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Frijns Structural Steel Middle East W.L.L. & University of Twente

Internship Report

"Assisting the management team of Frijns Structural Steel in order to develop a tool to gain more control over the projects and the production in the company"

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August 2015 - January 2016

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1 - Preface

In the period of August 2015 till January 2016 I did my internship abroad in Qatar, for the master Mechanical Engineering. The internship was done at Frijns Structural Steel Middle East in Mesaieed, Qatar. I have been given the opportunity to work in a dynamic environment in a fast developing country. I would like to thank Rob Frijns (owner and managing director) for giving me this chance and the support during my internship. Throughout the months I could closely work together with ir. Robert Corsius (CFO and general affairs) which was a true pleasure. I have learned a lot from Robert about the organization of a project-oriented company and a lot about the managerial aspects of fast growing companies in developing countries. Last but not least, I would like to thank ir. Wieteke de Kogel-Polak for guiding and supervising me during this internship.

Definition of the assignment

Upfront my trip to Qatar, I have had contact with Robert Corsius about definition of my assignment. During these discussions, it became clear that as an intern, I will assist the management team to develop some tools to get more insight in the organization; to get more control over the projects at Frijns Structural Steel.

At the start of the internship, the management had no clear overview of the status and progress of all projects and production. Some department used their own tracking sheets but did not actively shared them within the organization, other departments didn't even had one. Missing as well is a master production planning, where all projects together form an overview of the total workload and needed capacities in time. Using this information performance could be measured of the different departments and the financial settlement of projects could be improved. When such an overview is provided, the opportunities to plan the production ahead can be further researched, in order to get a financial forecast as well. There is not an ERP-system or some similar software used within Frijns; so all the information has to be gathered by actively requesting information from colleagues own information sources. At the start of the internship there was no meeting structure in which defined information is shared with each other. The following internship-assignment is defined:

"Assisting the management team of Frijns Structural Steel in order to develop a tool to gain more control over the projects and the production in the company"

The approach of this internship is top-down, this is a personal choice. I prefer to have a total overview of the company, before I go into depth in a certain problem. The assignment will be in corporation with the management, which are having a top down view as well. Therefore the first step is to get to know the organization, this will be done by interviews. Later on, a more specific project to execute this internship will be defined.

N.B. : Throughout the report some financial information is shown as well, there has to be noted that these numbers are not real. All the prices and rates are fictive, though the order of magnitude is right.

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2 - Frijns Structural Steel Middle East

The company I did work for during this internship is Frijns Structural Steel Middle East. This company is located in Qatar, and is founded in corporation with the Al Faisal Group. As for most of the countries in the Middle East, it is necessary to have a local partner to set up a company, this partner usually is the main shareholder of the company. Frijns Qatar is founded in 2009 in Al-Shahaniya, over the years the company has grown rapidly and in the beginning of 2015 a second production facility is opened in Mesaieed, where the main office is as well. The office in Al-Shahaniya is only used for the local operational organization. The internship was performed at Mesaieed, with a few visits to the Al-Shahaniya site.

Frijns Structural Steel is an originally Dutch structural steel company which is lead by the third generation of the Frijns-family, resulting in over 50 years of experience. They are providing steel structures for a broad scope of businesses, including petrochemical, civil and process industries. Frijns Qatar has grown rapidly in the past years and has currently almost 500 employees. The yearly turnover is in the range of 100 million Qatar Riyal, approximately 25 million euros. The workshop in Mesaieed has a maximum capacity of processing approximately 300 tons of steel per week. Currently the workload of the workshop is about 60-70%, although the expectation is that in the near future this will increase quickly.

The strength of Frijns Structural Steel is having all the facilities in house to perform steel construction projects. This begins with engineering the constructions and it finishes with the erection of the structure at the clients site. The main advantage in here is the engineering; other structural steel companies outsource the engineering. Therefore Frijns Qatar can easily adapt to changes from the client and when problems are noticed during fabrication or installation, these can be solved quickly. This does also mean flexibility in planning, since there is no dependence on the planning of a third party for the engineering.

The construction project Frijns Structural Steel is making, are both primary and secondary steel structures. The primary is the main steel structure of a construction or building, the secondary steel will be build up on the primary. On the next page an overview of pictures of projects which are build by Frijns is shown. The projects are among other things:

1. A superstructure for a ship yard (totally 10.000 tons of steel)
2. A sunshade structure with aluminium panels (total length 1400 meters)
3. Integration of structural steel structures onto concrete structures.
4. The fabrication and installation of maintenance platforms for an airplane maintenance shop.
5. A landmark monument with aluminium and stone panels.
6. The steel structure of a roof including suspended catwalk (170 tons roof structure)

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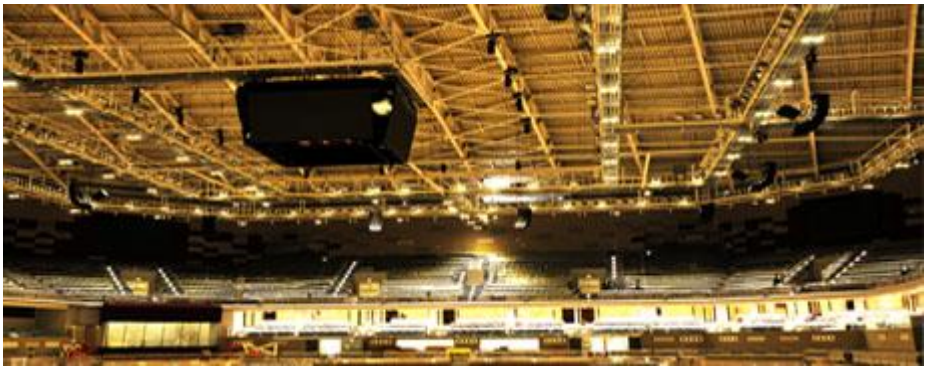

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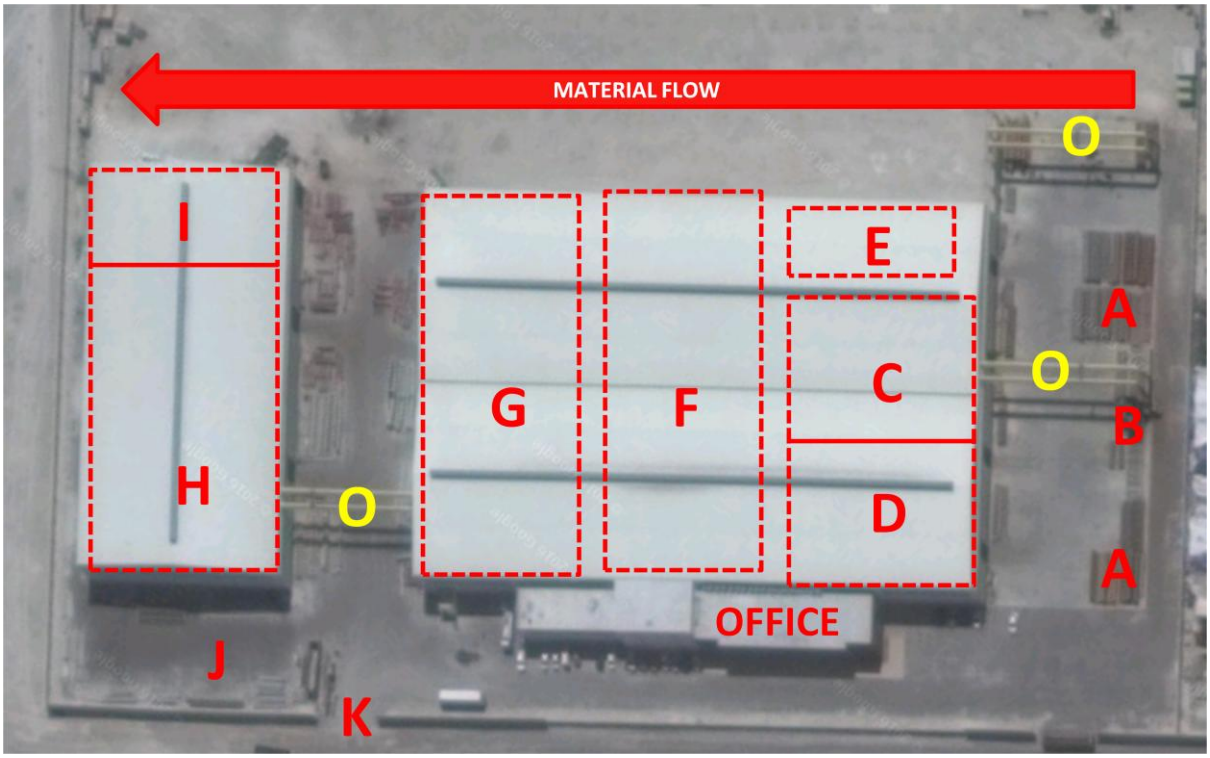
3 - Introduction to steel construction fabrication

This chapter will explain the production process of a steel construction, step by step. First the layout of the factory in Mesaieed, the main location, will be explained. This shows a first brief overview of the fabrication process, followed by a virtual walk through the factory, showing the production steps more detailed and the production machines used at Frijns. The last part of this chapter will address some organizational aspects of the workshop of a steel construction company.

Factory lay out

Fabricating a steel construction is basically a very simple process. Steel columns and beams arrive at the shop, first they will be cut at length. Then the connecting plates will be welded to the beam, and the last step is applying the paint layer. Roughly spoken, this is how the factory is build up as well when taking a look at a sketch of the floor plan.



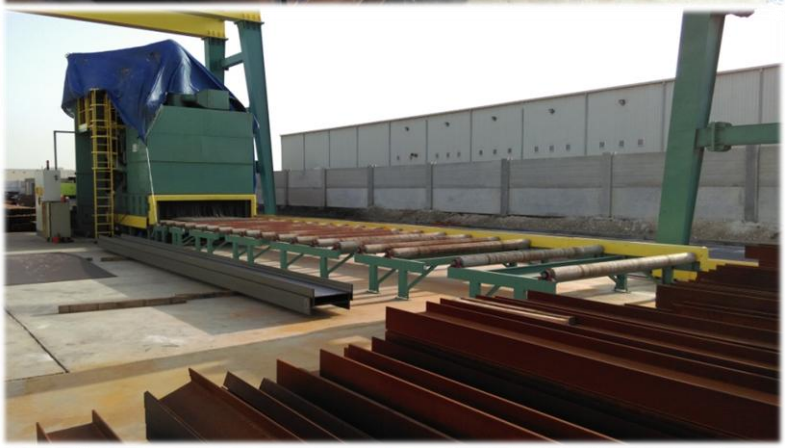
The raw materials, beams, columns and plates, are stored outside at locations A. Using the overhead cranes O, they will be brought to the sand blasting machine B, before they enter the workshop. Area D is called the work preparation. Plates will be cut into smaller pieces using a plasma cutting machine. Then, the plates will be machined up to the specifications, and small components are made here as well. All the beams and columns will enter area C where the sawing line is placed and the columns will be cut to length. When beams needs to be bended, this will be done using a bending machine placed in area E. The assembly and welding process takes place in respectively area F and G, assemblies containing curved beams will be build 'at the top' of those areas (close to the machine in area E). The paint shop is build separately from the workshop, to prevent pollution of the air by the welding and grinding processes. The paint shop is situated in area H, and area I is the workshop for stainless steel materials. When assemblies are finished and the transport is not ready yet, they can be stored at location J. The entrance and exit of the factory site is letter K.

The fabrication process

The process starts with the delivery of the raw materials, which are steel beams, columns, bars or plates. These materials are shipped from all over the world to Qatar, and are delivered by truck. Using overhead cranes at the side of the factory the truck will be unloaded and the material will be stacked outside. During the unloading each beam will be checked and marked.

Normally a delivery of materials is related to one project only. The processing in the workshop is project based, so the materials are stacked per project as well. Each beam has denoted its project number, dimensions and the steel quality.

Before the materials are processed in the workshop, the corrosion will be removed. This is done using a blasting machine, where reusable abrasive particles are blasted against the steel material. The collision of the abrasive material with the beam, will remove the loose rust particles. Then the rust particles are filtered out, so that the abrasives can be used again.



After the blasting process, the beams are transported to the "sawing line" in the work shop. This automated Voortman-machine measures the beam and does cut it automatically at the set length and it can drill holes at the same time (programmed, like the length). There is a buffer zone upfront the machine, as well as after it. A second sawing machine, not automated, is available as well.

As can be seen in the picture above, behind the sawing line some small machines are located. These are small machining machines like a drilling machine, belt saw, nibbler and a plate bending machine. In a steel construction, a lot of connection plates are used, these plates are machined in this area of the workshop.

Plates are sand blasted as well before they enter the workshop. Out of a big plate, a lot of different plates can be made using a plasma cutting machine. This machine has five independent moving cutting heads, it can be programmed such that is can automatically cut the plate into pieces.

Normally all the beams and columns do have standard dimensions, which are available on the steel market. In some cases the standard does not meet the design requirements, and then the beam has to be made by Frijns. These beams are mostly used for heavy supporting construction, undergoing extreme forces. In this case the beams or columns will be composed out of steel plates, which will be welded together. Since the plates are very thick, and the stresses in the construction high, the weld needs to fully penetrate the material. These two factors result in the choice for a Submerged Arc Welding process. An automated welding machine guided on rails will move over the assembly and weld the plates together.

In case a beam needs to be curved, there is a bending machine which can bend the columns and beams. This machine consumes a relative large amount of space in the workshop. The beam enters the machine at one side, and leaves it at the other. A bending process takes several iterative steps, so the beams needs to moved around the machine over and over.

Since a curved beam consumes more space, the top part of the workshop is dedicated for these beams. The curved construction can't be moved around easily, and therefore it will be assembled and welded at the same location. In this way it does not affect the flow of the normal straight materials.

The flow of the normal materials is in its longitudinal direction. After the sawing line, the beams are moved forward to the assembly area. Here, the construction will be assembled. This can be adding connection plates to a beam, or stiffness plates to increase the strength of the structure, or assemble multiple beams to a (sub-)assembly. During the assembly the number of welds used are minimal, since there is always a possibility that it has to be rebuild, when dimensions are not correct.

When the assembly is finished the construction can move another step forward in the workshop, for the final welding. The dimensions are checked and correct, so the structural welds can be placed and the assembly phase will be finished.

After the assembly of the steel structure, it needs to be painted. This can be from a simple coating to prevent it from corrosion, up to a fireproofing coating or a high quality varnish for a proper look. Before the painting, the structure will be sand blasted again and cleaned. When the painting is finished, the structure will be stored inside, or directly loaded onto the truck.

There is a special workshop for stainless steel products. To prevent for using the wrong materials (e.g. welding wires) on the wrong products, this workshop is separately organised. Typical product made here are base plates, which will be casted in concrete, being the connection between the steel construction and the concrete.

Organization of the workshop

The operational manager is responsible for the operational aspects of the company, including the production. This production is roughly split up in three phases, the work preparation, the welding and the painting. There are three production leaders, each taking responsibility for one of these phases. The bottleneck in the production is the welding process; the capacity of the work preparation and paint shop exceeds the welding department. Taking a look at the sketch of the floor plan; the capacity of areas F and G mostly is fully used, there is no more space available. The final welding is a time consuming process, and therefore the assemblies are not moving quickly to the next production step. So the leader of the welding group is determining the production planning, the work preparation will follow the instructions of the welding department; a pull system. Where the paint shop will paint what they get delivered, a push system. In an ideal situation the entire production should be pulled by the project managers, who are requiring structures at the site of the client. The factory should follow their planning. Due to a lot of problems in Qatar regarding delivery of raw materials and the reliability of installation schedules at the client's site, it is hard to follow this system. Usually a rough estimation is made when certain assemblies are needed, then based on that planning materials are ordered, and production is scheduled.

