

# Knowledge integration in developing distant problem solving processes: The case of Diesel engine failure in cargo vessels

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## Introduction

Unexpected events are often related to catastrophic outcomes, and in many cases, organizations and humans are not able to take decisions to efficiently cope with them (Tamuz and Lewis 2008). In the maritime industry, unexpected events are rather common and very costly for the owner or the shipping management company operating the vessel. Coordination among the different organizations involved, i.e. the crew members, the shipping management company and the technical service provider, is crucial in containing the negative consequences of these events. Knowledge integration from different sources becomes pivotal in developing innovative processes to cope with unexpected events. In relation to unexpected events, an example of innovative process is distant problem solving where the involved parties, through the use of technology, are able from a distance to diagnose, assist or solve the problem even though it might occur halfway around the world. To develop distant problem solving processes the involved parties need to integrate knowledge and not simply combine complementary knowledge. This challenge faced by organizations may hinder them from developing and implementing the innovative processes.

Decision making while coping with an unexpected event is especially difficult when the involved parties do not share and integrate their knowledge. Ignoring warning signs or acquiring unreliable data, hinders foresight. In this context, human bounds of rationality (Simon 1955) and awareness (Chugh and Bazerman, 2007) during an unexpected event further aggravate decision processes. Temporary disruptions in organizational processes are part of unexpected events creating more limited interruptions than catastrophic events. Such events are temporarily unpredictable, while their extent is also impossible to foresee. Two main challenges described in the literature relate to collecting and interpreting the warning signals as well as making decisions to cope with the event (Tamuz & Lewis 2008). These involve the technologies, which enable data collection and monitoring of the environment, and humans reporting and analysing the data as well as interpreting the signals.

In this paper we empirically investigate the ways in which actual practices help or hinder knowledge integration necessary for developing distance problem solving processes in the maritime industry. We focus on how coordination, information acquisition, interpretation and use takes place among the members of the different parties when an unexpected event, in the form of temporary disruptions, happens. Our empirical context involves condition based-maintenance activities and accidents in vessels with Diesel engines and the study revolves around the relationship between the engine's service provider, and the crew onboard, the vessel ship management company and the owner of the vessel as well.

### **Empirical Context**

We investigate how a Diesel engine manufacturer, responsible for service and maintenance of Diesel engines installed in vessels, is trying to develop and implement innovative process of distant problem solving to cope with unexpected events in the form of engine failures.

Service engineers from the Diesel engine manufacturer must solve the problem promptly in collaboration with the customer's marine engineers onboard the vessel. The service engineers either communicate with marine engineers by phone, or travel and board a vessel in order to participate directly in the problem solving. The work of the service engineers is based on small amount of contextual information because of the lack of day-to-day contact with the specific engine, and thus, each problem solving situation requires fast updating about the context for the engine in question (Augier et al., 2001). The service engineers report that phone based communication with marine engineer does not allow fast updating about the context for engines, and thus, in many cases they need to travel to the vessel in order to repair the engine e.g., in the middle of the Pacific Ocean. This is a very expensive activity both for the owner of the vessel, the manufacturer as well as the customer. In many cases, service engineers have to integrate knowledge from the involved parties in order to fix the problem and get the engine running and the ship sailing. As such they have a number practices aiming at fixing the problem as fast as possible and at the lowest possible cost.

Timing is highly important for vessels due to scheduling of space in a port. Changes to the schedule, involves high costs as the rent prices increase dramatically in the short run. In an attempt to reduce these costs the Diesel engine manufacturer, which offers technical support service and maintenance services, will introduce a new technological solution, which will allow visual data in the form of video streaming to be transmitted from the vessel to the service engineers. This is expected to provide the service engineers with richer information about the situation onboard the vessel, and improve the collaboration between them and the marine engineers onboard due to increase in media richness (Daft & Lengel, 1986).

Diesel engines are a continuous improving product, which develop due to the experience accumulated by R&D engineers of the Diesel engine manufacturer. A Diesel engine failure in a specific vessel is treated as a unique event. The engine is part of a vessel, which has

numerous systems that work in concert for the vessel to function. Thus, each engine co-exists in a unique environment, the vessel, with a number of other systems. This implies differences in the conditions of the engine, e.g., replacement time for spare parts, maintenance requirements, filtering and consumption of oil by the engine etc. A technical failure, causing a temporary disruption and potentially huge costs to the customer, is an unexpected event in terms of the temporal dimension and the extent of the interruption.

