Symposium 2009

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Seafarers International Research Centre Symposium Proceedings (2009)

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Foreword

Helen Sampson

The Seafarers International Research Centre (SIRC) is an essentially policy-related Centre which undertakes research on the human and organisational aspects of the shipping industry. As such, staff at the Centre have interests in industry regulation, systems of education and training, human resource management, the management of risk, the context within which seafarer and vessel casualties occur, health and welfare issues, industrial relations, and work processes. The Centre's success is built upon the support of key stakeholders within the maritime 'community'. Across the sector organisations have: commissioned projects; provided 'core-funding' for the Centre; facilitated research access; and provided funding for events such as this which, in 2009, has been generously supported by the Lloyd's Register Educational Trust to which we are grateful. Such on-going collaboration suggests a keen interest within the sector in attaining a deeper insight into some of the issues relating to the organisation and functioning of the shipping industry.

The SIRC Symposium is held every two-years with the intention of feeding back our findings to those across the sector who may find them of interest, and use, in forming policy, in reaching decisions about strategy, and in considering operational matters. The Symposium attracts an audience from a wide range of organisations. Not everyone who attends will share a similar perspective. Some organisations are primarily focussed upon seafarers' welfare, some upon safety, some upon the competitive operation of ships, some upon the representation of seafarers, and some upon the regulation of the sector. Whatever the reason for taking an interest in our work, however, we hope that the papers presented will be of use, and that our research might impact, if only in small ways, upon the improvement of policies and practices in the industry, most particularly those which effect seafarers' health, safety and welfare.

Introduction to Day One

Helen Sampson

Three papers are presented in this, the first, session of the 2009 SIRC Symposium. Two of these relate to work that has been funded by the Lloyd's Register Educational Trust and one is the product of the individual work of one of our senior Nippon Foundation Fellows – Capt Mohamed Ghanem[1].

In the first paper of the day, Professor Michael Bloor presents some findings that have emerged from our efforts to gather data relating to seafarer injuries from Maritime Administrations. The paper demonstrates that the data collected by Maritime Administrations are highly variable and in most cases are not found to be directly comparable. It further illustrates the extent to which it is possible to demonstrate that the under-reporting, or under-recording, of injuries is widespread across the industry and that as a result of variations in recording/reporting practices even such trends as are identified by social researchers (for example what appear, on the surface, to be statistically significant differences in the injury rates of seafarers of different nationality), could well be artefacts of the reporting/recording system rather than a reflection of 'real' differences in casualty rates. The paper is a reminder of the need for more robust systems of data collection to be put in place by organisations, such as the IMO, which have already established some requirements for the recording and collation of information with regard to serious incidents at sea. The usefulness of current requirements aimed at establishing intelligence regarding injury rates in the industry is severely limited by the prevalence of variable recording practices. These render the aggregation of industry-wide data virtually meaningless. Furthermore the calculation of both injury, and fatality rates, is hampered by an absence of evidence

[1] SIRC has been awarded a grant by the Nippon Foundation to support people with a social science or a maritime-related background (including former seafarers) through a programme of post-graduate level research which has the potential to culminate in the award of a PhD. The objective of the funding is to support the development of an international network of social scientists focussing on 'human-related' work in the maritime sector. There are currently eighteen SIRC-Nippon Foundation fellows based within the Seafarers International Research Centre and four alumni from the programme. For further details of their backgrounds and research please visit the SIRC-Nippon Foundation Fellowships website at www.sirc.cf.ac.uk -> Nippon Fellows.

relating to the numbers of seafarers employed on vessels registered with particular maritime administrations. This absence of data makes it impossible to calculate injury or fatality rates with any semblance of accuracy and forces researchers to rely on estimates and patchy information in making even rough calculations. Given that Maritime Administrations are already tasked, by the IMO, with collecting data on serious incidents at sea it seems particularly regrettable that the additional steps which are required to facilitate the production of robust and reliable casualty rates for the industry have not, so far, been taken. Such steps could be of a relatively simple nature involving guidance about recording in terms of what information should be recorded, and in relation to which types of incidents, and instruction as to the categorisation of data to facilitate uniformity, and thus comparability.

