Training and Technology: Findings from the Questionnaire Study

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Abstract

This paper reports some of the early findings from a questionnaire administered to seafarers as part of a study of training associated with the introduction of new technology. These findings relate to: seafarers' perceptions of their own knowledge of a selection of equipment on the bridge and in the engine room, their preferred training methods in relation to new shipboard technology and the learning activities that have contributed to their knowledge of existing 'new' equipment.

Introduction

Technological innovation has underpinned social and industrial transformation, in general, and the shipping industry in particular. It makes it possible to operate bigger, faster, safer, and more specialised ships with fewer people on board. In the last few decades, a range of new equipment developed as a result of technological innovation has been introduced aboard ships. This includes ARPA, GMDSS, AIS, ECDIS, and automated engine and cargo control systems.

Inevitably, the introduction of new technology demands new skills of shipboard personnel. In relation to new technology the literature indicates that these are best developed as a consequence of education and training. Over the past two decades, a large body of research literature has repeatedly confirmed that training increases productivity in both the manufacturing and service sectors (e.g. Barrett and O'Connell, 2001; Bartel, 1994; Dearden et al., 2000; Trucotte and Rennison, 2004; Zwick, 2006). More specifically there are indications that training is important in relation to the introduction of Information and Communications Technology (ICT). Having analysed the 1999 Canadian Workplace and Employer Survey data, Trucotte and Rennison (2004) found strong evidence that use of ICT was positively associated with higher productivity. They further discovered that the productivity increase associated with ICT use was enhanced when more workers received ICT training.

In the shipping industry, training and technology is also a much discussed topic, though often the indications are that training in this area is lacking. A recent survey of British seafaring officers' perceptions of shipboard technology suggests that while, in general, officers embrace new technology, they are greatly concerned about the sufficiency of relevant training and an over-dependence on technology (Allen, 2009). Furthermore, several Maritime Accident Investigation Branch (MAIB) reports have suggested that inappropriate use of shipboard technology, due to poor training, has caused accidents. Lack of familiarity with the shipboard ECDIS equipment, for example, was a contributory factor in several accidents, including the groundings of *Pride of Canterbury* and *CFL Performer* (MAIB, 2008a; 2009). Similarly, the inappropriate use of ARPA radar was identified as a factor leading to the collision between *Costa Atlantica* and *Grand Neptune* (MAIB, 2008b). In another incident where the vessel *Prospero* made contact with a jetty, ship officers' inadequate knowledge of the vessel's podded propulsion system was found to be a contributory factor (MAIB, 2007). In the wake of the introduction of AIS, studies monitoring its usage found that seafarers appeared to be insufficiently familiar with AIS which led to transmission of erroneous information (Bailey, 2005; Bailey et al., 2008; Harati-Mokhtari et al., 2007; Norris, 2007). In the face of such information researchers, commentators, and policy makers have recommended the provision of adequate training on, and sufficient familiarisation with, new technology/equipment (Bailey, 2005; Gray, 2008; Grey, 2008; Hadnett; 2008; Harati-Mokhtari et al., 2007; IMO, 2003; Lloyd's List, 2007; Norris, 2007). It remains unclear, however, to what extent such calls have been met and, in part, this paper seeks to address this question.

The Study

This paper reports some of the early findings from a questionnaire administered to seafarers as part of a study on new technology being undertaken under the auspices of The Lloyd's Register Educational Trust research unit at SIRC[1].

New technology is likely to be applied on the bridge and in the engine room and deck officers and engineers are the major operators and users on board any vessel. It is also generally

[1] A full report will be available online later in 2011 (Sampson and Tang, forthcoming).

officers and engineers who require related training. Therefore, the target population for the questionnaire was deck officers and engineers.

Before designing the questionnaire, a pilot study, which involved thirteen interviews with seafarers and college lecturers, was carried out. Its aim was to identify issues to be explored in the questionnaire. We also did an extensive review of the literature on ICT adaptation and training in other contexts (such as schools and business firms). This gave us a better understanding of training and technology in general, which was of help in designing the questionnaire. At various stages of the design process, we consulted people with seafaring experience, and we also piloted an early version of the questionnaire. All these measures helped us to refine the questionnaire.

In the process of questionnaire distribution, we utilised 27 seafarer centres in 14 countries. One advantage of this approach, compared with distribution through training centres/colleges or shipping companies, is that seafarers visiting centres are less likely to be under direct influence of their employers and/or immediate training environments, and are more likely to be able to reflect on their learning experiences. A number of port chaplains kindly helped us to distribute questionnaires to seafaring officers visiting their ports. Our researchers also went to several big centres to administer questionnaire distribution and collection. Via these efforts we achieved a broad and varied distribution which produced a diverse sample of seafarers. However, this is not a random sample in the strict sense of the term which limits the extent to which we can generalise from the findings.

Sample Characteristics

Our sample consisted of 1,007 seafarers. These were roughly divided between engine officers (524) and navigation (deck) officers (478) [2]. In terms of hierarchy (see Figure 1), the sample included 405 senior officers (including captains, chief officers, chief and second engineers), and 597 junior officers (including second and third officers, third and fourth engineers, electricians, and cadets)[3].

[2] Five respondents did not specify their rank.
[3] Because cadets were in the transitional stage and they had very limited experience, they were not included in the analysis for this paper.

Overall, respondents represented 52 countries. To facilitate analysis, we divided them into six groups the largest of which were single nationality groups: Filipino; Indian; Chinese; European; ASEAN; and Others. Figure 2 shows the sample distribution in relation to these six groups.

