

Improving Transition from Engineering to Construction Using a Project Execution Model and BIM

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Abstract

Usually engineering takes place during a given time period, followed by construction. Shorter time from project start-up to delivery gives higher parallelism between project phases. Construction pushed in parallel with engineering places greater demands on the actors. Parallelism calls for increased interaction between engineering and construction. This paper assesses how transition from engineering to construction can be improved with the use of a project execution model (PEM) and utilization of building information models (BIM). Findings are presented in three interdependent dimensions; process, people and technology. Research is based on case studies of major oil and gas projects, where data is gathered through Kvaerner, a Norwegian EPC (engineering, procurement and construction) contractor. Primary focus is on EPC contracts, where engineering and procurement is subcontracted, which corresponds to design-build contracts in the construction industry. The EPC contractor will build in a sequence that is cost effective for them, while the engineering subcontractor prefers to think in a totality until engineering is finished. Parallelism challenge this. To improve transition, it is important with a correlation between how one conducts engineering and how one plan to build. How can deliveries from the engineering subcontractor be produced in an order that fits into the desired build sequence to the contractor? The paper portrays how an alternative contract model is used, how common drivers are established and how the use of a 3D design environment, which corresponds to BIM in the construction industry, is rearranged to support this. "Right the first time" is when a certain quality level is achieved to a certain point in time. Using a PEM supports this by defining requirements on each milestone that must be achieved to reach the desired quality level. If some disciplines are behind and some ahead of a milestone, it will not be "right the first time". How can the engineering subcontractor satisfy milestone requirements to the contractor and deliver "right the first time"? The paper shows how the engineering subcontractor, with certain additions and adjustments to their milestones, can support this. The integrated design and delivery solutions (IDDS) approach relate the findings towards the construction industry.

Keywords: building information model, build sequence, joint venture, milestone requirements, project execution model

1. Introduction

In current practice, engineering and construction phases are not well integrated (Luth et al., 2013), and usually engineering takes place at given period of time, followed by construction. In offshore projects, executed at EPC (engineering, procurement and construction) contracts, construction is often pushed in parallel with engineering. EPC contracts corresponds to design-build contracts in the construction industry, where the engineering and construction are contracted by a single contractor. Influence and inclusion of contractors in engineering in design-build contracts is important since contractors can receive deliveries based on their expertise in buildings solutions (Berard and Karlshoej, 2012). This involves grouping activities into work packages so that construction can start before the design phase is complete (Bogus et al., 2011). To improve transition, it is important that there is a correlation between how one conducts engineering and how one plan to build. When working in parallel, the contractor starts at a certain place and build, and that is the place engineering should have drawings and materials first. The paper assesses how deliveries from the engineering subcontractor can be produced in an order that fits into the desired build sequence to the contractor. This can be fulfilled using a project execution model¹ (PEM), an alternative contract model, common drivers for the project team, together with an altered structure of a 3D design environment². A 3D design environment corresponds to a building information model³ (BIM) in the construction industry. The paper investigates how the engineering subcontractor can satisfy the milestone requirements to the contractor and deliver “right the first time”. The engineering subcontractor can accomplish this by adjusting their milestone requirements in the design phase. Primary focus is on EPC contracts, where engineering and procurement is subcontracted.

The findings in this paper are divided into three interdependent dimensions; process, people and technology. Process, people and technology are identified as core organizational issues (Sacks et al., 2010) or categories used to classify challenges and benefits in an integrated design process (Rekola et al., 2010). To succeed requires a holistic approach, where all three dimensions are mutual dependent of each other. The first part, process, looks closer at parallelism in EPC contracts and how an engineering subcontractor can support this by adapting to a desired build sequence to the EPC contractor. This requires “right the first time” deliveries, with right information at the right time, and milestone coordination between the engineering subcontractor and EPC contractor. To accomplish this requires focus on the second dimension, people, which identifies common incentives and drivers. This includes the possibilities of establishing a joint

¹ A project execution model (PEM) reflects a logic sequence in critical project activities where progress and quality requirements are aligned at significant milestones. The objective of a PEM is to secure predictability in project execution using a standard methodology well known to the team Kvaerner, 2012b).

