	0:01	0:14	11:12	0:32	1:31
6	6	10	7.5	10:05	10:41	0:36	10:42	0:01	10:56	0:02	0:15	11:30	0:34	1:25
7	7	11	8.25	10:45	11:19	0:34	11:20	0:01	11:33	0:24	0:14	12:06	0:33	1:21
1	8	10	7.5	11:11	11:41	0:30	11:42	0:01	11:57	0:09	0:16	12:26	0:29	1:15
2	9	10	7.5	11:30	11:58	0:28	11:59	0:01	12:15	0:02	0:17	12:42	0:27	1:12
3	10	11	8.25	11:42	12:17	0:35	12:18	0:01	12:34	0:03	0:17	13:07	0:33	1:25
4	11	11	8.25	12:05	12:44	0:39	12:45	0:01	12:59	0:11	0:15	13:34	0:35	1:29
1	12	10	7.5	12:15	12:46	0:31	13:00	0:14	13:14	0:01	0:15	13:44	0:30	1:29
3	13	11	8.25	12:26	13:01	0:35	13:15	0:14	13:28	0:01	0:14	14:02	0:34	1:36
8	14	10	7.5	12:55	13:29	0:34	13:30	0:01	13:42	0:02	0:13	14:15	0:33	1:20
9	15	10	7.5	13:15	13:51	0:36	13:52	0:01	14:04	0:10	0:13	14:39	0:35	1:24
6	16	10	7.5	13:45	14:16	0:31	14:17	0:01	14:30	0:13	0:14	15:00	0:30	1:15
3	17	11	8.25	14:02	14:35	0:33	14:36	0:01	14:49	0:06	0:14	15:21	0:32	1:19
8	18	10	7.5	14:14	14:46	0:32	14:50	0:04	15:04	0:01	0:15	15:35	0:31	1:21
9	19	10	7.5	14:26	14:57	0:31	15:05	0:08	15:17	0:01	0:13	15:47	0:30	1:21
6	20	10	7.5	14:55	15:31	0:36	15:32	0:01	15:48	0:15	0:17	16:22	0:34	1:27
Trips: 20		208 m³												

Date: Tuesday, June 25, 2019

Structures: Slab

Original Order (m³): 125

Booking Date

Sunday, June 23, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11	8.25	7:45	8:22	0:37	8:26	0:04	8:37		0:12	9:11	0:34	1:26
2	2	10	7.5	7:56	8:31	0:35	8:38	0:06	8:48	0:01	0:11	9:21	0:33	1:25
3	3	10	7.5	8:06	8:40	0:34	8:49	0:08	8:59	0:01	0:11	9:30	0:31	1:24
4	4	10	0	8:16	8:51	0:35	9:00	0:09	9:10	0:01	0:11	9:43	0:33	1:27
5	5	11	8.25	8:27	9:06	0:39	9:11	0:05	9:22	0:01	0:12	9:56	0:34	1:29
6	6	11	8.25	9:10	9:50	0:40	9:51	0:01	10:02	0:28	0:12	10:40	0:38	1:30
7	7	10	7.5	9:30	10:12	0:42	10:13	0:01	10:23	0:11	0:11	11:02	0:39	1:32
8	8	10	7.5	9:39	10:20	0:41	10:24	0:04	10:34	0:01	0:11	11:12	0:38	1:33
1	9	11	8.25	9:55	10:39	0:44	10:40	0:01	10:51	0:05	0:12	11:32	0:41	1:37
3	10	10	7.5	10:15	10:54	0:39	10:55	0:01	11:05	0:03	0:11	11:41	0:36	1:26
5	11	11	8.25	10:55	11:37	0:42	11:38	0:01	11:49	0:33	0:12	12:30	0:41	1:35
2	12	10	7.5	11:15	11:55	0:40	11:57	0:01	12:07	0:07	0:11	12:47	0:40	1:32
6	13	8	6	12:01	12:43	0:42	12:44	0:01	12:52	0:37	0:09	13:31	0:39	1:30
Trips: 13		133 m³												

10

Date: Thursday, October 10, 2019

Structures: Beam

Original Order (m³): 41

Booking Date

Saturday, October 5, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	9:15	9:50	0:35	9:55	0:05	10:09		0:15	10:40	0:31	1:25
2	2	10.00	7.5	9:25	9:56	0:31	10:10	0:14	10:24	0:01	0:15	10:52	0:28	1:27
3	3	11.00	8.25	9:37	10:09	0:32	10:25	0:16	10:40	0:01	0:16	11:10	0:30	1:33
4	4	10.00	7.5	9:48	10:17	0:29	10:41	0:24	10:58	0:01	0:18	11:24	0:26	1:36
1	5	4.00	3	10:48	11:25	0:37	11:27	0:02	11:37	0:29	0:11	12:13	0:36	1:25
Trips: 5		45 m³												

1

Date: Tuesday, October 15, 2019

Structures: Beam

Original Order (m³): 71

Booking Date

Sunday, October 13, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11.00	8.25	8:34	9:10	0:36	9:17	0:07	9:37		0:21	10:11	0:34	1:37
2	2	11.00	8.25	8:44	9:18	0:34	9:38	0:20	9:57	0:01	0:20	10:27	0:30	1:43
3	3	10.00	7.5	8:55	9:36	0:41	9:59	0:23	10:15	0:02	0:17	10:55	0:40	2:00
4	4	10.00	7.5	9:06	9:46	0:40	10:17	0:31	10:31	0:02	0:15	11:07	0:36	2:01
5	5	10.00	7.5	9:19	9:57	0:38	10:33	0:36	10:49	0:02	0:17	11:25	0:36	2:06
6	6	9.00	6.75	9:45	10:27	0:42	10:51	0:24	11:06	0:02	0:16	11:47	0:41	2:02
2	7	10.00	7.5	10:05	10:43	0:38	11:08	0:25	11:22	0:02	0:15	11:58	0:36	1:53
4	8	5.00	3.75	11:15	11:51	0:36	11:53	0:02	12:09	0:31	0:17	12:44	0:35	1:29
Trips: 8		76 m³												

2

Date: Sunday, March 3, 2019

Structures: Beam

Original Order (m³): 46

Booking Date

Saturday, March 2, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	12:38	13:04	0:26	13:08	0:04	13:21		0:14	13:49	0:28	1:11
2	2	11.00	8.25	12:51	13:15	0:24	13:22	0:07	13:37	0:01	0:16	14:05	0:28	1:14
3	3	10.00	7.5	13:20	13:52	0:32	13:53	0:01	14:05	0:16	0:13	14:39	0:34	1:19
4	4	10.00	7.5	13:38	14:06	0:28	14:07	0:01	14:20	0:02	0:14	14:51	0:31	1:13
5	5	7.00	5.25	14:15	14:42	0:27	14:44	0:02	14:58	0:24	0:15	15:27	0:29	1:12
Trips: 5		48 m³												3

Date: Monday, April 15, 2019

Structures: Beam

Original Order (m³): 65

Booking Date

Saturday, April 13, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	7:48	8:21	0:33	8:27	0:06	8:39		0:13	9:15	0:36	1:27
2	2	11.00	8.25	8:08	8:37	0:29	8:40	0:03	8:54	0:01	0:15	9:25	0:31	1:17
3	3	10.00	7.5	8:19	8:51	0:32	8:55	0:04	9:08	0:01	0:14	9:44	0:36	1:25
4	4	10.00	7.5	8:31	9:00	0:29	9:09	0:09	9:23	0:01	0:15	9:56	0:33	1:25
5	5	11.00	8.25	9:06	9:41	0:35	9:42	0:01	9:57	0:19	0:16	10:35	0:38	1:29
1	6	9.00	6.75	9:26	10:03	0:37	10:04	0:01	10:20	0:07	0:17	11:01	0:41	1:35
2	7	5.00	3.75	10:10	10:41	0:31	10:43	0:02	11:00	0:23	0:18	11:33	0:33	1:23
Trips: 7		66 m³												4

Date: Saturday, January 5, 2019

Structures: Beam

Original Order (m³): 65

Booking Date

Thursday, January 3, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11	8.25	12:51	13:27	0:36	13:32	0:05	13:48		0:17	14:22	0:34	1:31
2	2	9	6.75	13:16	13:51	0:35	13:53	0:02	14:05	0:05	0:13	14:38	0:33	1:22
3	3	9	6.75	13:45	14:21	0:36	14:22	0:01	14:34	0:17	0:13	15:09	0:35	1:24
4	4	11	8.25	14:15	15:03	0:48	15:05	0:02	15:18	0:31	0:14	16:02	0:44	1:47
1	5	11	8.25	14:41	15:19	0:38	15:19	0:00	15:32	0:01	0:14	16:08	0:36	1:27
2	6	9	6.75	15:01	15:44	0:43	15:45	0:01	15:59	0:13	0:15	16:44	0:45	1:43
5	7	5	3.75	15:30	16:11	0:41	16:12	0:01	16:26	0:13	0:15	17:06	0:40	1:36
Trips: 7		65 m³												