Figure 1: Sample Distribution by Rank

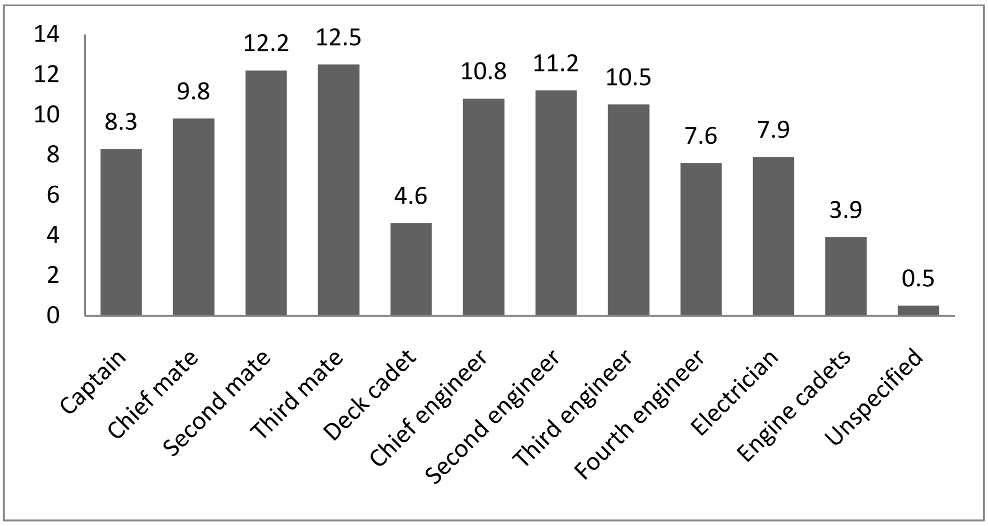
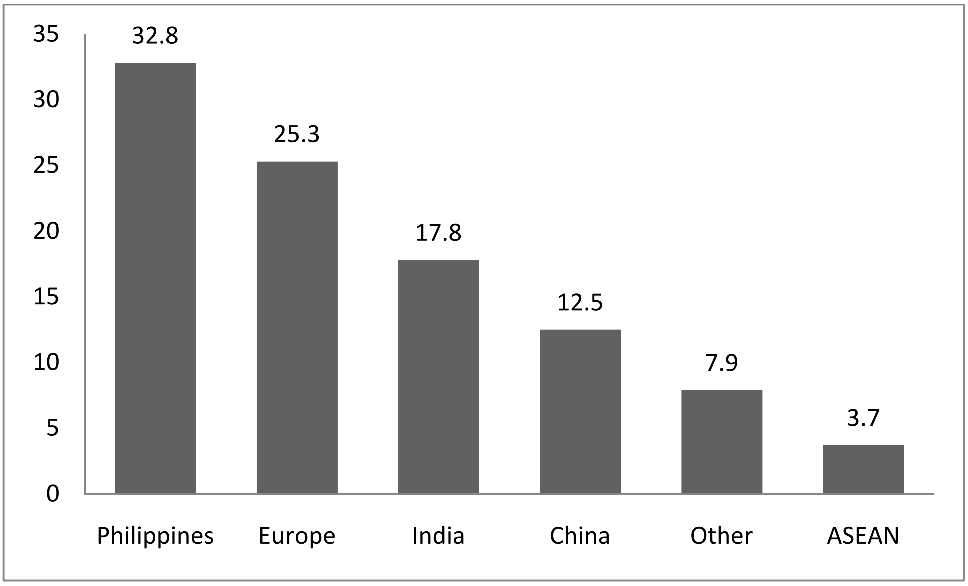


Figure 2: Sample Distribution by Nationality



Approximately fifty percent of respondents were working aboard container vessels and a quarter were working on bulk carriers. To facilitate analysis, we grouped ships into five main groups: container; bulk; tanker; general cargo; and others. The percentage of each group is shown in Figure 3. The age range of the sample was from 17 to 69. They were divided into four age groups, the details of which are shown in Table 1.

Figure 3: Sample Distribution by Ship Type

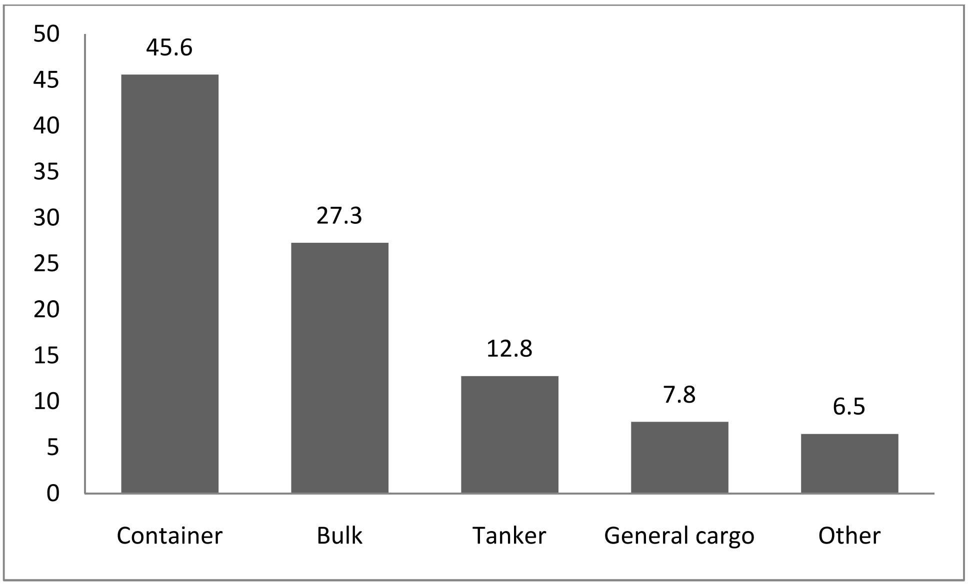


Table 1: Age Distribution

Age group	Frequency	Percent
Below 30	349	34.7
30s	301	29.9
40s	210	20.9
50 and above	138	13.7
Unspecified	9	0.9