Taking a look at the floor plan of the factory, it looks like a job shop. Machines are grouped according to their function, and not based the type of product they make. The sawing machines are placed next to each other and the work preparation area contains all the other machines, including the plasma cutting machine for the plates. The products are moving from one machine to another. Although, when looking at the material flow, it looks like an flow shop as well. The raw materials are entering the shop at one side, and finished products leave it at the other side. Though looking inside the production hall, it happens quite often that during the assembly additional holes need to be drilled for example, and then the assembly will be placed back to the drilling machine. So it can be said that the workshop is a job shop.

4 - Steel construction projects

This chapter will describe the current general workflow of the steel construction projects at Frijns Qatar. It will help to introduce the different departments in relation with the project and explain their added value to a project. Firstly, a more general description of the process will be given in a chronological order, and later the interfaces between departments will be analysed, to identify what information is communicated. There has to be noted that there is no ERP-system available at Frijns. Some of the departments have their own system of controlling the projects and workload, other don't have. The purpose of this chapter is to understand the current way of working, In the next chapter some weaknesses and opportunities will be analyzed.

The workflow

For this internship report the workflow of a steel construction project will start after a contract has signed. Before that moment, the estimation department together with the financial department have offered a tender document to the client which includes a proof that Frijns is able to handle the project and of course a quotation. After negotiation, the final contract will be signed. In here, agreements with Frijns' steel suppliers about steel prices are made as well. In the contract, the specifications of the project are described extensively, e.g. the quality of the used materials or the painting and welding specifications. Of course, deadlines to finish the (sub-)project is mentioned, and much more, for example the labour standards for the worker of Frijns. Since the internship is about the production process, the tendering phase will be excluded.

The engineering department will detail out the entire construction. Using CAD-software “Tekla®” the entire steel structure will be modelled and evaluated. Then the technical drawings will be created and checked. First, so called shop-drawings will be made and sent to the client. If these shop-drawings are approved by the client, the fabrication drawings can be created. When this drawing is approved, it will be printed out and marked, in order to make sure that no other versions will be used, unless a new approved version will be available of course. The deliverables of the engineering department are the technical drawings and the Bill Of Materials with all the necessary specifications. This will be delivered per assembly; each beam-structure is seen as an assembly. A project consists of many assemblies; all the beams together form the steel structure.

The work preparation at the workshop will receive the drawings and the BOM, to prepare the fabrication process. Since Frijns has two production facilities, the decision to which workshop the job will be sent, is based on expertise. Both locations are comparable, though some machines are available in Mesaieed, and not in the other workshop. Then the production engineer will optimize the use of raw materials (e.g. cutting optimization in order to reduce the leftover ends of the beams, or plates). When the optimization is done, it is known how many raw materials are needed, with the specifications, e.g. material grade. After checking the inventory, the raw materials that are needed, will be requested at the procurement department. The production engineer determines the sequence of jobs per work order, he defines as well on which machine they will be made. Based on the priority of the job, the sequence of orders per work stations is determined. This priority is mainly determined by project management, so the priority of an entire project, not specifically that job on a machine within a project. Briefly summarized, the workshop scheduling is based on expertise. The planning system is a pile of drawings on a table per work station, where the top drawing has the highest priority.

Buying the materials is the responsibility of the procurement department. This department will receive a request to order from the workshop. Based on agreements with suppliers, which are already made in the tendering phase of a project, they will order the required materials.

The fabrication of steel constructions can be divided into five steps. First the raw materials which are delivered to the factory will be sandblasted to remove all the corrosion. Then the raw material will be cut to length, in case of a beam. Or plate material will be cut out of the raw plates. After all the parts are made, they will be assembled together with "small welds". This assembly is to make sure the dimensions will be within tolerance, which will be checked by the quality department. After the assembly is done properly and checked, the final welds can be made, to finish the assembled product. If necessary, the assembled product (a beam with attached connection plates) can be painted. The paint shop is separated from the workshop. This is done to provide a “less polluted” environment, such that the paint won't get polluted with for example steel dust particles. When the welding is finished and if necessary the product is painted, the fabrication is finished and the assemblies can be loaded on a truck and sent to the client. As discussed before, the bottleneck in the production is the welding phase, therefore the production will be scheduled on this welding phase.

Quality control is a very important factor in steel construction projects, throughout the entire production process. In the contract signed for a project, all the specifications are defined, and the delivery of a project is not finished if the quality documents are not there. When raw materials are delivered, they will have with them a material certificate or mill certificate. This is an official certificate that proofs the properties and composition of the material. For each delivery to the client, it has to be proven that all the materials meet the prescribed specifications and qualities. Every step in the fabrication as described before, will be checked by the quality department. After the assembly all the dimensions will be checked, later the quality of the welds will be inspected and the paint quality will be verified as well. These inspections are for internal control, in the contract with the client a certain inspection frequency is prescribed. Usually an independent third party will come to the workshop and inspect a batch of the assemblies. Based on these third party inspections the client will judge the quality of a project. Along with each delivery of assemblies to the client, the necessary quality documents will be provided. In such a delivery report can be found the documentation about the material or mill test certificates, the third party inspection reports, internal inspection reports and the delivery note itself, to make sure that the client confirms the delivery of the products. This delivery report has to be handed over officially, signing this document means accepting the materials as inspected. Here the client accepts the materials and thus approves the delivery of goods. If the client does not agree with the report, even though the materials are delivered, it is not an official accepted delivery. Based on these accepted documents, invoices can be sent to the client, therefore is it very important that the delivery reports will be accepted.

When the assemblies are delivered at the client, Frijns Qatar can erect the structures as well. In this case the production process continues at the site of the client. A team of workers of Frijns will erect the steel structure piece by piece. when a certain part of the construction is erected, Frijns can request an inspection, such that the client will approve the installation of the structure. This is an official document, like the delivery report discussed before.

Interfaces between departments

As seen in the previous section, a project will flow from one department to the other. Some of the connections between departments are trivial, for example when assemblies are finished, the logistics needs to ship them to the client. The same holds for the paint shop, this will follow the output of the workshop. Though, in between a few departments some more information is communicated. This paragraph will highlight some other connections.

Engineering-workshop

The engineering department only provides the workshop with the bill of materials and the technical drawings. First, those documents will be checked by the client after the engineers created them. When the entire set of documents is finished for a certain job or (sub-)project, they will be delivered to the production engineer/work preparation through the document controller. The sequence of releasing the documents is determined by the engineer, when he finishes modelling a part of the structure, he will finish the drawings. The engineer does make its own planning, independent of the workshop. The workshop does only receive information from the engineers, except when there is a fault in the drawings, then this will be solved together with the responsible engineer.

Workshop-procurement

The production engineer does sent a Request For Material to the procurement department. Usually this is just a list of materials. The procurement officer has to request additional information regarding the quality standards of the material. When the order is sent to the supplier the procurement officer will receive an expected delivery date, which is not communicated with the production. When the material is delivered, the logistic department will inform the workshop, since they take care of the transports and deliveries.

Workshop - quality

A lot of interaction occurs between the quality department and the workshop. Every production step has to be checked by the quality inspectors. So the workshop has to tell quality that products are ready for inspection and quality has to inform the workshop whether the product are approved and thus can continue with the next process step. This is all verbal communication, the quality reports will be kept with the quality department. The quality engineers keep track of what products are checked and thus what production phase is finished; the production progress. This is done in an internal progress sheet, which is only distributed to the workshop office, when they request to do so.

Project management - all departments

The project department creates a planning for every project, where all phases from engineering up to erection are planned. The project planner requests information at the workshop for the progress of the production. As well as for the erection of the steel structures, the planner has to ask the site manager (at the site of the client) for the progress. So the planner will only be informed after he requests information. At this moment the planning is only used to report progress to the client.

The project manager has to inform the responsible engineer whether there are changes in the situation on the site (place where the construction will be built). It could be that the pouring of the concrete, some dimensions are not met. In this case the design of the steel structure has to change.

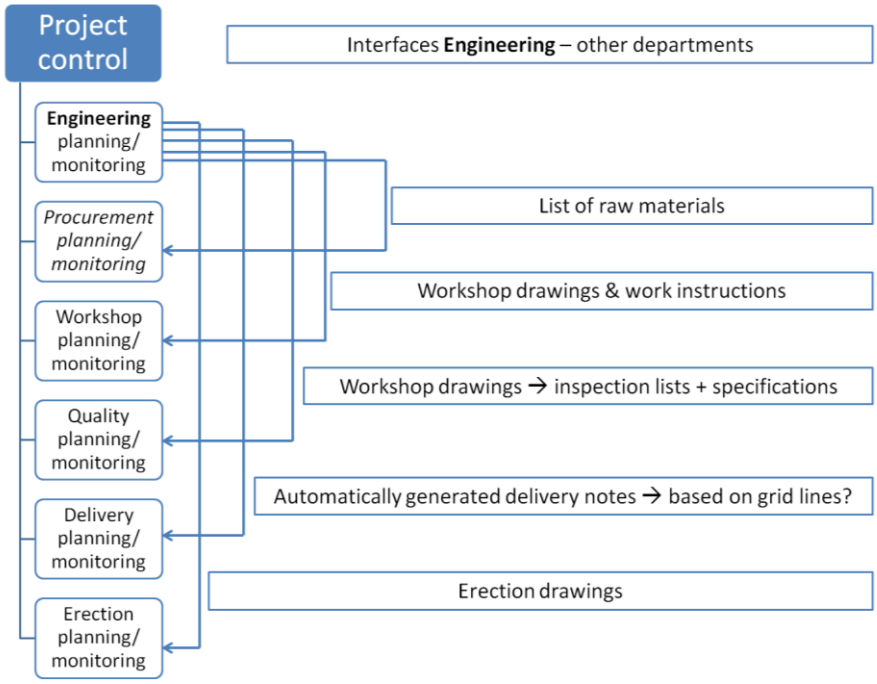
5 - Improvement analysis

The previous chapter described the current way of working within Frijns. During interviews with colleagues from all the departments some analysis are made about the interaction with other department. Out of these interviews some weaknesses are identified and for each department an interface with the other departments is designed. In this chapter the results will be presented; per department first the analysis and secondly the interface. The schedule of the interface is presented to the management, in this report a bullet wise explanation will be given.

Engineering

Engineering is the department which provides all the departments with the information. The engineer creates the model of the steel structure and creates the drawings, which will be approved by the client. All the information related to the technical aspects of a project has to come from the engineer, and in an ideal organisation the engineering department will provide all this information to the necessary persons on forehand. At the moment of this interview, the procurement department is provided with a list of materials which needs to be ordered. Then the approved drawings will be sent to the shop floor and the quality department, where the erection team will be provided with the erection drawings, when they request it. Currently the paint shop has to deduct the paint specifications from each individual drawing. They could get better input from the engineers with a specific list containing the items to be painted per project, with their specifications. Furthermore, the workshop has to determine how the products will be produced, on which machines and in which sequence. To help the workshop, they could be provided with more production relevant information, so called ‘design for production’. Since the erection drawings are created by the engineers, they know in what sequence the structure will be erected and thus they define the sequence of delivery of the materials as well. So based on the available information, the delivery notes guiding the transport of the materials, can be generated and provided by the engineering department as well, using this automated feature in the CAD-software. In this case the logistics department will use the same source of information as the other departments. Generally spoken, the engineering department is the information source for the company. All departments will be provided with project related information by the engineers. The biggest challenge is to communicate this information is a proper way to the right people at the right moment.

A schedule of the proposed interface is shown on the next page, followed by a bullet wise explanation.



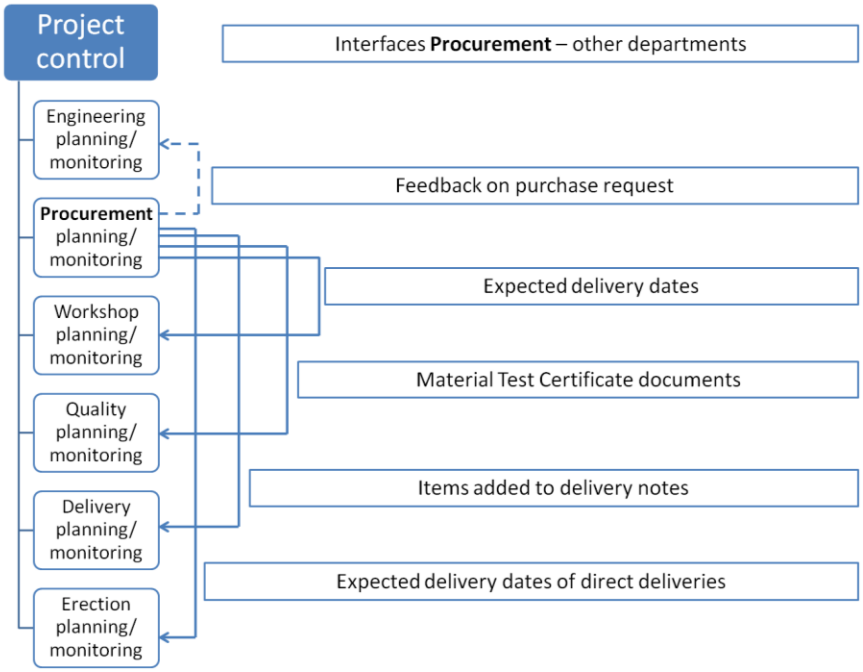
- The engineer has all the specifications of the needed materials, by communicating directly with the procurement officer, all the necessary information will be transferred, and the officer can immediately start the procurement process. Before the detailed engineering has finished, the list of raw materials is already determined. If this list of materials is sent to the procurement department, in this earlier phase of the project, the procurement can be planned more accurate. Instead of ordering materials at the last moment, it can be done on time, ensuring a more reliable delivery time. There is also the possibility to combine orders from different projects, which could result in financial advantages for Frijns.
- When the procurement already has its information, the workshop should only receive the shop drawings, paint information and welding specifications. Just the right information for them, to know what they will have to do.
- The quality department has to receive roughly spoken the same information as the workshop. Based on this information they can make their inspection plans.
- The logistics department has to collect the necessary information to know what assemblies should be on which shipping list. Since the erection sequence is determined by the engineer and thus the sequence of deliveries, the logistic department can receive an automatically generated shipping list (delivery note) from the engineer.
- The erection drawings should be sent to the installation manager when they are finished, not when the manager is requesting them. In this way the feedback of the people working on site can be processed on time.

Procurement

The procurement department is responsible for purchasing all goods which are needed within the company. Project related, a list of mainly all items to be bought will be provided by the engineering department. It is important for them to receive feedback whether the items could be purchased and if the right information is provided, such as steel grades and origins of the materials. When orders are placed at the supplier, an expected delivery time will be provided by this supplier. In order to enable production planning it is essential to communicate these dates with the work and paint shop.

For the quality assurance of the project, the material certificates and all other relevant documents provided by the supplier along with the material delivery, should be shared with the quality department as well. Where goods will be delivered at the production location, goods will transported from there to the client as well. In some cases goods will be transported to the client without processing at the factory. Then the logistics department has to be informed directly by the procurement department, of the existence of these goods, since de logistic department is responsible for the delivery notes to the client. When goods are ordered by the procurement department, and they will be delivered directly to the erection site, this has to be communicated with the site team, of course. Since the deliveries of materials are done by another department, or at the site location of the client, it is a challenge to collect all the necessary documents. Another issue is the clear communication about the progress of orders and expected delivery times.

A schedule of the proposed interface is shown below, followed by a bullet wise explanation.