5

Date: Thursday, February 14, 2019

Structures: Beam

Original Order (m³): 31

Booking Date

Monday, February 11, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11	8.25	15:55	16:23	0:28	16:24	0:01	16:37		0:14	17:08	0:31	1:13
2	2	9	6.75	16:11	16:34	0:23	16:38	0:04	16:48	0:01	0:11	17:12	0:24	1:01
3	3	9	6.75	16:23	16:47	0:24	16:55	0:08	17:07	0:07	0:13	17:32	0:25	1:09
4	4	6	4.5	17:04	17:34	0:30	17:35	0:01	17:46	0:28	0:12	18:18	0:32	1:14
Trips: 4		35 m³												

6

Date: Saturday, February 16, 2019

Structures: Beam

Original Order

(m³): 16

Booking Date

Tuesday, February 12, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10	7.5	14:55	15:16	0:21	15:20	0:04	15:43		0:24	16:03	0:20	1:08
2	2	6	4.5	15:47	16:06	0:19	16:07	0:01	16:27	0:24	0:21	16:45	0:18	0:58
Trips: 2		16 m³												7

Date: 2/29/2019

Structures: Beam

Original Order

(m³): 20

Booking Date

Monday, February 25, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11	8.25	13:12	13:46	0:34	13:47	0:01	14:07		0:21	14:44	0:37	1:32
2	2	11	8.25	14:11	14:42	0:31	14:43	0:01	14:59	0:36	0:17	15:31	0:32	1:20
Trips: 2		22 m³												8

Date: Wednesday, May 15, 2019

Structures: Beam

Original Order

(m³): 18

Booking Date

Monday, May 13, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	8:44	9:20	0:36	9:27	0:07	9:47		0:24	10:21	0:34	1:37
2	2	9.00	6.75	9:57	10:28	0:31	10:29	0:01	10:48	0:42	0:20	11:15	0:27	1:18
Trips: 2		19 m³												9

Date: Wednesday, November 20, 2019

Structures: Beam

Original Order

(m³): 36

Booking Date

Monday, November 18, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11.00	8.25	9:34	10:09	0:35	10:16	0:07	10:34		0:19	11:07	0:33	1:33
2	2	11.00	8.25	9:44	10:17	0:33	10:35	0:18	10:52	0:01	0:18	11:21	0:29	1:37
3	3	10.00	7.5	9:55	10:35	0:40	10:53	0:18	11:09	0:01	0:17	11:48	0:39	1:53
4	4	4.00	3	10:06	10:48	0:42	11:10	0:22	11:25	0:01	0:16	12:03	0:38	1:57
Trips: 4		36 m³												10

Date: Monday, January 14, 2019

Structures: Beam

Original Order (m³): 44

Booking Date

Sunday, January 13, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9.00	6.75	7:55	8:21	0:26	8:23	0:02	8:39		0:17	9:03	0:24	1:08
2	2	9.00	6.75	8:15	8:44	0:29	8:46	0:02	9:00	0:07	0:15	9:25	0:25	1:10
3	3	9.00	6.75	8:55	9:22	0:27	9:23	0:01	9:36	0:23	0:14	10:02	0:26	1:07
4	4	11.00	8.25	9:22	9:56	0:34	9:57	0:01	10:16	0:21	0:20	10:46	0:30	1:24
1	5	10.00	7.5	9:58	10:29	0:31	10:30	0:01	10:47	0:14	0:18	11:16	0:29	1:18
Trips: 5		48 m³												11

Date: Saturday, February 16, 2019

Structures: Beam

Original Order (m³): 65

Booking Date

Thursday, February 14, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
0	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9.00	6.75	7:15	8:00	0:45	8:09	0:09	8:25		0:17	9:06	0:41	1:51
2	2	10.00	7.5	7:35	8:23	0:48	8:26	0:03	8:44	0:01	0:19	9:29	0:45	1:54
3	3	10.00	7.5	7:55	8:39	0:44	8:45	0:06	9:00	0:01	0:16	9:42	0:42	1:47
4	4	9.00	6.75	8:20	9:05	0:45	9:06	0:01	9:20	0:06	0:15	10:03	0:43	1:43
5	5	11.00	8.25	8:49	9:28	0:39	9:33	0:05	9:51	0:13	0:19	10:28	0:37	1:39
1	6	9.00	6.75	9:11	10:00	0:49	10:01	0:01	10:15	0:10	0:15	11:01	0:46	1:50
2	7	10.00	7.5	10:35	11:22	0:47	11:24	0:02	11:37	1:09	0:14	12:23	0:46	1:48
Trips: 7		68 m³												12

Date:

Structures: Beam

Original Order

(m³): 55

Booking Date

Tuesday, March 26, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9.00	6.75	11:10	11:38	0:28	11:45	0:07	11:59		0:15	12:29	0:30	1:19
2	2	9.00	6.75	11:55	12:21	0:26	12:22	0:01	12:37	0:23	0:16	13:07	0:30	1:12
3	3	9.00	6.75	12:20	12:54	0:34	12:55	0:01	13:07	0:18	0:13	13:43	0:36	1:23
4	4	10.00	7.5	12:44	13:14	0:30	13:16	0:02	13:33	0:09	0:18	14:06	0:33	1:22
5	5	9.00	6.75	12:59	13:28	0:29	13:35	0:07	13:49	0:02	0:15	14:20	0:31	1:21
5	6	10.00	7.5	13:29	13:58	0:29	14:00	0:02	14:16	0:11	0:17	14:47	0:31	1:18
Trips: 5		56 m³		13										

Date: Wednesday, May 22, 2019

Structures: Beam

Original Order

(m³): 40

Booking Date

Tuesday, May 21, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11	8.25	8:51	9:22	0:31	9:27	0:05	9:46		0:20	10:18	0:32	1:27
2	2	9	6.75	9:14	9:48	0:34	9:50	0:02	10:05	0:04	0:16	10:41	0:36	1:27
3	3	11	8.25	9:45	10:21	0:36	10:22	0:01	10:40	0:17	0:19	11:16	0:36	1:31
4	4	9	6.75	10:40	11:18	0:38	11:20	0:02	11:37	0:40	0:18	12:14	0:37	1:34
Trips: 4		40 m³		14										

Date: Wednesday, June 26, 2019

Structures: Beam

Original Order (m³): 70

Booking Date

Tuesday, June 25, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11.00	8.25	7:34	8:05	0:31	8:12	0:07	8:32		0:21	9:01	0:29	1:27
2	2	11.00	8.25	7:58	8:35	0:37	8:36	0:01	8:55	0:04	0:20	9:28	0:33	1:30
3	3	9.00	6.75	8:15	8:51	0:36	8:56	0:05	9:11	0:01	0:16	9:46	0:35	1:31
4	4	9.00	6.75	8:33	9:05	0:32	9:12	0:07	9:27	0:01	0:16	9:55	0:28	1:22
1	5	11.00	8.25	9:06	9:48	0:42	9:49	0:01	10:08	0:22	0:20	10:46	0:38	1:40
2	6	11.00	8.25	9:35	10:07	0:32	10:09	0:02	10:28	0:01	0:20	10:56	0:28	1:21
5	7	10.00	7.5	10:15	10:53	0:38	10:54	0:01	11:10	0:26	0:17	11:44	0:34	1:29
Trips: 7		72 m³												15

Date: Saturday, June 29, 2019

Structures: Beam

Original Order (m³):

77

Booking Date

Wednesday, June 26, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11	8.25	11:44	12:06	0:22	12:14	0:08	12:34		0:21	12:59	0:25	1:15
2	2	11	8.25	12:32	13:00	0:28	13:02	0:02	13:23	0:28	0:22	13:52	0:29	1:20
3	3	9	6.75	12:55	13:20	0:25	13:25	0:05	13:41	0:02	0:17	14:07	0:26	1:12
4	4	10	7.5	13:15	13:42	0:27	13:43	0:01	14:01	0:02	0:19	14:27	0:26	1:12
1	5	11	8.25	13:48	14:10	0:22	14:18	0:08	14:39	0:17	0:22	15:00	0:21	1:12