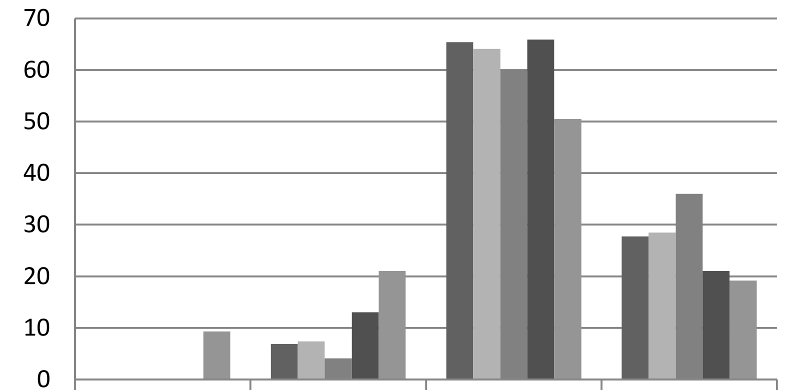
Knowledge of Specific Equipment

In the questionnaire, deck officers were asked to indicate how much they felt they knew about specific pieces of equipment on the bridge: AIS; GPS; RADAR/ARPA; GMDSS; and ECDIS. Overall, and as one might hope, they appeared to feel confident in operating such equipment, and the majority self-reported ‘good’ or ‘excellent’ knowledge. Further analysis indicated that respondents did not have equal confidence in relation to all the specified equipment, however. Their knowledge of ARPA/RADAR was reported to be the best, followed by that of AIS and GPS. Confidence with ECDIS was reported to be the lowest of the five items specified and more than 30 percent of deck officers reported either ‘zero’ or ‘basic’ knowledge of it[4] (for details, see Figure 4).

We further interrogated these findings to establish whether or not any significant variations between groups of seafarers were present.

When senior and junior officers were compared, no significant difference was found with regard to four pieces of equipment: AIS, GPS, RADAR/ARPA, and ECDIS. Regarding GMDSS, however, senior officers reported better knowledge than junior officers, as Figure 5 shows.

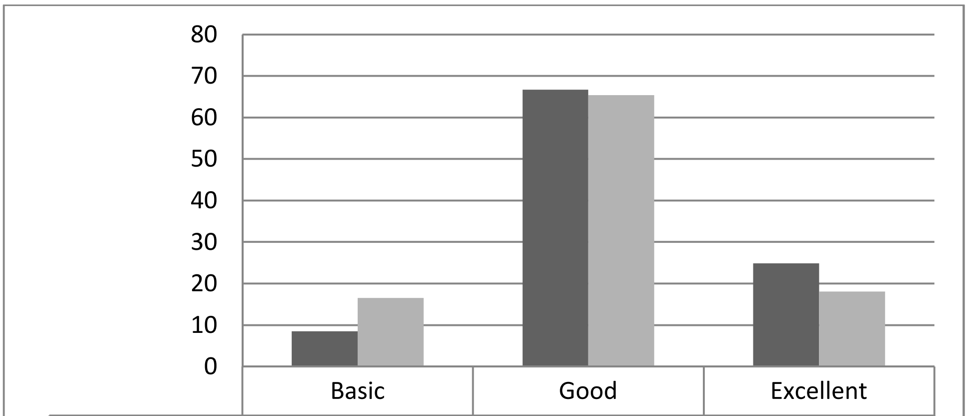
Figure 4: Knowledge Levels of Bridge Equipment



	Zero	Basic	Good	Excellent
AIS	0	6.9	65.4	27.7
GPS	0	7.4	64.1	28.5
ARPA/RADAR	0	4.1	60	36
GMDSS	0	13	65.9	21
ECDIS	9.3	21	50.5	19.2

[4] NB: ECDIS has not been universally installed on all vessels.

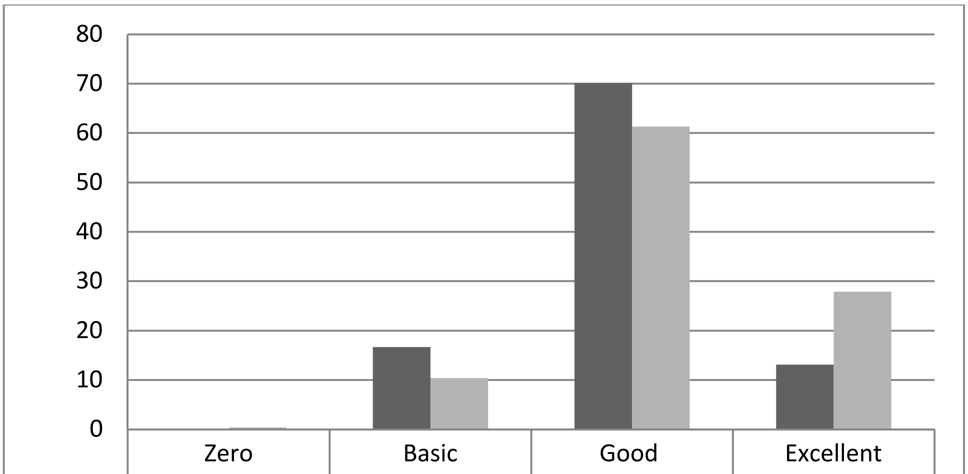
Figure 5: GMDSS Knowledge Level by Rank



	Basic	Good	Excellent
Senior officers	8.5	66.7	24.9
Junior officers	16.5	65.4	18.1

Engineer respondents were asked to state their knowledge of engine room machinery including the main engine manoeuvring and control system (ME) and the oily water separator (OW). While the majority of engineers expressed confidence in operating both pieces of equipment, they reported a better knowledge of oily water separators (see Figure 6).