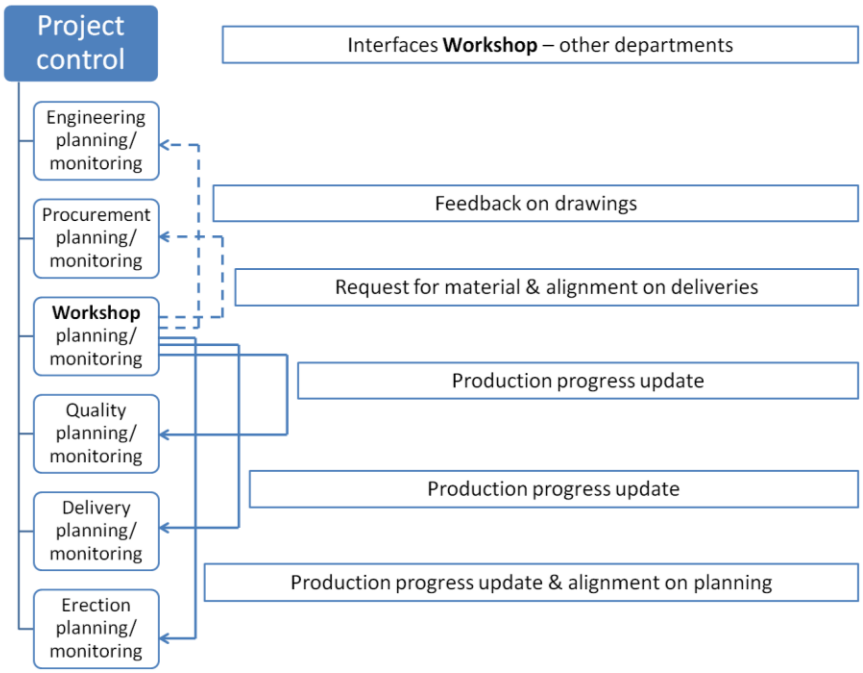
- The procurement can give feedback on the provided information by the engineering department. This can be either a request for extra information, or it can be a change of the material request, if some materials can't be delivered.
- For the workshop it is very important to know when materials will be delivered, such that the right jobs can be planned at the right moment. The stock of leftover material is handled by the workshop, this needs to be taken into account when ordering new materials.
- The quality department needs to receive all the necessary documents regarding the material specifications. Along with each delivery of raw materials, these documents should be provided, and analysed by the quality department.
- Some goods won't need to be processed in the factory and can be delivered to site directly, for example bolts, nuts and washers. Even though these goods are received at the factory of Frijns by the logistic department, they have to know that these can be shipped to a certain building site. This is information that the procurement department has to deliver.

- For deliveries of materials directly from the supplier to the building site of the client, it is important to know when these items will come. Usually the installation manager request certain materials himself, and he needs to have an expected delivery date.

Work shop

The work shop will receive the fabrication drawing from the engineering department, when there are things not clear, they will give feedback to the engineers or request for extra information. When the work shop needs goods, they will request an order at the procurement department; this is mainly the case for consumable goods and not the BOM-items. When there is a miscommunication about deliveries, the procurement will be contacted, as well as for alignment of the production planning with the delivery of goods. When items are produced, the quality department needs to check whether the specifications are met, in order to check this, they need to get a signal from the production department to start the control procedure. The same holds for the logistics; the delivery of goods can only occur when the items are produced. And therefore the production schedule and delivery schedule needs to be aligned. This is also the case for the communication between the work shop and the erection team at the client's site. Since a lot of departments are directly related to the workshop, it is important that there is a clear view of the current production status. By knowing what is produced already, in production or waiting to produce, the other departments can align their planning with the workshop. At this moment there not such a clear view, a lot of planning is done by head, and there is not central registration of the progress. In this way it is very hard to plan as well.

A schedule of the proposed interface is shown below, followed by a bullet wise explanation.



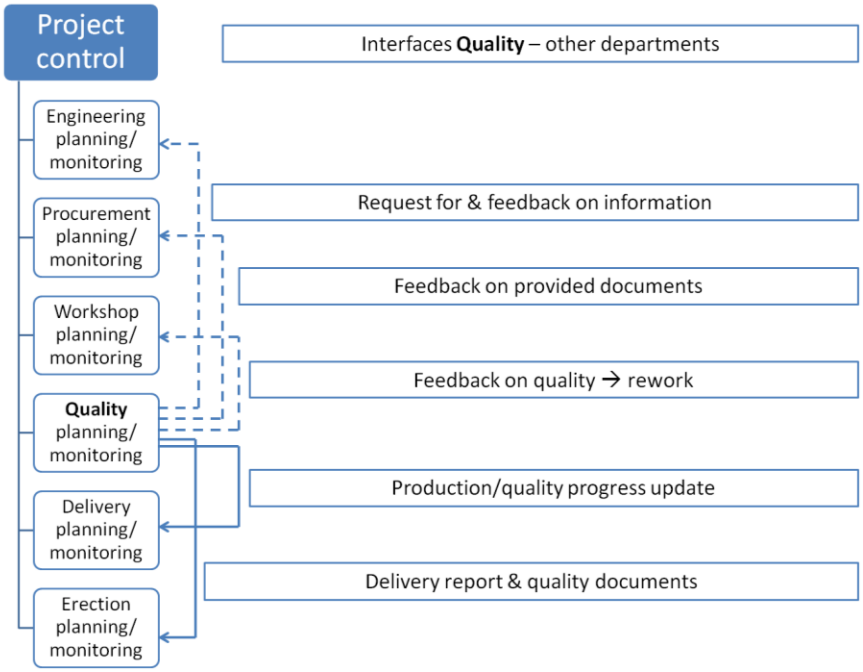
- The workshop receives the drawings and other information by the engineers, when there things not clear, feedback is given to the engineer.
- The workshop can request materials as well, mainly consumable goods used for production. Furthermore it is of course very important to align the ordering/delivery of raw materials with the procurement department.

- Updates about the production progress should be given to the quality department. In this way they can quickly inspect the assemblies and release them for the next production step.
- When assemblies are finished, they can be shipped to the client. The logistic department is responsible for clustering assemblies to truck loads and ship them, though they need to know what is ready at what time. This information should be provided by the workshop.
- Erection of a steel construction can only be done when all the necessary assemblies are available at site, therefore it is important for the installation manager to know when which assemblies are ready. In this way the erection planning can be made.

Quality

The quality department is not only responsible for the physical quality of the structure, but also for all the documents related to production and quality controls. The inspection points are based on the fabrication drawings, so there has to be feedback to the engineers about the drawings in case of faults. When steel will be delivered, the quality documents from the supplier have to be judged and if necessary additional information will be requested. The most important communication for the quality department is those with the work shop. Quality has to give feedback on the work done on the shop floor, especially in the case of rework. It should be clear for the workshop what went wrong, and what needs to be repaired. When quality notices an issue which could affect the deliveries of goods, they can immediately inform the logistics department. All the necessary documents related to ensure the quality of the products has to be handed over to the client through the erection team at the site, along with the delivery report.

A schedule of the proposed interface is shown below, followed by a bullet wise explanation.



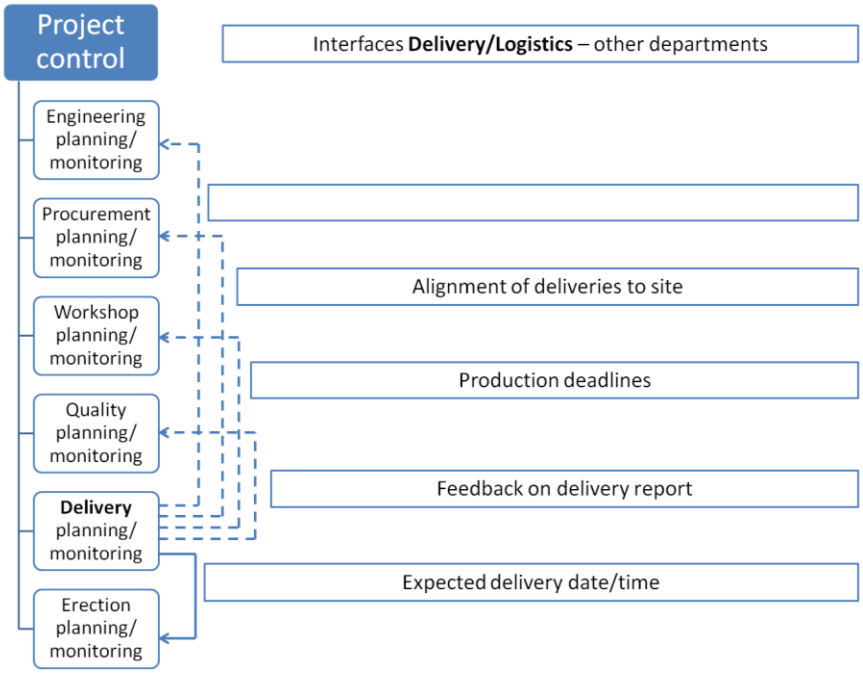
- The quality department will receive the drawings from the engineer, together with the project quality requirements. When drawing are incorrect or the requirements are not clear, the quality inspector should give feedback in order to get the proper information.
- When documents regarding the quality assurance of the materials are missing or incorrect, the quality inspector has to solve this issue together with the procurement department.

- As discussed, it is obvious that the quality department should give feedback about the quality of the work in the workshop and necessary rework.
- When there is a quality issue regarding the assemblies or paperwork, that could affect the delivery of the goods, the logistic department has to be informed.
- All the necessary quality documents has to be sent to the client through the team of Frijns at the building site of the client. Also the inspection of the erected construction at site is the responsibility of the quality department.

Logistics

The logistic department has to align the delivery planning of the assemblies with the site erection team. Based on that planning they have to give feedback to the production and quality department to make sure the planning will be met. Or to gather information to adjust and re-align the planning of the departments. The logistics department is responsible for the delivery report; a set of paperwork containing the delivery notes and all necessary quality documents related to the delivery. When documents are missing, the logistics department will give feedback to the quality department, or other departments when this is needed. When a delivery is approved by the client, the signed delivery note has to return to Frijns. This document will be used in the progress reports and interim project bills.

A schedule of the proposed interface is shown below, followed by a bullet wise explanation.



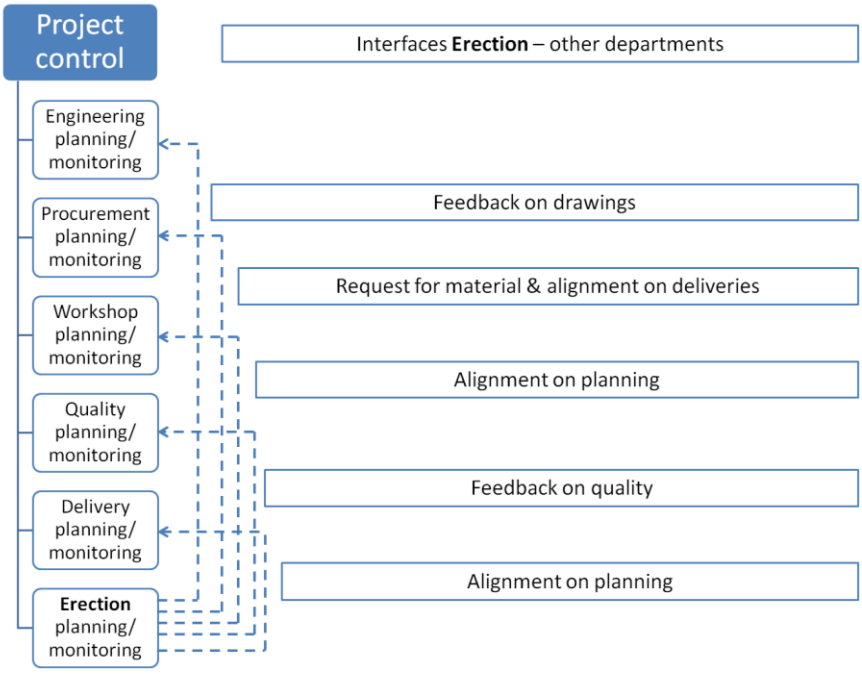
- The procurement department will inform the logistics officer when there are goods to be delivered at site, without processing in the workshop. The planning of these deliveries have to be aligned with the expected delivery date of it, in corporation with the procurement officer.
- The logistics department is dependent on the planning of the workshop and quality department when assemblies can be shipped. Therefore frequent feedback is necessary, on the workshop planning and the documentation process of the quality department.

- Of course the delivery of assemblies has to be in line with the site planning. All the necessary resources should be available to unload the truck and store the materials. Also the sequence of assemblies should be aligned.

Erection

The site team which will execute the erection of the steel structure will receive the erection drawings from the engineering department. When the plan of erection will change, this has to be discussed and agreed with the engineering department. In principle all the materials required will be delivered at the site, as determined by the engineers. However, when additional materials are needed, the site team can request materials from the procurement department directly. Throughout a project a lot of changes in the planning will occur, therefore constantly the time schedule has to be aligned with the production department. The last feedback loop is connected with the quality department; on site the client will perform their own quality checks on the delivered goods. When the requirements are not met, the assemblies has to be repaired or re-inspected either on site or it has to sent back to the work shop. Therefore it is important for the work shop to get feedback about the quality to know what they can improve. But more important, if material will be sent back, these will have a high priority, and therefore it should be scheduled in the production planning with this priority taken into account.

A schedule of the proposed interface is shown below, followed by a bullet wise explanation on the next page.



- The first step in the erection process is agreement on the erection drawings, this is done in close corporation with the engineers.
- All other interfaces are feedback loops with the different department about the alignment of the planning. As discussed before, the planning at a building site constantly changes, and all these changes should be communicated with the departments. Besides the changes in planning, progress updates should be communicated as well, to know the status of the erection process.

6 - Project control

Out of the previous chapter, a lot of improvement plans can be made. It is an illusion that during this internship all improvements will implemented. Therefore an improvement needs to be selected, which is doable to implement in a few months. A lot of weaknesses are in the communication between departments, and the provision of the right information. It is not possible to completely rebuild the organization, and set up a meeting structure which enables a complete clear communication structure. After discussion with the management, a view from the project manager is taken for the project of this internship.

Currently it is very hard to provide a clear overview of the status of a project, for the project manager. For example when the client is requesting a specific assembly to be delivered as soon as possible, the project manager has to check with the engineer whether the drawings are already finished. If so, then the procurement officer will be asked if the material is already available and the workshop will be asked if it is already in production or even if it is finished. It could be even the case that the assembly was already delivered to the building site of the client. So production wise, the project manager had not a clear overview of the status of his projects. As a consequence, the management didn't have this overview as well. For the operational, financial or managing director, it took a lot of effort to get a companywide view of all the projects together. For this reason a top-down approach is chosen, build up out of several steps, which can be finished, depending on the amount of time left for this internship:

- First to understand the structure of a project, the contracts have to be analyzed. In this way the parameters can be identified, which have an impact on controlling and managing the project.
- Out of these parameters, a concept dashboard can be made, showing all the necessary information to manage a project. For one project this dashboard can be tested. The outcome of the interviews with departments and managers will be used here as well.
- Another product of the contract parameters will be a contract summary form. It became clear during the interviews that the project managers do not have a clear overview of the contract particulars. Therefore a summary form will be developed, aiming to be a cheat sheet for the project managers.
- The dashboard should be filled with data, which is not available yet. Though for a specific project which is in progress now, a lot of information is available through the Interim Payment Application. Using this project, a standard format for an IPA can be made, with an information source that can serve the project dashboard as well.
- Finally to test the project dashboard, a project can be chosen, such that it can be tested with a real ongoing project.

Contract parameters

There are a lot of different types of contracts in the construction business. The main content of the contract consists about detailed information about the product, the steel construction. These are among other things, specifications about what materials are allowed to use, labour law specifications, client drawings on which an agreement is made, etc. These conditions, related to the product, will not necessary influence the way the project will be controlled or managed. Important parameters to control a project are related to financial conditions and time constraints. Sometimes the reporting structure to the client is defined as well, though this will be neglected here.