2	6	11	8.25	14:33	15:01	0:28	15:03	0:02	15:23	0:24	0:21	15:53	0:30	1:20
5	7	9	6.75	14:48	15:19	0:31	15:25	0:06	15:39	0:02	0:15	16:11	0:32	1:23
6	8	9	6.75	15:33	15:57	0:24	15:58	0:01	16:16	0:19	0:19	16:42	0:26	1:09
Trips: 8		81 m³		16										

Date: Monday, July 29, 2019

Structures: Beam

Original Order (m³): 29

Booking Date

Sunday, July 28, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10	7.5	5:12	5:43	0:31	5:48	0:05	6:10		0:23	6:42	0:32	1:30
2	2	10	7.5	5:22	5:46	0:24	6:14	0:28	6:30	0:04	0:17	6:53	0:23	1:31
3	3	9	6.75	5:34	6:03	0:29	6:33	0:30	6:46	0:03	0:14	7:13	0:27	1:39
Trips: 3		29 m³		17										

Date: Tuesday, August 13, 2019

Structures: Beam

Original Order (m³): 77

Booking Date

Sunday, August 11, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m³	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	7:34	8:18	0:44	8:25	0:07	8:43		0:19	9:25	0:42	1:51
2	2	10.00	7.5	7:44	8:23	0:39	8:44	0:21	9:04	0:01	0:21	9:39	0:35	1:55
3	3	11.00	8.25	7:55	8:36	0:41	9:06	0:30	9:28	0:02	0:23	10:08	0:40	2:13
4	4	11.00	8.25	8:06	8:54	0:48	9:30	0:36	9:52	0:02	0:23	10:36	0:44	2:30
5	5	11.00	8.25	8:19	9:00	0:41	9:54	0:54	10:15	0:02	0:22	10:54	0:39	2:35
6	6	9.00	6.75	8:45	9:24	0:39	10:17	0:53	10:33	0:02	0:17	11:11	0:38	2:26
7	7	11.00	8.25	9:05	9:43	0:38	10:35	0:52	10:58	0:02	0:24	11:34	0:36	2:29
4	8	9.00	6.75	10:15	10:59	0:44	11:01	0:02	11:17	0:03	0:17	12:00	0:43	1:45
Trips: 8		82 m³												

18

Date: Wednesday, May 22, 2019

Structures: Beam

Original Order (m³): 38

Booking Date

Tuesday, May 21, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10	7.5	7:44	8:15	0:31	8:20	0:05	8:39		0:20	9:11	0:32	1:27
2	2	9	6.75	8:12	8:46	0:34	8:48	0:02	9:03	0:09	0:16	9:39	0:36	1:27
3	3	10	7.5	8:40	9:16	0:36	9:17	0:01	9:35	0:14	0:19	10:11	0:36	1:31
4	4	9	6.75	9:22	10:00	0:38	10:02	0:02	10:19	0:27	0:18	10:56	0:37	1:34
Trips: 4		38 m³												19

Date: Saturday, October 5, 2019

Structures: Columns

Original Order (m³): 28

Booking Date

Wednesday, October 2, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11	8.25	4:46	5:21	0:35	5:28	0:07	5:54		0:26	6:21	0:27	1:35
2	2	10	7.5	4:58	5:31	0:33	5:56	0:25	6:18	0:02	0:22	6:46	0:28	1:48
3	3	7	5.25	5:10	5:40	0:30	6:19	0:39	6:44	0:01	0:25	7:12	0:28	2:02
Trips: 3		28 m³												1

Date: Saturday, February 15, 2020

Structures: Column

Original Order (m³): 38

Booking Date

Thursday, February 13, 2020

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11	8.25	16:55	17:20	0:25	17:21	0:01	17:34		0:14	18:04	0:30	1:09
2	2	9	6.75	17:11	17:35	0:24	17:36	0:01	17:52	0:02	0:17	18:19	0:27	1:08
3	3	9	6.75	17:23	17:45	0:22	17:53	0:08	18:08	0:01	0:16	18:31	0:23	1:08
4	4	9	6.75	18:04	18:30	0:26	18:31	0:01	18:46	0:23	0:16	19:16	0:30	1:12
Trips: 4		38 m³												2

Date: Saturday, February 15, 2020

Structures: Column

Original Order (m³):

27

Booking Date

Thursday, February 13, 2020

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9	6.75	13:11	13:30	0:19	13:31	0:01	13:43		0:13	13:58	0:15	0:47
2	2	9	6.75	13:45	14:04	0:19	14:05	0:01	14:21	0:22	0:17	14:45	0:24	1:00
3	3	9	6.75	14:20	14:41	0:21	14:42	0:01	15:00	0:21	0:19	15:10	0:10	0:50
Trips: 3		27 m³												3

Date: Tuesday, January 28, 2020

Structures: Columns

Original Order

(m³): 60

Booking Date

Saturday, January 25, 2020

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site- St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11	8.25	13:54	14:59	1:05	15:00	0:01	15:18		0:19	16:19	1:01	2:25
2	2	9	6.75	14:10	15:22	1:12	15:23	0:01	15:43	0:05	0:21	16:51	1:08	2:41
3	3	9	6.75	14:45	16:05	1:20	16:06	0:01	16:22	0:23	0:17	17:38	1:16	2:53
4	4	11	8.25	15:15	16:22	1:07	16:23	0:01	16:41	0:01	0:19	17:44	1:03	2:29
5	5	9	6.75	15:41	17:00	1:19	17:01	0:01	17:15	0:20	0:15	18:30	1:15	2:49
6	6	11	8.25	16:15	17:28	1:13	17:29	0:01	17:48	0:14	0:20	18:57	1:09	2:42
Trips: 6		60 m³												4

Date: Wednesday, February 5, 2020

Structures: Column

Original Order

(m³): 14

Booking Date

Sunday, February 2, 2020

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site- St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9.00	6.75	12:59	14:04	1:05	14:05	0:01	14:30		0:26	15:32	1:02	2:33
2	2	5.00	3.75	13:55	14:53	0:58	14:54	0:01	15:10	0:24	0:17	16:06	0:56	2:11
Trips: 2		14 m³												5

Date: Monday, September 9, 2019

Structures: Column

Original Order

(m³): 29

Booking Date

Sunday, September 8, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9.00	6.75	18:32	19:20	0:48	19:24	0:04	19:44		0:21	20:28	0:44	1:56
2	2	9.00	6.75	19:15	19:56	0:41	19:57	0:01	20:16	0:13	0:20	20:51	0:35	1:36
3	3	11.00	8.25	19:55	20:39	0:44	20:40	0:01	20:56	0:24	0:17	21:38	0:42	1:43
Trips: 3		29 m³												6

Date: Sunday, December 15, 2019

Structures: Foundations

Original Order

(m³): 30

Booking Date

Saturday, December 14, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9.00	6.75	13:41	14:22	0:41	14:25	0:03	14:41		0:17	15:20	0:39	1:39
2	2	9.00	6.75	14:09	14:50	0:41	14:52	0:02	15:07	0:11	0:16	15:47	0:40	1:38
3	3	9.00	6.75	14:36	15:15	0:39	15:16	0:01	15:31	0:09	0:16	16:07	0:36	1:31
4	4	3.00	2.25	15:26	16:08	0:42	16:09	0:01	16:16	0:38	0:08	16:56	0:40	1:30
Trips: 4		30 m³												7

Date: Monday, September 9, 2019

Structures: Column

Original Order (m³): 51

Booking Date

Sunday, September 8, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site- St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9.00	6.75	11:48	12:50	1:02	12:55	0:05	13:11		0:17	14:09	0:58	2:21
2	2	9.00	6.75	12:19	13:15	0:56	13:16	0:01	13:31	0:05	0:16	14:21	0:50	2:02
3	3	10.00	7.5	12:55	13:49	0:54	13:50	0:01	14:08	0:19	0:19	14:56	0:48	2:01
4	4	11.00	8.25	13:35	14:25	0:50	14:26	0:01	14:43	0:18	0:18	15:27	0:44	1:52
5	5	11.00	8.25	14:11	15:00	0:49	15:01	0:01	15:19	0:18	0:19	16:02	0:43	1:51
3	6	4.00	3	15:01	15:47	0:46	15:48	0:01	16:05	0:29	0:18	16:49	0:44	1:48
Trips: 6		54 m³												8