The second paper of the session is also concerned, indirectly, with injuries and fatalities. However, in this case the focus is on their prevention rather than on identification. Since the inception of the Lloyd's Register Educational Trust Research Unit at the Seafarers International Research Centre we have been engaged in a project relating to the ways in which risk is seen by the employees of ship operators. The first, major, phase of this study entailed the administration and analysis of a large scale questionnaire which revealed that significant differences in perception were prevalent amongst different groups of employees. These were identified between different ranks/positions, between different nationalities and between different departments and many of the findings were reported at the last symposium. In the paper presented by Dr Nicholas Bailey to the 2009 symposium such differences are further explored. The paper sheds light on why it might be that despite company efforts to effect change in perceptions of risk, parts of the industry workforce remain strongly resistant to corporate messages about safety and about risk in relation to working practices. It illustrates the impact upon seafarers of personal (and second hand) involvement in real accidents and reveals how such experiences have far greater meaning for employees than injury or fatality data presented in statistical/tabulated form. The paper encourages us to consider the perspectives of employees when thinking about risk management and risk communication strategies across the sector and is a prelude to further analysis of a considerable quantity of qualitative data collected in the course of the study.

The final paper of the day is presented by Captain Mohamed Ghanem. Captain Ghanem begins with a description of accident causation models which have made an impact upon organisational practices and accident investigation in several high risk sectors (for example nuclear and rail). He then describes how following a process of content analysis of existing Marine Accident Investigation Reports it is possible to identify an absence of any strong influence from such models (generally speaking) in the conduct and reporting of accident investigations. Implicit within the paper is the understanding that if such accident models are not followed in analysing accidents, then it is possible that the fundamental causal factors underlying accidents may be overlooked and accidents of the same type and with the same underlying causes may be repeated time and again.

Introduction to Day Two

Helen Sampson

In the course of the first session of the SIRC 2009 symposium, the findings from several well-established research projects were presented and discussed. By contrast the papers presented for the second session derive from the early stages of several studies and to some degree can be understood as indicative of future work within the Centre.

In the first paper of the morning Professor David Walters discusses the extent to which health and safety can be managed across supply chains. The paper derives, in large part, from a broad literature review undertaken in relation to land-based supply chains. The main findings and implications of this review are sketched out before being considered in relation to the maritime context. This work builds not only upon the extensive work of Professor Walters in relation to health and safety management but also upon previous work conducted at the Centre on behalf of EMSA which illustrated, amongst other things, the unseen 'costs' of the outsourcing of labour in relation to standards of education and training. This, as well as preliminary work relating to some of the health and safety implications of chartering relationships will be combined in an attempt to seek future funding to conduct detailed empirical work relating to the management of health and safety across supply chains in the maritime sector.

The second paper of the session relates to an exciting new project which will be undertaken in connection with the Lloyd's Register Educational Trust Research Unit (LRETRU), but which also forms the basis for the PhD of one of the Centre's long-standing Research Associates – Mr Neil Ellis. The study, which is in its early stages, will consider the relationship between the built environment and the health and well-being of seafarers. In doing so, it will consider the physical and social impact of vessel design and will point to some ways in which relatively minor, but nevertheless, beneficial changes might be effected without great cost to ship operators. The paper is indicative of work and ideas to come rather than definitive in its objectives. It

provides us with some food for thought in relation to the internal design of ships and reminds us of the importance of the environment in which we live and work and how the quality of the built environment may impact upon well-being.

The final paper of the day is presented by Dr Lijun Tang (formerly a SIRC-Nippon Foundation Fellow) who has recently joined the team of the LRETRU in order to further the planned programme of work for the Unit. The first study with which Dr Tang has been engaged relates to the introduction of new technology aboard vessels and the exploration of the provision of associated training. Phase one of this research has already been completed. It entailed focussing upon the introduction of AIS and considering the extent to which seafarers appeared to be competent with regard to its use and management. This was assessed following periods of data collection at the Dover Coastguard which focussed upon AIS transmission errors and VHS communications. Phase Two of the study combines the use of qualitative interviews and a large scale questionnaire in an attempt to understand more about the experiences of seafarers in relation to training centred upon new technologies and new pieces of on board equipment. Dr Tang reports upon the findings of an initial literature review considering the effectiveness, and usefulness, of training for ICT in shore-based sectors, and additionally highlights the findings of a small number of interviews with seafarers and maritime lecturers which facilitated the development of a better understanding of the issues of relevance, and underpinned the design of a questionnaire which will be distributed to seafarers internationally in the coming months.

Feedback on the content of the papers presented herewith is welcome and should be addressed in the first instance to the author/s of the paper/s concerned.