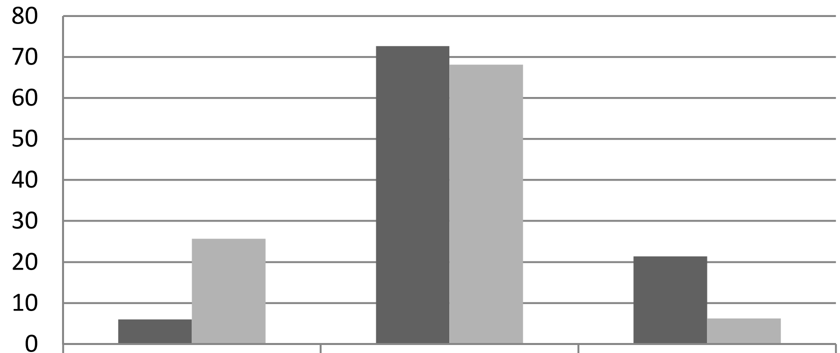
Figure 6: Knowledge Levels of Engine Room Machinery



	Zero	Basic	Good	Excellent
ME	0	16.7	70.1	13.1
OW	0.4	10.4	61.3	27.9

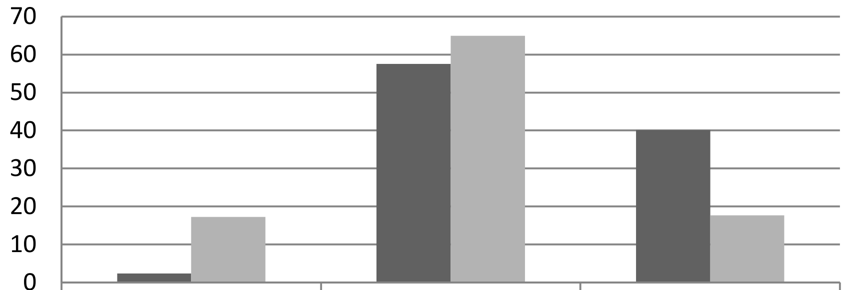
In the engine room, rank was found to have an impact. Senior engine officers reported a better knowledge of both pieces of equipment than junior ones (see Figure 7 and Figure 8). Because rank is strongly related to age and sea time, seniority in terms of the latter two were also likely to predict better knowledge.

Figure 7: ME Knowledge Level by Rank



	Basic	Good	Excellent
Senior	6	72.6	21.4
Junior	25.7	68.1	6.2

Figure 8: OWS Knowledge Level by Rank



	Basic	Good	Excellent
Senior	2.4	57.5	40.1
Junior	17.3	64.9	17.7

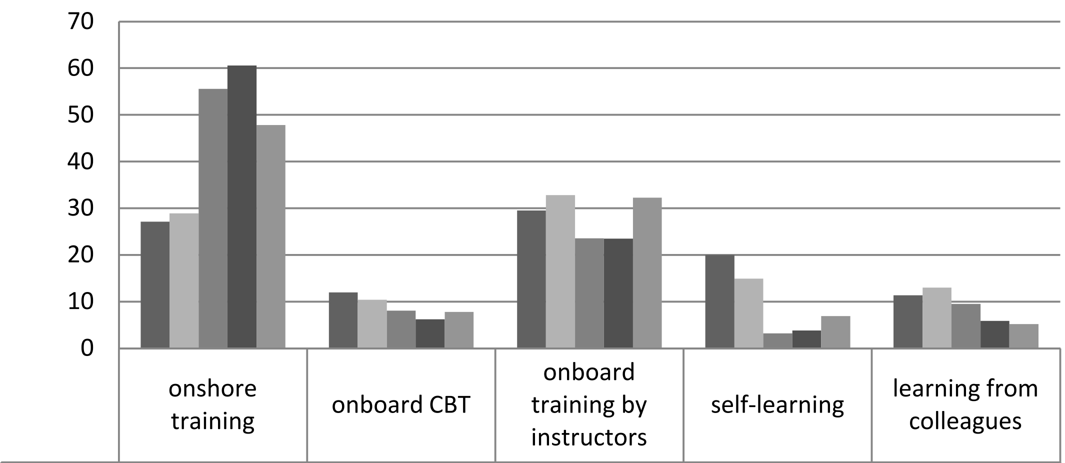
It is encouraging that the majority of respondents felt confident with shipboard equipment. However, it is simultaneously of concern that a number of them (and it is important to note that cadets have been excluded from these findings) reported ‘basic’ or even ‘zero’ knowledge of some equipment

The questions posed by our questionnaire required respondents to *self-rate* their knowledge. Whilst there are likely to be some people who underestimate their own knowledge, a substantial amount of research evidence has demonstrated that on the whole people tend to think of themselves in a rather positive light (Taylor, 1989). Taking this insight into account, it may be that self-rated answers overestimate the knowledge levels of seafarers with regard to new onboard equipment. In this context, the small percentage of respondents whose answers indicated a lack of confidence may be of some concern. This is particularly the case given the ‘safety-critical’ nature of the shipping industry.

Preferred training methods

In the course of the questionnaire, we asked seafarers which training methods they would recommend in relation to different pieces of equipment. With regard to bridge equipment, in general, deck officers tended to express a preference for onshore training and onboard training delivered by instructors, as shown in Figure 9. Thus, instructor led training methods[5] were favoured. Interview data with seafarers supported this finding (see Tang, 2009 for a fuller account of interviews conducted for this research). Other research indicates that instructors may be favoured by learners in some contexts because they posses not only in-depth knowledge of the subject, but also training and mentoring skills. The guidance from instructors can also save learners time and effort in finding relevant information and solving problems.