Date: Wednesday, September 4, 2019

Structures: Column

Original Order (m³): 57

Booking Date

Thursday, August 29, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site- St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9.00	6.75	14:45	15:12	0:27	15:17	0:05	15:31		0:15	15:57	0:26	1:12
2	2	10.00	7.5	14:57	15:30	0:33	15:32	0:02	15:46	0:01	0:15	16:14	0:28	1:17
3	3	9.00	6.75	15:27	15:58	0:31	15:59	0:01	16:14	0:13	0:16	16:43	0:29	1:16
4	4	9.00	6.75	15:57	16:26	0:29	16:27	0:01	16:44	0:13	0:18	17:11	0:27	1:14
5	5	11.00	8.25	16:15	16:46	0:31	16:47	0:01	17:01	0:03	0:15	17:31	0:30	1:16
6	6	9.00	6.75	17:05	17:34	0:29	17:36	0:02	17:52	0:35	0:17	18:20	0:28	1:15
Trips: 6		57 m³												9

Date: Wednesday, September 4, 2019

Structures: Column

Original Order

(m³): 16

Booking Date

Thursday, August 29, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	12:55	13:23	0:28	13:28	0:05	13:53		0:26	14:20	0:27	1:25
2	2	6.00	4.5	13:40	14:12	0:32	14:13	0:01	14:33	0:20	0:21	15:00	0:27	1:20
Trips: 2		16 m³												10

Date: Monday, November 4, 2019

Structures: Column

Original Order

(m³): 61

Booking Date

Saturday, November 2, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	8:10	8:54	0:44	8:55	0:01	9:13		0:19	9:56	0:43	1:46
2	2	11.00	8.25	8:30	9:12	0:42	9:20	0:08	9:40	0:07	0:21	10:17	0:37	1:47
3	3	10.00	7.5	9:12	9:57	0:45	9:59	0:02	10:16	0:19	0:18	10:59	0:43	1:47
1	4	10.00	7.5	9:55	10:45	0:50	10:53	0:08	11:09	0:37	0:17	11:57	0:48	2:02
2	5	11.00	8.25	10:33	11:25	0:52	11:27	0:02	11:46	0:18	0:20	12:37	0:51	2:04
4	6	9.00	6.75	11:30	12:18	0:48	12:19	0:01	12:33	0:33	0:15	13:20	0:47	1:50
Trips: 6		61 m³												11

Date: Tuesday, November 5, 2019

Structures: Column

Original Order (m³): 57

Booking Date

Monday, November 4, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	10:00	10:33	0:33	10:38	0:05	10:56		0:19	11:28	0:32	1:28
2	2	11.00	8.25	10:11	10:47	0:36	10:58	0:11	11:17	0:02	0:20	11:48	0:31	1:37
3	3	10.00	7.5	10:25	11:04	0:39	11:18	0:14	11:35	0:01	0:18	12:12	0:37	1:47
4	4	10.00	7.5	10:45	11:26	0:41	11:36	0:10	11:52	0:01	0:17	12:31	0:39	1:46
5	5	10.00	7.5	11:09	11:45	0:36	11:53	0:08	12:09	0:01	0:17	12:44	0:35	1:35
6	6	9.00	6.75	12:33	13:15	0:42	13:17	0:02	13:31	1:08	0:15	14:12	0:41	1:39
Trips: 6		60 m³			12									

Date: Saturday, February 29, 2020

Structures: Columns

Original Order (m³): 80

Booking Date

Thursday, January 30, 2020

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10	7.5	9:54	10:24	0:30	10:25	0:01	10:40		0:16	11:06	0:26	1:12
2	2	11	8.25	10:33	11:05	0:32	11:06	0:01	11:24	0:26	0:19	11:52	0:28	1:19
3	3	11	8.25	10:54	11:28	0:34	11:29	0:01	11:48	0:05	0:20	12:18	0:30	1:24
4	4	10	7.5	11:14	11:54	0:40	11:55	0:01	12:10	0:07	0:16	12:46	0:36	1:32
2	5	11	8.25	11:45	12:23	0:38	12:24	0:01	12:43	0:14	0:20	13:17	0:34	1:32
3	6	11	8.25	12:30	13:03	0:33	13:04	0:01	13:23	0:21	0:20	13:52	0:29	1:22
5	7	9	6.75	13:10	13:49	0:39	13:50	0:01	14:04	0:27	0:15	14:39	0:35	1:29
6	8	10	7.5	13:55	14:28	0:33	14:29	0:01	14:44	0:25	0:16	15:13	0:29	1:18
Trips: 6		83 m³			13									

Date:

Structures: Column

Original Order

(m³): 51

Booking Date

Saturday, January 5, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11.00	8.25	14:45	15:12	0:27	15:17	0:05	15:31		0:18	15:57	0:26	1:12
2	2	10.00	7.5	14:56	15:29	0:33	15:31	0:02	15:45	0:00	0:15	16:13	0:28	1:17
3	3	11.00	8.25	15:37	16:08	0:31	16:09	0:01	16:24	0:24	0:20	16:53	0:29	1:16
4	4	11.00	8.25	16:01	16:30	0:29	16:31	0:01	16:48	0:07	0:22	17:15	0:27	1:14
5	5	10.00	7.5	16:45	17:16	0:31	17:17	0:01	17:31	0:29	0:16	18:01	0:30	1:16
Trips: 6		53 m³												14

Date: Monday, February 4, 2019

Structures: Column

Original Order

(m³): 51

Booking Date

Sunday, February 3, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	13:12	13:43	0:31	13:48	0:05	14:02		0:16	14:32	0:30	1:20
2	2	10.00	7.5	13:22	13:59	0:37	14:04	0:05	14:18	0:02	0:18	14:50	0:32	1:28
3	3	10.00	7.5	13:45	14:23	0:38	14:24	0:01	14:39	0:06	0:19	15:15	0:36	1:30
4	4	10.00	7.5	14:22	14:51	0:29	14:52	0:01	15:09	0:13	0:18	15:36	0:27	1:14
5	5	11.00	8.25	15:12	15:46	0:34	15:47	0:01	16:01	0:38	0:20	16:34	0:33	1:22
Trips: 5		51 m³												15

Date: Thursday, March 14, 2019

Structures: Column

Original Order (m³): 71

Booking Date

Sunday, March 17, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	9:45	10:14	0:29	10:19	0:05	10:35		0:17	11:03	0:28	1:18
2	2	10.00	7.5	10:10	10:47	0:37	10:49	0:02	11:06	0:14	0:18	11:38	0:32	1:28
3	3	10.00	7.5	10:35	11:07	0:32	11:08	0:01	11:24	0:02	0:17	11:54	0:30	1:19
4	4	11.00	8.25	10:58	11:31	0:33	11:32	0:01	11:53	0:08	0:22	12:24	0:31	1:26
5	5	11.00	8.25	11:08	11:39	0:31	11:54	0:15	12:14	0:01	0:21	12:44	0:30	1:36
6	6	9.00	6.75	11:18	11:47	0:29	12:16	0:29	12:31	0:23	0:16	12:59	0:28	1:41
1	7	10.00	7.5	11:29	11:57	0:28	12:33	0:36	12:49	0:19	0:17	13:16	0:27	1:47
Trips: 6		71 m³												16

Date: Sunday, April 28, 2019

Structures: Column

Original Order (m³): 70

Booking Date

Thursday, April 25, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11.00	8.25	13:15	13:44	0:29	13:49	0:05	14:08		0:20	14:36	0:28	1:21
2	2	11.00	8.25	13:26	13:59	0:33	14:10	0:11	14:31	0:02	0:22	14:59	0:28	1:33
3	3	11.00	8.25	13:38	14:16	0:38	14:32	0:16	14:54	0:01	0:23	15:30	0:36	1:52
4	4	10.00	7.5	13:50	14:26	0:36	14:55	0:29	15:12	0:01	0:18	15:46	0:34	1:56
5	5	9.00	6.75	14:35	15:07	0:32	15:13	0:06	15:29	0:01	0:17	16:00	0:31	1:25
2	6	11.00	8.25	15:10	15:51	0:41	15:52	0:01	16:12	0:23	0:21	16:52	0:40	1:42
3	7	9.00	6.75	16:10	16:39	0:29	16:40	0:01	16:57	0:28	0:18	17:25	0:28	1:15
Trips: 7		72 m³												17

Date:

Structures: Column

Original Order

(m³): 42

Booking Date

Thursday, May 2, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site- St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11.00	8.25	8:00	8:40	0:40	8:45	0:05	9:04		0:20	9:43	0:39	1:43
2	2	11.00	8.25	8:11	8:49	0:38	9:06	0:17	9:31	0:02	0:26	10:04	0:33	1:53
3	3	11.00	8.25	8:55	9:29	0:34	9:32	0:03	9:58	0:01	0:27	10:30	0:32	1:35
4	4	9.00	6.75	9:30	10:01	0:31	10:02	0:01	10:19	0:04	0:18	10:48	0:29	1:18
Trips: 4		42 m³												18