Some contracts do only contain a few pages, where others are complete books consisting hundreds of pages. Though, the contract parameters we are looking for to manage the project, can always be found in each type of contract, how big or small they are. Basically four types of contracts can be distinguished.

- **Main contract**: this is the initial leading contract within a project. All the project conditions are agreed in here.
- **Change orders**: in agreement, the client can make changes to the main contract, these usually consist of design changes. Whenever these changes are not covered by the main contract, a separate change order will be agreed on.
- **Variation order**: additional work related to the scope of the main contract is called a variation. When for example a steel structure is build, the main contract could only consist out of this structure. Later on the client could ask Frijns to supply and install the cladding as well. This is definitely not part of the steel structure, but it is related to it (the cladding will be mounted on the structure).
- **P.O.** (Purchase order): usually the smaller orders, they can be seen as a separate project, though it is that small that it can be produced very quickly. It is not related to a main contract.

Several contracts are analyzed to identify the contract parameters. In discussion with the management the following list is compiled, with a short explanation.

- **Contract value**: of course the value of a project and thus the contract is very important. The value of a contract is measured in money [QAR] and weight [kg].
- **Contract bonus**: when a project is completed, meeting all the contract requirements, a bonus can be provided as percentage of the contract [%] or a fixed value [QAR].
- **Contract type**: there are two different types of measuring the value of a contract. In a lump sum contract, the monetary value is fixed. So when the project is finished, the contract amount will be paid by the client, even though it turned out that much more steel was needed to complete the project. In a re-measurable contract a unit rate is agreed, and the client will pay for the actual installed amount of steel.
- **Advance**: clients can do an advance payment so that the contracter is able to procure the raw materials. This is a percentage of the contract value [%]. In return the contractor has to provide a bond facility to the client.
- **Retention**: it is normal that the client will not pay the full bill, but it will hold a certain percentage of retention [%]. This is to ensure that the contractor will complete its work according to the contract. When the project is finished as well as the warranty period, the client will pay the retention.
- **Return retention**: A part of the retention [%] can be paid already after the completion of the project, usually this is half of the total value of the retention.
- **Maintenance/Warranty period**: the length of the maintenance period and the warranty period of the complete structure.
- **Payment terms**: projects will have a lead time of several months. In the contract a payment term is negotiated at which the contractor can sent an interim progress report with an attached invoice (the Interim payment Application).

- **Payment condition**: the time within the client has to pay the invoice, after agreement on the value of it [days].
- **Delay penalties**: this is a penalty system in which the subcontractor can get fined when they exceed the agreed deadlines. The penalty is a percentage of the contract value per time unit of delay [%/time]. There is always a maximum percentage defines as well.
- **Performance security**: The subcontractor has to provide a financial bond of a certain percentage of the contract value [%] to show the commitment that it will perform, and that the project will meet the specifications.
- **Performance security term**: this term will define how long the performance bond will be valid, after completion of the project by either the sub-contractor or main-contractor [years].
- **Project duration**: here the maximum lead time of the project will be defined [time].
- **Commencement dates**: here specific deadlines for project elements or specific sub-projects can be agreed.
- **Project elements**: this is the most important part of a contract from control perspective. In this part all the project elements are listed, with its weighting factor [%]. The progress of each project element can be reported to the client, and put into the Interim Payment Application. In this way the sub-contractor will get more money in an earlier stage of the project. The following project elements can be applied:
  - Design & Engineering: The engineering phase of a project.
  - Delivery and inspection of raw materials: When materials are ordered, delivered and paid, the client can pay for the materials as well, usually at 80% of the value.
  - Fabrication: When assemblies are ready in the fabrication phase, they could be put on the IPA as well, two sub-elements are distinguished:
    - *Welded and inspected assemblies*
    - *Painted and inspected assemblies*
  - Delivered to site: when materials are delivered at the building site of the client, and the materials are approved by the client, here progress can be updated as well.
  - Final documentation: After finishing a project, the as-build-drawings need to be handed over to the client. When they accept them, the project can be closed and the client will hand over a completion certificate.

Contract summary form

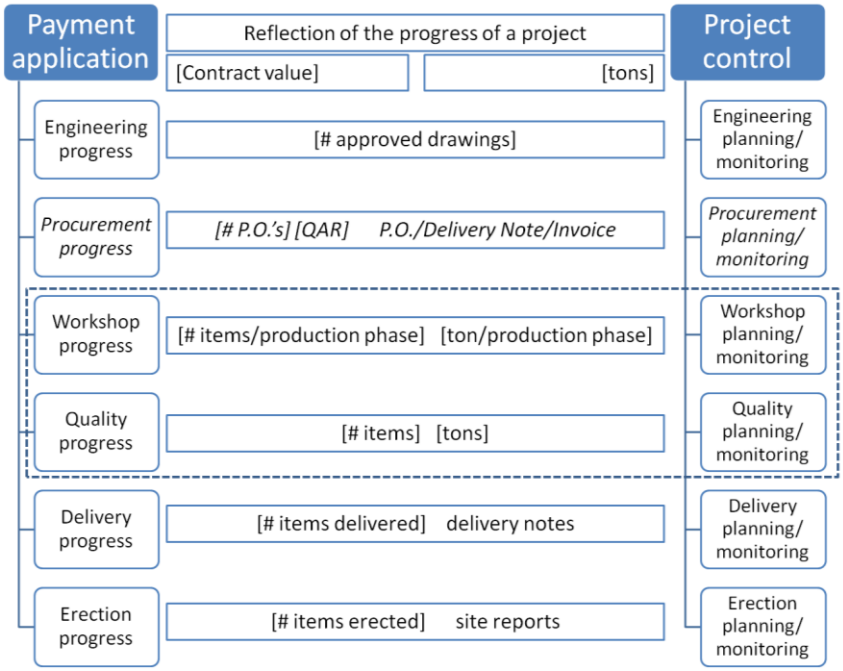
Now all the parameters are determined, a summary of a contract can be made. This should be done by the project manager of that project. In this way the project manager is forced to carefully look into the details of the contract, and not only focus on the technical aspects of the contract. It is important to known which project elements are worth money, to avoid pushing the wrong departments to make progress. The contract summary form can be found in appendix 1 "Contract summary form".

Measuring progress

There is a wish from the management to have a sort of dashboard per project, in which all the necessary information will be presented. To build up this dashboard two different approaches are used. One is using the interviews to understand how the progress can be measured per department. The other is discussing with and interviewing the management what information they would like to

have, in order to gain insight in the progress of the projects. Throughout these discussions the project dashboard is developed and adjusted again after each meeting.

When taking a look at the project parameters, again, the project elements do have a lot in common with the organization structure of Frijns Structural Steel. Almost each project element can be matched with a department in the organisation of Frijns. So by measuring the progress of a department, the progress for that project element can be determined. During the improvement analysis a schedule of the interfaces is used to determine the information flows between departments. The same schedule will be used to identify a measurable per department that can be used to control the department, and which can be used in the progress report to the client, along with the Interim Payment Application. So in fact, there is a search for a connecting parameter between the operational control of the project and the payment progress application. The schedule is shown below.



At the left side the project elements in the payment application are shown. Actually this is just the progress of that specific department which should be planned and monitor itself, shown at the right side. In the Interim Payment Application the progress is translated in a contract value [QAR], where the planning and monitoring per department will be done in its own 'unit load'. In between for each department a more or less Key Performance Indicator is determined. For the IPA this KPI can be converted to a value according to the contract and for the operational aspect of project control, the KPI can be converted into weight. In an ideal situation all departments should process more or less the same amount of weight over a certain period of time. This would show that the organization is balanced and in control.

- For the engineering department it is the hardest KPI to determine. One week an engineer is working full time on building a model for a new project, where the other week only drawings will be made. Despite this unbalanced workload, there is decided to use the number of drawings as output, where these drawings can be converted to weight, according to the

weight of the designed assembly. And this weight can be converted into money using the distribution of weighting factors for the project elements.

- The procurement department is processing a number of purchase orders with a value and a weight. These measurables can be used to control this department and to measure the progress for a specific project.
- The progress measurement of the workshop and the quality department can be seen as the same. Though the quality department has to deliver a lot of paperwork, but the workshop has work preparation to do, this will balance the workload. There is decided to measure the progress in the workshop by the weight only, the complexity and thus time will not be taken into account. So a complex assembly is assumed to be equal with a simple beam having the same weight. This could give misleading figures, but it is assumed that the simple and complex products will balance each other out.
- To measure the exact activity of the logistic department the number of shipped items can be measured. Though, for simplicity, in practice the weight of the shipped assemblies is used. Using the weighting factor of the project element, this can be converted to money easily.
- The same holds for the last department and second last project element, the erection or installation of the steel structure. Based on the site reports, the number of installed assemblies can be used, though for simplicity again the weight is used. In this way the measurables of all department can be compared easily.

Project dashboard

The contract is split up in several parameters, and for the project elements a way to measure progress is determined. Now, a dashboard can be build in which the management can get a clear overview of the entire status of a project on one A4-paper. After several design iterations the final dashboard can be found in appendix 2 "Project dashboard". An important note has to be made that all the numbers, weight and values are fictive. The order of magnitude of the numbers are comparable to a real project, though the final numbers are a random guess. This project is based on a real project, but it is only used to show the working principle of the dashboard. In this paragraph the dashboard will be explained piece-wise; first a screenshot of a part of the dashboard is shown, and the explanation will follow underneath it.

Monthly progress of project [Tonnage]

Monthly totals

	April	May	June	July	August	September	October
Fabrication	0.0	0.0	0.0	992.9	1.1	0.0	0.0
Delivered	0.0	0.0	0.0	122.8	221.2	445.7	0.0
Erected	0.0	0.0	0.0	40.7	147.8	473.9	0.0

Cumulatives

Fabrication	0.0	0.0	0.0	992.9	993.9	993.9	993.9
Delivered	0.0	0.0	0.0	122.8	344.0	789.8	789.8
Erected	0.0	0.0	0.0	40.7	188.5	662.4	662.4

The top part will show the physical progress of the project in numbers, per month. For the three production stages, fabrication, delivery to site and installation, per month the total progress in weight [ton] is shown. The first table does show the progress per month, giving insight in progress of that specific month. Where the second table is used to present the cumulative numbers over all months, to make an comparison with the contract value, in order to see whether the project is close to finishing.

Monthly progress of project [QAR]

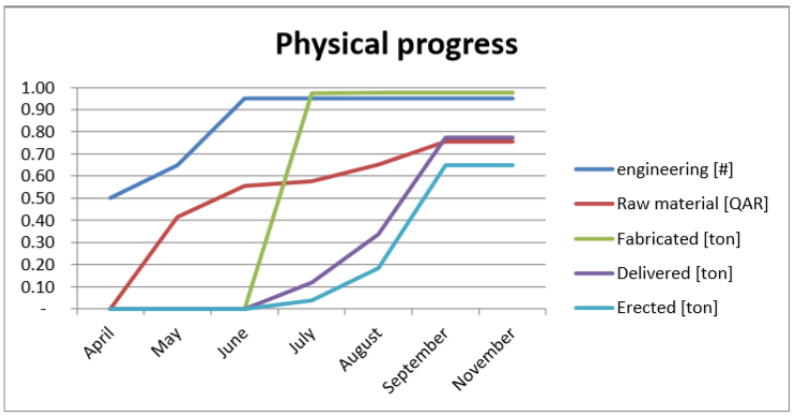
Monthly totals

		April	May	June	July	August	September	October
10%	engineering	735,000	220,500	441,000	0	0	0	0
40%	Raw material	0	2,438,638	829,305	119,300	444,952	615,151	0
30%	Delivered	0	0	0	531,783	957,453	1,929,436	0
20%	Erected	0	0	0	117,317	426,627	1,367,629	0
	Total	735,000	2,659,138	1,270,305	768,400	1,829,032	3,912,216	0

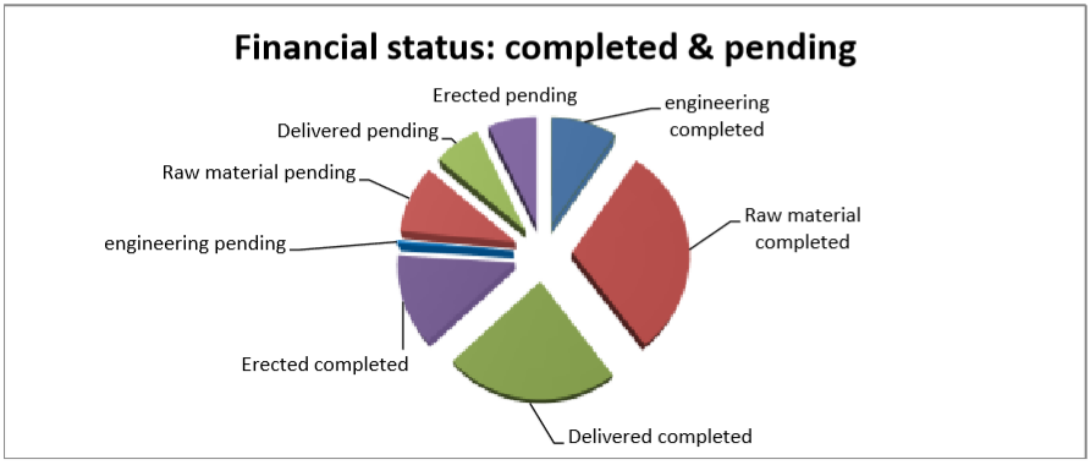
Cumulatives

										% of Contract Value
10%	engineering	735,000	955,500	1,396,500	1,396,500	1,396,500	1,396,500	1,396,500	1,470,000	95%
40%	Raw material	-	2,438,638	3,267,943	3,387,243	3,832,196	4,447,346	4,447,346	5,880,000	76%
30%	Delivered	-	-	-	531,783	1,489,236	3,418,672	3,418,672	4,410,000	78%
20%	Erected	-	-	-	117,317	543,944	1,911,573	1,911,573	2,940,000	65%
	Total	735,000	3,394,138	4,664,443	5,432,844	7,261,875	11,174,091	11,174,091	14,700,000	76%

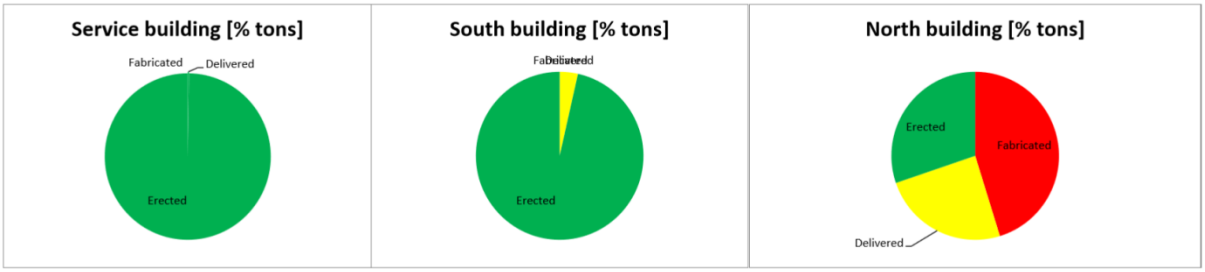
The second part of the table section is showing the project elements. Here the project elements which are taken into account are shown, together with its weighting factor. For this project these are engineering, delivery of raw materials to the factory, the delivery of assemblies to the site of the client and the erection of the steel structure. Based on the approved drawings the engineering element will book its progress, which starts already in the month of April. The first materials are bought in May and the installation at site started in July, and of course the delivery did so as well. Again, the upper table shows the progress per month, where the second table is representing the cumulative value per project element. Then a comparison can be made with the total contract value, which is done at the end of this table. In this example, the total project represents a value of 14,7 Million QAR, and above it, the value of each project element is shown.