Figure 9: Preferred Training Methods of Deck Officers



	onshore training	onboard CBT	onboard training by instructors	self-learning	learning from colleagues
AIS	27.1	12	29.5	20	11.4
GPS	28.9	10.4	32.8	14.9	13
ARPA	55.6	8.1	23.6	3.2	9.5
GMDSS	60.6	6.2	23.5	3.8	5.9
ECDIS	47.8	7.8	32.3	6.9	5.2

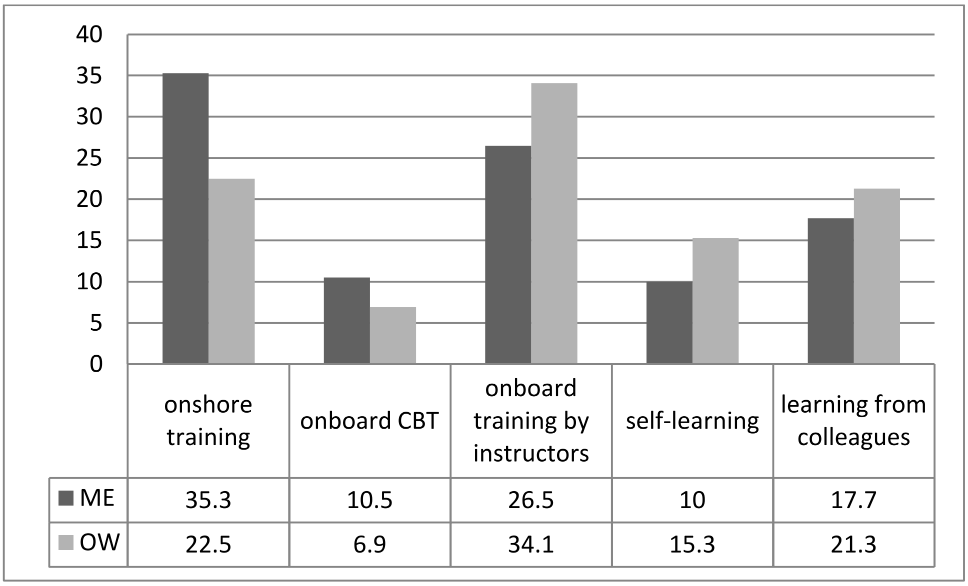
[5] NB: ‘Onshore training’ can generally be presumed to be understood by seafarers as formal training courses ashore. For the purpose of this paper it is therefore categorised as ‘instructor-led’.

Whilst there was a general preference for instructor-led training, the responses of deck officers were more nuanced than this implies in as much as they gave varying responses in relation to the five specified pieces of equipment. While the preferred training method for ARPA/RADAR, GMDSS, and ECDIS was onshore training, respondents indicated that onboard training was their favoured option for training in relation to AIS and GPS. The difference is likely to reflect the different technical characteristics of the equipment. ARPA/RADAR, GMDSS, and ECDIS are more complicated than AIS and GPS. Information acquisition and interpretation associated with GPS and AIS is relatively straightforward, compared with the skill required to read and make correct use of ARPA/RADAR and ECDIS displays. Research relating to ICT implementation suggests that formal training is more appropriate with regard to some pieces of equipment than others (Sharma and Yetton, 2007). Technologies characterised by high technical complexity are associated with high knowledge barriers and in this situation, formal training is more effective in helping learners overcome these (Robey et al., 2002). This could explain why deck officers felt that onshore training was the most beneficial for more complicated equipment, even though attending such training is often associated with the loss of leave time. In contrast with regard to less complicated technology such as AIS and GPS, seafarers might feel that onboard training, though brief, is sufficient, and can be put into immediate practice.

Respondents were also more likely to display a preference for other forms of learning, such as ‘self-learning’, ‘learning from colleagues’ and ‘onboard CBT’ for AIS and GPS than they were for the other three pieces of equipment. This further suggests that the operation of AIS and GPS may be regarded as less complicated than ECDIS, ARPA/RADAR, and GMDSS by seafarers and thus produces a lower demand for formal training.

Engineer respondents’ preferences for learning about engine room machinery repeated the pattern found amongst deck officers. Overall, they also favoured instructor-led training methods. With regard to the main engine, ‘onshore training’ was the most favoured method of training, while ‘onboard training delivered by an instructor’ was the preferred training format for oily water separators. Arguably, this indicates that the latter was regarded as less complex in terms of its operation than the former. Perhaps as a result, engineer respondents were also more likely to suggest a preference for ‘self-learning’ and ‘learning from colleagues’ in relation to oily water separators than in relation to the main engine.

Figure 10: Preferred Training Methods amongst Engine Officers



In general, engineers were more likely to suggest that they preferred ‘learning from colleagues’, and less likely to express a preference for ‘onshore training’, than deck officers. In the next section of the paper we explore which learning activities have contributed to seafarers’ knowledge *in practice*.