Date: Sunday, June 9, 2019

Structures: Column

Original Order (m³): 47

Booking Date

Saturday, June 8, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site- St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	14:10	14:37	0:27	14:42	0:05	14:56		0:15	15:22	0:26	1:12
2	2	10.00	7.5	14:30	15:03	0:33	15:05	0:02	15:19	0:09	0:15	15:47	0:28	1:17
3	3	10.00	7.5	15:20	15:51	0:31	15:52	0:01	16:07	0:33	0:16	16:36	0:29	1:16
4	4	9.00	6.75	15:57	16:26	0:29	16:27	0:01	16:39	0:20	0:13	17:06	0:27	1:09
1	5	10.00	7.5	16:11	16:42	0:31	16:43	0:01	17:01	0:04	0:19	17:31	0:30	1:20
Trips: 5		49 m³												19

Date: Thursday, August 22, 2019

Structures: Column

Original Order

(m³): 30

Booking Date

Wednesday, August 21, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11.00	8.25	7:45	8:12	0:27	8:17	0:05	8:39		0:23	9:05	0:26	1:20
2	2	10.00	7.5	8:22	9:00	0:38	9:02	0:02	9:18	0:23	0:17	9:51	0:33	1:29
3	3	9.00	6.75	9:45	10:16	0:31	10:17	0:01	10:32	0:59	0:16	11:01	0:29	1:16
Trips: 3		30 m³												20

Date: Tuesday, October 8,

2019

Structures: Foundations

Original Order

(m³): 95

Booking Date

Monday, October 7, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9	6.75	10:22	11:20	0:58	11:24	0:04	11:35		0:12	12:30	0:55	2:08
2	2	8	6	10:55	11:45	0:50	11:46	0:01	11:57	0:11	0:12	12:45	0:48	1:50
3	3	9	6.75	11:10	12:02	0:52	12:03	0:01	12:12	0:06	0:10	13:01	0:49	1:51
4	4	9	6.75	11:22	12:17	0:55	12:18	0:01	12:27	0:06	0:10	13:20	0:53	1:58
5	5	8	6	11:33	12:26	0:53	12:28	0:02	12:36	0:01	0:09	13:24	0:48	1:51
6	6	9	6.75	11:43	12:34	0:51	12:37	0:03	12:46	0:01	0:10	13:35	0:49	1:52
7	7	9	6.75	12:38	13:33	0:55	13:35	0:02	13:44	0:49	0:10	14:36	0:52	1:58
8	8	10	7.5	13:08	14:02	0:54	14:03	0:01	14:13	0:19	0:11	15:04	0:51	1:56

2	9	11	8.25	13:20	14:09	0:49	14:14	0:05	14:25	0:01	0:12	15:11	0:46	1:51
3	10	8	6	13:43	14:37	0:54	14:38	0:01	14:46	0:13	0:09	15:37	0:51	1:54
5	11	9	6.75	13:53	14:45	0:52	14:47	0:01	14:56	0:01	0:10	15:47	0:51	1:54
1	12	4	3	15:09	16:00	0:51	16:01	0:01	16:05	1:05	0:05	16:57	0:51	1:48
Trips: 16		103 m³												

1

Date: Tuesday, October 8, 2019
Structures: Foundations
Original Order
(m³): 211

Booking Date Monday, October 7, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11	8.25	7:53	8:23	0:30	8:27	0:04	8:37		0:10	9:09	0:32	1:16
2	2	10	7.5	8:04	8:42	0:38	8:53	0:11	9:08	0:16	0:15	9:45	0:37	1:41
3	3	10	7.5	8:26	8:58	0:32	9:09	0:11	9:16	0:01	0:07	9:48	0:32	1:22
4	4	10	7.5	8:37	9:08	0:31	9:17	0:09	9:25	0:01	0:08	9:52	0:27	1:15
5	5	9	6.75	8:49	9:24	0:35	9:26	0:02	9:33	0:01	0:07	10:06	0:33	1:17
1	6	11	8.25	9:15	9:47	0:32	9:48	0:01	10:01	0:15	0:13	10:33	0:32	1:18
6	7	11	8.25	9:26	9:58	0:32	10:03	0:05	10:12	0:01	0:09	10:43	0:31	1:17
3	8	10	7.5	9:35	10:11	0:36	10:15	0:04	10:24	0:03	0:09	10:57	0:33	1:22
5	9	10	7.5	10:19	10:49	0:30	10:50	0:01	11:00	0:26	0:10	11:31	0:31	1:12
7	10	9	6.75	11:01	11:33	0:32	11:34	0:01	11:43	0:34	0:09	12:14	0:31	1:13
8	11	11	8.25	11:14	11:49	0:35	11:50	0:01	12:00	0:07	0:10	12:34	0:34	1:20
9	12	11	8.25	11:32	12:05	0:33	12:06	0:01	12:16	0:06	0:10	12:48	0:32	1:16
2	13	9	6.75	11:45	12:16	0:31	12:18	0:02	12:25	0:02	0:07	12:57	0:32	1:12
10	14	11	8.25	12:00	12:34	0:34	12:35	0:01	12:46	0:10	0:11	13:22	0:36	1:22
2	15	9	6.75	12:13	12:49	0:36	13:04	0:15	13:13	0:18	0:09	13:48	0:35	1:35
5	16	10	7.5	12:45	13:23	0:38	13:24	0:01	13:35	0:11	0:11	14:12	0:37	1:27
6	17	11	8.25	12:56	13:35	0:39	13:36	0:01	13:47	0:01	0:11	14:25	0:38	1:29
9	18	10	7.5	13:28	14:10	0:42	14:11	0:01	14:20	0:24	0:09	15:03	0:43	1:35

7	19	10	7.5	13:39	14:18	0:39	14:21	0:03	14:30	0:01	0:09	15:07	0:37	1:28
2	20	10	7.5	13:52	14:28	0:36	14:31	0:03	14:41	0:01	0:10	15:15	0:34	1:23
2	21	9	6.75	14:22	14:56	0:34	14:57	0:01	15:07	0:16	0:10	15:38	0:31	1:16
2	22	7	5.25	15:22	15:51	0:29	15:52	0:01	16:08	0:45	0:16	16:40	0:32	1:18
Trips: 22		219 m³												

2

Date: Saturday, October 5, 2019

Structures: Foundations

Original Order (m³): 271

Booking Date

Wednesday, October 2, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	6:13	6:50	0:37	6:58	0:08	7:09		0:12	7:43	0:34	1:30
2	2	11.00	8.25	6:32	7:06	0:34	7:12	0:06	7:23	0:03	0:12	7:55	0:32	1:23
3	3	10.00	7.5	6:39	7:14	0:35	7:25	0:11	7:35	0:01	0:11	8:07	0:32	1:28
4	4	9.00	6.75	6:50	7:20	0:30	7:37	0:17	7:46	0:02	0:10	8:14	0:28	1:24
5	5	9.00	6.75	6:57	7:26	0:29	7:49	0:23	7:58	0:02	0:10	8:22	0:24	1:25
6	6	10.00	7.5	7:03	7:35	0:32	7:59	0:24	8:09	0:01	0:11	8:39	0:30	1:36
7	7	11.00	8.25	7:20	7:55	0:35	8:11	0:16	8:22	0:01	0:12	8:54	0:32	1:34
8	8	11.00	8.25	7:30	8:04	0:34	8:24	0:20	8:35	0:01	0:12	9:06	0:31	1:36
9	9	10.00	7.5	7:50	8:27	0:37	8:37	0:10	8:47	0:01	0:11	9:21	0:34	1:31
1	10	10.00	7.5	8:00	8:34	0:34	8:48	0:14	8:58	0:01	0:11	9:29	0:31	1:29
2	11	11.00	8.25	8:28	9:00	0:32	9:07	0:07	9:18	0:08	0:12	9:49	0:31	1:21
3	12	10.00	7.5	8:38	9:15	0:37	9:20	0:05	9:30	0:01	0:11	10:07	0:37	1:29
4	13	9.00	6.75	8:49	9:20	0:31	9:32	0:12	9:41	0:01	0:10	10:09	0:28	1:20
6	14	9.00	6.75	9:01	9:37	0:36	9:42	0:05	9:51	0:01	0:10	10:25	0:34	1:24
7	15	11.00	8.25	9:24	9:55	0:31	9:58	0:03	10:09	0:06	0:12	10:39	0:30	1:15
10	16	9.00	6.75	9:38	10:11	0:33	10:15	0:04	10:24	0:05	0:10	10:55	0:31	1:17
9	17	10.00	7.5	9:56	10:36	0:40	10:37	0:01	10:47	0:12	0:11	11:32	0:45	1:36
1	18	10.00	7.5	10:07	10:39	0:32	10:54	0:15	11:04	0:07	0:11	11:35	0:31	1:28
11	19	10.00	7.5	10:19	10:49	0:30	11:06	0:17	11:16	0:01	0:11	11:44	0:28	1:25

