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Transferring Tacit Knowledge During Maritime Pilot Training: Assessment of Methods in Use

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ABSTRACT

Accurate knowledge management is vital for an organization to perform well. Managing explicit knowledge is relatively easy but managing tacit (implicit) knowledge is not. Effective transfer of tacit knowledge from experts to novices in an organization is therefore essential. Maritime pilotage is a safety-critical operation in which pilots use their expertise to guide vessels in specific waters. The purpose of this study is to improve the Pilot Training Programme (PTP) run by the Swedish Maritime Administration (SMA). The aim of this study is to evaluate and describe the prevailing methods of transferring tacit knowledge during the PTP. This study includes 20 maritime pilots and covers a complete PTP. A qualitative mixed-methods approach was used, based on activity theory and including observations, interviews, questionnaires, and document analyses. The results showed that tacit knowledge transfer during the PTP occurs during situated learning, such as apprenticeships, hands-on learning and communities of work. However, the transfer methods are not sufficiently documented from a didactic perspective.

Keywords: Tacit knowledge, Maritime education and training, Maritime pilot

INTRODUCTION

Accurate knowledge management is vital if an organization is to improve its performance (Nonaka and Takeuchi, 1995), stay competitive (Teece, 1998) and assure productivity (Haldin-Herrgard, 2000). Knowledge management includes the creation, retention and transfer of knowledge (Argote, 2021). However, transferring knowledge in an organization is a complex task. Even if members of the organization are willing to share knowledge, they may be unable to do so (Polanyi, 1966). A substantial amount of knowledge in an organization is hidden and dispersed among its members (Lee, 2000). Members move in and out of the organization due to such things as termination of employment, new recruitment, organizational change or retirement. Thus, there is a genuine risk of knowledge disappearing when people depart (Smith, 2001); the result being a depleted organization. Explicit knowledge may be located, managed and shared with relatively ease (Moreland and Myaskovsky, 2000). This is because it can be coded, documented, stored and transferred (Polanyi, 1958). Literature, instructions, standard operating procedures and manuals are all ways of transferring

explicit knowledge (Hyttinen and Rintala, 2005). Implicit knowledge, or tacit knowledge (Kirsner et al. 1998), is not immediately available for conscious retrieval. Tacit knowledge evolves over long periods and is not easily accessible for articulation in speech or writing (Polanyi, 1966). It may be found on both the individual and organizational levels (Nonaka and Takeuchi, 1995). Tacit knowledge may be expressed as skills (Nelson and Winter, 1982), as know-how (Kogut and Zander, 1992) or as procedural knowledge (Stanley and Williamson, 2001). Studies of tacit knowledge have been conducted in organizational settings (Jasimuddin et al. 2005), healthcare (Ambrosini and Bowman, 2001) and security operations centers (Cho et al. 2020). Tacit knowledge has been conceptualized differently depending on the domain (Kothari et al. 2012). However, tacit knowledge transfer largely requires personal interaction and proximity to other individuals, as seen in mentoring, apprenticeships, job rotations or communities of practice (Lave and Wenger, 1991). The tacit knowledge of experienced operators is especially crucial to the safe and efficient operation of safety-critical organizations. Maritime pilotage is a safety-critical operation and a crucial part of the maritime industry in assuring safe, economic and sustainable naval operations (SMA, 2022). Based on extensive local as well as tacit knowledge, maritime pilots (hereinafter referred to as "pilots") provide navigational guidance to mariners on specific waterways, such as harbors, river mouths, canals and on the open sea. Pilots interact with the crew of the piloted vessel, providing advisory information as to navigation and specific properties of the water (depth, obstacles, tides, infrastructure and so on). They also assist during tugging, birthing and mooring operations (SMA, 2022). The SMA assures maritime pilotage in Swedish territorial waters and employs about 200 pilots, who conduct some 33,000 missions annually. The SMA is responsible for the pilot training in Sweden, in which experienced mariners from the shipping industry can enroll, following application, evaluation and selection.

PURPOSE AND AIM

The purpose of this study was to identify ways to improve the PTP to mitigate increasing requirements for safe, economical and environmentally sustainable shipping in Swedish territorial waters. The study aimed to: (1) locate, catch, crystallize, document and describe prevailing methods of tacit knowledge transfer during different elements in the PTP; and (2) provide suggestions on improving the transfer of tacit knowledge.