In this graph the physical progress of the project elements are shown over the time. The progress ratio is used, so the percentage of the cumulative progress against the contract value of the project. An interesting result is that it can be seen that in June the fabrication moves from zero to approximate 95%, where is does exceed the preceding project elements. Physically this is impossible, then the workshop would have fabricate materials which are not even ordered yet. Though after research it turned out to be truth. The administration at the procurement department had some backlog and therefore it was not calculated in the progress report. This shows immediately the value of the such a graph, now the management can respond to anomalies within the organisation, and they can be proofed.



In this pie-chart a complete overview of the value of the project is presented. Each project element is partly paid and some of the value is still pending. Out of this chart, attention point can be taken, for the management to control certain project elements more precisely. In this case this could be the pending part of the raw material (red); this is the biggest part of the pending money. Be aware that the fact that the part related to the raw materials is the biggest, has not a direct relation with the backlog of administration, seen in the previous graph. As can be seen in the second set of tables, the raw materials have a weighting factor of 40%, so the value of this project element is the highest and therefore it could be that the pending money for this part, is higher than for a consecutive project element.



The four pie-charts show the physical progress of the total project, and for in this case three sub-projects (the total progress pie-chart is not shown here). This example project is split-up into three smaller projects, which for each the progress can be monitored. It can be seen that one building is already completely erected, another one almost, only a few percent is waiting, but is already delivered at site. The last building probably now has the main focus of the project manager, over there a lot of work needs to be done.

The last part of the dashboard does show information for the financial department, about the financial status of the project. Here, per month the submitted IPA can be tracked, with the amount which is certified (Payment Certificate), how much is invoiced by Frijns, when the payment is due and how much is paid by the client. The last columns show the value of the retention build up so far, and how much of the advance payment by the client is recovered (e.g. if the total progress of the project is 50% of its value, then the advance payment will be recovered (paid back to the client) for 50% as well).

Now a dashboard is made, it is known what the management would like to know about the status of a project. But it is still not clear how the information will be provided to fill in the dashboard.

7 - Interim Payment Application (IPA)

The proposed dashboard will be used internally in Frijns Structural Steel, by the management to gain insight in the status of a project. Each department should provide information to fill the dashboard, this information are the measurables as defined in one of the previous paragraphs. Though it is not entirely clear yet, how this information should be provided. The IPA could give a solution for this problem.

Project elements

An Interim Payment Application is a progress report which is sent each month to the client. Here, the progress of the project is reported, along with the necessary documents to proof this progress. The progress is measured in contract value, money. So this IPA does contain the distribution key between physical progress of the project and the value of the contract. Therefore, the project elements are used. As explained at the contract parameters, a project can be divided into several project elements. These elements can be among other things the engineering and design of a structure, the procurement of raw materials, the fabrication, delivery and/or installation of the structure at the client's building site. Each element is representing a part of the total contract value in money [QAR], based on weighting factors that are defined in the contract. So the value of a project element is completely independent of the actual (added) value of the physical process which the project element is representing. So in the example project that is used for the dashboard, the raw materials had a weighting factor of 40%, it could be that the contribution to the unit rate of a ton of steel structure is less than 40% (or more of course). For the sub-contractor, like Frijns, it is the best to have a high weighting factor at the first project elements. The first project elements will finish as first as well, and sub consequently more money will come in an earlier stage of the project, than when the erection of a steel structure will get a high weighting factor. So the negotiation of the weighting factors is important, when agreeing on a contract.

When the progress of the project elements is known, the payment application can be filled in, resulting in an invoicing value for that month. Though, the progress of the project element still needs to be determined. An actual project that is under progress now, is used to build a standard format for the IPA, which can be used for other projects as well. The project chosen for this new IPA is a project with a demanding client, requesting a lot of detailed information about the progress. A few IPAs are sent already and thus a lot of information is already available. The result of the new IPA will be discussed, starting with the actual progress measurement for each project element. The IPA can be found in appendix 3 "Interim Payment Application IPA", again be aware that all the numbers and values in this report are fictive, though the order of magnitude is comparable to a real project. Later on, there will be referred to the pink cells, to explain more about the inputs for this IPA.

Measuring progress

Four project elements are used in this project; the engineering, the procurement of the raw material for the steel structure only, fabrication and painting and finally the erection of the structure at site, which includes a proof of delivery. The elements have a weighting factor of respectively 10%, 40%, 30% and 20%, this can be seen in the third column of the upper table. Finally the progress of the engineering phase is measured in weight [ton]. Each drawing represents a part of the structure, with a corresponding weight. The client has to approve the shop-drawings, and the sum of the corresponding weights of those drawings is the progress made by the engineering department.

The progress for the raw material element is measured by the actual value of the procured structural steel materials. The specific conditions in the contract prescribe that only the raw materials directly for the structural may be taken into account. For example the weight of the bolts and nuts and metal decking can not be taken into this value. Initially, this client is not willing to pay the full amount of the raw materials, it will pay at 80% of the value. The philosophy behind this project element is that the client is supporting the sub-contractor by doing an (extra) advance payment for the raw materials. In the end, the client will pay for the full contract of course, though the project elements are used to get money from the client at an earlier stage of the project, than the final stage. The progress is based on the actual value of the purchase orders, and it has to be proofed with supporting documents such as a copy of the P.O., delivery note and invoice from the steel manufacturer.

Fabrication and painting of the steel structure is the next project element that is measured in this IPA. The progress of it is measured in weight as well [ton]. The actual progress is based on production reports which are shared with the client, through the project planner. In this report the cumulative weights for several items on the Bill Of Material are calculated, based on information received by the workshop. Then the total weight for the items related to the structural steelwork only are used to measure the progress of the fabrication element. As discussed with the raw materials as well, the project elements are a tool to get money in an earlier phase. So in the end the client will pay for production of course, but the 'advance' payments are only for the structural steelwork.

The last project element is the erection of the steel structure, with a proof that the materials are delivered as well. So first the necessary documents needs to be provided to show that the client did accept the assemblies and materials. Then based on the measurement sheet and site installation progress reports (compiled by the installation manager). To keep track of the installation progress and the deliveries a tracking sheet is used, based on the BOM. An example of such a sheet can be found in appendix 4 "IPA-Tracking sheet". This is a tracking sheet in which the different departments can enter their progress information, which then can be used to measure the progress of the project. This tracking sheet is the list of the Bill Of Materials, containing the names/numbers of each assembly (the column in green), the quantity of this assembly in this project, the unit and total weight for this assembly. Then basically the next column represent the project phases. In this example fabrication, delivery to site and installation. A part is copied here:

ASSEMBLY					FABRICATED						DELIVERED TO SITE					
					QUANTITY (ASSEMBLY)			WEIGHT (TON)			QUANTITY (ASSEMBLY)			WEIGHT (TON)		
Sl.No.	DESCRIPTION	QTY	UNIT WEIGHT (TON)	TOTAL WEIGHT (TON)	PREVIOUS	TO DATE	CUMULATIVE	PREVIOUS	TO DATE	CUMULATIVE	PREVIOUS	TO DATE	CUMULATIVE	PREVIOUS	TO DATE	CUMULATIVE
STRUCTURAL STEELWORKS																
	COLUMNS															
1	C2001	1	2.64	2.64	1		1	2.64		2.64		1	1	-	2.64	2.64
2	C2002	1	2.63	2.63	1		1	2.63		2.63			0	-	-	-
3	C2003	1	2.64	2.64	1		1	2.64		2.64	1		1	-	2.64	2.64
4	C2004	5	1.53	7.64	5		5	7.64		7.64	3		3	-	4.58	4.58
5	C2005	8	1.52	12.17	8		8	12.17		12.17	5		5	-	7.60	7.60
6	C2029	3	1.49	4.48	3		3	4.48		4.48	2		2	-	2.98	2.98
7	C2006	2	1.53	3.06	2		2	3.06		3.06	1		1	-	1.53	1.53
8	C2007	1	2.64	2.64	1		1	2.64		2.64			0	-	-	-
9	C2008	1	2.64	2.64	1		1	2.64		2.64			0	-	-	-
10	C2009	1	2.63	2.63	1		1	2.63		2.63		1	1	-	2.63	2.63
11	C2031	1	1.46	1.46	1		1	1.46		1.46		1	1	-	1.46	1.46
12	C2032	2	1.49	2.98	2		2	2.98		2.98		2	2	-	2.98	2.98
13	C2033	1	1.44	1.44	1		1	1.44		1.44			0	-	-	-
14	C2010	3	1.35	4.06	3		3	4.06		4.06	1	2	3	1.35	-	1.35
15	C2011	3	1.35	4.04	3		3	4.04		4.04	1	2	3	1.35	-	1.35
16	C2012	3	1.10	3.29	3		3	3.29		3.29	1	2	3	1.10	-	1.10
17	C2013	3	1.14	3.41	3		3	3.41		3.41		3	3	-	3.41	3.41
18	C2014	3	0.72	2.16	3		3	2.16		2.16		3	3	-	2.16	2.16
19	C2015	1	1.48	1.48	1		1	1.48		1.48	1		1	1.48	-	1.48
20	C2016	3	1.40	4.21	3		3	4.21		4.21	1	2	3	1.40	-	1.40
21	C2017	3	1.48	4.43	3		3	4.43		4.43	1	2	3	1.48	-	1.48
22	C2018	2	1.48	2.96	2		2	2.96		2.96		2	2	-	2.96	2.96
23	C2019	3	1.40	4.21	3		3	4.21		4.21		3	3	-	4.21	4.21
24	C2020	1	1.48	1.48	1		1	1.48		1.48		1	1	-	1.48	1.48

The progress is measured both in quantities and weight. The input will be quantity, the weigh will be calculated automatically. Shown is the progress of last month (the column "PREVIOUS"), the progress of this month ("TO DATE") and a total progress ("CUMULATIVE"). Of course the cumulative now, will be the previous for the next IPA. Since the fabrication progress is based on separate production reports, this tracking sheet is only used for the erection element of the project. The installation manager will report daily which assemblies are erected (according to the mark numbers) and this will be updated in the sheet. Each sub project has its own tracking sheet. In this example project there are three buildings; North, South and a Service building. By adding up the weights of all assemblies per sub-project the total erection progress will be obtained.

Progress measurement sheet

Now the progress of the project elements is known, the Interim Payment Application can be filled in, to show the total overview of this project, this is done in the progress measurement sheet. This is the main sheet of the IPA, summarizing the progress updates and it gives a complete financial progress overview for the client. The explanation will be bottom up, it will start at the end, with the final value of this month's progress. Then step by step the calculation will be explained, going more and more into depth, ending up at the progress measurements of each project element.

Starting with the final grey table at the bottom of the sheet.

Gross net progress	**7,690,542.92**	**5,850,308.74**	**13,540,851.66**
Additions - Variation No. 1		149,475.07	149,475.07
Additions - Site instruction No. 4		80,000.00	80,000.00
Contra charge			
Advanced payment recovery (10%)	(769,054.29)	(607,312.92)	(1,376,367.22)
Retention (10%)	(769,054.29)	(607,978.38)	(1,377,032.67)
Total cumulative	6,152,434.33	4,863,827.04	11,016,261.38
Net total this payment application		**4,863,827.04**	

The three columns are build up as follows; the first one is the total up to the last IPA, the middle one is the progress of this month and the last column is the cumulative, and thus shows the current status of the project. The most important number presented is the one in the last row, this is the amount of money the client has to pay this month. The numbers of the first column are punched in out of the cumulative column of the previous IPA. In the Excel-sheets the cumulative column is updated, and then automatically the progress of this month will be calculated. In the first row the gross net progress is shown. For now, this is the sum of the values of all the project elements together, so this is the progress of the main contract. Then the value of the progress of the additional contracts are added up to this, here variation orders and site instructions (which are comparable to change orders). In this example the client has paid an advance payment of 10% of the contract value, this advance payment will be recovered over the monthly payments, until the advance has been fully recovered of course. So the advance recovery will stop at 10% of the value of the main contract. The retention is taken over the complete project, including the additional contracts.

So now it has to be explained how the gross net progress is build up. There will be started with the stretched table at the top of progress measurement sheet. Here, the first three of four project elements are measured and the given a value. The table is split in two, on the next page.

Item no.	Description	Rate	Amount	correction for erection		
		[%]	[QAR]	Origin	Cum. Weight	price/ton
1	**Designing and Engineering**	10%	1,669,820.00	Percentage	1,109.99	1,429.14
2	**Raw Material of structural steel**	40%	6,679,280.00	Invoices	1,137.29	2,231.51
3	**Structural steel fabrication and painting**	30%	5,009,460.00	Product. report	1,179.19	4,103.83

Here, each line represent a project element, Design and Engineering, raw material of structural steel and structural steel fabrication and painting. At the column 'Rate' the weighting factor for each element is given, and the column 'Amount' does show the value of this element. The purpose of the sub-table 'correction for erection' is to determine a price per ton for that project element. For the first two elements this is calculated backwards from the progress in weight and the value of it, taken out of the 'physical progress' and 'value of progress' respectively. For the fabrication, the cumulative weight is taken out of the production reports. The 'value of progress' is based on ratio of fabricated amount so far and the total weight of the contract (according to the Bill Of Quantity). Later on in the IPA this price/ton will be used.

Physical progress [%]			Value of progress [QAR]			Reduction progress		
Previous	This month	Cumulative	Previous	This month	Cumulative	Deducted	Remaining	
90.00%	5.00%	95.00%	1,323,000.00	263,329.00	1,586,329.00	(1,013,133.36)	573,195.64	
30.00%	8.00%	38.00%	2,436,755.90	101,106.73	2,537,862.63	(1,581,942.14)	955,920.49	80% of value
85.25%	11.35%	96.60%	2,859,745.18	1,979,447.03	4,839,192.20	(2,909,251.76)	1,929,940.44	raw materials

For the project element Engineering, the progress is based on a percentage of completion, this is filled in the sub-table for physical progress. For the other two elements this physical progress is obtained indirectly from other inputs. the value for the raw materials is filled in, in the next sub-table 'Value of progress'. This value is based on 80% of the total value of all the procured structural steel raw materials. So, the first three elements are explained, the fourth 'installation' is next.

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE	AMOUNT	PREVIOUS	CURRENT	CUMMULATIVE
				QAR/unit	QAR	[tonnage]		
1	**Structural Steelworks**	Ton	472.59	11,000.00	5,198,490.00	12.77	162.83	175.59
2	**Roof Lighting Support - RHS**	Ton	12.50	13,000.00	162,500.00	-	12.50	12.50
3	**Steel Support for Inclined Louvers**	Ton	14.40	14,000.00	201,600.00	-	14.40	14.40
4	**Steel Staircase (Frijns Design)**	Ton	44.30	9,000.00	398,700.00	-	-	-
				Subtotal erected		12.77	189.73	202.49
5	**Steel Purlins Z252 x 2.0 mm thick**	Ton	26.14	10,000.00	261,350.00	-	-	-
6	**Metal Decking Works**	M²	2,470.00	150.00	370,500.00	-	-	-
7	**Shear Studs, Connection Bolts, Anchors, etc.**	LS	1.00	100,000.00	100,000.00	12.77	162.83	175.59
8	**1 Hour Rating Instumenscent Fireproofing for Steelwork & Steel Stair**	M²	10,254.00	100.00	1,025,400.00	12.77	162.83	175.59
				Value North building	7,718,540.00			

The last project element 'Installation' is split up per sub-project, this case three: North, South and Service building. In the contract, the quantities for each sub-project are defined in the Bill Of Quantity. Here the main items are listed, with its unit rate and the quantity. For this project the BOQ is grouped in items which are part of the structural steel (the first table) and items which are not. For each item the quantity, unit rate and total value is given. At the bottom of each sub-project, the total value of that building is given. Together the sub-projects will sum op to the value of the main contract. Based on the values per item on the BOQ, the value of the installation element of the project is determined, so this is not the last 20% when the weighting factors are used.