² A 3D design environment refers to a multi-discipline and object based 3D design integrated with a number of information systems that serves as the main source of information for engineering and construction (Kvaerner, 2012a).

³ A building information model (BIM) can be defined as a digital representation of physical and functional characteristics of a facility, and a shared knowledge resource for information about a facility that forms a reliable basis for decisions during its life cycle (NBIMS, 2007) .

venture between the engineering subcontractor and EPC contractor, identify drivers to secure alignment to common goals and mobilize new project teams. This also requires focus on the last dimension, technology, which investigates how a 3D design environment (hereafter called BIM) can be utilized to support a desired build sequence to the EPC contractor.

The integrated design and delivery solutions (IDDS) approach (Owen et al., 2009) is applied to discuss whether the findings on process, people and technology are relevant towards the construction industry. The IDDS approach is used to elucidate that these findings are factors that should support performance improvement in the construction industry. The construction industry is under pressure to reduce project delivery times and costs despite increased complexities in today's projects (Jaafari, 1997, Bogus et al., 2005). The approach challenges traditional industry structures and contractual processes, which corresponds with the research presented in this paper.

2. Research method

The research is qualitative and based on case studies. Data is gathered from three case projects in the oil and gas industry through Kvaerner, a Norwegian EPC (engineering, procurement, construction) contractor, executed as EPC contracts. The primary case project has been the topside for one of four platforms of the Johan Sverdrup field on the Norwegian continental shelf, which started detailed engineering in 2015. Secondary case projects have been the topsides for the Edvard Grieg platform and the Eldfisk platform, delivered in 2014. All three consists of a combined living quarter and utility module. Data collection has been conducted by the author through interviews, supplemented with relevant company and project documentation. Data has primarily been gathered from 8 semi-structured interviews, with the use of interview guides, from March 2013 to October 2015. Four of the interviews, had main focus on transition between engineering and construction, three on the use of PEM, and the last on the use of BIM. The average length of the interviews has been 1 hour 47 minutes. Each interview has been conducted with one to two interviewees in key positions in the cases, including Project Manager, Information Manager (responsible for all aspects of information handling in the project), and Head of PEM. The stepwise-deductive-inductive (SDI) method (Tjora, 2012) has been applied to analyze the collected data. The principle of this method is to work stepwise from data to concepts or theories (inductive) and verify these theoretically to the more empirically (deductive). The collected data has been transcribed and used to develop “empiric-close” coding that reflects the contents of the text. The codes have been sorted into larger groups of themes, called categories, and used as a basis to develop concepts that capture central characteristics of observations and findings. This is similar to what Halkier (2011) has described as “category zooming”, as a way to generalize qualitative data. This is a three-step process, from coding and categorizing, through tracing of systematic relationships between categories and finally aiming for conceptualizing.

3. Process

3.1 Parallelism and build sequence

According to Lee et al. (2005), parallelism, or concurrent engineering and construction, is gaining popularity due to the increased demand for shorter time frame of projects. In Kvaerner, parallelism gives greater challenges than if construction can be deferred until after the engineering has completed. The extent of the challenge depends on client’s requirements to the contractor. The client sets the scene in terms of how complex the process becomes, by setting the time frame from the contract is signed to delivery date. Longer time frame gives more predictability between the phases. Shorter time frame gives a higher degree of parallelism between the phases. The more parallelism there is in a project, the greater demands are put on the participants in that they know what the sequence and the quality requirements of the project is. This is similar to what Succar (2009) has defined as "BIM stage 2", where engineering and construction is in parallel, and is driven by construction providing design-related services, and engineering increasingly adding construction and procurement information into their BIM. Integration of engineering and construction is not new, and similar terms and techniques have been used to respond to the time and cost pressures in projects (Jaafari, 1997). Parallelism is similar to concurrent engineering (CE), where the aim is to reduce the total delivery time and cost of a project by overlapping activities that are normally performed in a sequence (Bogus et al., 2011). In the last decade, the concept of integrated concurrent engineering (ICE) have also been introduced, where the focus is to “speed up the process by increasing task parallelism and reducing response latency and lag, which decelerate legacy multi-disciplinary construction engineering processes” (Alhava et al., 2015).