METHOD

Theoretical Framework

Activity theory (Leontiev 1978, 1981; Vygotsky and Cole, 1978) is a conceptual framework in which activity is the prime unit of analysis. Activity theory is distinguished by collective learning (Kaptelinin, 2005). The human mind evolves by interaction with the environment in which human activities take place; social settings modulated by cultural and social influences

(Kaptelinin and Uden, 2013). Activity systems analysis seeks to systematically extract data (Yamagata-Lynch, 2010) and analyse development within social activities (Sannino et al. 2009), most often in socio-technical systems (Engeström, 1987). Activity systems analysis has been used for research into learning (Scanlon and Issroff, 2005), design (Hjort af Ornäs, 2010) and information systems (Kaptelinin and Nardi, 2006). An activity system is divided into six components of analysis (Engeström 1987, 2000). In such a system the *object* is the activity, the *subject* is the individual(s) being studied, the *tool* is the mediating device providing the means for the activity to be conducted, the *rules* comprise formal/informal rules affecting how the activities take place, the *community* is the social group with which the subject interacts during the activities and the *division of labour* governs the distribution and organization of work in the community. The outcome of the activity system is the result of transforming the object into the outcome (Engeström, 1999). According to Kaptelinin and Nardi, (2006), activities may be further analysed at various levels of abstraction, with activity, action and operation thereby showing different hierarchal levels of activity. Activities are driven by the motivation of the subject; actions are driven by a set of goals and operations are driven by a set of conditions. Furthermore, activities may be conducted based on multiple motives (Kaptelinin and Nardi, 2006). Activity theory has been deployed in organizational studies. However, some researchers claim that it is poorly understood and, indeed, too specialized for that field (Thompson, 2004). Nardi (1996) described activity theory as a powerful tool rather than a theory for making predictions. However, Blackler and Reagan (2009) stated that activity theory is relevant to organizational studies since it gravitates toward studying the dynamic relationships and subsequent friction between individuals, collectivities, objects and language.

The Pilot Training Programme

The PTP lasts about a year and comprises three parts: (1) an introductory course (INTRO) lasting 1-3 months and covering employment conditions, safety, regulations, the SMA organization and general pilotage procedures; (2) a Swedish basic training for maritime pilots course (BASIC) lasting six weeks and comprising maneuvering, navigation, marine resource management (MRM), governmental officer duties, boarding operations, hoisting and hypothermia. The training is held in classrooms, in a simulator environment and in the actual maritime environment. The INTRO and BASIC parts may overlap; and (3) a local training plan (LTP) for 6-12 months depending on location, in which maritime pilot students (hereinafter referred to as "students") acquire knowledge by participating in 50 actual pilotage missions, supervised by a certified pilot. During the PTP, the development of knowledge is strongly characterised by learning in social settings, as with an apprenticeship. The PTP concludes with an examination after which a pilot certificate and pilot license (level 1) are issued. The pilot license regulates the category of vessels for which the pilot is approved. Ultimately, the goal is to gain enough experience to obtain the highest-level pilot license (levels 4-5), permitting unrestricted pilotage. Every third year, re-training is conducted in different

focus areas. Simulator training and MRM are used to provide this. The SMA also conducts such continuous training as open-sea pilotage (red card), transitions to other SMA vessels (such as ice-breakers) and evaluations of new routes and procedures.

Study Design

Activity theory was used to evaluate the PPT as an activity system. This entailed a qualitative, mixed-methods study approach comprising observations, interviews, questionnaires and document analysis (for triangulation).

Data Collection

Data collection was conducted intermittently during two different PTP courses in 2020 and 2021. A total of 21 participants were included in the study, consisting of eight students, seven less experienced but licensed pilots, five licensed, experienced master pilots (also serving as instructors) and one administrator who also served as an SMA coordinator for the present study. The mean age was 46, with a standard deviation of eight years. All participants were males, operating out of seven different pilot stations in Sweden. All stations differed in terms of waters, infrastructure and piloted tonnage. A total of 119 hours of observation were conducted and documented over 13 training days. These observations were made during classroom and simulator training at the central SMA training facility in Gothenburg, at pilot stations and during actual missions entering or exiting a major international harbor. No observations were made at the scale ship-handling training facility. Interviews were held individually with all participants, ranging in length from 45 to 60 minutes. A six-point Likert scale questionnaire was also distributed to the participants. This contained background questions, plus questions on knowledge transfer during the PTP.