In the second table [tonnage] the progress in weight will be updated. This will be done automatically out of the BOM-tracking sheet in which per assembly will be filled in whether it is already delivered and erected. For all the items of the BOQ, this will be done automatically. Then a subtotal for

erected items will be calculated for the items related to the structural steel group. Based on the progress in weight, the relative progress in percentages will be calculated. Multiplying this ratio with the contract value of that item, the progress value in [QAR] will be obtained. In case the project will be finished, the progress for all the items for each sub-project will be 100%, for this project element 'installation'. But then only for the last project element, the entire contract value should be paid, where the client is giving the sub-contractor, Frijns Structural Steel, a sort upfront payments for the first three project elements, for the structural steel works. So in the end these first three elements should be deducted from the structural steel erection work, in order not to exceed the contract value of the main contract. In this deduction part, the price per ton for these project elements will be used, which are calculated at the stretched top table.

PREVIOUS	CURRENT	CUMMULATIVE	PREVIOUS	CURRENT	CUMMULATIVE
[%]			[QAR]		
2.70%	34.45%	37.16%	140,463.58	1,791,081.31	1,931,544.90
0.00%	100.00%	100.00%	-	162,500.00	162,500.00
0.00%	100.00%	100.00%	-	201,600.00	201,600.00
0.00%	0.00%	0.00%	-	-	-
	Subtotal structural steel		**140,463.58**	**2,155,181.31**	**2,295,644.90**
	Deduction engineering		(16,065.46)	(273,327.98)	(289,393.44)
	Deduction raw materials		(28,582.99)	(423,286.13)	(451,869.11)
	Deduction fabrication & painting		(35,092.89)	(795,911.59)	(831,004.49)
	Total structural steel		**37,098.82**	**686,279.04**	**723,377.86**
0.00%	0.00%	0.00%	-	-	-
0.00%	0.00%	0.00%	-	-	-
2.70%	34.45%	37.16%	2,702.01	34,453.88	37,155.88
2.70%	34.45%	37.16%	27,706.38	353,290.05	380,996.43
	Erection progress Service Building		**67,507.22**	**1,074,022.96**	**1,141,530.18**

The first part of the table contains the progress for the structural steel part, from these totals the three elements have to be deducted. The second table at the erection element are items that are on the BOQ of the main contract, but are not structural steel works. So in the previous project elements, there is not paid for these items, thus can be put on the payment sheet for the full contract rate. In the first part of the table per sub-project, the total weight of erected structural steel elements is calculated. Based on the cumulative weight what has been erected so far, the first three project elements will be deducted. First the subtotal value for the structural steel items will be calculated in the row 'subtotal structural steel'. Then using the price per ton per project element, the elements will be deducted from the subtotal, resulting in the 'Total structural steel' erection value. As last part, the non-structural steel items will be added up to obtain a total value for the 'Erection progress' per sub-project (building). The gross net progress of the project is the sum of the erection progresses of all sub-projects and the first three project elements. In the last two columns of the stretched top table, an overview of the deduction process is given. Here per project element the total deducted value is shown, together with the remaining amount to be deducted.

Closure

This chapter did start with the recapitulation of project elements and measuring the progress of them. Step by step the Interim Payment Application format is build up and in the main sheet (the 'Progress Measurement Sheet') the link is made between the progress of each individual item of the Bill Of Materials and the monthly project progress in money.

8 - Implementing the project dashboard: a simplified test

When designing the project dashboard for the management, the conclusion was that it was not clear how the information should be provided, to fill in the dashboard. Now a standard format for the Interim Payment Application is developed, taking its information out of a tracking sheet for the assemblies which are on the BOM. This tracking sheet could be used for the project dashboard as well. The project elements and the departments actively involved in the construction projects are almost the same, so the progress measurements of it are the same as well (as shown in the paragraph measuring progress). As last part of this internship a test will be done, to see whether the dashboard could work in real practice. A small project is chosen, of which the design is almost finished, before the fabrication starts. In this way the complete BOM is known, and a tracking sheet can be build. Furthermore, this project manager is working with priorities. The complete steel construction is build up in phases or priorities, having the weight of one truck load. Then the first priority contains the first assemblies needed to start the erection at the building site of the client. And the second will follow up on the first one, etcetera. The work orders for the production will be based on these priorities as well, so keeping track of the progress over the different project phases, can be done by relatively easy based on these priorities.

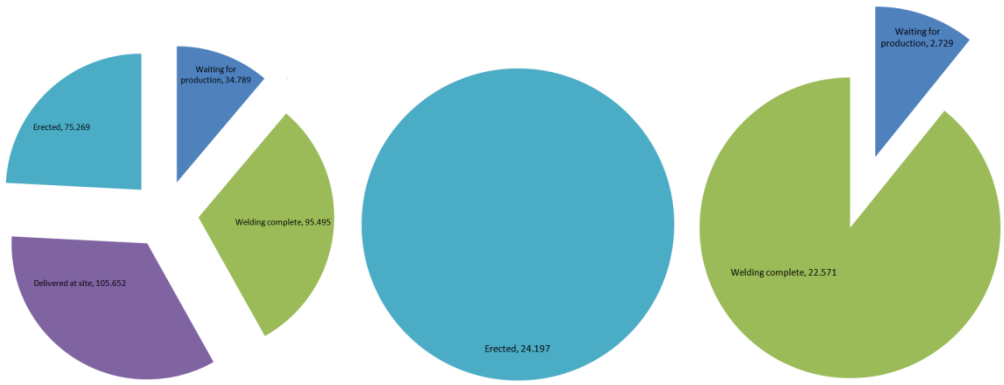
The tracking sheet for the example project for the IPA, did contain only the project phases fabrication, delivery and erection at site. This sheet should be elaborated with all the phases the management wants to monitor, or all the phases that needs to provide information in order to control a project. Then each department should update the progress of the project according to the BOM, this could be a simple checkmark that it is completed. For this test a few very simple excel files will be used, and a selection of the project phases will be monitored. The structure of the tracking sheet will remain the same; a list of all the assemblies according to the BOM with several columns representing the project phases. When a detailed monitoring is needed for a project, both the BOM and the project phases can be extended. Now, the BOM only consist of the final assemblies which will be on the shipping list, sub-assemblies or even single parts are not monitored. For the project phases, only engineered and ready for production (drawings completed), production (welding complete and inspected), delivery at site and erection will be monitored. The number of project phases can be expanded, by adding for example painting and procurement. The depth of monitoring can be much more specified as well, e.g. the different fabrication steps in the workshop; work preparation, assembly, quality inspection, etc can be added.

A colleague from each department which will be monitored, will fill in for his department the progress. For monitoring the fabrication progress, the quality department will be used. Currently the quality department is already using a progress sheet per project, so they are used to it, and the fabrication phase ends with an inspected assembly, so the quality department will be last department involved in the fabrication of the assembly. The first step is filling in the BOM by the engineer, when an item is on the BOM, the drawing is approved as well, so this will cover the first project phase. As explained, the quality department will keep track of the fabrication progress. The logistics officer will fill in which priorities have been sent to the building site. The last phase, the installation at site will be filled in by the project manager, based on the site reports provided by the installation manager at site.

Each department will get its own excel file in which they fill in the progress of the project. One master file will combine all the information. The structure of this master file is as follows.

Sl No:	Mark No:	Total Qty	Item Description	Level	Grid location	Phase / Priority	Unit Weight	Total Weight	Fabrication drawing finished	Welding QA/QC		Delivered to Site		Erected at site	
		No's					T	T	#	T	No's	No's	T	No's	T
	QTY	*637*						*311.205*	*0*	*276.416*	*494*	*162*	*180.921*	*54*	*75.269*
	%	*637*							*0%*	*89%*	*78%*	*25%*	*58%*	*8%*	*24%*
151	**C1009**	1	UB610*305*238	**17,413**	**1/B**	3	5.596	5.596	1	5.596	1	1	5.596	1	5.596
152	**C1010**	1	UB610*305*238	**17,411**	**1/C**	3	5.581	5.581	1	5.581	1	1	5.581	1	5.581
153	**C1011**	1	UB610*305*238	**17,305**	**1/A**	2	4.847	4.847	1	4.847	1	1	4.847	1	4.847
154	**C1012**	1	UB610*305*238	**17,305**	**1/D**	1	4.795	4.795	1	4.795	1	1	4.795	1	4.795
155	**C2001**	1	UB610*305*238	**23,095**	**4/B**	13	7.606	7.606	1	0	0	0	0	0	0
156	**HB1001**	1	UC254*254*73	**12,030**	**2-3/B-A**	8	0.646	0.646	1	0	0	0	0	0	0
157	**HB1002**	1	UC254*254*73	**12,030**	**1-2/B-A**	5	0.655	0.655	1	0.655	1	1	0.655	0	0
158	**HB1003**	1	UC254*254*73	**12,030**	**1-2/D-C**	5	0.632	0.632	1	0.632	1	1	0.632	0	0
159	**HB1004**	1	UC254*254*73	**12,030**	**1-2/D-C**	5	0.641	0.641	1	0.641	1	1	0.641	0	0

The first white part of the table does contain all the information about the assemblies, this is the Bill Of Materials. This list is automatically generated out of the CAD-software Tekla®. The BOM provides information about the mark number of the assembly, the quantity to be delivered (for that priority), a small description of the main beam, the level in the steel structure, the grid location of that item within the steel structure, to which priority it belongs and the unit and total weight for that line in the BOM. This master file does automatically read the tracking files of the different department (those files have the same structure of this master file). In the light orange table at the right, the progresses are shown. Per department they fill in how many of that mark number for that priority are finished. For the fabrication, delivery to site and erection, the weight will be calculated automatically. In this example all the quantities are equal to one. Now the information or data is collected, the dashboard can be filled.



All priorities *Priority 3* *Priority 8*

For this test only the pie-chart of the total project progress will be filled in. The left chart shows the progress of the entire project. The blue pie represents the assemblies which are engineered, but not finished in production yet, the green ones are finished in production and waiting to be transported. All assemblies on site waiting to be erected are shown in the purple pie and the erected assemblies are the last light blue pie. The BOM list in the master file can be filtered, such that selections of the BOM can be analyzed. The second graph shows that priority three has been fully erected. Priority eight is nearly finishing production; almost 90% is already finished, the last assemblies are blue yet.

Unfortunately there was not more time to implement the complete dashboard. But the working principle is proofed, the departments can provide the right information to obtain an overview of the project. And the with the IPA it is proven that this information can be transferred to financial information as well.

9 - Side-projects

The main project of this internship was assisting the management team in gaining insight in the progress and status of all the projects which are running in the company. This has resulted in a standard format for the Interim Payment Application and a proof of concept for a project dashboard. Besides this main project, several other projects are done. Three of these side-projects are will be highlighted in this chapter.

Setting up a business controlled procurement flowchart

Throughout the production and installation process of a steel construction, a lot of materials have to be procured. At first the steel materials which have to be machined and assembled, followed with primers and different types of paint, according to the project specifications. Then, when assembling the construction at location, the structure will be bolted together. Throughout the process a lot of consumable items will be used as well, like welding materials and for example grinding discs. It is very important for the project manager to know which materials has been ordered so far and when and where these materials will be delivered. For the financial department this information is needed as well, to know when invoices can be booked and paid. Next to this, the procurement process itself, sending an order to a suppliers, has to meet certain standards related to business control. This means that it should not be able for one person in the company to procure goods without permission of some authorized colleague.

During the internship it became clear that there is no clear view on which items are ordered, related to a certain project, and of the items ordered, the status was not clear. For some materials the delivery was unknown; if it has been delivered already, and if so the location (one of the two factories, or directly at site) and the quantity of the delivered goods were often not available. These lacks in information could cause a lot of delay. Especially when the project manager assumes certain critical items are ordered, where this is not the case, and these items have a long lead time (an example could be custom made roller shutter doors). Another problem which could occur that the items were delivered on time and in the right quantities, but having wrong specifications. Especially in the steel industry, the specifications are very important. As example the grade of the bolts can be taken, for certain applications a higher grade of bolts is required, usually due to heavy operating conditions (high forces, cyclic loads, etc). It could happen that the wrong specifications are ordered, where the procurement officer was not aware of these special requirements. So the requesting employee should check the purchase order before it will be sent to the supplier.

Summing up all these findings, a procurement flowchart is initiated. This should help to organize the procurement department in a better manner and it will introduce a certain business control. The flowchart is conducted together with the procurement and financial department, the result can be found in appendix 5 "Procurement flowchart" and will be explained in this paragraph. For each item which has to be procured, a Material Request Form has to be filled in by the 'Requester'. This form has to contain all necessary details like specification, brand, quantity, delivery time, etc. Then the head of the department of the requesting person has to approve the material request, both persons has to sign the form. Then the approved form can be sent to the procurement department, where the procurement officer can create a purchase order (P.O.). Depending on the value of the order, first a quotation and selection process has to be taken, which has to be approved by the procurement head. The P.O. has to be checked by the requester, whether all information is filled in correctly. Before sending the P.O. to the supplier, each P.O. has to be approved by one of the

members of the management. This is an important step for the business control procedure. So besides the procurement manager, another manager will approve the P.O. Herewith the second persons approves the need for this order and that the order will be procured from an acceptable vendor with an acceptable price.

When the P.O. is sent to the supplier, an order confirmation has to be received, together with an expected delivery time. This information should be kept together with the P.O. in the administration of the procurement department. At the delivery of materials at Frijns, the delivery note has to be checked against the corresponding P.O. Here, a check will be performed to see if the delivered materials met the specifications of the request. As well as if the materials which are on the delivery note, are all physically delivered. This is very important for big boxes of bolts and nuts for the quantity and for special goods to see whether the specifications are met. When the P.O. is (partly) delivered, the invoice can be booked as well. An invoice can only be booked when the delivery note is there, and the value of the invoice can never exceed the delivered quantity. When all the documents are collected, the payment can be released, and the procurement department can close the P.O. All the documents related to the order has to be kept at the procurement department, this will ensure that there is one specific location where all relevant documents can be found.

This flowchart is used to define a business controlled procurement process. This does help the project manager in such a matter, that it knows that the right goods are ordered. Though he does still not have a clear overview of which materials are ordered and when materials will be delivered. Therefore a second form is released, see appendix 6 "Project P.O. register". The basic idea is that for each project a specific box file will be used at the procurement department. In this box file all documents regarding P.O.s for this project will be stored, sorted per P.O. So if a P.O. is closed, one can find here (if applicable) the M.R.F., quotation, P.O., delivery note and invoice. The front page in each box file is simple listing of all the P.O. numbers, with the supplier name and the value of the P.O. Throughout the procurement process, phases can be checked and therefore the project manager can follow the status of the P.O.s; when an P.O. has been created, it will be on this list. When a P.O. has been (partly) delivered and/or paid, this can be seen as well, since the checkboxes will be marked. In this way, using a simple form, the project manager can easily gain some insight in the procurement status of his project.

Man power planning at site

After two months in this internship, the workload on construction sites of clients together was increasing rapidly. Several projects were installing the steel structure at the same moment, and the planning for the upcoming weeks was showing an even higher workload. Though, the man power available at site would not increase. There is a group of workers who are able to do this installation work, but all of them were already planned. Normally, when there is a lack of man power at site, the law of the jungle would apply. The installation or project managers who are the most dominant will claim the people for their projects.