Engine failures are slowly incubating events, and thus, observing warning signs is likely to have a profound impact on the decisions and actions taken while coping with such events. The communication technology will be used to provide richer and previously lacking information on the different parts of the Diesel engine, as part of maintenance tasks as well as provide contextualized information during an unexpected event, typically an engine failure. The service engineers should be better able to decide, seek, and observe warning signs as well as better support problem solving while coping with the engine failure and guide the marine engineer onboard a vessel from distance by combining the new and existing sources of information.

At the same time, the people in the vessel, i.e. the marine engineers and the captain, are not permanent employees, nor are they owners of the vessel. Their contracts with the vessel vary from 2 to 12 months. The vessel is an organization with temporal membership. This makes the people in the vessel less concerned with the incurred costs due to an engine failure and the maintenance services. These institutional arrangement of temporary employee contracts hinders the knowledge integration from occurring since these employees are not interested in learning the engine or being involved in new innovative processes.

In sum, we investigate how organizational practices enable or hinder knowledge integration for distant problem solving when coping with unexpected engine failure. There are some

special conditions surrounding these events, which have developed because of organizational path dependencies and provide an interesting empirical context to investigate. First there is variation in the level of engine maintenance on board different vessels, and every engine has evolved in a unique manner due to the level of maintenance. Second, there are variations in technological configuration of every engine., Finally, there is temporal organizational membership (Daciulyte & Aranauskaite, 2012) of marine engineers in the vessel (i.e., doing the onboard shift for a specific period of time on one vessel and then change to another vessel). The underlying path dependencies may hinder to successful implementation of innovative process such as distance problem solving which could benefit all the involved parties.

### **Theoretical background**

The theoretical background of this study is mainly rooted in Sydow et al.'s three-stage model capturing path dependencies in an organizational context (2009). We use theoretical concepts of this model to analyse our interview data with an aim to identify operational rigidities which may hinder development and implementation of distant problem solving processes, the reinforcing mechanisms related to these operational rigidities and the triggering event likely to have set the process in motion.

Moreover, we approach knowledge integration among the different organizations by using insights from Sydow and Windeler (2005) underline the tensions and contradictions that characterizes the relationship of knowledge, trust and control among organizations. These concepts are crucial in coping with unexpected events.

Another human factor concerns incentives and accountability. The more severe is the punishment for a human error, the lower is the incentive to report it especially in hierarchical relationships (Tamuz & Lewis 2008).

Numerous studies of decision making underline the role of individual and organizational learning from related past events triggering recognition primed decisions (for example Klein, 1998) and acting based on expertise when in teams (Rosen et al 2008).

Our study contributes to understanding of how organizational practices influence the development and implementation of innovative processes by enabling or hindering knowledge integration. The innovative processes involve coping with unexpected events when the involved parties do not share location and context.

### **Methodology**

Our research aims at investigating how service engineers cope with unexpected events in the form of engine failures. Given this purpose, we adopted an interpretive approach, which allows us to give voice to the informants' experiences and practices. We conducted qualitative interviews, which involve the headquarters of B&W Diesel, which provides the technical services and superintendents of ship management companies.

More interviews with crew members and in-situ observations when failures occur will be conducted during the first quarter of 2015.

The choice of B&W Diesel is based on the fact that it constitutes a typical intensity case, which illustrates what is typical when coping with unexpected events. In addition, engines from B&W Diesel are installed roughly 50% of the vessel population of the world. Hence, one can say that in some ways B&W Diesel is "in charge for half of the world trade". This makes the case very rich in information because the technical service department gets calls from all over the world.

The richest source of empirical data for investigating our research question stems from semi-structured interviews with service engineers. Over a six-month period, we carried out 25 interviews with superintendents (technical service engineers), managers and directors at

B&W Diesel's premises in Copenhagen. We also have interviewed 5 superintendents from shipping management companies who are in direct communication with the crew members in the vessels. An interview guide was developed prior to the interviews containing open-ended questions about the technical assistance provided during the occurrence of unexpected events. Each interview lasted on average 50 minutes. The interviews were transcribed verbatim amounting to approximately 310 pages. In addition to the interviews, we collected company documents as well as emails and service technical reports (approximately 50 pages) about specific instances, which were brought up during the interviews.