Data Analysis

The observations took the form of passive participant observations (DeWalt et al. 2010). Field notes (Bogdan and Biklen, 2003) were collected using an observation protocol. Semi-structured interviews (Edwards and Holland, 2013) based on a specified interview guide, were adapted from the eight-step model (Mwanza, 2002b). Interviews were recorded, transcribed and assessed using a thematic (reflective) inductive analysis (Clarke, 2006) and then coded and organized into themes. An even scale was selected so as to exclude a neutral center option (Allen and Seaman, 2007).

Document analyses (Bowen, 2009) were used to provide background and context, identify additional questions, provide supplementary data, track evolution and verify findings (triangulation). The document analyses included assessments of training curriculums, course literature, operating procedure descriptions, intranet databases, printed and electronic documents, illustrations and films. A thematic (reflective) inductive analysis (Clarke, 2006) was used to code and organize the data into themes. Relevant documents were also discussed with the PTP administrative personnel and with PTP instructors. Emerging data was thematized and compared to

Mwanza's (2002b) eight step-model for interpreting an activity system. The eight step-model conceptualized data from the study into components of the activity system model proposed by Engeström (1987, 2001).

RESULTS

The PTP was analysed as an activity system (Figure 1), aided by observations, interviews, questionnaires and document analyses. The PTP was analysed on the activity level where the *outcome* was the examination/certification of new pilots to adhere to set SMA requirements. The *motives* had two dimensions: the SMA motive to provide suitable training and the students' motive to progress towards a new profession. The *object* of the PTP is to reproduce pilot-specific skills, using theoretical, non-situated learning in classroom settings combined with situated learning in apprenticeship settings.

The *subjects* have different roles during the PTP. Students are exposed to knowledge in various ways at various times and at various locations such as pilot stations, pilot vessels, piloted vessels, scale ship-handling facilities, simulators, classrooms and self-studies on or off-site (Table 1). Informal interactions, such as during meals and coffee breaks, during walks, or during free-time activities were important knowledge transfer nodes. These nodes were also important for transferring tacit knowledge, among other things by telling stories from the domain and thus verbalizing tacit knowledge at some level. Instructors provided teaching according to a set syllabus. However, this syllabus did not sufficiently describe (in terms of didactics) how the PTP was to be implemented. *Tools* were predominantly: (1) the ship-bridge simulator, (2) the actual pilot missions during the LTP and (3) creation of the navigation booklet. All three serve as important vehicles for transferring tacit knowledge. Students prepared, performed, evaluated and discussed ship-bridge simulator sessions in an open (non-punitive) environment, interacting with each other and with their instructors. This afforded a foundation for discussions and animations from completed sessions and created a collective learning environment.

Briefings and de-briefings connected to these sessions provided students with (tacit) knowledge emanating from their instructors. This took the form of heuristics, such as golden rules, guidelines, applied experience and know-how. Non-situated theoretical learning, such as ship handling, navigation and stability is provided during the PTP to some degree but is mostly expected to have already been acquired. Students are already experts in their profession as mariners and the PTP may be viewed as a new dimension of that profession. Comprehensive course literature could be a way to review old knowledge and introduce new knowledge in a more organized manner. During the LTP, the students entered a state of apprenticeship. Embedded in actual pilot missions, students progressed towards their new profession in a community of practice. Interacting with their supervisors, students developed trade-specific hands-on knowledge. The LTP exposed students to a substantial amount of tacit knowledge which, in turn, is crystalized in the navigational booklet. This booklet has dual functions: 1) it crystalizes knowledge for the student,