To avoid discussions within the organization of Frijns, a very basic capacity planning is set up to allocate the workers over all the building sites. The result is a schedule where for all the project per day the needed amount of man power can be filled in, see appendix 7 "Site capacity planning". The structure is very simple, per project the installation or the project manager will tell for the upcoming weeks how many people they think they need on each day. One person who is managing this file will

update it. Then during the weekly operational meeting, teams of workers can be created, to allocate the people for the upcoming week. If there is a shortage of people, a solution can be generated together with all the colleagues, instead of that dominant person who will determine what will happen. The advantage of having this overview of the needed man power capacity per site for the next week, is that potential future problems can be predicted now, and tackled. If it is seen that in three weeks, there is not enough man power, there can be decided to re-arrange the planning for some project to balance the capacities per day.

Improvement project QA/QC

Throughout this report the department involved the quality is called the quality department. However the official name is the QA/QC department; Quality Assurance and Quality Control. The main activities of the department are inspecting and thus controlling the quality of products that are made at Frijns, for both fabrication, painting and erection. The other part is the assurance of the quality, this is more related to documentation. The assemblies which are shipped to the client do meet the specification, but that has to proven as well. So with each shipment a delivery report will follow, containing all the information about the materials that are used and inspections that are done. However, the registration of inspections is lacking. Currently the inspections done are logged on paper in a table, where is filled in which assembly is checked, what check is done and the result, an OK or not OK. This table will be filled chronologically, according the inspections the quality inspector has done in the workshop. Though, in the workshop multiple projects are done at the same time, so the inspection log contains information of multiple projects on the same sheet.

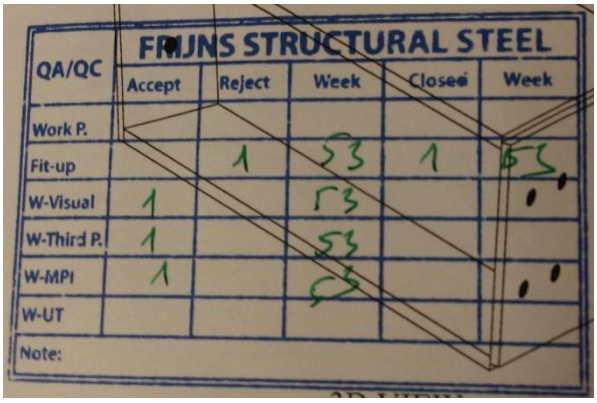
The purpose of quality assurance is that in case after a while a client reports an anomaly, Frijns can proof that the product they delivered has met all the specifications and requirements and is approved by the client. This requires a proper storing of all information regarding the quality inspections. When such an anomaly is reported a year after completion of the project, it is barely impossible to track down that specific assembly on the tracking sheet used now. In fact, there should be a proof for each assembly that it is inspected and approved. Besides the quality assurance in relation with the client, the internal assurance is minimal as well. There is no clear view of the quality of the workshop. The number of non-approved inspections and the amount of rework is not registered.

The management did ask for a first improvement step of this department. With an discussion with the QA/QC-manager the focus is determined to be the quality assurance towards the client for the assemblies made in the workshop. This is seen as the biggest thread at this moment; when a client would ask to proof that a certain assembly is inspected and approved, that would not be possible. The QA/QC department does print out the drawings on paper, to bring them into the workshop for the inspections. Normally after inspection these drawings would be discarded. Though these drawings could be used for the quality assurance. If the quality inspector would write on it that the assembly is inspected and approved, a first assurance system is created.

Throughout the fabrication process several inspection have to be done. The outcome of each inspection is an acceptance or rejection. When the results are not ok and the assembly is rejected, rework needs to be done to close the inspection. The different inspections are:

- Work preparation: the dimensions of the parts need to be checked, before they can be assembled.
- Fit-up: this is de dimensional check of the assembly, before the final welds are placed.
- Welding Visual: after the welding of the assembly is completed, the quality inspector of Frijns will perform a visual inspection of the weld, of they are according the quality standards.
- Welding Third Party: to avoid biased inspections, a portion of the assemblies will be inspected by an independent third party.
- Welding Magnetic Particle Inspection: this is a Non-Destructive Test, which is more significant than a visual test only.
- Welding Ultrasonic Testing: this is another test more significant than an MPI test as well, detecting anomalies inside the weld.

To avoid a lot of writing work for quality inspector on the drawings, a stamp is designed which can be used to fill in the inspection results. This stamp is owned by the QA/QC-department, so only they are officially able to perform the inspection since other departments can't place this stamp signature.



Here all the possible tests are listed, in the following column if the assembly passed the inspection, or if it is rejected, including the week number of the inspection. After rework is performed another inspection will be held to close that inspection item for this assembly. Furthermore notes can be added. Another advantage of registering the inspection results on the drawing, is the ability of explaining more precisely the location of the found anomaly. On the drawing itself it can be highlighted.

Now each drawing will have a stamp, which is filled in with quality information. This could be seen as the document assuring the quality of that assembly. When all these drawings are saved in box files per project, a first quality assurance system is build. When a client will come to request the documents, they can be found easily.

10 - Conclusion and Epilogue

The assignment was assisting the management team in order to develop a tool to get more control over the projects and the production. To do so, fist the organization of the company was known by doing interviews with all the departments. Out of these interviews a lot of improvement opportunities are identified. Together with the management, there is chosen first to design a dashboard in which all project related information will show up, to control the project. Consequently, the definition of what information is needed to control a project will follow out of this. Then the Interim Payment Application is used to create a link between the item wise progress of the different departments, and the overall project progress in both a physical and financial way. The last part of this internship this information source is used to successfully test a part of the proposed dashboard. Unfortunately there was not enough time to fully implement this project dashboard. However there has to be noted that the proposed system still is a combination of excel files that have to filled in, updated and processed by hand. This is certainly not a replacement for an ERP-system or something similar, in which much more advanced control mechanisms can be applied.

After five fantastic months in Qatar, I can truly say, have learned a lot. Working together with the management of Frijns Structural Steel has been a great experience. I did gain a lot of knowledge about managing big construction projects and the organization of such a project oriented company. The corporation with colleagues from all over the world has been a challenging but great experience. Besides the main project for this internship, I was able to implement a few other project as well. This did show the confidence of the management and the rest of the company in me. I am thankful for getting the chance to discover what role I would like to play in an organization, after I graduate.

Appendices

Contract Summary Form

FRIJNS STRUCTURAL STEEL MIDDLE EAST W.L.L.

Project number

Client

Description

Contract type

Subcontract | Change order

Variation order | P.O.

Contract value

QAR

Weight [ton]

Project bonus yes / no

Value

Contract type

Lump sum | Re-measurable

Payable overhead and profit rate yes / no

Value

Letter of credit yes / no

Validity

Interim Payment Application

Payment frequency

Due date payment application

Response time client on IPA

Payment condition

Commencement dates

Submission shop drawings / /

Delivery materials to site / /

Contruction activities / /

Completion date / /

Insurance

Workers compensation yes / no

Motor Vehicle Third party insurance yes / no

Plant and Equipment Insurance yes / no

Property All Risks Insurance yes / no

Professional indemnity yes / no

Freight or Marine transit Insurance yes / no

Insurance penalty yes / no

Value

Penalty frequency

Contract parameters

Advance [%]

Retention [%]

Return Retention [%]

Delay time [days]

Delay penalties

% per period

Frequency

Max %

Performance security/bond yes / no

%

end of contract from subcontractor / main contractor

term [days]

Length maintenance period [days]

Length warranty period [days]

Paint

Steel

Design clause provided / specified

Collateral warrenties yes / no

Project elements for IPA

Design & Engineering yes / no , %:

Delivery and inspeciton raw materials yes / no , %:

Welded and inspected assemblies yes / no , %:

Painted and inspected assemblies yes / no , %:

Assemblies delivered to site yes / no , %:

Erected assemblies yes / no , %:

Final documentation yes / no , %:

Site information

Filled in by

Checked by

Additional information

150000-Project xxxx

September 2015

Monthly progress of project [Tonnage]

Monthly totals

	April	May	June	July	August	September	October
Fabrication	0.0	0.0	0.0	992.9	1.1	0.0	0.0
Delivered	0.0	0.0	0.0	122.8	221.2	445.7	0.0
Erected	0.0	0.0	0.0	40.7	147.8	473.9	0.0

Cumulatives

Fabrication	0.0	0.0	0.0	992.9	993.9	993.9	993.9
Delivered	0.0	0.0	0.0	122.8	344.0	789.8	789.8
Erected	0.0	0.0	0.0	40.7	188.5	662.4	662.4

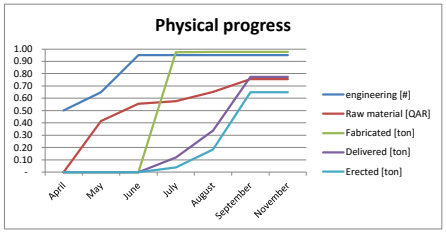
Monthly progress of project [QAR]

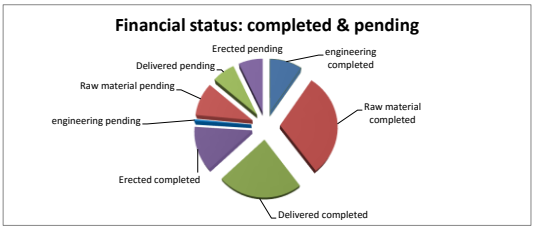
Monthly totals

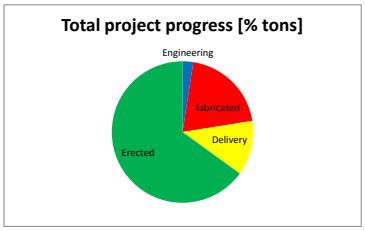
	April	May	June	July	August	September	October
10% engineering	735,000	220,500	441,000	0	0	0	0
40% Raw material	0	2,438,638	829,305	119,300	444,952	615,151	0
30% Delivered	0	0	0	531,783	957,453	1,929,436	0
20% Erected	0	0	0	117,317	426,627	1,367,629	0
Total	735,000	2,659,138	1,270,305	768,400	1,829,032	3,912,216	0

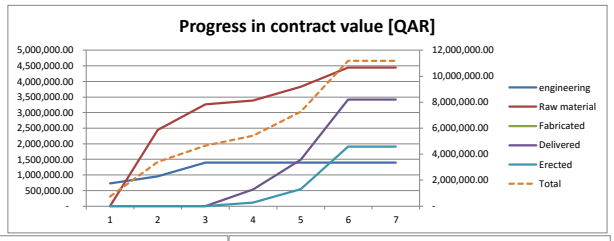
Cumulatives

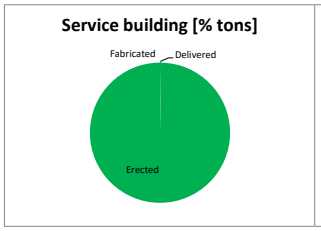
									% of Contract Value
10% engineering	735,000	955,500	1,396,500	1,396,500	1,396,500	1,396,500	1,396,500	1,470,000	95%
40% Raw material	-	2,438,638	3,267,943	3,387,243	3,832,196	4,447,346	4,447,346	5,880,000	76%
30% Delivered	-	-	-	531,783	1,489,236	3,418,672	3,418,672	4,410,000	78%
20% Erected	-	-	-	117,317	543,944	1,911,573	1,911,573	2,940,000	65%
Total	735,000	3,394,138	4,664,443	5,432,844	7,261,875	11,174,091	11,174,091	14,700,000	76%

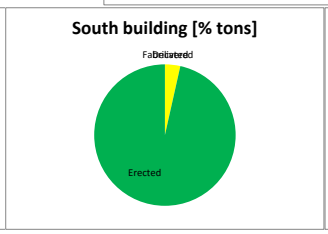


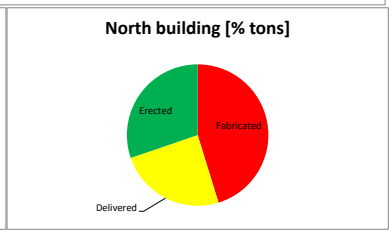






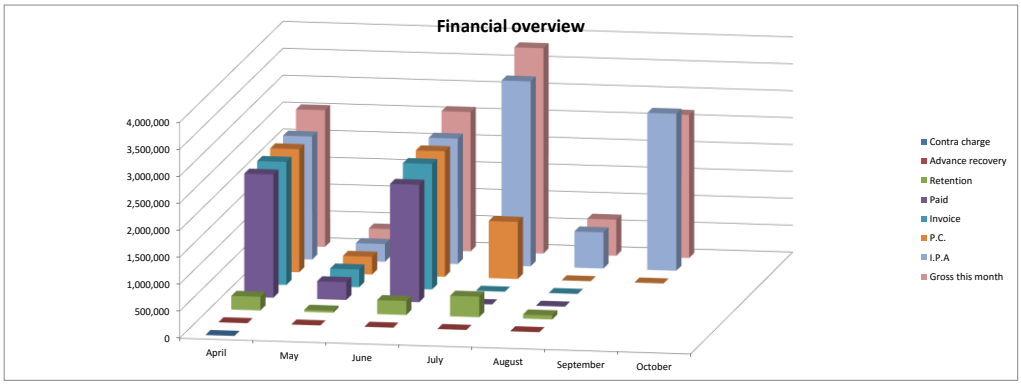






Financial overview

	Gross month	I.P.A	P.C.	Invoice	Payment due	Paid	Retention	Advance recovery	Contra charge
April	2,540,025	2,286,023	2,286,023	2,286,023	dd/mm/yy	2,286,023	254,003	0	0
May	2,906,411	329,747	329,747	329,747	dd/mm/yy	329,747	36,639	0	
June	5,496,027	2,330,655	2,330,655	2,330,655	dd/mm/yy	2,180,080	258,962	0	
July	9,313,198	3,435,453	1,060,563	0	dd/mm/yy	0	381,717	0	
August	10,059,508	671,679	0	0	dd/mm/yy	0	74,603	0	
September	11,970,983	2,917,381			dd/mm/yy				
October					dd/mm/yy				



150000 PROJECT XXXXXXX **Progress Measurement Sheet - Payment Application No. 06 September 2015**

Item no.	Description	Rate [%]	Amount [QAR]	correction for erection			Physical progress [%]			Value of progress [QAR]			Reduction progress		
				Origin	Cum. Weight	price/ton	Previous	This month	Cumulative	Previous	This month	Cumulative	Deducted	Remaining	
1	**Designing and Engineering**	10%	1,669,820.00	Percentage	1,109.99	1,429.14	90.00%	5.00%	95.00%	1,323,000.00	263,329.00	1,586,329.00	(1,013,133.36)	573,195.64	
2	**Raw Material of structural steel**	40%	6,679,280.00	Invoices	1,137.29	2,231.51	30.00%	8.00%	38.00%	2,436,755.90	101,106.73	2,537,862.63	(1,581,942.14)	955,920.49	80% of value
3	**Structural steel fabrication and painting**	30%	5,009,460.00	Product. report	1,179.19	4,103.83	85.25%	11.35%	96.60%	2,859,745.18	1,979,447.03	4,839,192.20	(2,909,251.76)	1,929,940.44	raw materials