2	20	11.00	8.25	10:42	11:12	0:30	11:25	0:13	11:36	0:09	0:12	12:04	0:28	1:22
4	21	9.00	6.75	10:53	11:31	0:38	11:37	0:06	11:47	0:01	0:10	12:24	0:37	1:31
5	22	9.00	6.75	11:08	11:38	0:30	11:51	0:13	12:01	0:03	0:10	12:28	0:27	1:20
12	23	11.00	8.25	11:20	11:46	0:26	12:02	0:16	12:14	0:01	0:12	12:37	0:23	1:17
13	24	9.00	6.75	11:43	12:20	0:37	12:38	0:18	12:48	0:23	0:10	13:24	0:36	1:41
14	25	8.00	6	11:55	12:34	0:39	12:50	0:16	12:59	0:02	0:09	13:37	0:38	1:42
6	26	9.00	6.75	12:07	12:47	0:40	13:06	0:19	13:16	0:07	0:10	13:54	0:38	1:47
7	27	10.00	7.5	12:23	12:57	0:34	13:18	0:21	13:29	0:01	0:11	14:02	0:33	1:39
10	28	5.00	3.75	12:30	13:06	0:36	13:31	0:25	13:37	0:01	0:06	14:10	0:33	1:40
2	29	11.00	8.25	12:42	13:12	0:30	13:38	0:26	13:50	0:01	0:12	14:17	0:27	1:35
4	30	9.00	6.75	12:54	13:29	0:35	13:52	0:23	14:02	0:01	0:10	14:35	0:33	1:41
5	31	10.00	7.5	13:07	13:39	0:32	14:04	0:25	14:15	0:01	0:11	14:46	0:31	1:39
13	32	5.00	3.75	13:50	14:20	0:30	14:43	0:23	14:49	0:27	0:06	15:16	0:27	1:26
Trips: 32		306 m³												3

Date: Thursday, May 9, 2019

Structures: Foundations

Original Order

(m³): 140

Booking Date

Wednesday, May 8, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9	6.75	8:38	9:10	0:32	9:15	0:05	9:26		0:12	9:55	0:29	1:17
2	2	11	8.25	8:47	9:29	0:42	9:35	0:06	9:46	0:09	0:12	10:26	0:40	1:39
3	3	10	7.5	8:58	9:46	0:48	9:49	0:03	9:59	0:03	0:11	10:44	0:45	1:46
4	4	9	6.75	9:07	9:58	0:51	10:05	0:07	10:14	0:06	0:10	11:03	0:49	1:56
5	5	10	7.5	9:15	10:07	0:52	10:16	0:09	10:26	0:02	0:11	11:13	0:47	1:58
6	6	11	8.25	9:25	10:14	0:49	10:27	0:13	10:38	0:01	0:12	11:25	0:47	2:00
7	7	11	8.25	10:35	11:15	0:40	11:16	0:01	11:27	0:38	0:12	12:04	0:37	1:29
8	8	8	6	10:41	11:17	0:36	11:29	0:12	11:37	0:02	0:09	12:10	0:33	1:29
2	9	11	8.25	10:51	11:30	0:39	11:40	0:10	11:51	0:03	0:12	12:27	0:36	1:36
3	10	11	8.25	11:01	11:35	0:34	11:53	0:18	12:04	0:01	0:12	12:35	0:31	1:34
5	11	10	7.5	11:26	12:03	0:37	12:11	0:08	12:21	0:07	0:11	12:57	0:36	1:31
6	12	11	8.25	11:38	12:13	0:35	12:23	0:10	12:34	0:01	0:12	13:09	0:35	1:31
9	13	10	7.5	11:48	12:24	0:36	12:36	0:12	12:46	0:01	0:11	13:19	0:33	1:31
7	14	10	7.5	11:57	12:31	0:34	12:49	0:18	12:59	0:03	0:11	13:31	0:32	1:34
8	15	5	3.75	12:06	12:37	0:31	13:01	0:24	13:06	0:02	0:06	13:36	0:30	1:30
9	16	5	3.75	13:30	14:01	0:31	14:08	0:07	14:13	1:02	0:06	14:42	0:29	1:12
Trips: 16		152 m³												

4

Date: Monday, February 11,
2019

Structures: Foundations

Original Order (m³): 135

Booking Date

Saturday, February 9, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site- St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11.00	8.25	14:22	15:10	0:48	15:14	0:04	15:25		0:12	16:10	0:45	1:48
2	2	9.00	6.75	14:36	15:14	0:38	15:27	0:13	15:38	0:02	0:12	16:14	0:36	1:38
3	3	11.00	8.25	14:48	15:22	0:34	15:41	0:19	15:52	0:03	0:12	16:23	0:31	1:35
4	4	9.00	6.75	14:57	15:29	0:32	15:53	0:24	16:02	0:01	0:10	16:32	0:30	1:35
5	5	11.00	8.25	15:25	16:01	0:36	16:05	0:04	16:16	0:03	0:12	16:47	0:31	1:22
1	6	11.00	8.25	15:45	16:17	0:32	16:18	0:01	16:29	0:02	0:12	16:59	0:30	1:14
3	7	9.00	6.75	15:55	16:30	0:35	16:33	0:03	16:42	0:04	0:10	17:14	0:32	1:19
2	8	11.00	8.25	16:04	16:37	0:33	16:44	0:07	16:55	0:02	0:12	17:25	0:30	1:21
4	9	11.00	8.25	16:45	17:20	0:35	17:20	0:00	17:31	0:25	0:12	18:03	0:32	1:18
5	10	9.00	6.75	16:57	17:40	0:43	17:41	0:01	17:50	0:10	0:10	18:30	0:40	1:33
6	11	11.00	8.25	17:10	17:55	0:45	17:56	0:01	18:07	0:06	0:12	18:51	0:44	1:41
2	12	11.00	8.25	17:21	18:04	0:43	18:08	0:04	18:19	0:01	0:12	19:02	0:43	1:41
3	13	6.00	4.5	17:33	18:17	0:44	18:43	0:26	18:49	0:24	0:07	19:30	0:41	1:57
7	14	9.00	6.75	18:20	18:54	0:34	18:54	0:00	19:03	0:05	0:10	19:35	0:32	1:15
8	15	2.00	1.5	19:39	20:13	0:34	20:14	0:01	20:16	1:11	0:03	20:49	0:33	1:10
Trips: 15		141 CUM												

5

Date: Wednesday, June 19, 2019
 Structures: Foundations
 Original Order
 (m³): 140

Booking Date Tuesday, June 18, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site- St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9.00	6.75	7:45	8:31	0:46	8:38	0:07	8:49		0:12	9:29	0:40	1:44
2	2	9.00	6.75	8:01	8:45	0:44	8:51	0:06	9:02	0:02	0:12	9:38	0:36	1:37
3	3	9.00	6.75	8:11	8:53	0:42	9:03	0:10	9:12	0:01	0:10	9:51	0:39	1:40
4	4	11.00	8.25	8:29	9:14	0:45	9:17	0:03	9:28	0:05	0:12	10:01	0:33	1:32
5	5	8.00	6	8:44	9:26	0:42	9:31	0:05	9:39	0:03	0:09	10:16	0:37	1:32
6	6	9.00	6.75	8:54	9:35	0:41	9:41	0:06	9:50	0:02	0:10	10:29	0:39	1:35
7	7	9.00	6.75	9:19	10:01	0:42	10:03	0:02	10:12	0:13	0:10	10:51	0:39	1:32
1	8	11.00	8.25	9:29	10:08	0:39	10:14	0:06	10:25	0:02	0:12	11:01	0:36	1:32
2	9	9.00	6.75	10:18	10:58	0:40	11:00	0:02	11:09	0:35	0:10	11:46	0:37	1:28
8	10	10.00	7.5	11:15	11:56	0:41	11:58	0:02	12:08	0:49	0:11	12:46	0:38	1:31
9	11	8.00	6	11:26	12:04	0:38	12:10	0:06	12:18	0:02	0:09	12:55	0:37	1:29
5	12	9.00	6.75	11:37	12:16	0:39	12:19	0:03	12:28	0:01	0:10	13:07	0:39	1:30
7	13	9.00	6.75	11:47	12:27	0:40	12:30	0:03	12:39	0:02	0:10	13:16	0:37	1:29
10	14	11.00	8.25	12:21	13:07	0:46	13:09	0:02	13:20	0:30	0:12	13:54	0:34	1:33
6	15	4.00	3	14:15	14:54	0:39	14:55	0:01	14:59	1:35	0:05	15:34	0:35	1:19
Trips: 15		135 m³												

