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► **To cite this version:**

Kristina Kjersem, Marte Giskeødegård. Planning Procurement Activities in ETO Projects. IFIP International Conference on Advances in Production Management Systems (APMS), Aug 2020, Novi Sad, Serbia. pp.565-572, 10.1007/978-3-030-57997-5\_65 . hal-03635649

**HAL Id: hal-03635649**

**<https://inria.hal.science/hal-03635649v1>**

Submitted on 20 Jun 2023

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# Planning procurement activities in ETO projects

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**Abstract.** The complexity of ETO projects reflects also in the challenges of planning and controlling them. Most ETO companies apply planning procedures based on elements from the traditional project management literature with a linear approach that cannot deal with the challenges of such an environment. Moreover, most of these procedures focus on planning the production activities with little focus on planning the design-, engineering-, and procurement activities. This research looks into how ETO characteristics affect the planning of procurement activities since their outcome have a significant effect on the total cost of the project. The studied literature reveals a need for more knowledge on how to actually plan procurement activities since delayed materials and components contribute to major costs overruns and delays in ETO projects.

**Keywords:** ETO projects, Procurement, Planning

## 1 Introduction

Most Engineer-To-Order (ETO) products are highly customized, unique, and are delivered through a project based approach where the customer is involved in all phases from design to testing and delivery [1]. Usually, this production strategy involves a large number of specialized suppliers that contribute with products, materials, and services at different stages of the project. For example, 60-80% of the value added in shipbuilding projects is procured from external suppliers that must be coordinated by the entity responsible for delivering the final product. Hence, shipbuilding companies had to develop a core competence in integrating such a large number of project participants, an approach that requires considerable coordination and collaboration [2]. Nevertheless, dealing with all these suppliers becomes a challenge especially when several teams perform the procurement activities at different project phases. For example, a specialized procurement team (SPT) together with the design team negotiate delivery terms for the key-components, then the procurement team (at the main yard) negotiate the rest of the components and equipment, while the hull yard negotiate the equipment and materials within their scope of work. There are also other big work packages that are outsourced to specialized suppliers, e.g., electro, accommodation, piping. These suppliers are often in charge of negotiating the procurement of the materials and equipment

within their scope of work and within the frame of the project. This is a phase-based project management approach where different entities deliver specific parts of the project through well-defined contractual agreements [3].

In a recent research performed together with a Norwegian shipbuilding company, the research team discovered that delayed procurement activities increased significantly the total cost of the project. Since one of the main activities in that research is to analyze the project planning as performed by the case company, we decided to look at how the procurement activities are in fact planned and controlled. One of the preliminary findings shows that even though some procurement activities are included in the project plan, none of the purchasers managed to report the real status of their activities. In fact, the number of issues to be solved together with the customer, design-, engineering-, and production teams while dealing with each specific supplier, overwhelmed the procurement team. They were on a constant firefighting and they had to prioritize placing purchasing orders (POs) based on what items were most delayed. Even though they were working overtime daily, they were never á jour with placing POs within the recommended time frame. The result of delayed POs was higher costs for a significant number of purchased items since suppliers had to deliver them as express orders. Following the plan created at the beginning of the project was an appealing topic, but the negotiating process as well as delayed information from customer, engineering team and suppliers, took too much of their daily work. A closer look at the identified challenges, reveal that many of them were related to the ETO characteristics, e.g., customer involvement, unclear specification, as well as outsourcing and customization. Hence, the main research question for this article is: How do ETO characteristics challenge the planning of procurement activities?

## **2 Theoretical background**

ETO is a production strategy where design-, engineering- and production activities commence only after a customer order is confirmed [4]. This is also applicable to the procurement phase since it cannot be started without information from the customer, the engineering- and the production teams. The ETO environment is characterized by the following elements: products that are customer specific, produced in low volumes and highly customized. To achieve such deliveries, ETO companies apply non-repetitive processes that are labor intensive and demand highly skilled labor [5]. Moreover, several phases and parts of an ETO project are outsourced to specialized suppliers [6, 7] increasing the number of organizations participating in each project [8]. These ETO characteristics have a strong influence on the total planning process [9], that includes the planning of procurement activities.