Engineering influences all project phases. In Kvaerner’s PEM, the design phase consists of three stages with corresponding milestones (M2A, M2B and M2C). During these stages, the BIM is developed to a quality level where the design and all interfaces (between disciplines) are frozen. When the last milestone, M2C (“Global design complete”), is reached, the the BIM should have reached a defined quality level so that the engineering subcontractor can start issuing drawings, and Kvaerner can start construction (see principle in Figure 1).

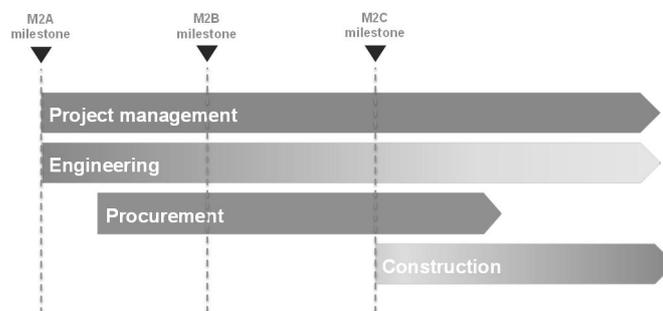


Figure 1 Parallelism between E, P and C (Kvaerner, 2013)

With parallelism in EPC contracts, it is important to be aligned in the sense that there is a correlation between how one conducts engineering and how one plans to build. A common challenge is that Kvaerner will build in a sequence, which is cost effective for them, while the

engineering subcontractor would prefer to think in a totality until design is complete. In order to get drawings and materials at the right time when construction is pushed in parallel with engineering, Kvaerner has made a build sequence that engineering and procurement must know of, because they will need to deliver according to it. The ambition to Kvaerner is that engineering is conducted in an order that fits into the build sequence that gives the fewest possible hours in the workshop. The dilemma is that the engineering subcontractor do not know Kvaerner's build sequence, and Kvaerner does not know how the engineering subcontractor conducts their engineering deliveries. Kvaerner's PEM can describe how it is done and at what status deliveries should be on each milestone, but Kvaerner has to tell the engineering subcontractor what they need to deliver. Kvaerner has therefore spent a lot of time with the engineering subcontractor to explain how Kvaerner's build sequence is and what they require of engineering deliveries, including drawings, materials as well as equipment components, to support this, so that the engineering subcontractor can adapt its engineering deliveries to Kvaerner's build sequence.

3.2 "Right the first time"

According to Kvaerner, the various input factors must have come to a certain level in quality and progress, on a given milestone. If someone goes too far and others too short, it will not be "right the first time". In the design phase, all disciplines should know at any given point in time how far they should have come with their design. If a discipline has come too short and not fulfilled the requirements at a milestone, they can influence the others when they are finished. If a discipline has gone too far, the discipline might need to redo much of what is done while the other catches up, because the discipline have made assumptions that are not met. Similarly, Lee et al. (2005) has stated that successor activities that have to start without complete information from predecessor activities, may lead to a chain of wrong decisions in other related activities. Whoever succeeds to optimize the process best will be the cheapest and fastest.

"Right the first time" is doing it right the first time and not having to do it over again, and is something Kvaerner strive for. Kvaerner's PEM supports "right the first time" by defining milestone requirements and associated discipline checklists to all stages in each project phase. In each project, the client will have contractual milestones. The milestones defined by Kvaerner in their PEM are distributed as parallel as possible with the contractual milestones to the client, so that it is consistency between these. It is also to avoid communicating a different message to the project team in every project. When the final milestone in the design phase, M2C, is reached, the objects in the BIM are at a quality level that one can begin issuing drawings for construction. The design is frozen, and should by definition not be changed. At the M2C milestone, engineering should have fulfilled the milestone requirements to satisfy Kvaerner's build sequence, so that Kvaerner safely can start construction. This is similar to what Schade et al. (2011) identifies as a quality gate, where design maturity is synchronized and evaluated, and reflects the detailing of the design, in a concurrent engineering approach. When Kvaerner conducts projects with engineering and procurement on a subcontract, both parties has their own PEM. Like Kvaerner, the engineering subcontractor has organized their work in a way where they have milestone requirements and associated checklists (for each discipline). To make sure the engineering subcontractor has come as far as required on the last milestone to start deliveries to construction,