Patterns in injury reporting

Neil Ellis, Michael Bloor & Helen Sampson

Abstract

This paper considers injury data obtained from 16 anonymised maritime administrations. Evidence is examined of reporting biases which militate against the aggregation of different administrations' datasets. Some important dimensions of reporting bias are analysed. Taking two different large maritime administrations, evidence is presented indicating that injuries are systematically under-reported in general cargo ships, compared to other types of trades, and that injuries are systematically under-reported by some crew nationalities within a given maritime administration. The paper concludes that there is a clear need to invest in studies of the social processes of shipboard injury reporting, if we are to be able to interpret seafarer injury statistics.

Keywords: injury rates; reporting bias; injury reporting; secondary analysis

The occupation of seafaring is characterised by comparatively high rates of work-related deaths and injuries. In the last two decades a small number of studies have demonstrated that seafaring, alongside commercial fishing, is an occupation with one of the highest identified rates of mortality in OECD countries such as Denmark and the UK (Roberts and Williams 2007, Hansen 1996). However, robust data on seafarer fatalities and most notably work-related injuries has been scarce in relation to the global fleet and the international workforce.

The reasons for such scarcity become rapidly apparent when setting out to undertake research on seafarer deaths and injuries across the global fleet, as we have recently attempted in conjunction with a research project on perceptions of risk established as part of the programme of work undertaken at the Lloyd's Register Educational Trust Research Unit. Here we have been beset with problems of accessing data from Maritime Administrations (where some are reluctant to make such information public or may not collect/collate it at all) and in working with such data as have been kindly made available. The methods we have utilised in collecting data for this study have been previously outlined (Ellis 2007) however it is worth briefly rehearsing some of

the major difficulties associated with the analysis of seafarer injury and fatality data before briefly outlining the methods we have used in collecting the data underpinning this paper and discussing how that data which is available is best interpreted and understood.

Deficiencies in available data

In order to produce occupational rates of injury or fatality it is necessary to have access to relatively reliable information on both the numbers of reported injuries and fatalities at sea by flag (for example), and within a given time period. This is termed numerator data. However, it is also necessary to know the numbers of seafarers employed on ships carrying the specific flag concerned in the same time period. These are termed denominator data. The presence of both types of data allows for a rate to be calculated which can then be utilised in making comparisons between, or within, industries – for different vessel types for example, or for different flags. The problems in collecting such data in the shipping industry are both that there are considerable reporting biases apparent in the available numerator data (numbers of casualties), and that there is an absence of reliable denominator data - so that often the numbers of seafarers employed is not known and an estimate is established in its stead. This allows for the presentation of, at best, a patchy and somewhat unreliable picture of seafarer casualty rates.

Method

Fatality and injury numerator data were collected as part of a larger study which collected accident and incident data from maritime administrations (Ellis 2007). Such administrations are legally required to record all accidents and major incidents that occur to their flagged vessels, and thus were seen as a comparatively robust source of casualty data. The largest 30 administrations, as defined by gross tonnage, were sent questionnaires which asked about the type of casualty data kept, the nature of these

(i.e. casualty reports, statistics, tabulated), as well as whether the administrations would be willing to provide these data for academic research. These 30 administrations represented 87.5% of the world fleet's overall gross tonnage (Lloyd's Register Fairplay 2005). Of these,16 provided casualty data. In order to compare the data provided by the administrations the datasets were recoded to allow representation in a standardised format. This recoding related to incident types, rank of seafarers, and vessel types. Fishing and navy vessels were excluded from the datasets. Although data were provided for a large range of years, a common dataset was only available for a shorter range of 2000 to 2005. As a condition of their provision the source of data was anonymised, and is referred to by an alphabetical identifier.

For the present analysis, the 16 maritime administrations were re-contacted and asked to provide denominator data on their seafarer populations. Of the 16, seven provided this information. Information about the number of ships in the world fleet was obtained from annually published World Fleet Statistics (e.g. Lloyd's Register Fairplay 2005).

The interpretation of available injury data

When the data sent by the sixteen maritime administrations were considered in detail it was found that only seven provided data which could be used with regard to the reporting of seafarer injuries. Of these, four provided sufficient detail to allow us to categorise the information on injuries into different types corresponding with commonly utilised groupings, i.e. break, fracture, dislocation; bruising; burns; crush/trap injuries; cuts/piercings; electric shocks; strains, sprains, twists; loss of consciousness; other. The distribution of the reported injuries is illustrated in Table One which also includes the data available on numbers of fatalities for the administrations concerned in the same time frame.