Hicks, et.al.,[10] found that most ETO companies use a reactive approach to procurement where functions are departmentalized and predominantly clerical in nature. That is endorsed by [11] who discuss the negative influence and the waste created by the contracting practices that tend to limit procurement performances through focus on contractual specification. Most research regarding procurement in ETO projects refers to the strategies needed to identify the right tactics in choosing and managing their large

network of suppliers [12]. Among others, [13, 14], discuss suppliers integration in customer-driven environments, proposing different approaches to categorize and treat the relationships between the participating entities. These studies contribute to a better understanding on the necessity to integrate both customers and suppliers in the decision process. Yet, based on the studied literature, there is a knowledge gap on how to actually plan procurement activities in ETO project given the particularities of this strategy.

Since most ETO products are delivered through a project-based approach [15], the management methods applied by these ETO companies are inspired from the traditional project management literature. Such an approach emphasizes the focus on e.g. contractual agreements, risk management issues, setting the scheduled dates, and communication with the suppliers. These elements are included in a procurement management plan [16] without in fact focusing on planning these activities. That is because planning procurement activities is not seen as part of planning of both engineering and production activities. Yet, since engineering, procurement, and production phases are often performed concurrently, most ETO companies are dependent on an effective collaboration and a dynamic planning process [9] as well project participants that are committed to the planning process [17]. To the best of our knowledge, there is no well-defined planning process for procurement activities in ETO projects.

Moreover, the traditional approach to planning ETO projects, do not take into consideration the iterative nature of most engineering activities, the concurrency among project phases [8], or the uncertainty within ETO product specifications. A consequence of such working models is that procurement activities are at times chaotic and fall behind the schedule resulting in delayed project deliveries and cost overruns.

### **3 Research method**

This research adopts an explorative approach to the topic of the role of planning purchasing activities in ETO projects. The data analyzed in this article stem from a thematically broader research project, on integrated planning in the shipbuilding sector. Within this project, we have conducted 28 semi-structured interviews with the entire project organization at the yard, internal, and external. In addition, the researchers have observed seven project planning meetings. The purpose of this data gathering process was to get a better understanding of key issues in the project management process, and more specifically, the role of planning in this respect. Other sources of data include document analysis of project plans, reports and so forth, and three master thesis written within the project. The collected data was then structured in NVIVO by topics (e.g. planning, digitization), phases and levels of planning for each department.

Planning purchasing activities emerged as a central topic in the analysis and seemed to be an issue permeating in all levels of the project. As the challenges of planning purchasing activities became central, the project team initiated a comparative project at another yard targeting specifically planning of purchasing activities in ETO projects. The yard chosen as the second empirical case is relevant due to its role as a key player

in the industry. The study was designed by outlining a topic for a master thesis, supervised by the project leader. In this master thesis, five interviews were conducted, specifically targeting planning of purchasing activities from several different perspectives.

At this yards, two project planners, two purchasers and one production manager were interviewed. Thus, the methodological strategy in this article is explorative, following up on emerging topics identified through systematic analysis of the preliminary findings. One of the most relevant challenge in both companies is that they do not have a follow-up system that can in fact visualize the effects of delayed procurement activities. While the current article recognizes this as a key issue, we identify a need for a more extensive study on planning purchasing activities in ETO projects. Because our research project is still going, the results presented here are preliminary.

#### **4 Case company – challenging issues**

The main case company uses an ETO approach to deliver highly customized vessels to several markets like offshore, cruise, fishing and shipping. They use advanced planning software to create a project plan after the contract is signed and this plan includes a certain number of procurement activities. Nevertheless, these activities are usually the ones falling behind the schedule as soon as the project has started and many of the reasons are connected to the ETO characteristics as discussed later.