their milestone is checked against Kvaerner's milestone (M2C). The methodology is based on the fact that the requirements that Kvaerner has made for the last milestone in the design phase (M2C), in terms of what the disciplines should deliver and to what quality level, is adapted to Kvaerner's build sequence. The requirements for each discipline at the M2C milestone and the corresponding milestone to the engineering subcontractor is compared through a GAP analysis, to see if the engineering subcontractor are close to fulfilling the requirements at the M2C milestone. They identify the gaps between the two milestones, and go through the checklists for all relevant disciplines, and look at where they need to increase the requirements. Kvaerner wants the engineering subcontractor to use their own PEM, but with certain milestone additions and adjustments, to satisfy Kvaerner's build sequence. The main reason for this is that the barriers for adapting new milestone requirements are lower when using a familiar PEM. If the engineering subcontractor meet the requirements in the last milestone in the design phase, it is very likely that Kvaerner's build sequence can be used.

4. People

How do you merge engineering and procurement with construction? According to Kvaerner, when working as an EPC contractor with control over both engineering, procurement and construction, rational considerations can be made in terms of how spending and earnings should be, in order to optimize the bottom line. It is the company that determines the optimal sequence and the desired order of deliveries from engineering, procurement and construction in each project. When there are two separate companies, the interests of one may not always easy favored by the other because of different economic drivers. With engineering and procurement on a subcontract, there can be different contract models between the EPC contractor and the engineering subcontractor. As soon as these two parties have a contract regime that exist between them, the engineering subcontractor will work according to their drivers - that often do not correspond with the drivers the EPC contractor has. It is typically the contractual terms to the engineering subcontractor that drives them. If they have day penalties on deliveries, or reduced compensation if they spend too many hours, they work according to that. But then it might be that they are not as concerned about whether the quality of the deliveries is 100%. According to Jaafari (1997) each actor in a project tends to manage their own scope in a way that minimizes their own exposure to risks and maximizes their gain, which may lead to divergence of objectives of the parties from project objectives.

According to Kvaerner, the engineering subcontractor can work according to a fixed price or paid per hour with a profit, in a subcontract. They must take responsibility for their deliveries - either through performance milestones or through milestones with day penalties. If drawing quality is too poor, drawings must be recalled and updated on their own expense. A subcontract can work out if the contractor requires defined drawing deliveries, and can set fines or bonuses on deadlines. They can probably agree on a better order of the drawings (in relation to the build sequence). Kvaerner emphasizes that it is important that the contractor and the engineering subcontractor have common drivers related to engineering deliverables. This leads to another variant, a joint venture, where the two parties share a common bottom line. According to Owen et al. (2010), contractors can operate integrated on individual projects, or establish temporary joint ventures, to

provide cost, time and delivered quality benefits through more integrated processes. The understanding throughout joint venture is that if the engineering subcontractor (or contractor) do not manage to deliver, there will be no bottom line to share. For Kvaerner this is the most effective, because then they do not need to be as aggressive in trying to follow up the engineering subcontractor as in a traditional subcontract. Then they are partners, both knows what applies, and have the same drivers. In the agreement Kvaerner has made with the engineering subcontractor in the primary case project, the parties have established a joint venture for a joint EPC, where they are "joint and several" responsible. This means in practice that if one part is not performing, it has a consequence for the other. If one part goes bankrupt, then the other part must complete the work the other should have done. They are mutually dependent of both parties performing and they share profits on the bottom line in a percentage distribution. It is a model that better prepare for an improved transition between engineering and construction, because they have a common driver. The engineering subcontractor only get their expenses covered through invoicing, and only get the profits from what is left of the cash balance in the end. This means that the engineers at the engineering subcontractor should be motivated to perform and deliver as planned. If not, they can go from sharing profits to covering deficits afterwards.