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Date: Thursday, April 4, 2019

Structures: Foundations

Original Order (m³): 220

Booking Date

Monday, April 1, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11.00	8.25	7:35	8:30	0:55	8:32	0:02	8:41		0:10	9:33	0:52	1:58
2	2	10.00	7.5	7:43	8:30	0:47	8:43	0:13	8:54	0:02	0:12	9:39	0:45	1:56
3	3	9.00	6.75	7:54	8:36	0:42	8:56	0:20	9:05	0:02	0:10	9:44	0:39	1:50
4	4	8.00	6	8:02	8:47	0:45	9:06	0:19	9:14	0:01	0:09	9:57	0:43	1:55
5	5	11.00	8.25	8:33	9:14	0:41	9:15	0:01	9:26	0:01	0:12	10:02	0:36	1:29
6	6	8.00	6	8:43	9:27	0:44	9:31	0:04	9:39	0:05	0:09	10:21	0:42	1:38
7	7	11.00	8.25	9:04	9:49	0:45	9:50	0:01	10:01	0:11	0:12	10:43	0:42	1:39
8	8	9.00	6.75	9:14	10:02	0:48	10:03	0:01	10:12	0:02	0:10	10:57	0:45	1:43
1	9	8.00	6	9:23	10:07	0:44	10:13	0:06	10:21	0:01	0:09	11:02	0:41	1:39
3	10	9.00	6.75	10:01	10:44	0:43	10:46	0:02	10:55	0:25	0:10	11:35	0:40	1:34
4	11	8.00	6	10:30	11:18	0:48	11:20	0:02	11:28	0:25	0:09	12:15	0:47	1:45
8	12	9.00	6.75	11:03	11:48	0:45	11:50	0:02	11:59	0:22	0:10	12:44	0:45	1:41
9	13	9.00	6.75	11:43	12:29	0:46	12:30	0:01	12:39	0:31	0:10	13:22	0:43	1:39
10	14	9.00	6.75	12:21	13:10	0:49	13:12	0:02	13:21	0:33	0:10	14:08	0:47	1:47
11	15	9.00	6.75	13:02	13:45	0:43	13:47	0:02	13:56	0:26	0:10	14:38	0:42	1:36
3	16	9.00	6.75	13:12	13:56	0:44	13:58	0:02	14:07	0:02	0:10	14:50	0:43	1:38
6	17	8.00	6	13:44	14:29	0:45	14:32	0:03	14:40	0:25	0:09	15:24	0:44	1:40
7	18	9.00	6.75	13:58	14:46	0:48	14:48	0:02	14:57	0:08	0:10	15:44	0:47	1:46
12	19	11.00	8.25	14:12	14:58	0:46	15:00	0:02	15:11	0:03	0:12	15:56	0:45	1:44
10	20	9.00	6.75	14:23	15:12	0:49	15:13	0:01	15:22	0:02	0:10	16:10	0:48	1:47
11	21	9.00	6.75	14:53	15:40	0:47	15:42	0:02	15:51	0:20	0:10	16:37	0:46	1:44
7	22	9.00	6.75	15:16	15:58	0:42	16:00	0:02	16:09	0:09	0:10	16:50	0:41	1:34
9	23	8.00	6	15:35	16:22	0:47	16:24	0:02	16:32	0:15	0:09	17:18	0:46	1:43
6	24	8.00	6	16:45	17:28	0:43	17:30	0:02	17:38	0:58	0:09	18:20	0:42	1:35
2	25	7.00	5.25	17:55	18:40	0:45	18:43	0:03	18:50	1:05	0:08	19:34	0:44	1:39
Trips: 25		225 m³												

Date: Thursday, December 5, 2019
Structures: Foundations

Booking Date Wednesday, December 4, 2019
Original Order (m³): 230

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time Between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	11.00	8.25	13:18	14:16	0:58	14:21	0:05	14:32		0:12	15:27	0:55	2:09
2	2	9.00	6.75	13:33	14:23	0:50	14:34	0:11	14:45	0:02	0:12	15:33	0:48	2:00
3	3	9.00	6.75	13:57	14:45	0:48	14:47	0:02	14:56	0:02	0:10	15:41	0:45	1:44
4	4	9.00	6.75	14:17	15:03	0:46	15:06	0:03	15:15	0:10	0:10	15:59	0:44	1:42
5	5	11.00	8.25	14:42	15:26	0:44	15:29	0:03	15:40	0:14	0:12	16:23	0:43	1:41
6	6	10.00	7.5	15:09	15:57	0:48	16:01	0:03	16:11	0:21	0:11	16:57	0:46	1:47
7	7	9.00	6.75	15:21	16:07	0:46	16:12	0:05	16:21	0:01	0:10	17:04	0:43	1:43
8	8	9.00	6.75	15:45	16:33	0:48	16:34	0:01	16:43	0:13	0:10	17:28	0:45	1:43
9	9	10.00	7.5	15:54	16:43	0:49	16:44	0:01	16:59	0:01	0:16	17:45	0:46	1:51
10	10	11.00	8.25	16:04	16:48	0:44	17:01	0:13	17:12	0:02	0:12	17:53	0:41	1:49
1	11	11.00	8.25	16:16	16:58	0:42	17:13	0:14	17:28	0:01	0:16	18:09	0:41	1:53
2	12	9.00	6.75	16:27	17:13	0:46	17:29	0:15	17:41	0:01	0:13	18:27	0:46	2:00
3	13	9.00	6.75	16:39	17:25	0:46	17:42	0:17	17:57	0:01	0:16	18:40	0:43	2:01
4	14	9.00	6.75	16:52	17:36	0:44	17:59	0:23	18:21	0:02	0:23	19:03	0:42	2:11
5	15	11.00	8.25	17:15	17:58	0:43	18:23	0:24	18:34	0:02	0:12	19:16	0:42	2:00
6	16	10.00	7.5	17:27	18:15	0:48	18:35	0:19	18:45	0:01	0:11	19:31	0:46	2:03
7	17	9.00	6.75	17:39	18:20	0:41	18:46	0:25	18:55	0:01	0:10	19:34	0:39	1:54
8	18	9.00	6.75	17:41	18:27	0:46	18:56	0:28	19:05	0:01	0:10	19:49	0:44	2:08
9	19	10.00	7.5	17:52	18:34	0:42	19:06	0:31	19:16	0:01	0:11	19:56	0:40	2:03
10	20	11.00	8.25	18:05	18:50	0:45	19:17	0:26	19:28	0:01	0:12	20:11	0:43	2:05
2	21	9.00	6.75	18:35	19:24	0:49	19:29	0:04	19:38	0:01	0:10	20:25	0:47	1:49
1	22	11.00	8.25	18:55	19:37	0:42	19:39	0:01	19:50	0:01	0:12	20:30	0:40	1:34
4	23	9.00	6.75	19:08	19:57	0:49	19:59	0:01	20:08	0:09	0:10	20:55	0:47	1:46
5	24	11.00	8.25	19:19	20:07	0:48	20:09	0:01	20:20	0:01	0:12	21:06	0:46	1:47
3	25	9.00	6.75	19:29	20:11	0:42	20:21	0:09	20:30	0:01	0:10	21:10	0:40	1:40
6	26	10.00	7.5	19:45	20:31	0:46	20:33	0:01	20:43	0:03	0:11	21:27	0:44	1:41
8	27	9.00	6.75	20:55	21:37	0:42	21:39	0:01	21:57	0:56	0:19	22:37	0:40	1:41
Trips: 27		264 m³												