Like other similar companies, the main case company divides the procurement responsibilities between several entities: SPT and basic design (BD), procurement department (PD) located at the main yard, procurement team at the hull yard and procurement performed by other participating organizations (e.g., piping, electro, etc.). Based on information from customer and BD, the SPT negotiates conditions for most of the key-components in the beginning of the project. The negotiation process contains several phases: a) choose the suppliers that are relevant for each specific item; b) customer approves the selected suppliers; c) start negotiation based on preliminary product specifications; d) agree on delivery dates for the preliminary documentation that is needed by the design and engineering departments; e) agree on delivery dates for the physical product; f) agree the destination to be delivered (e.g., hull yard or main yard). Each of these phases might contain several iterations until agreements with each supplier and the customer can be reached.

The PD takes over the procurement process after the customer has signed the contract for the new vessel. They further negotiate equipment and materials while considering customer requirements and engineering recommendations. Since the case company applies some levels of concurrency between engineering, procurement and production phases, this issue adds several iterations during the procurement process. Some of the iterations are included in the project plan, still, most of them appear as a result of customer involvement in defining the product features after the project has started.

After rating the best alternatives, the PD negotiates with one or more suppliers the delivery terms and the necessary documentation. If customers and/or suppliers propose changes to the materials or equipment, a new discussions with the customer, engineers, production and class are necessary. When all parts agree on all the terms of the delivery

and the customer approves the drawings/models, the production can start. Sometimes, due to pressure on project delivery, production activities have already been started based on the preliminary drawings and incomplete information.

Typically, the contract with the customer is based on the specifications document (Spec) that defines all the features and components on the final product. The level of detail in the Spec varies from project to project and quite often it contains items that are described in uncertain terms. According to some purchasers, that is because *“a more detailed description would give suppliers a lot more negotiating power and eventually, higher prices for the respective items. We have written such a general Spec that no one knows what we actually want”* (I1). Therefore, each key component and equipment gets more details while the iterative negotiating process with suppliers and customers is ongoing. Since each project deals with a large number of specialized suppliers, negotiating with each of them is often a demanding task that results in a lack of prioritization and POs that are placed so late that suppliers have to deliver more or less on express rates. Hence, the estimated price that was based on normal lead time is then changed to higher rates. An example in one of the interviews was an item that costs about 250 thousand euros at the beginning of the project, but due to a delayed PO, the price increased to 350 thousand euros. Or as a purchaser put it *“it costs so much more, that you get dizzy when you look at the total price we pay for an express deliveries”* (I2).

Another challenging issue for planning procurement activities is that each project purchaser has to deal with over 400 suppliers that can deliver several hundred items to each project. In average, one purchaser at the main case company works with about 25-30 suppliers per day the whole project duration. Planning all these activities becomes a challenging task. Yet, the interviewed purchasers stated that they were interested in a better planning process for their activities because *“If we would have had time to plan these activities, the total cost of the procurement, and implicitly the project, would have been reduces a lot”* (I1). The same purchasers referred to challenges originating in the volatile market that leads to ups and downs on the order level, which in turn challenges shipbuilding companies to adapt to less known environments.

In a similar line of thoughts, one project planner at the second company argues for better planning and control on the procurement activities by stating: *“The main challenge is that the phases are concurrent. We start with the plan for the hull and in the same time, we are planning the engineering and procurement phases. Then we try matching these plans, but it never matches. There are always collisions in dates and time, so our main challenge is to find ways to do planning in a better way”* (I2).

Based on the arguments presented above, the planning practice for procurement activities is in need for improvements that can support a better control over deliveries of the required documents, materials and components in ETO projects.

## 5 Discussion

The aim of this article is to identify and analyze how ETO characteristics influence the planning of procurement activities. As indicated in Section 2, the existing literature on

ETO reveals following characteristics: highly customized products, extensive outsourcing, project-based procurement approach, iterations, concurrency, and project-based type of management. These characteristics have a strong influence on the total planning process [9] including the procurement activities that usually are planned only partially. Table 1, summarizes the ETO characteristics described in Chapter 2, and how they challenge the planning of the procurement activities.

