Detecting Early Warning Signs of Delays in Shipbuilding Projects

Sara Haji-kazemi(✉), Emrah Arica, Marco Semini, Erlend Alfnes, and Bjørn Andersen

NTNU, Trondheim, Norway
{sara.hajikazemi,emrah.arica,marco.semini,
erlend.alfnes,bjorn.andersen}@ntnu.no

Abstract. Ship design and construction involves numerous activities that have to be effectively performed, coordinated and integrated. Various elements can influence the effectiveness of the process due to projects' large number of stakeholders and the high level of uncertainty. One of the most challenging issues is the delay in product delivery. However, the elements which might result to delay do not develop overnight and there might be early warning signals addressing that the delay, is likely to happen. This paper discusses that by following an early warning procedure, it will be possible to identify possible early warning signs of potential problems which might cause delay. These signs can provide an aid for the project team to take actions before the problem reaches its full impact, thus delaying the project delivery.

Keywords: Early warning signs · Ship building projects · Delays · Proactive project management

1 Introduction

Despite the application of project management tools and techniques in projects worldwide, still a large number of projects fail to meet their objectives. There is a consensus among authors that the growing technology, global economy and the nature of information technology is bringing more complexity to projects and their environments. The increase of complexity is partly the cause of projects going wrong and difficulty in bringing them to successful completions (Williams 2002). Shipbuilding is an interesting industry in which highly complex products with tight delivery times are produced mainly in project organization forms (Koivunen 2007). It is a complex process that involves numerous related activities, such as design, tendering, contracting, engineering, procurement, production, commissioning, delivery, and guarantee service (Andritsos and Perez-Prat 2000). In the recent years, the ship design and construction community has become increasingly aware of the significance of the operational and managerial side of such activities if they are to be effectively performed, coordinated and integrated (Semini et al. 2014). The large number of stakeholders involved within the process and the complexity of the product creates a potential for delay in shipbuilding projects.

S. Umeda et al. (Eds.): APMS 2015, Part II, IFIP AICT 460, pp. 215–222, 2015.
DOI: 10.1007/978-3-319-22759-7_25

Based on studies on the history of failed or troubled projects, it is obvious that projects do not result in problems overnight. Usually, they proceed from "green," to "yellow," to "red," and during this process early warning signs can indicate if a project is on its way to failing or if urgent changes are needed (Kerzner 2011). With hindsight, project managers are often able to point out the most likely factors leading to project failure. One approach towards prevention of project failure or deviation from the main goal is to detect possible signs of project problems in early stages of projects. These signs are referred to in the literature as Early Warning (EW) signs.

Clearly, the higher the risk of upcoming events, the more crucial it is to be able to predict and take actions in order to decrease the threat of failure. There is a need for more careful planning, close monitoring, and strict control of large, high-risk projects (Couillard 1995). Identification of EW signs and relating them to the appropriate project problems and their causes can contribute positively to the prevention of undesired consequences (Nikander and Eloranta 2001).

This paper addresses the possible delay factors within shipbuilding projects in general and the possible EW signs of the elements which might cause delay within these types of projects. It also suggests that applying an EW procedure within shipbuilding projects can contribute to prevention or lessening the impact of the delay factors on the project delivery time.

2 Shipbuilding Projects

The main ship design and construction activities are often categorized into two categories including acquisition/information processes and production processes (Andritsos and Perez-Prat 2000; Gale 2003). Acquisition/information processes are the non-physical activities performed prior to production, such as planning, design and acquisition. They generate an enormous amount of information which needs to flow seamlessly across units, departments and companies. Production processes carry out the physical transformation of materials, components, and equipment. In Semini et al. (2014), we illustrate how the different activities in the ship design and construction process may be organized in different ways depending on the degree of customer involvement. Figure 1 shows the typical approach the Norwegian shipbuilding industry uses to build highly customized ships, where most activities are carried out based on a specific customer's requirements and expectations.

Usually, the different activities are not performed by a single company, but a network of geographically dispersed parties with different roles and interactions. Even a single activity, such as engineering, can be split among several parties. The degree to which each party is involved in the various activities differs from project to project, and so does the level of integration and coordination between them. This is a characteristic of ship design and construction.