Date: Thursday, April 25, 2019

Structures: Foundations

Original Order

(m³): 144

Booking Date

Wednesday, April 24, 2019

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	9	6.75	8:35	9:35	1:00	9:40	0:05	9:51		0:12	10:36	0:45	2:01
2	2	9	6.75	8:46	9:36	0:50	9:52	0:16	10:03	0:01	0:12	10:43	0:40	1:57
3	3	10	7.5	9:06	9:54	0:48	10:04	0:10	10:14	0:01	0:11	10:57	0:43	1:51
4	4	11	8.25	9:15	10:00	0:45	10:15	0:15	10:26	0:01	0:12	10:56	0:30	1:41
5	5	10	7.5	9:35	10:18	0:43	10:27	0:09	10:37	0:01	0:11	11:15	0:38	1:40
6	6	9	6.75	9:58	10:47	0:49	11:00	0:13	11:09	0:23	0:10	11:45	0:36	1:47
7	7	9	6.75	10:38	11:17	0:39	11:24	0:07	11:33	0:15	0:10	12:09	0:36	1:31
8	8	10	7.5	10:50	11:38	0:48	11:55	0:17	12:05	0:22	0:11	12:50	0:45	2:00
1	9	9	6.75	11:08	11:57	0:49	12:09	0:12	12:18	0:03	0:10	13:04	0:46	1:56
9	10	9	6.75	11:40	12:24	0:44	12:26	0:02	12:35	0:07	0:10	13:16	0:41	1:36
2	11	9	6.75	11:55	12:38	0:42	12:40	0:02	12:49	0:05	0:10	13:31	0:41	1:35
4	12	11	8.25	12:17	13:08	0:51	13:09	0:01	13:20	0:19	0:12	14:11	0:51	1:54
6	13	9	6.75	12:47	13:35	0:48	13:37	0:02	13:46	0:16	0:10	14:31	0:45	1:44
7	14	10	7.5	13:18	14:02	0:44	14:03	0:01	14:13	0:17	0:11	14:55	0:42	1:37
8	15	9	6.75	13:29	14:12	0:43	14:14	0:02	14:23	0:01	0:10	15:05	0:42	1:36
5	16	7	5.25	15:35	16:15	0:40	16:16	0:01	16:23	1:52	0:08	17:01	0:38	1:26
Trips: 16		150 m³												

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Date: Saturday, October 5, 2019

Booking Date
Original Order
(m³):271

Wednesday, October 2, 2019

Structures: Foundations

Truck	Trip.	Trip	Mixing Time	Ex-Plant	On-Site	Travel Time	St. Unloading	On Site-St. Unloading	Fn. Unloading	Time between two trk.	Unloading Time	Return	Travel Time	Trip Hrs.
Id	No.	Qty m3	min.	Time	Time	hr.	Time	Time	Time	min.	min.	Time	hr.	hr.
1	1	10.00	7.5	6:15	6:47	0:32	6:55	0:08	7:06		0:12	7:35	0:29	1:20
2	2	11.00	8.25	6:33	7:08	0:35	7:09	0:01	7:20	0:03	0:12	7:53	0:33	1:20
3	3	10.00	7.5	6:41	7:13	0:32	7:21	0:08	7:31	0:01	0:11	8:00	0:29	1:19
4	4	9.00	6.75	6:53	7:27	0:34	7:32	0:05	7:41	0:01	0:10	8:13	0:32	1:20
5	5	9.00	6.75	6:58	7:30	0:32	7:42	0:12	7:51	0:01	0:10	8:18	0:27	1:20
6	6	10.00	7.5	7:10	7:48	0:38	7:52	0:04	8:02	0:01	0:11	8:38	0:36	1:28
7	7	11.00	8.25	7:20	7:52	0:32	8:03	0:11	8:14	0:01	0:12	8:43	0:29	1:23
8	8	11.00	8.25	7:30	8:06	0:36	8:15	0:09	8:26	0:01	0:12	8:59	0:33	1:29
9	9	10.00	7.5	7:48	8:24	0:36	8:27	0:03	8:37	0:01	0:11	9:10	0:33	1:22
1	10	10.00	7.5	8:00	8:35	0:35	8:38	0:03	8:48	0:01	0:11	9:20	0:32	1:20
2	11	11.00	8.25	8:26	8:58	0:32	8:59	0:01	9:10	0:11	0:12	9:41	0:31	1:15
3	12	10.00	7.5	8:37	9:13	0:36	9:14	0:01	9:24	0:04	0:11	10:00	0:36	1:23
4	13	9.00	6.75	8:48	9:21	0:33	9:25	0:04	9:34	0:01	0:10	10:04	0:30	1:16
6	14	10.00	7.5	9:01	9:36	0:35	9:37	0:01	9:47	0:03	0:11	10:20	0:33	1:19

7	15	11.00	8.25	9:22	9:56	0:34	9:57	0:01	10:08	0:10	0:12	10:41	0:33	1:19
10	16	9.00	6.75	9:37	10:12	0:35	10:13	0:01	10:22	0:05	0:10	10:55	0:33	1:18
9	17	10.00	7.5	9:54	10:32	0:38	10:33	0:01	10:43	0:11	0:11	11:26	0:43	1:32
1	18	10.00	7.5	10:09	10:43	0:34	10:44	0:01	10:54	0:01	0:11	11:27	0:33	1:18
11	19	10.00	7.5	10:17	10:49	0:32	10:55	0:06	11:05	0:01	0:11	11:35	0:30	1:18
2	20	11.00	8.25	10:37	11:08	0:31	11:09	0:01	11:20	0:04	0:12	11:49	0:29	1:12
4	21	9.00	6.75	10:51	11:25	0:34	11:26	0:01	11:36	0:06	0:10	12:09	0:33	1:18
5	22	9.00	6.75	11:08	11:41	0:33	11:42	0:01	11:52	0:06	0:10	12:22	0:30	1:14
12	23	11.00	8.25	11:18	11:54	0:36	11:55	0:01	12:07	0:03	0:12	12:40	0:33	1:22
13	24	9.00	6.75	11:33	12:09	0:36	12:10	0:01	12:20	0:03	0:10	12:55	0:35	1:22
14	25	10.00	7.5	11:48	12:25	0:37	12:26	0:01	12:37	0:06	0:11	13:13	0:36	1:25
6	26	10.00	7.5	12:07	12:47	0:40	12:48	0:01	12:59	0:11	0:11	13:37	0:38	1:30
7	27	11.00	8.25	12:22	12:56	0:34	13:00	0:04	13:12	0:01	0:12	13:45	0:33	1:23
10	28	5.00	3.75	12:57	13:33	0:36	13:34	0:01	13:40	0:22	0:06	14:13	0:33	1:16
Trips: 28		276 m ³												

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CURRICULUM VITAE

MUSTAFA EL-NAJJAR
Khobar Saudi Arabia
m.w.alnajjar@hotmail.com
+966569004814

• Education

Master's degree in engineering and Construction Management (2017-2021)

King Fahd University of Petroleum and Minerals

- Graduated with the first honors with a GPA of 3.78/4

Bachelor's Degree in building engineering and Science (2012-2017)

Imam Abdul Rahman bin Faisal University

- Graduated with the first honors with a GPA of 4.78/5

• Professional Experience

Site Engineer – Nesma & Partners (2019-Present)

concrete precast yard in charge for all oil & gas projects



- Managing and scheduling of the weekly activities for more than 55 manpower.
- Secure the required manpower and materials for the construction activities
- Maintain the required concrete quality
- Review the drawings and the technical inquiries
- Review the change orders with the quantity surveyors

Technical Sales Engineer – Saudi Ready-Mix (2017-2019)

- Concrete design with the customer to meet the project specifications
- Negotiating the terms of an agreement and closing the sale



- **Research Experience**

Graduated Research

- Concrete Delivery Scheduling Using Simulation in Saudi Arabia, submitted for the award of Master of Construction Engineering and management (2021)
- AHP based approach for crane selection of building construction in Saudi Arabia: A case study published in Canadian Society for Civil Engineering (2019)

Undergraduate Research

- Effect of silica manganese fume on concrete, submitted for the award of Bachelor of Building Science (2017)

- **Computer Skills**

Microsoft office, Auto Cad, Revit, Ecotect2011, Dialux Evo.

- **Area of Interest**

Building material, Concrete, Sustainability & Green Building, Construction Management, Scheduling and planning, Cost estimation, Value engineering, Plumbing systems, HVAC systems.

- **Attended Courses**

- 35 hours PMP preparation course (2020)
- Sandler sales training (2019)
- Sustain safety shield (2017)

- **Languages**

- Arabic
- English

- **Activities and Interests**

Sports: Soccer, Judo, Swimming

Travel: Turkey, Jordan, Many cities at Saudi Arabia