LOCATION	ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE QAR/unit	AMOUNT QAR	PREVIOUS [tonnage]	CURRENT [tonnage]	CUMMULATIVE [tonnage]	PREVIOUS [%]	CURRENT [%]	CUMMULATIVE [%]	PREVIOUS [QAR]	CURRENT [QAR]	CUMMULATIVE [QAR]
North Building	1	**Structural Steelworks**	Ton	472.59	11,000.00	5,198,490.00	12.77	162.83	175.59	2.70%	34.45%	37.16%	140,463.58	1,791,081.31	1,931,544.90
	2	**Roof Lighting Support - RHS**	Ton	12.50	13,000.00	162,500.00	-	12.50	12.50	0.00%	100.00%	100.00%	-	162,500.00	162,500.00
	3	**Steel Support for Inclined Louvers**	Ton	14.40	14,000.00	201,600.00	-	14.40	14.40	0.00%	100.00%	100.00%	-	201,600.00	201,600.00
	4	**Steel Staircase (Frijns Design)**	Ton	44.30	9,000.00	398,700.00	-	-	-	0.00%	0.00%	0.00%	-	-	-
					Subtotal erected		12.77	189.73	202.49		**Subtotal structural steel**		**140,463.58**	**2,155,181.31**	**2,295,644.90**
											Deduction engineering		(16,065.46)	(273,327.98)	(289,393.44)
											Deduction raw materials		(28,582.99)	(423,286.13)	(451,869.11)
											Deduction fabrication & painting		(35,092.89)	(795,911.59)	(831,004.49)
											Total structural steel		**37,098.82**	**686,279.04**	**723,377.86**
	5	**Steel Purlins Z252 x 2.0 mm thick**	Ton	26.14	10,000.00	261,350.00	-	-	-	0.00%	0.00%	0.00%	-	-	-
	6	**Metal Decking Works**	M²	2,470.00	150.00	370,500.00	-	-	-	0.00%	0.00%	0.00%	-	-	-
	7	**Shear Studs, Connection Bolts, Anchors, etc.**	LS	1.00	100,000.00	100,000.00	12.77	162.83	175.59	2.70%	34.45%	37.16%	2,702.01	34,453.88	37,155.88
	8	**1 Hour Rating Instumenscent Fireproofing for Steelwork & Steel Stair**	M²	10,254.00	100.00	1,025,400.00	12.77	162.83	175.59	2.70%	34.45%	37.16%	27,706.38	353,290.05	380,996.43
					Value North building	7,718,540.00					**Erection progress Service Building**		**67,507.22**	**1,074,022.96**	**1,141,530.18**

LOCATION	ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE QAR/unit	AMOUNT QAR	PREVIOUS [tonnage]	CURRENT [tonnage]	CUMMULATIVE [tonnage]	PREVIOUS [%]	CURRENT [%]	CUMMULATIVE [%]	PREVIOUS [QAR]	CURRENT [QAR]	CUMMULATIVE [QAR]
South Building	1	**Structural Steelworks**	Ton	472.59	11,000.00	5,198,490.00	103.82	303.87	407.70	21.97%	64.30%	86.27%	1,142,060.73	3,342,596.45	4,484,657.18
	2	**Roof Lighting Support - RHS**	Ton	12.50	13,000.00	162,500.00	-	12.50	12.50	0.00%	100.00%	100.00%	-	162,500.00	162,500.00
	3	**Steel Support for Inclined Louvers**	Ton	14.40	14,000.00	201,600.00	-	14.40	14.40	0.00%	100.00%	100.00%	-	201,600.00	201,600.00
	4	**Steel Staircase (Frijns Design)**	Ton	44.30	9,000.00	398,700.00	-	-	-	0.00%	0.00%	0.00%	-	-	-
					Subtotal erected		103.82	330.77	434.60		**Subtotal structural steel**		**1,142,060.73**	**3,706,696.45**	**4,848,757.18**
											Deduction engineering		(130,622.68)	(490,475.46)	(621,098.13)
											Deduction raw materials		(232,398.37)	(737,406.15)	(969,804.52)
											Deduction fabrication & painting		(285,328.15)	(1,498,179.25)	(1,783,507.40)
											Total structural steel		**301,637.69**	**1,172,709.43**	**1,474,347.12**
	5	**Steel Purlins Z252 x 2.0 mm thick**	Ton	26.14	10,000.00	261,350.00	-	-	-	0.00%	0.00%	0.00%	-	-	-
	6	**Metal Decking Works**	M²	2,470.00	150.00	370,500.00	-	26.42	26.42	0.00%	100.00%	100.00%	-	370,500.00	370,500.00
	7	**Shear Studs, Connection Bolts, Anchors, etc.**	LS	1.00	100,000.00	100,000.00	103.82	303.87	407.70	21.97%	64.30%	86.27%	19,772.18	66,496.28	86,268.46
	8	**1 Hour Rating Instumenscent Fireproofing for Steelwork & Steel Stair**	M²	10,254.00	100.00	1,025,400.00	103.82	303.87	407.70	21.97%	64.30%	86.27%	214,007.46	670,589.32	884,596.77
					Value South building	7,718,540.00					**Erection progress South building**		**535,417.32**	**2,280,295.03**	**2,815,712.35**

LOCATION	ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE QAR/unit	AMOUNT QAR	PREVIOUS [tonnage]	CURRENT [tonnage]	CUMMULATIVE [tonnage]	PREVIOUS [%]	CURRENT [%]	CUMMULATIVE [%]	PREVIOUS [QAR]	CURRENT [QAR]	CUMMULATIVE [QAR]
Service Building	1	**Structural Steelworks**	Ton	72.20	11,000.00	794,200.00	70.89	0.93	71.82	98.19%	1.29%	99.47%	779,799.90	10,228.13	790,028.03
	2	**Steel Staircase (Frijns Design)**	Ton	8.63	9,000.00	77,670.00	-	-	-	0.00%	0.00%	0.00%	-	-	-
					Subtotal erected		70.89	0.93	71.82		**Subtotal structural steel**		**779,799.90**	**10,228.13**	**790,028.03**
											Deduction engineering		(89,189.26)	(13,452.53)	(102,641.79)
											Deduction raw materials		(158,681.77)	(1,586.73)	(160,268.51)
											Deduction fabrication & painting		(194,822.27)	(99,917.61)	(294,739.88)
											Total structural steel		**205,958.43**	**26,419.43**	**232,377.86**
	3	**Metal Decking Works**	M²	815.00	150.00	122,250.00	-	15.29	15.29	0.00%	100.00%	100.00%	-	122,250.00	122,250.00
	4	**Shear Studs, Connection Bolts, Anchors, etc.**	LS	1.00	80,000.00	80,000.00	70.89	0.93	71.82	98.19%	1.29%	99.47%	78,549.47	1,030.28	79,579.76
	5	**1 Hour Rating Instumenscent Fireproofing for Steelwork & Steel Stair**	M²	1,870.00	100.00	187,000.00	70.89	0.93	71.82	98.19%	1.29%	99.47%	183,609.39	2,408.29	186,017.68
					Value service building	1,261,120.00					**Erection progress Service building**		**468,117.30**	**152,107.99**	**620,225.30**

Cumulative value	16,698,200.00
Contra charge	-
Contract value	16,698,200.00

Total erection progress	1,071,041.84	3,506,425.98	4,577,467.82

Gross net progress	**7,690,542.92**	**5,850,308.74**	**13,540,851.66**
Additions - Variation No. 1		149,475.07	149,475.07
Additions - Site instruction No. 4		80,000.00	80,000.00
Contra charge			
Advanced payment recovery (10%)	(769,054.29)	(607,312.92)	(1,376,367.22)
Retention (10%)	(769,054.29)	(607,978.38)	(1,377,032.67)
Total cumulative	6,152,434.33	4,863,827.05	11,016,261.38
Net total this payment application		**4,863,827.05**	

NORTH BUILDING

Project Name : QSTP Tech 4 Building - South Building
Project No. : 140105
Client : Qatar Foundation
Consultant : WSP/ Technip
Main Contractor : Butec and Murray & Roberts - JV

ASSEMBLY					FABRICATED						DELIVERED TO SITE						ERECTED AT SITE					
					QUANTITY (ASSEMBLY)			WEIGHT (TON)			QUANTITY (ASSEMBLY)			WEIGHT (TON)			QUANTITY (ASSEMBLY)			WEIGHT (TON)		
Sl.No.	DESCRIPTION	QTY	UNIT WEIGHT (TON)	TOTAL WEIGHT (TON)	PREVIOUS	TO DATE	CUMULATIVE	PREVIOUS	TO DATE	CUMULATIVE	PREVIOUS	TO DATE	CUMULATIVE	PREVIOUS	TO DATE	CUMULATIVE	PREVIOUS	TO DATE	CUMULATIVE	PREVIOUS	TO DATE	CUMULATIVE
STRUCTURAL STEELWORKS																						
	COLUMNS																					
1	C2001	1	2.64	2.64	1		1	2.64		2.64		1	1	-	2.64	2.64		1	1		2.64	2.64
2	C2002	1	2.63	2.63	1		1	2.63		2.63			0	-	-	-					-	-
3	C2003	1	2.64	2.64	1		1	2.64		2.64		1	1	-	2.64	2.64		1	1		2.64	2.64
4	C2004	5	1.53	7.64	5		5	7.64		7.64		3	3	-	4.58	4.58		2	2		3.06	3.06
5	C2005	8	1.52	12.17	8		8	12.17		12.17		5	5	-	7.60	7.60		3	3		4.56	4.56
6	C2029	3	1.49	4.48	3		3	4.48		4.48		2	2	-	2.98	2.98		3	3		4.48	4.48
7	C2006	2	1.53	3.06	2		2	3.06		3.06		1	1	-	1.53	1.53		1	1		1.53	1.53
8	C2007	1	2.64	2.64	1		1	2.64		2.64			0	-	-	-					-	-
9	C2008	1	2.64	2.64	1		1	2.64		2.64			0	-	-	-					-	-
10	C2009	1	2.63	2.63	1		1	2.63		2.63		1	1	-	2.63	2.63		1	1		2.63	2.63
11	C2031	1	1.46	1.46	1		1	1.46		1.46		1	1	-	1.46	1.46					-	-
12	C2032	2	1.49	2.98	2		2	2.98		2.98		2	2	-	2.98	2.98		2	2		2.98	2.98
13	C2033	1	1.44	1.44	1		1	1.44		1.44			0	-	-	-		1	1		1.44	1.44
14	C2010	3	1.35	4.06	3		3	4.06		4.06	1	2	3	1.35	-	1.35	1	2	3	1.35	2.71	4.06
15	C2011	3	1.35	4.04	3		3	4.04		4.04	1	2	3	1.35	-	1.35		3	3		4.04	4.04
16	C2012	3	1.10	3.29	3		3	3.29		3.29	1	2	3	1.10	-	1.10		3	3		3.29	3.29
17	C2013	3	1.14	3.41	3		3	3.41		3.41		3	3	-	3.41	3.41		2	2		2.28	2.28
18	C2014	3	0.72	2.16	3		3	2.16		2.16		3	3	-	2.16	2.16		2	2		1.44	1.44
19	C2015	1	1.48	1.48	1		1	1.48		1.48	1		1	1.48	-	1.48	1		1	1.48	-	1.48
20	C2016	3	1.40	4.21	3		3	4.21		4.21	1	2	3	1.40	-	1.40		3	3		4.21	4.21
21	C2017	3	1.48	4.43	3		3	4.43		4.43	1	2	3	1.48	-	1.48		3	3		4.43	4.43
22	C2018	2	1.48	2.96	2		2	2.96		2.96		2	2	-	2.96	2.96		2	2		2.96	2.96
23	C2019	3	1.40	4.21	3		3	4.21		4.21		3	3	-	4.21	4.21		2	2		2.80	2.80
24	C2020	1	1.48	1.48	1		1	1.48		1.48		1	1	-	1.48	1.48					-	-

Procurement process

Procurement flowchart

Niels van Noord

FRIJNS STRUCTURAL STEEL MIDDLE EAST W.L.L.

M.R.F. sign	Material request form filled in by requester, filled in as complete as possible with each requirement **specified**.	**All departments**
Approve sign	Department head has to approve the request, and judge the quality of the information.	
Quotation & selection	If necessary procurement will request (several) quotations from the preferred/required supplier(s) and the best will be selected. *For an order > QR 3000/- : minimum 3 quotations*	**Procurement department**
Approve	The selection of the quotation has to be approved.	
P.O. creation sign	Creation of P.O. A P.O. can only correspond with one project and one supplier. Fill in as complete as possible, with reference to M.R.F.	
Check & approve Sign 2x	P.O. has to be checked by requester of corresponding M.R.F. and approved by procurement manager and one other member of the management team.	
Order confirmation + delivery time	The supplier has to sent an order confirmation with the confirmation of the delivery time.	
Delivery goods	Goods will be delivered at the company or at site and the quantity and quality of the materials will be verified including the documents.	**Material controller Storekeeper**
Check sign	The delivered goods has to be checked against the delivery note. The delivery note hast to be checked against the P.O.	
Receiving invoice	The invoice has to be received by the procurement department.	**Procurement department**
Check sign	The invoice has to be checked against the delivery not of the goods ordered on the P.O.	
Book invoice	A checked invoice can be booked in the Liemar-system	
Check	When the invoice is booked, the finance department has to check the booking and release the payment.	**Finance department**
Close order	When the P.O. is fully paid and **ALL DOCUMENTS ARE ATTACHED**, the order can be closed in the Liemar-system.	**Procurement department**

Project P.O. register

FRIJNS STRUCTURAL STEEL MIDDLE EAST W.L.L.

Project No.

Project Name

P.O. No.	Supplier	P.O. Value	Delivery		Invoice	
		QAR	*Partly*	*Complete*	*Partly*	*Complete*
			☐	☐	☐	☐
			☐	☐	☐	☐
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Site capacity planning

Niels van Noord

			48							49							50							51							52						
			23-11							30-11							7-12							14-12							21-12						
	Site	Function	mo	tu	we	th	fr	sa	su	mo	tu	we	th	fr	sa	su	mo	tu	we	th	fr	sa	su	mo	tu	we	th	fr	sa	su	mo	tu	we	th	fr	sa	su
130047	bojamhoor	total	3	3	3	3		3	3	3	3	3	3		3	3	3	3	3	3		3	3	3	3	3	3									
135077	**QDVC (155036 /150037)**	**total**	9	9	9	9		9	9	9	9	9	9		9	9																				
150108	**Show CANADA**	total	3	3	3	3		3	3																											
130090	J&P	total	4	4	4	4		4	4	4	4	4	4		4	4																				
140008	RSS	total	3	3	4	4					3	4	4																							
140025	Shapoorji	total	3	3	3	3		6	6	6	6	6	6		6	6	6	6	6	6		6	6	6	6	6	6		6	6	6	6	6	6			
140105	QSTP	total	13	13	13	13		9	9	9	9	9	9		9	9	9	9	9	9		9	9	9	9	9	9									
140110	Al Ryum	total	5	5	5	5		5	5	5	5	5	5		5	5	5	5	5	5		5	5	5	5	5	5		6	6	6	6	6	6		6	6
140115	Brookfield	total	5	5	5	5																														
150021	Harinsa	total																																		
150025	Samsung OHL JV	total																																		
150026	bojamhoor	total	3	3	3	3		3	3	3					3	3	3	3	3	3					3	3	3		3	3	3	3	3	3			
150027	UEG	total																																		
150065	FYAP	total	6	6	6	6		6	6	6	6	6	6		6	6																				
150071	Gulf	total	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4		4	4	4	4	4	4									
150083	MAN Enterprise	total	5	5	5	5		5	5	5	5	5	5		5	5	5	5	5	5																
156000	Extention Mesaieed	total																																		
150099	Handrails Lusail	total																																		
150098	Samsung Mock up	total	5	5	5	5		5	5	5	5	5	5		5	5																				
150105	FYAP Mock-up building	total	5	5	5	5		5	5	5	5	5	5		5	5	5	5	5	5		5														
	CUMULATIVE	**total**	**76**	**76**	**77**	**77**		**67**	**67**	**64**	**64**	**65**	**65**		**64**	**64**	**40**	**40**	**40**	**40**		**32**	**27**	**27**	**30**	**30**	**30**		**15**	**15**	**15**	**15**	**15**	**15**		**6**	**6**
	left over	total																																		
	capacity	total																																		