The parties with the most significant roles in carrying out the ship design and construction activities include the ship designer, shipyard, ship owner, main equipment suppliers and the classification society. Each of these parties has tasks and responsibilities in one or several of the activities presented in the previous section. The level of

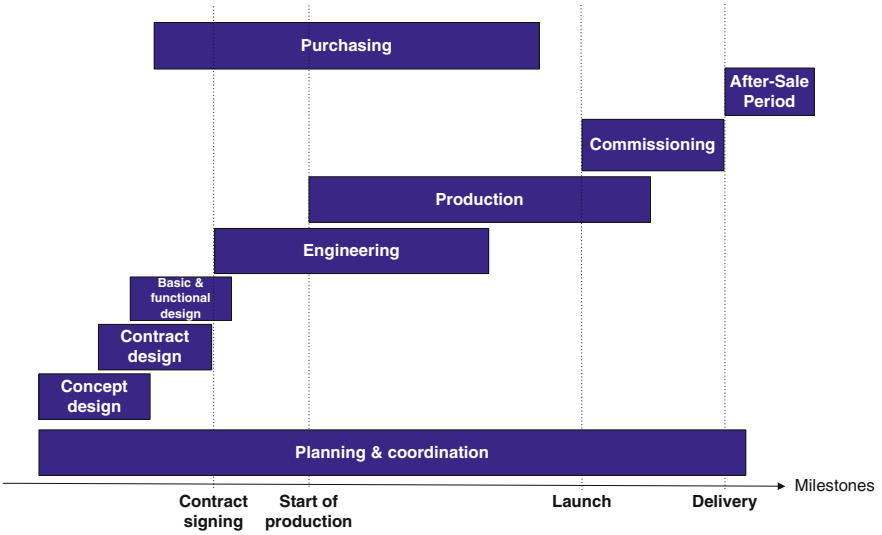

Fig. 1. The main activities in the design and construction of a customized ship (Semini et al. 2014)

integration between them varies from project to project. Sometimes, several parties belong to the same company or group, but they are often independent.

The next section deals with the uncertainties involved with different stages in the project which might result to delays and extra costs in shipyard projects.

3 Delay Factors in Shipbuilding Projects

The occurrence of delays is a major problem that impacts the performance of a company and its supply chain in Engineering to Order (ETO) projects in general (Mello 2015). Long delays and reworks are common in the large engineering projects since these types of projects require several refinements during the implementation stage that increase lead times and costs (Caron and Fiore 1995). The delay might occur in different stages within the project life cycle due to various reasons. The causes of project delay also varies considerably in different projects due to the existence of diversifies types of uncertainties (Elfving 2003; Gosling et al. 2012). Uncertainty is an important factor which has been recognized as one of the major factors leading to delays in complex projects (Mello 2015).

Although all the project stages are interrelated and delay in one stay will eventually result in delay in the subsequent stages as well, however according to Mello (2015), one of the most important milestones within a shipbuilding project is when the vessel is scheduled to enter into operation. At this point, the ship owner puts pressure on both the ship designer and the shipyard to deliver the vessel as soon as possible in order to avoid penalties from the oil and gas company. Since companies are most likely not able to effectively coordinate the project, problems arise causing rework and delays which increase the lead time. Mello (2015) in his work mentions a number of factors which

contribute to delay within the project. These factors are seen as uncertainty elements which if identified and managed timely enough and acted upon accordingly might result in avoiding the delay. The uncertainty elements also referred here as delay factors and the specific stage where it belongs to are mentioned in Table 1.

Table 1. Uncertainty elements within the project lifecycle (Based on Mello (2015))

Uncertainty elements	Relevant stage
Product changes after the production process starts	Manufacturing and assembly
Delay in delivering the detailed engineering drawings	Engineering
Occurrence of unpredictable events	Whole life cycle
High number of quality problems	Engineering, manufacturing
Self-over-evaluation of partners on their skills	Concept design, engineering
Delay to deliver equipment	Procurement
Poor quality of design alternatives	Concept design
Poor risk management	Project planning and detailed design
Inadequacy of supplier competence	Procurement

4 The Concept of Early Warning (EW) in Projects

The general idea of EW is a broad concept. It applies to almost any area where it is important to obtain indications as early as possible of some development that in the future will become clearer, usually of a negative nature. The concept of EW in a management context was first discussed by Ansoff in 1975 and was later supported by Nikander (2002) in his doctoral dissertation. Ansoff stated that strategic surprises do not appear out of the blue, it is possible to predict their occurrence by the aid of signs which are called weak signals. A weak signal was defined by him as "…imprecise early indications about impending impactful events…all that is known is that some threats and opportunities will undoubtedly arise, but their shape and nature and source are not yet known" (Ansoff 1984).

In Nikander's words (2002), "an EW is an observation, a signal, a message or some other item that is or can be seen as an expression, an indication, a proof, or a sign of the existence of some future or incipient positive or negative issue. It is a signal, omen, or indication of future developments". In his study he devises a preliminary model illustrating the character of EW observations (See Fig. 2).

This model sees project events as a time-bound consecutive stream of events. At a given moment, information about this stream can be obtained (e.g. EWs of potential future project problems). This information is processed and responses are required in

order to influence the flow of the project. A crucial factor in choosing a response appears to be, according to Ansoff (1984), time available for responses before the potential problem significantly impacts the project.