It might be that despite establishing a joint venture, the motives for the two partners can be different. It may be so that the engineering subcontractor that works for Kvaerner can lose more on another contract than the contract in question, if they do not make a greater effort. They might choose to withdraw personnel and move over to the project that has greater challenges or that has a greater risk associated with it. The engineering subcontractor that works for Kvaerner can also work for several other construction yards, which has no build sequence, not the same requirements to a build sequence, or does not have the same requirements to a PEM that Kvaerner has, which can make the adoption more challenging to accomplish. In this case they must reach down to every discipline and get them to understand that now they need to satisfy another build sequence, which is another way to deliver on. Kvaerner point out that there are mechanisms that can support this. They can both select key personnel. Both parties must then approve the competence of key personnel that the other deploy into the project. By exchanging CVs on key personnel, they both can be assured that they are putting on experienced and competent personnel, on equal terms. There will be penalties if any of the personnel are withdrawn from the project. This will prevent the ability to juggle too much with personnel and competence. Both parties should feel equally safe for doing the best they can. A key to influence and train engineers is the use of a PEM with common milestone requirements, so that engineering can be executed in a manner that is adapted to Kvaerner's build sequence. Because the bottom line is the main driver, the project team do not need any additional drivers. As long as Kvaerner manage to explain what the requirements are and why the requirements are the way they are, the engineering subcontractor get insight in what is needed to be able to increase the bottom line. To support this, they carry out what they call inductions, which is an introductory package for the engineers as they come aboard the project.

For Kvaerner, success is also related to the competence and experience of the project team. Most project participants bring along experience from the last project – in terms of both methodology, requirements and deliverables. It will always be a challenge to include those who were part of the project last time when an engineering subcontractor mobilizes for a new project together with

Kvaerner. If they repeatedly get more common projects ahead, they can adapt to each other better. Kvaerner has experienced that if they have 70% engineers who have been part of a project team that worked according to the requirements in Kvaerner's PEM, there is a great chance that it goes better in the new project than the last time. If they have 30% engineers who have worked according to the requirements in Kvaerner's PEM and 70% beginners, there is a great chance that the new project will not turn out well. To succeed in future EPC projects, it is important to seek a form of strategic alliance with the preferred engineering subcontractor, and use the same from project to project. Experiences from strategic alliances that Kvaerner has today with engineering subcontractors, indicate that there are virtually no conflicts.

5. Technology

When the engineering subcontractor works in the BIM without the contractor having set the boundaries for the different sections, they work relatively unhindered. Disciplines work with the entire platform, because many of the objects modelled go through several sections. Kvaerner has experienced that to get a discipline to split the model in objects that are going onto to the different sections, when the boundaries are set, is a challenge to accomplish, and increases the complexity, with many interfaces. It is an added cost, and more time consuming, because the discipline must spend time to go in and out of the sections. There is a maximum limit to how much parallelism one can manage in that context. The splitting of the BIM towards fabrication and construction are based on the main areas as defined by the contract. The sub areas, called fabrication assemblies, are defined by Kvaerner to control the parts that are sent out for fabrication. All necessary documentation, including drawings, are related to each fabrication assembly. FAS (fabrication assembly section) express the horizontal area, and FAV (fabrication assembly volume) the volume above. FAS is the first that comes into production. FAV is established when they have added several sections that are finished. Some of the planned activities go towards the area, while some of the activities goes towards the volume. There are certain activities that requires several volumes composed simultaneously. For instance, a cable can not be cut from volume to volume, and must be drawn as one cable. Cable activities are planned against all volumes it goes through. A pipe can be split, because it must be welded together.. Piping activities may be connected against each FAV, because they can draw out the pipes and welds between them. Fabrication assemblies are similar to what Jaafari (1997) define as clusters, referring to particular parts of the project. Clusters can include relevant front-end activities, procurement and construction activities. Each cluster can be assigned to a team and executed as an integrated part. Similarly, Luth et al. (2013) states that sequencing knowledge and methods, in addition to construction means, can be incorporated in the BIM, in order to reach a sufficient quality level to produce drawings for construction.