Learning activities contributing to knowledge

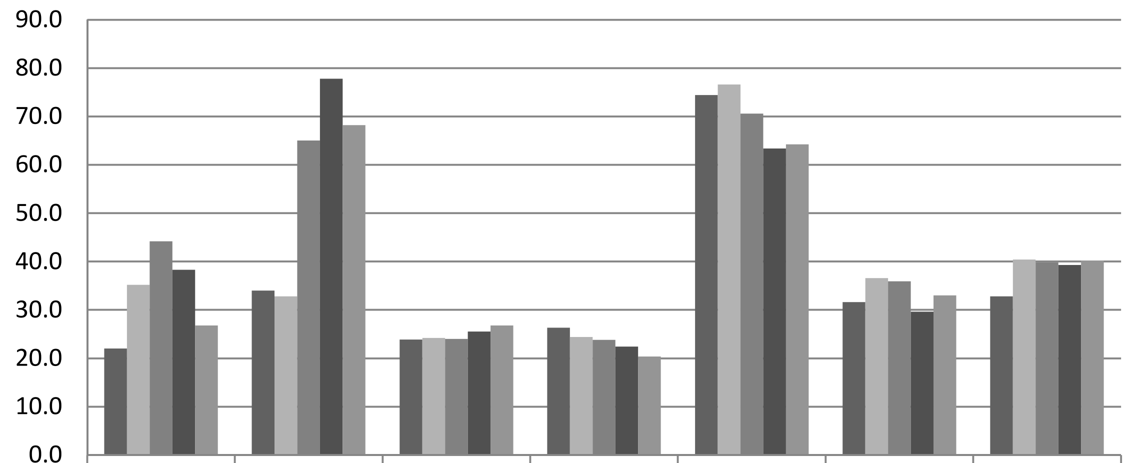
In the first stage of this study we considered the use of AIS and the errors associated with it. Over a period of several years observation we determined that seafarers’ competence in operating AIS had improved over time (Bailey et al. 2008). This finding raised a question about how seafarers had learned to use AIS equipment. In the questionnaire (phase two of the study), we asked a series of multiple response questions to find out which activities, from a given list, had contributed to respondents’ knowledge of on board equipment. The list of possible responses included ‘cadet training, onshore training, onboard computer based training, onboard training from technicians and dedicated trainers, consulting manuals, handover familiarisation and notes, and consulting colleagues’. Figures 11 and 12, show the replies of deck officers and engineers respectively.

The responses suggested that both deck and engine officers rarely believed they had learned from ‘onboard CBT’ and ‘onboard training from installation technician/dedicated trainer’.

They most commonly suggested that they had learned from ‘consulting manuals’. This may seem inevitable given the requirement for manuals to be available on board regardless of the time of day or night whereas this cannot be said of colleagues or trainers. The response highlights the importance of manuals. As such, the user friendliness of manuals can be seen as a concern, especially when they are not written in seafarers’ first languages.

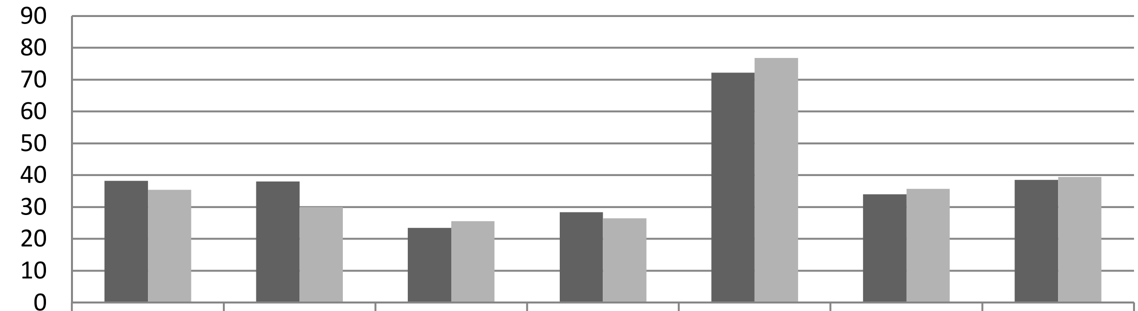
Notwithstanding the importance of manuals, however, they cannot be seen as a substitute for formal training (IMO, 2003). As mentioned earlier in relation to much equipment, seafarers preferred instructor-led training methods. Ideally and in this context, the role of manuals should be supportive: they should serve to provide well-trained seafarers with a constantly available reference and an additional means for obtaining specific information.

Figure 11: Learning Activities Contributing to Knowledge of Deck Officers



	Cadet training	Onshore training	Onboard CBT	Onboard training from technician /trainer	Consulting manuals	Hand-over familiarisa -tion	Consulting colleagues
AIS	22.0	34.0	23.9	26.3	74.4	31.6	32.8
GPS	35.2	32.8	24.2	24.4	76.6	36.6	40.4
ARPA	44.2	65.0	24.0	23.8	70.6	35.9	39.8
GMDSS	38.3	77.8	25.5	22.4	63.4	29.6	39.3
ECDIS	26.8	68.2	26.8	20.4	64.2	33.0	40.2

Figure 12: Learning Activities Contributing to Knowledge of Engine Officers



	Cadet training	Onshore training	Onboard CBT	onboard training from technician/ trainer	Consulting manuals	Hand-over familiarisa -tion	Consulting colleagues
ME	38.2	38	23.5	28.4	72.2	34	38.5
OW	35.4	30	25.6	26.5	76.8	35.7	39.4

Learning about equipment via formal training was another route identified by respondents. More deck officers stated that onshore training contributed to their knowledge of ARPA/RADAR, GMDSS, and ECDIS, than said that onshore training contributed to their understanding of AIS and GPS. This seems to suggest that formal onshore training is focussed more on ARPA/RADAR, GMDSS, and ECDIS.

Engineers similarly highlighted the contribution that onshore training had made to their knowledge of the main engine manoeuvring system whilst fewer identified on shore training as important in relation to the operation of the oily water separator. This difference corresponds once again with the relative technical complexity of the equipment: onshore training had made a greater contribution to knowledge about the more complex equipment and had made less of a contribution to knowledge about simpler technology.