Table 1: Injuries and Fatalities Compared Across Four Flags 2000-05

	Flag A	Flag B	Flag C	Flag D
Break, Fracture, Dislocation	26 (9.0%)	49 (36.6%)	9 (4.9%)	439 (25.2%)
Bruising	3 (1.0%)	14 (10.4%)		272 (15.6%)
Burn	15 (5.2%)	6 (4.5%)	6 (3.3%)	68 (3.9%)
Crush or Trap Injury	12 (4.1%)	12 (9.0%)		116 (6.6%)
Cut or piercing injury	22 (7.6%)	27 (20.1%)	1 (0.5%)	279 (16.0%)
Electric Shock		1 (0.7%)		8 (0.5%)
Strain, sprain or twist	6 (2.1%)	15 (11.2%)		456 (26.1%)
Unconscious	1 (0.3%)	5 (3.7%)		37 (2.1%)
Other	5 (1.7%)	3 (2.2%)		
Fatalities	**200 (69.0%)**	**2 (1.5%)**	**167 (91.3%)**	**70 (4.0%)**

The major conclusion which can be drawn from these data is that there is considerable variation in the practice of recording/reporting injuries across maritime administrations. The ratio of injuries to fatalities might be expected to vary across administrations for any given year, however, it could reasonably be anticipated that injuries would outweigh fatalities where injuries are being reported in any kind of systematic fashion. However, these data indicate that for two, of the four, administrations (A and C) numbers of reported fatalities are far higher than numbers of reported injuries with fatalities constituting 91% of all reports in administration C, and 69% of the total reports in administration A. This clearly indicates significant under-reporting of injuries in these administrations which may only record injuries associated with major incidents (where fatalities have occurred alongside non-fatal injuries for example), or may only record those injuries deemed to be most serious. Such variations in recording/reporting practices make it impossible to aggregate data across administrations, as like cannot be compared with like, and the data are clearly unreliable. However, data produced by individual maritime administrations may be analysed to consider, for example, variations in patterns over time, variations in reporting by rank and variations in reporting by nationality.

When we considered trends in data over time across individual maritime administrations we were able to identify a tendency for injuries and fatalities to reduce over the period. In one Administration – E – these trends for injuries and fatalities were found to be statistically significant (see Table Two).

Table 2: Seven-year Trend Data in Injuries and Fatalities in Flag-State E

	2000	2001	2002	2003	2004	2005	2006
Seafarer Population	23,470	23,225	22,282	21,836	21,683	22.343	22,995
Injuries	912 (3.9%)	778 (3.3%)	881 (3.6%)	774 (3.5%)	635 (2.9%)	444 (2.0%)	422 (1.8%)
Fatalities	22 (0.1%)	17 (0.1%)	13 (0.1%)	11 (0.1%)	28 (0.1%)	9 (0.0%)	5 (0.0%)

In another administration (D) where we only have denominator data (that is, numbers of seafarers data) for those seafarers based in the home state, home-state officers were found to have significantly lower injury rates over the six-year period 2000-05 than home-state ratings (see Table Three).

Table 3: Six-Year Trend Data in Injuries by Rank 2000-05 in Flag-State D (Home State Seafarers Only)

	2000	2001	2002	2003	2004	2005
Total officers & cadets	14,080	13,900	14,070	14,580	14,670	14,950
Total ratings	10,800	6,680	9,510	10,490	10,270	9,320
Officer Injuries	1 (0.0%)	0 (0.0%)	1 (0.0%)	1 (0.0%)	2 (0.0%)	8 (0.1%)
Ratings Injuries	10 (0.1%)	3 (0.0%)	10 (0.1%)	18 (0.2%)	32 (0.3%)	22 (0.2%)
Total Injuries	11 (0.0%)	3 (0.0%)	11 (0.0%)	19 (0.1%)	34 (0.1%)	30 (0.1%)

In relation to variations in injury rates according to nationality a debate between academics interested in such patterns has been on-going for some time and concerns the identification of apparently different rates of injuries across different national groups. These may be interpreted as 'real differences' in which case they are generally considered to indicate differences in risk taking behaviours (see for example Hansen 2008) or they may be considered to be manifestations of different reporting practices which might relate to considerations such as employment status (i.e. temporary as opposed to permanent contracts) and fear of job loss.