Anumba and Evbuomwan (1997) define the aim of concurrent engineering (CE) to reduce lead times and improve quality and cost by integrating fabrication in design, and maximizing parallelism. When engineering starts it is required that all large and heavy equipment are identified. According to Kvaerner, the disciplines need all design parameters of what they call critical packages (weight, where bolt holes are, where pipes are to be connected, how cables should be plugged in etc.). That is governing because the disciplines need to get this to fit together

(the floor needs to support the weight, any rotating equipment must withstand the rotational forces etc.). The bigger and more expensive equipment, the longer time it takes to fabricate. It is therefore important to get this equipment ordered as early as possible, to get the vendor drawings and to get it delivered on time. The sequence of purchase orders is made based on criticality. Kvaerner define criticality in terms of how much equipment (i.e. the information on the equipment) are of importance for the design development, and is categorized from 1 to 3, where 1 is the most demanding equipment ("long lead items") and 3 is the least demanding. Preliminary information of equipment is based on the initial purchase orders and used as important input to the fabrication assemblies. The information is updated when the orders are finalized.

6. Discussion

Are the findings on process, people and technology in this paper relevant towards the construction industry? The IDDS approach, which aims to utilize BIM and make sure that improvements in construction projects are based on a combination of process, people and technology, is used to assess this. IDDS consist of four main elements; collaborative processes, knowledge management, enhanced skills and integrated information and automation systems (Owen et al., 2009). Process, people and technology are closely related and mutually dependent. Findings on process can be related to collaborative processes and knowledge management, where the latter also have a close interface towards people and technology. Findings on people can be related to enhanced skills, while findings on technology can be related to integrated information and automation systems (see illustration in Figure 2). The conditions and main challenges each of these elements address, have been briefly identified, followed by how key findings on process, people and technology can address these.

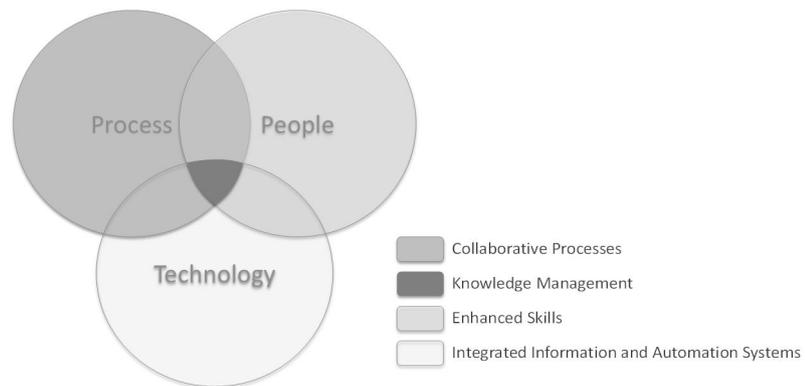


Figure 2 Relation between process, people and technology and the four elements of IDDS

Collaborative Processes: Improved design and delivery through better coordination and integration is essential. To support this, information technology tools will need to provide increased capability for knowledge sharing and development, rather than for just information exchange, aggregation and storage. Collaborative approaches, linked with an effective knowledge management system, would facilitate this. Further benefits may result from adoption of new approaches to work processes being developed in other sectors (Owen et al., 2010). Kvaerner's ambition is always to build in as short time as possible and have as high parallelism as possible

and as few working hours as possible, but at the same time meeting the quality requirements. To be able to work integrated, the EPC contractor must describe the build sequence for the engineering subcontractor, so that they manage to deliver their drawings and materials into that specific sequence. PEM shall ensure that the status on the engineering deliveries at the last milestone in the design phase satisfies Kvaerner's build sequence.

Knowledge Management: Codified knowledge in companies typically exists within individual groups (discipline, trade, function) and is seldom shared with others. Applying knowledge management, which includes codifying, using and constantly updating critical knowledge and business processes, is only done in a few leading companies (Owen et al., 2010). PEM supports "right the first time" through milestone requirements, to make sure engineering has come as far as required to start construction. Kvaerner's milestone requirements in the design phase are compared to the engineering subcontractor's corresponding milestones. The gaps are identified, and additional requirements are added to their milestones. In that way the engineering subcontractor can keep their own milestones but with certain additions (or deductions) to support Kvaerner's build sequence. The core to success is that Kvaerner is able to get the message out to the disciplines. Kvaerner's PEM, which is knowledge management in practice, has two functions in respect to that; tell the disciplines what they should have done at a given milestone and to check whether it is achieved.