**Table 1.** ETO characteristics and their influence on planning procurement activities

<b>ETO characteristics</b>	<b>Procurement challenges</b>
Customization	Customers select and approve the components, equipment and materials to be mounted on the vessel. Approving process can affect the procurement plan by delaying negotiations with suppliers.
Outsourcing to specialized supplier	Large network of suppliers to be handled and included in the project plan. Each supplier demands a signed contract before they start delivering documents and information. Delays with one supplier can affect negotiations with other suppliers. The contracting practices between shipyards and suppliers are often limiting a proper integration through the planning process due to information sensitivity or other specific issues.
Project-based approach	Materials, components and equipment are specifically purchased for each project and cannot be ordered before the contract is signed. Key-items, especially the customized ones, may need long lead times and placing POs late leads to unplanned extra costs.
Iterations	Engineering department is dependent on the information from the procurement and vice versa. Meanwhile, the procurement team must collect information (from one or more suppliers) discuss it with engineering- and production teams while negotiating further. Not all iterations can be planned and that leads to extra working hours on solving unplanned issues.
Concurrency	Engineering, procurement and production teams are dependent on a dynamic information flow among them. Delays from one team affect the progress and the results for the others.
Incomplete specifications	Customers delay the decision process as long as possible and that reduces negotiating possibilities for the procurement team. Identifying proper solutions is dependent on iterative and demanding negotiation process with customers, suppliers and class societies. The result is an increased number of negotiations periods and iterations. As a way to guard themselves against high process, the shipyards reveal pieces of information about the needed product while the negotiating process has started. Such approach extends the procurement process since everyone has to clarify the specifications within own company before continuing the negotiating process.
Phase-based project management	Procurement is divided between several entities: SPT, design, engineering, production, hull yard, and suppliers. Each entity creates own project plans that are difficult to match with each other. This approach leads to lack of control on the status of procurement activities at the project level.

The type and nature of the challenges presented in Table 1, show a complex picture about the difficulties in planning procurement activities in ETO projects. Such challenges cannot be solved only by using existing planning software that are quite rigid and unable to integrate a large number of project participants. There is a need for a better planning process for the procurement activities in order to facilitate coordination and collaboration among all entities involved in each project. However, the existing planning approaches applied to ETO projects are based on a sequential type of thinking that do not consider the challenges originating in ETO characteristics. That is because the traditional project planning methods applied by most ETO companies are based on a linear strategy that implies dependent, sequential phases executed according to a plan established at the beginning of the project [18]. A proper planning process implies all activities of collecting and delivering right information at the right time to the right people so that procurement activities can be performed as planned.

Based on the presented data, shipbuilding companies, a representative ETO environment in Norway, are in need for a better system that can in fact visualize the effects of delayed procurement. Most of the interviewed people are aware of such cost overruns, however, no one could provide a clear number about the degree to which these are due to POs that are placed later than planned. Continuous firefighting demands attention to solving each issue within the current frames at the moment these issues must be solved. Often, it implies express rates for a large amount of the POs, and according to most purchasers, these rates could be avoided through better planning and control of the procurement activities. A future research step would be to collect data from other types of ETO companies to see if their planning of the procurement activities is as challenging as in the observed shipbuilding companies. While these are typical ETO shipbuilding projects, broader studies on cost overruns due to lack of planning are necessary to be able to claim such challenges critical for ETO projects in general.

As also observed by e.g., [13, 14], customer involvement in the procurement process requires different approaches to categorization and integration strategies applied to the large network of suppliers. This line of thinking should also be applied to the planning of procurement activities in ETO since customer involvement in the process of approving the supplies, the drawings and the product affect the results of the planning process in its entirety. Yet, most literature on ETO project planning addresses planning of production activities with little focus on design- and engineering activities [19], and even less focus on procurement activities. In other words, planning procurement activities in ETO project must be improved as part of the whole project planning process.

Acknowledgements: We want to thank master students Kristian Granberg and Vetle Terland for the data collected at the second shipbuilding company.

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