To shed further light on this issue we have examined the reported injuries for one maritime administration (E) over a seven-year period. In doing this we have considered reports of 'slips, trips and falls' against reports of all other injury types on the assumption that slips, trips and falls represent the least incapacitating category of injuries and are thus most subject to variations in self-reporting, i.e. these are the kinds of minor injuries most likely to go un-reported by seafarers. We have also compared two single nationality groups (home state and Filipino seafarers grouped separately) with all other nationals grouped together. Despite the fact that this analysis considers data where we know that we have a great deal of missing information we nevertheless feel that there is evidence that there are nationality-based variations in injury reporting: as a proportion of the total numbers of injuries they report, Filipinos and other nationalities both report significantly fewer slips, trips and falls than seafarers from the home (flag) state (see Table Four).

Table 4: 2000-06 Injury Rates by Reported Cause in Flag-State E, comparing Home-State-Nationals, Other Nationals and Filipinos

	Home-State	Other Nationals	Filipinos	Filipinos and other nationals combined
Slips, trips or falls on same level	538 (30.8%)	73 (19.5%)	138 (26.0%)	211 (23.3%)
All other injuries	1206 (69.2%)	302 (80.5%)	392 (74.0%)	694 (76.7%)

Such data do not necessarily invalidate the arguments mentioned earlier of Hansen and others that there may be cultural differences in risk behaviour between different national groups, but they do indicate that there are *also* systematic differences between national groups in their propensity to self-report injuries, particularly where these are less severe.

Such reporting biases were also manifestly present when we considered variations in injury patterns by ship type. Here, as with the maritime administrations, we see that whilst some ship types have predictable ratios of injuries to fatalities for others, the ratios are highly disproportionate and indicative of high levels of under-reporting in relation to injuries (see Table Five). We have compared general cargo, passenger/ro ro, tankers/OBOs and all other ship types (grouped) to facilitate analysis and it can be

seen that reports of injuries from general cargo ships disproportionately appear to represent fatalities (16%) and involve only a very small quantity (6.6%) of reports of minor injuries (represented by the separate consideration of strains, sprains, and twists). In contrast, the proportion of fatalities reported in relation to passenger/ro ro vessels is very low (0.79%) whilst of all reported injuries aboard these vessels very minor injuries (strains, sprains and twists) make up a considerable proportion of the total (30.1%) which is more in line with reasonable expectation. This indicates that aboard general cargo vessels there is a tendency to report only serious injuries and fatalities whilst this tendency is less pronounced for other vessel types (particularly passenger/ro ro vessels).

Table 5: Injury Rate by Reported Cause in Flag-State D, compared by ship-type

	Fatalities	**Strains, Sprains, or Twists**	**All other non-fatal injuries**	**Total**
General Cargo	17 (16%)	7 (6.6%)	82 (77.3%)	106 (100%)
Tanker (incl OBO)	4 (3.5%)	15 (13.2%)	94 (83.1%)	113 (100%)
Passenger & Ro-Ro*	8 (0.79%)	307 (30.1%)	702 (69%)	1017 (100%)
All other ship types	41 (5.9%)	127 (18.4%)	522 (75.6%)	690 (100%)

*NB data do not include information on passenger injuries. Passengers are not included in the dataset.

Conclusion

In understanding patterns of injuries amongst seafarers it is essential to recognise that any injury data collated by maritime administrations are subject to potentially significant reporting biases given the fact that seafarers (either those injured or their seniors) are able to decide whether or not to report injuries to maritime administrations and may choose not to do so. Reasons for failure to report might include: a fear of repatriation by their company; a fear of not being re-hired by their company; a fear of being 'blamed' for causing their own injury – of getting 'into trouble' and so forth.

This account has demonstrated that whilst there may be very real differences in patterns of seafarer injuries which could possibly relate to different trades, jobs, risk practices, and so forth, the currently available data cannot robustly support such interpretations given that reporting biases are as demonstrably high as we have shown them to be.

The social processes of shipboard injury reporting and the individual requirements and practices of maritime administrations are inevitably complex and quite unstudied, but there is a need to invest in such studies if we are to be able to better interpret seafarer injury statistics in the future.

Acknowledgments

We are deeply indebted to the Lloyd's Register Educational Trust for allowing us to use the injury and fatality data discussed in this paper. The opinions expressed in this paper, however, are those of the authors and not the Lloyd's Register Educational Trust.

We are also grateful to Nick Bailey, for his comments on earlier drafts.