Enhanced Skills: Increased performance requirements and complexity in construction increase the need for integration skills. Furthermore, project management in integrated projects need to focus on personnel with shared technical knowledge and integration experience as key selection criteria. Knowledge of prior projects and current requirements, will foster integrated work processes both between and within specific project phases and major activities (Owen et al., 2010). A joint venture with a common bottom line, that Kvaerner and the engineering subcontractor has established, with clearly defined project goals, which the parties have to align to, will increase the motivation to integrate for both contracting parties. The main advantage of an incentive-based contract, such as joint venture, is its potential to unite the objectives of the project team with project objectives. Kvaerner must get the engineering subcontractor to adapt to their build sequence and not what they have done towards other EPC contractors. That is what Kvaerner and the engineering subcontractor have spent time on in the relevant case project. If Kvaerner manage to get a new project with a majority of the same personnel, it would further improve integration.

Integrated Information and Automation Systems: Moving towards partial integration and automation of engineering, procurement and construction, will increase the overall performance of a project. This includes extracting information for fabrication from the design model. Further progress will require providing more complete design information models for use in construction (Owen et al., 2010). This is what Kvaerner has moved towards, when they split the BIM in sub areas, called fabrication assemblies. These are developed to be able to define and control what is sent out for fabrication. Drawings and all other relevant information is related to each fabrication assembly. Kvaerner has three categories of criticality, which is related to design and delivery time on equipment. Information on equipment is based on the purchase orders, and

will be updated as the orders are finalized. This is used as important input to the fabrication assemblies.

7. Conclusions

This paper has identified how transition from engineering to construction can be improved, based on experiences from offshore projects in the oil and gas industry through Kvaerner, executed as EPC contracts (design-build), with engineering and procurement on a subcontract. The results are structured according to three interrelated dimensions; process, people and technology. The first dimension, process, is related to parallelism and build sequence. Construction is pushed in parallel with engineering, because of the short time frame from contract is signed to delivery date. To get deliveries at the right time, Kvaerner has made a build sequence, according to their project execution model (PEM), that engineering and procurement must know and deliver according to. At the last milestone in the design phase, M2C, the design should be at a quality level that is required to start construction. PEM supports “right the first time” by defining requirements on the milestones in the design phase. The M2C milestone is checked against the corresponding milestone to the engineering subcontractor. The gap is identified and any additional requirements are added to the milestone to the engineering subcontractor, so that they can satisfy Kvaerner’s build sequence and deliver “right the first time”. The focus for the next dimension, people, is related to common incentives and drivers, and how Kvaerner can make sure that the engineering subcontractor adapt to the build sequence and align their milestones. Through a joint venture, where they share profits on the bottom line in a percentage distribution, the incentives are higher for both parties to satisfy, compared to a standard subcontract, because they are mutually dependent on each other. It is crucial that Kvaerner can influence the disciplines to adapt the design and deliveries to Kvaerner's build sequence. Success is related to the use of experienced and competent personnel on both sides in the project team that are commercially conscious to what mechanisms apply in the contract, and act according to that. The last dimension, technology, is related to the use of BIM and how it must be split into sub-areas, fabrication assemblies that contain all relevant information and is optimized for Kvaerner’s build sequence. Criticality related to lead-time on equipment and availability of correct vendor information at the right time will be important input to fabrication assemblies. The IDDS approach (Owen et al., 2010) is applied to increase the relevance of the findings towards the construction industry. It consists of four main elements and identify challenges in the industry on BIM and process, people and technology. Several of these challenges have been addressed with the findings in this paper, which increases the relevance towards the construction industry. Future research will focus on gathering additional data related to process, people and technology and analyze that to further develop concepts, for adaption towards the construction industry.

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