In order to investigate our research questions, we are employing constant comparative techniques (Strauss, & Corbin, 2008; Suddaby, 2006) to analyze the data in a systematic and iterative manner. We are in the process of organizing these first-order codes into tables that supported a single theme across the various data sources inspired by the in-vivo coding technique (Strauss, & Corbin, 2008). In the next step, we aim at developing the second-order themes. At this stage we have performed a first iteration where we have attempted at identifying the second order themes.

We intend to collect more data, this time in form of in-situ observations when engine failures occur as well as more interviews with crew members.

### **Preliminary findings**

The diesel engine failures are slowly incubating events that occur unexpectedly and the operation disruption has expensive consequences for the company involved. Some of these events can be prevented if appropriate maintenance of the engines happen. We investigate how the diesel engine manufacturer supports a customer during an unexpected event. By observing the actual practices of the different parties involved, we analyse how these practices enable or hinder knowledge integration for the development and implementation of distant problem solving, an innovative process that the engine manufacturer want to put in

place. Despite the obvious value of appropriate engine maintenance the study reveals that path dependencies do not allow for the use of the official guidelines and manuals. The lack of a formal procedure combined with the complexity and particularities of each engine in a specific vessel raise the probability of a failure. The problem may aggravate into serious operation disruption since the information leading to the failure is not collected or monitored. Thus, finding the actual cause of the problem and addressing all the related consequences could be a labourious task that takes time. This in turn raises costs for the customer.

The current culture of cost savings which is very prominent in the maritime industry appears to provide some short terms savings to the vessel management companies, but raises the probabilities of long term costs, since the choices made to delay or underperform maintenance tasks have magnifying effects to the engine as well as show spillover effects to other subsystems. In practical terms, saving a few hundreds Euros by not changing the oil filters as often as necessary may lead to a collapse in the engine that will cost thousands of Euros in the long run. The temporal status of the crew and the marine engineer on board may reinforce a mentality of time discounting (Daciulyte and Aranauskaite, 2012) since they do not feel responsibility for the vessel's long-term conditions and wish to push forward laborious tasks. This latter characteristic of the crew relates to how short time affects the behavior of humans with temporal organizational membership, who tend to focus more on the task at hand rather than the long-term issues.

Another related challenge is the lack of skills and experience, which are yet required when handling such a complicated system and high costs are at stake. It almost seems like if the fleet managing companies undervalue the actual risks involved in their decisions. In this context it would be very difficult if not impossible to discuss about using practices of observing cues indicating potential problems in the engines and reporting them. The crew experience difficulties in understanding the basic information provided in the manuals, and



thus, cannot follow a scheme-based approach when it comes to coordinating interdependent tasks. In this study we found that the current hiring strategy of vessel management companies focuses on the short term costs, and does not take into consideration the required skills of the crew.

In the present case additional challenges occur during an unexpected event, and depending on the underlining complexity of the event, the service engineers are the only ones that can identify a solution to the problem. Service engineers are also allocated almost randomly to vessels with an engine failure. When collaborating with the vessel's superintendent and the marine engineer on board the vessel to solve the specific problem, they form a temporary organization with a very specific mission and strong time constraints. The informants describe a combination of improvisation methods employed and which in some case are supported and enabled by the use of communication technologies. For example, sending pictures to headquarters, enables less experienced service engineers to tap into the knowledge of senior colleagues who may improvise and suggest solutions, which speed up problem solving. Besides, communication technologies support knowledge integration by enabling the creation of a broader group of people, who coordinate their efforts from dispersed geographical locations (e.g., manufacturer's headquarters, service hub, vessel's management company premises and on board the vessel) to swiftly solve the problem of the engine in the unknown environment of the vessel with a number of uncertainties. In this context, the job of service engineers from engine manufacturer becomes challenging, as they lack the necessary contextual information to quickly identify the cause of the problem and solve it. The service engineers are constantly trying to adjust in the customer needs, and they develop small and practical solutions to facilitate the maintenance activities. Additionally, their accumulated experience and expertise with the engines supports them in solving the problems despite the lack of information.

## **Current status of the study**

We are currently in the process of interviewing more superintendents from shipping management companies, and observing the work processes of service engineers conducting maintenance tasks onboard the vessels as well as interviewing crew members from vessels. We will complete our data collection in April 2015, and thereafter, we will continue our analysis of the empirical data. Hence, we can present our more complete findings in the final paper for EGOS 2015, which will be available to the other participants in the colloquium.

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