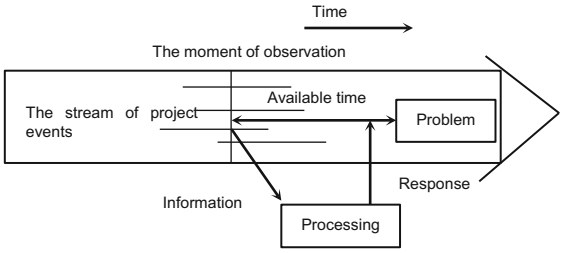

Fig. 2. Preliminary model illustrating the character of the phenomenon of EW (Nikander 2002)

The authors believe that in case EW signals are identified in the front-end stage of a project, the available time will be rather long enough for project managers to take the right actions in the subsequent stages of project. Identification of EW signs related to technical issues, can aid the responsible persons to make better decisions on risk management and production of key variables in the execution phase. Of course the challenge lies in the possibility of detecting the EW signs and their level of reliability.

5 Identifying EW Signs of Delay

According to Nikander (2002), two stages of assessing the future are included in EW utilization. First the severity, likelihood of materialization and time available of the potential problems should be analyzed, based on the view point of the evaluator, and second the decision maker should examine the impact of the planned responses on the project, and the reactions, and responses of the various project parties and/or outsiders in the situation at hand.

Although it is not a proven fact that identification of EW signals is a guarantee against project failure, there are a number of resources which consider paying attention to these signals and attempting to respond to them as a contribution to project success (Haji-kazemi 2015). Figure 3 presents the main steps which should be followed in order to identify and act upon EW signs in projects. The authors believe that although different projects face different types of problems which can have different EW signs, the procedure for identifying and acting upon them is common.

It should also be noted that there are different approaches for identifying EW signs in projects. Examples are performance measurement, risk analysis, stakeholder analysis, Earned Value Management (EVM), etc. (Haji-kazemi 2015). According to Emblemsvåg (2014), EVM is one of the practical approaches within shipbuilding projects which acts as an aid for reducing delays. However, it is said to have some shortcomings when it comes to the engineering phase of the project.

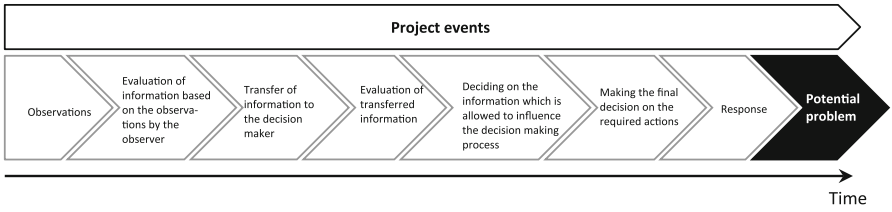

Fig. 3. The EW procedure (Haji-kazemi 2015)

As mentioned earlier, project problems do not appear overnight and therefor it is usually possible to point out a number of the most likely factors contributing to project problems and also identify a number of signs addressing the ensuing problem. The procedure can be carried out in each and every stage of the project life cycle. In other words, it is a dynamic process which should be applied to consciously monitor the possible EW signs addressing a future problem. Hereby we will focus on one of the elements mentioned in Table 1 as an example of a delay factor and analyze the possibilities for sensing the EW signs of its occurrence before it impacts the project. The example is based on the results of a case study done by Mello (2015) on a real ongoing shipbuilding projects located in Norway.

The demand for critical changes in the manufacturing phase can most probably be predicted in the design and engineering phase of the project. The product technical specifications in the design/engineering phase are usually involved with high level of uncertainty and changes are often required at later stages to cope with unforeseen challenges. They may also be required in order to adapt to changes in market requirements, regulations, and technology that occur during the project period.

It is crucial at this stage that the engineering and design departments in all the three main actors involved in the project (e.g. suppliers, shipyard and ship designer) have clear interfaces in order to be able to transparently communicate and transfer the information regarding a warning sign that a future development is about to happen in the manufacturing phase. For example quality problems regarding detailed engineering drawings and sketches or the number of unapproved engineering drawings can be EW signs that critical changes which lead to delay are likely to happen. The unclear interface among the engineering departments can be EW signs of later problems which if not identified and acted upon can lead to extensive delays. Development of indicators which aid project managers to foresee potential problems causing delays in later stages of the project life cycle is crucial in order to attempt for lessening the impact of these problems. One approach is to design key performance indicators which can act as a source of data for detecting possible EW signs of potential future problems (Fig. 4).