The analysis of the responses to questions about individual pieces of equipment suggested that nationality and rank made a difference. When we combined the answers to the questions about the learning activities that had contributed to knowledge of the five individual pieces of equipment we found a marked rank and nationality effect. Overall, junior deck officers were more likely than their senior counterparts to suggest that ‘cadet training’ had contributed to their knowledge of bridge equipment. Given that some pieces of equipment were introduced relatively recently and so will only have been covered by more recent cadet training courses this is entirely as we would expect. However, nationality variations were less predictable.

In terms of nationality (for detailed information see Appendix One), Chinese and ASEAN deck officers were the most likely to state that 'cadet training' had contributed to their knowledge of the equipment on the bridge whereas Filipinos were the least likely to suggest that this was the case. In contrast, Filipinos were the most likely group of respondents to suggest that 'onboard CBT' had contributed to their knowledge of bridge equipment, while Europeans, Chinese and Indians were far less likely to do so. As a group, Indian seafarers were the most likely to suggest that 'onshore training' had contributed to their knowledge of bridge equipment, and the least likely to do so were Chinese seafarers. Filipino and Chinese seafarers were also more likely than seafarers of other nationalities to state that 'handover familiarisation and notes' had contributed to their knowledge of the equipment on the bridge.

Arguably, the nationality differences point to several things. Firstly, Chinese deck officers seemed more likely to get something out of their cadet training in relation to developing an understanding of modern bridge equipment than other groups. However, there may be other explanations for this. For example it might be that Chinese seafarers had fewer opportunities to attend onshore training and therefore relied more on cadet training than other groups. In another question which asked respondents about the adequacy of training provision in their companies, Chinese respondents turned out to be the group who were the most likely to say it was 'inadequate'. While this question is not the focus of the paper, it nevertheless serves to shed light on the nationality differences here and to highlight the extent to which training issues are complex and interconnected. It further serves as a reminder that there may be several contributory explanations for patterns of response and that we should remain open to the idea that the most obvious explanations may not always be the strongest explanations. In this context it is worth considering the responses of Filipino seafarers in a little more detail. In a separate study of seafarers' perceptions of onboard CBT (Ellis et al. 2005) Filipino seafarers were identified as having a more positive view of CBT than other nationalities. One possible interpretation of this was that seafarers found the quality of the internationally supplied computer-based training modules superior in comparison with locally provided tuition. Thus it is conceivable that Filipino seafarers express a preference for CBT because of the poor standard of alternative training provision, a notion which would be supported by the tendency for Filipinos to be less likely than other groups to highlight cadet training as contributing to their knowledge of equipment. Finally, in relation to differences between groups of seafarers of different nationality, both Chinese and Filipino deck officers appeared to gain more from the effective use of handovers in terms of getting familiar with navigational equipment.

We also combined the answers given by engineers to questions in relation to two pieces of equipment –the main engine and the oily water separator. When considered in combination it became clear that senior engineers were more likely to suggest that ‘handover familiarisation’ and ‘consulting manuals’ had contributed to their knowledge of the two pieces of equipment than junior engineers (see Appendix Two). To make sense of this finding, two questions in the questionnaire which are not featured in this paper are worth mentioning. One was about the duration of handovers. Responses to this question indicated that senior officers had longer handover periods than juniors. This could explain why senior seafarers are more likely to state that they have contributed to their knowledge of equipment. The other question related to the action they usually took when not familiar with equipment. In response to this question senior respondents were slightly more likely to choose ‘consulting manuals’ than their more junior colleagues. This may be interpreted as suggesting that where there is a willingness to spend time reading manuals, seafarers can find that they have the capacity to enhance knowledge. The analysis also revealed that senior engineers were slightly more likely to suggest that ‘onshore training’ had contributed to their knowledge of the two pieces of equipment, than their more junior colleagues. This may indicate that senior engineers had more onshore training opportunities than junior ones, indeed our interview data do suggest that, perhaps for obvious reasons, companies prioritise senior officers in their training provision.

In terms of nationality (see Appendix Three), like their deck officer counterparts, Chinese engineers were most likely to feel that ‘cadet training’ had contributed to their knowledge. while Europeans and Filipinos were the least likely groups to do so. Similarly Filipino engineers, like their deck officer counterparts, were more likely to state that their understanding had improved as a consequence of ‘onboard CBT’, and Chinese, European, and Filipino engineers were more likely than other nationalities to suggest that ‘handover familiarisation and notes’ had contributed to their knowledge of engine room equipment.

Conclusion

Effective and sufficient training helps to harness the benefit of technology in enhancing productivity (Trucotte and Rennison, 2004). In contrast, however, a lack of training coupled with the introduction of technology can result in serious accidents. This may be particularly the case with regard to the operation of ships. Shipping can be seen to be a 'safety critical' industry where small operational errors have potentially great consequences.

In terms of seafarers' own assessments of their knowledge of new onboard equipment, the questionnaire study found that while the majority of respondents were confident about their understanding , there was nevertheless a small percentage of seafarers who reported that their knowledge with regards to specific items was either 'zero' or 'basic' indicating a perceived need for training.

Deck officers' self-reported knowledge levels did not vary significantly with rank. By contrast, engineers' self-reported knowledge levels in relation to engine room machinery were likely to vary with rank and experience.

In terms of preferred forms of training, both deck and engine officers stated that when learning about new shipboard equipment they would favour instructor-led training methods. They were more likely to desire onshore training for technically more complex equipment and to prefer onboard instructor-led training for relatively simple equipment. In practice, respondents did tend to receive more onshore training on the most complex equipment. However, they did not seem to get the onboard training on simple equipment that they would like, but largely relied on manuals instead.