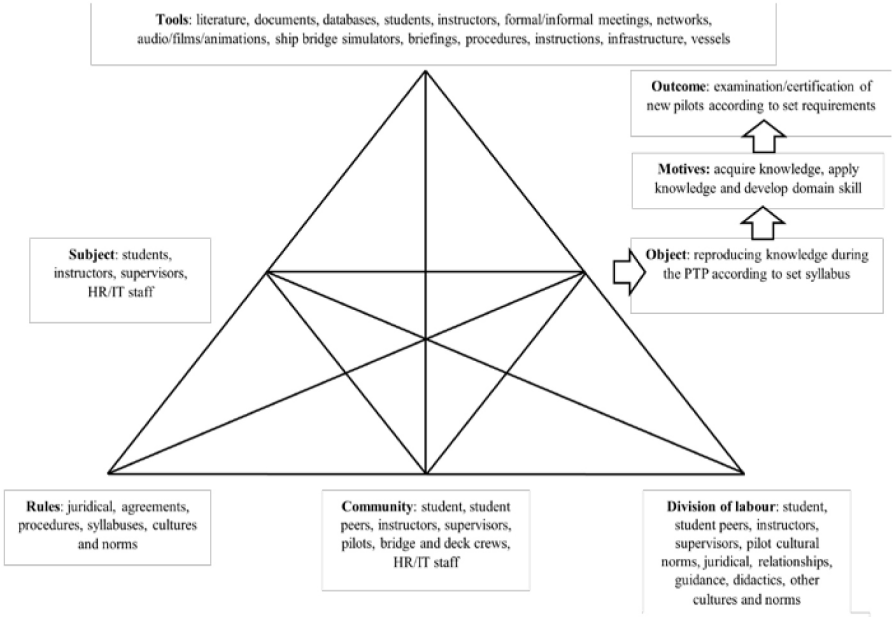

Figure 1: The pilot training program as an activity system. Adapted from Engestrom (2000).

Table 1. Compilation of tacit knowledge transfer locations in the PTP based on observations, interviews, questionnaires and document analyses.

	Course literature	Juridical	Databases	ICT	Film	Audio	Ship bridge simulator	LTP booklet	Formal meetings	Informal meetings	Written instructions	Verbal instructions	Briefings	Observations	Reflections in group	Peer students	Hands-on	Communities of practice
INTRO	•	••	•	•	-	-	-	-	•	•	••	••	-	••	•	•	•	•
BASIC	••	••	•	•	••	•	•••	••	•	••	••	•••	•••	•••	••	•••	•••	••
LTP	•	••	•	•	-	•	•	•••	••	•••	•	•••	•••	•••	•	-	•••	•••

- None • Minor •• Medium ••• Major.

acting as a didactic tool; and 2) it creates knowledge and acts as a personal knowledge basis for future pilot missions.

The use of tacit knowledge transfer tools during the PTP showed a low level of documentation in terms of didactics. *Rules* consisted of nautical regulations, procedures, syllabuses, group briefings/de-briefings solely in cultural settings. These rules play an important role in facilitating tacit knowledge transfer during the PTP. *Division of labour* in terms of students, student peers, instructors and the didactic prerequisites enabled the transfer of tacit

knowledge. However, consistent with the other elements of the activity system, this interaction was insufficiently documented.

DISCUSSION

We often know more than we can tell or explain to others. Some knowledge is so deeply embedded that we do not think about what we know and what we are doing – we just do it. This is tacit knowledge, expertise, or know-how and will have taken many years to achieve. The results of this study provide insight into how, where and when tacit knowledge is transferred during the PTP run by the Swedish Maritime Administration. Much of the knowledge transfer happens during situated learning environments and is not sufficiently documented, either in didactic terms or content. Much of the didactic management is therefore located at individual instructor level, resulting in personal knowledge transfer strategies. A standardised syllabus including specified didactics could help students prepare for their next training session and identify the level of knowledge required after it. Activity theory may be assessed at different hierarchical levels. The PTP was assessed at *activity* level as a motive-directed system. At the lower action level, goals direct actions and at the lowest operational level, conditions direct them. Actions carried out via operations may be seen as being executed without full attention to its execution. Such actions resemble the actions of procedural nature, skill and know-how; all of which are tacit-knowledge-based actions. This is consistent with observations during the PTP in which instructors provide know-how, heuristics, or guidelines in tactical terms. The capability to raise actions from an operational level to a conscious level is useful when assessing tacit knowledge transfer. Further assessing the PTP on an operational level can feed data into the suggested standardised syllabus. Developments causing drainage of knowledge in an organization, such as staff movements, may be unexpectedly beneficial for another (receiving) organization. Job rotation, in which experienced, non-instructor pilots act as mentors during designated parts of the PTP, could present a way to increase the transfer of tacit knowledge. An alumni function, with former students returning to the PTP as instructors/supervisors might be another way to feed applied experience into the PTP. The PTP has several elements, not all of which could be assessed using the methods in the study. Thus, the study had to rely on triangulation to mitigate this problem. Other shortcomings were that the number of observed pilot LTP missions had to be reduced due to Covid restrictions, the scale-model ship handling part could not be observed at all and the activities at the SMA training facility had to be observed over an extended and fragmented time.

CONCLUSION

The PTP is largely dependent on situated learning such as community of practice, apprenticeship, or hands-on training. Learning is therefore mainly located in the relationship between learning and the social situation in the specific environment of that learning. Didactic methods for transferring tacit

knowledge are furthermore located at individual instructor or supervisor level and are not sufficiently documented in didactic terms.

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