It is important to mention that concurrent engineering is becoming ever more common within the shipbuilding industry, where different project stages run simultaneously, rather than consecutively thus creating overlaps in different stages. This will create challenges regarding the time available for acting upon identified EW signs of potential problems causing delays within the project, and the concurrency also means more things are happing at the same time making assessing the situation more complex. The authors believe that although the time available will be more limited comparing to

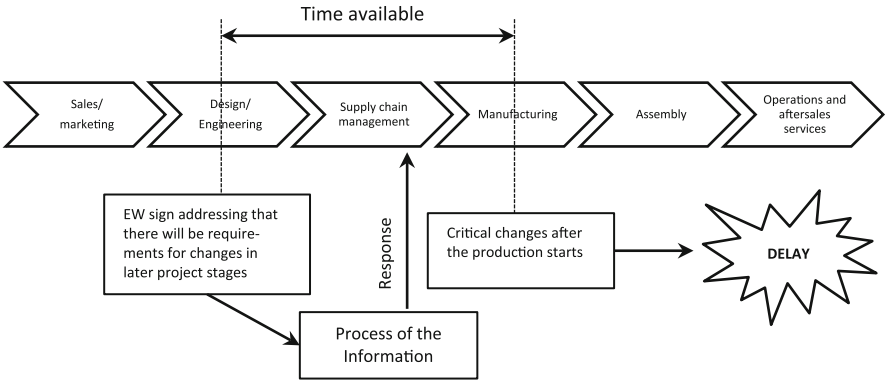

Fig. 4. Identification of EW signs within shipbuilding projects

non-concurrent approaches, it is still possible to identify EW signs of potential future problems. How-ever this requires efficient application of EW identification tools and urgent responses to the signals.

6 Conclusions

On-time delivery is one of the most important requirements in shipbuilding projects (Koivunen 2007). However there are various factors which cause delays (delay factors) in these types of projects. An attempt for overcoming these problems is to detect possible signs of delays in earlier stages of the project. These signs are referred to in the literature as EW signs. This study endeavors to indicate that in order to identify and act on these signs, it is crucial that an EW procedure is applied within the project. In addition, it tends to address that by following this procedure it will possible for project managers to foresee potential delay factors within shipbuilding projects. As a result, the delay can be prevented by acting upon these signs before the problem reaches its full impact thus leading to delay in project delivery time.

Acknowledgements. This research was made possible by the SUSPRO project (Decision support for sustainable production of offshore ships in global fluctuating markets. The authors would like to thank the participants of the project for providing the valuable inputs.

References

Andritsos, F., Perez-Prat, J.: The automation and integration of production processes in shipbuilding. European Commission, Joint Research Center, Institute for Systems, Informatics and Safety (2000)

Ansoff, H.I.: Implanting Strategic Management. Prentice/Hall International Inc., New York (1984). USA Couillard

Caron, F., Fiore, A.: Engineer to order companies: how to integrate manufacturing and innovative processes. Int. J. Proj. Manage. **13**(5), 313–319 (1995)

Couillard, J.: The role of project risk in determining project management approach. Proj. Manage. J. **25**(4), 3–15 (1995)
Elfving, J.A.: Exploring opportunities to reduce the lead time for engineered-to-order products. PhD dissertation, University of California, Berkeley, CA (2003)
Emblemsvåg, J.: Lean project planning in shipbuilding. J. Ship Prod. Des. **30**(2), 79–88 (2014)
Gale, P.A.: The ship design process. In: Lamb, T. (ed.) Ship Design and Construction. Society of Naval Architects and Marine Engineers (SNAME), Jersey City (2003)
Gosling, J., Naim, M.M., Towill, D.R.: A supply chain flexibility framework for engineer-to-order systems. Prod. Plan. Control Manage. Oper. **24**(7), 552–566 (2012)
Haji-kazemi, S.: The Early Warning Procedure in Projects; Foundations, Approaches and Challenges. PhD dissertation, Norwegian University of Science and Technology, Trondheim, Norway (2015)
Kerzner, H.: Project management metrics, KPIs, and dashboards: a guide to measuring and monitoring project performance. Wiley, Canada (2011)
Koivunen, N.: The art of shipbuilding, 19th Nordic Academy of Management Conference: "The Future of Nordic Business Schools", Bergen, Norway, 9–11 August 2007
Mello, M.H.: Coordinating an Engineer-to-Order Supply Chain - A Study of Shipbuilding Projects. PhD dissertation, Norwegian University of Science and Technology, Trondheim, Norway (2015)
Nikander, I.O., Eloranta, E.: Project management by early warnings. Int. J. Project Manage. **19**, 385–399 (2001)
Nikander, I.O.: Early warnings: a phenomenon in project management. Doctoral dissertation. Helsinki University of Technology, Espoo, Finland (2002)
Semini, M., Gotteberg Haartveit, D.E., Alfnes, E., Arica, E., Brett, P.O., Strandhagen, J.O.: Strategies for customized shipbuilding with different customer order decoupling points. Proc. Inst. Mech. Eng. Part M J. Eng. Marit. Environ. (2014). doi:10.1177/1475090213493770
Williams, T.M.: Modelling Complex Projects. Wiley, Chichester (2002)