The means via which seafarers had already acquired their knowledge of equipment was to a certain extent affected by nationality. This is likely to reflect the relative strengths and weaknesses of training provision in different regions and also regional training provision by companies.

Acknowledgments

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The Lloyd's Register Educational Trust (The LRET) is an independent charity working to achieve advances in transportation, science, engineering and technology education, training and research worldwide for the benefit of all.

References

Allen, P. (2009) ‘Perceptions of Technology at Sea amongst British Seafaring Officers’, *Ergonomics* 52(10): 1206-1214.

Bailey, N. (2005) ‘Training, Technology and AIS: Looking beyond the Box’, *Proceedings of the Seafarers International Research Centre’s Fourth International Symposium*. Cardiff: SIRC.

Bailey, N., Ellis, N. and Sampson, H. (2008) *Training and Technology Onboard Ship: How Seafarers Learned to Use the Shipboard Automatic Identification System (AIS)*. Cardiff: SIRC.

Barret, A. and O’Connell, P.J. (2001) ‘Does Training Generally Work? The Returns to In-Company Training’, *Industrial and Labour Relations Review* 54(3): 647-663.

Bartel, A. (1994) ‘Productivity Gains from the Implementation of Employee Training Programs’, *Industrial Relations* 33(4): 411-425.

Dearden, L., Reed, H. and van Reenen, J. (2000) ‘Who Gains when Workers Train? Training and Corporate Productivity in a panel of British Industries’, Working Paper of The Institute for Fiscal Studies.

Ellis, N., Sampson, H., Aguado, J.D., Baylon, A., Del Rosario, L., Lim, Y.F. and Veiga, J. (2005) *What Seafarers Think of CBT*. Cardiff: SIRC.

Gray, B. (2008) ‘Too Much Technology Can Hinder Human Safety’, *Lloyd’s List*, September 25.

Grey, M. (2008) ‘Time for Familiarisation Needed’, *Lloyd’s List*, August 28th.

Hadnett, E. (2008) ‘A Bridge Too Far?’, *The Journal of Navigation* 61(2): 283-289.

Harati-Mokhtari, A., Wall, A., Brooks, P. and Wang, J. (2007) 'Automatic Identification System (AIS): Data Reliability and Human Error Implications', *The Journal of Navigation* 60(3): 373-389.

IMO (2003) 'Issues to Be Considered When Introducing New Technology Onboard Ship', *MSC/Circ*. 1091.

Lloyd's List (2007) 'A Question of Competence', *Lloyd's List*, March 23rd.

MAIB (2007) Report on the Investigation of the Loss of Control of Product Tanker *Prospero*. *MAIB Report No 24/2007*.

MAIB (2008a) Report on the Investigation into the Grounding of *CFL Performer*. *MAIB Report No 21/2008*.

MAIB (2008b) Report on the Investigation of a Close-Quarter Situation between Costa Atlantica and Grand Neptune. *MAIB Report No 20/2008*.

MAIB (2009) Report on the Investigation into the Grounding of *Pride of Canterbury*. *MAIB Report No 2/2009*.

Norris, A. (2007) 'AIS Implementation – Success of Failure', *The Journal of Navigation* 60(1): 1-10.

Robey, D., Ross, J.W. and Boudreau, M. (2002) 'Learning to Implement Enterprise Systems: An Exploratory Study of the Dialectics of Change', *Journal of Management Information Systems* 19(1): 17-46.

Sharma, R. and Yetton P. (2007) 'The Contingent Effects of Training, Technical Complexity, and Task Interdependence on Successful Information Systems Implementation', *MIS Quarterly* 31(2): 219-238.

Tang, L. (2009) 'Training and Technology: Potential Issues for Shipping', *Seafarers International Research Centre Symposium Proceedings*. Cardiff: SIRC.

Turcotte, J. and Rennison, L.W. (2004) 'Productivity and Wages: Measuring the Effect of Human Capital and Technology Use from Linked Employer-Employee Data', Department of Finance Working Paper.

Zwick, T. (2006) 'The Impact of Training Intensity on Establishment Productivity', *Industrial Relations* 45(1): 26-46.

Appendix One

Kruskas-Wallis Test Ranks

	Nationality	Mean Rank
Cadet training (deck officers)	Philippines	156.22
	India	185.76
	China	222.50
	Europe	181.10
	ASEAN	232.04
	Other	171.50
Onshore training (deck officers)	Philippines	187.27
	India	191.48
	China	118.27
	Europe	170.65
	ASEAN	134.96
	Other	202.09
Onboard CBT (Deck officers)	Philippines	219.45
	India	164.88
	China	163.96
	Europe	140.59
	ASEAN	188.71
	Other	185.38
Handover familiarisation and notes (Deck officers)	Philippines	213.58
	India	140.11
	China	201.04
	Europe	157.21
	ASEAN	150.67
	Other	181.83

Appendix Two

Kruskas-Wallis Test Ranks

	Rank	Mean Rank
Onshore training (Engineers)	Senior officers	238.49
	Junior officers	215.31
Consulting manuals (Engineers)	Senior officers	249.12
	Junior officers	206.21
Handover familiarisation and notes (Engineers)	Senior officers	244.88
	Junior officers	209.84

Appendix Three

Kruskas-Wallis Test Ranks

	Nationality	Mean Rank
Cadet training (Engineers)	Philippines	202.57
	India	225.16
	China	337.65
	Europe	194.47
	ASEAN	258.90
	Other	229.61
Onboard CBT (Engineers)	Philippines	257.48
	India	216.02
	China	228.68
	Europe	209.00
	ASEAN	187.25
	Other	206.24
Handover familiarisation and notes (Engineers)	Philippines	238.92
	India	180.90
	China	268.69
	Europe	242.08
	ASEAN	211.60
	Other	196.86