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Making Sense of Differences in Perceptions of Risk

Nick Bailey

Abstract

Within high risk industries such as the rail and nuclear sectors, it has been found that different work groups within an organisation may perceive risk differently. This has implications for the effective management of occupational health and safety and the development of an organisational safety culture. This paper reports on a study examining such differences within the maritime industry and is based on five in-depth case studies, which were undertaken following the administration of a questionnaire[1]. Specifically the paper points to a number of factors that appear to contribute to how those in the maritime industry perceive work-based risk.

Keywords

Risk perception, Work-groups, OHS management, Maritime

Introduction

Through the processes of upbringing and schooling individuals are socialised into a given culture(s) and recognised ways of seeing the world which shape how they behave and act in different situations (Goslin, 1969; Schaffer, 1996). Likewise when individuals enter the world of work, they undergo a process of secondary socialisation as they are assimilated into both organisational and professional cultures (Brim and Wheeler, 1965; Carter, 1995; Coffey, 1996). In highly striated organisations with differentiated work-groups there may be different professional or work based cultures operating within the overall dominant organisational culture. That is, within organisations different work-groups while being socialised into the dominant organisational culture may still identify with particular work-based ways of seeing and doing. This tendency is strongly associated with occupations where professional learning is largely based on practice and time spent doing the job, i.e. as a form of apprenticeship. Newcomers to such work groups learn and gain proficiency by understudying experts or master practitioners. In such a context learning involves

[1] The findings from the questionnaire were reported at the SIRC 2007 Symposium.

discovering how to become like the expert, how to be a practitioner and so involves learning the wider social values, beliefs and ways of acting (Wenger, 1998).

Seafaring practice has developed over many years and is reproduced time and again on ships as one-generation passes on their experience to another. Although the system of training, especially for officers, incorporates a significant amount of college-based learning, nonetheless a fundamental part of the training and education of officers, and other workers, is based on experience in the job, with workers learning from their superiors and colleagues. It is through extended periods of ship-based practice, time spent doing the job in the company of other more experienced workers, that individuals are trained and acquire relevant skills. The importance of 'time served' is that workers not only learn how to "do" navigation, engineering or catering, but they **become** navigators, engineers and caterers. Thus as they become fully fledged members of a particular community of practice, they are likely to develop distinct work-based ways of understanding, seeing and doing. Indeed, in a number of high risk industries with organisations that are clearly striated with different and distinct work groups, such as the rail and nuclear industry, it has been found that different groups of workers developed their own unique concerns, objectives and behaviours (Harvey *et al.*, 2002; Clarke, 1999).

With the introduction of the International Safety Management (ISM) Code, the emphasis within the industry has moved from that of safety underpinned by professionalism and expertise to one inscribed within formal managerial systems and procedures. The emphasis is now on Managers to actively manage safety, in large part, through the creation of a common managerially led shipboard safety culture. As such a failure to appreciate differences in perception and understanding between 'work-groups' within an organisation can undermine the effective management of health and safety. Safety procedures or new initiatives, for example, may be misconstrued or ignored by groups of workers if they are not introduced in ways that chime with their understanding of situations. Indeed such interventions may be received with hostility and so serve to undermine the existing safety culture (Clarke, 1999; Harvey, et al. 2000). As Nordenstam and Di Mento (1990) have stated, safety initiatives and risk communication may fail due to a number of problems including: "source problem (who says it), message problem (what is said), channel problems

(how it is said)" (cited Gowda, 2003: 330). There has, however, been little research in this area within the maritime industry, and yet the structural arrangements that characterise it seem especially pertinent, as ships operate remotely from direct management oversight and the structural arrangements onboard naturally align seafarers according to a number of different work-based affiliations based on, for example, department and rank.

In 2005, the Lloyd's Register Educational Trust Research Unit (LRETRU), within the Seafarers International Research Centre (SIRC) at Cardiff University conducted a large scale questionnaire survey of managers and shipboard workers in the maritime sector in order to ascertain whether different work groups perceived work-based risk differently. The survey produced 2372 completed responses from individuals from 50 countries. This represented a response rate of approximately 36%. The key findings of the survey identified that there were indeed statistically significant differences between the ways in which different groups saw risk, principally along the dimensions of rank, work department, and nationality. To a lesser extent differences were also found according to age and experience (Bailey *et al.*, 2006 and 2007).

As part of the study, the questionnaire survey was further supplemented by five in-depth case studies. This involved interviews with managers and shipboard workers in five companies, both in the company offices and aboard ship. Formal interviews were further complemented by observation and analysis of company documents. In total some 125 interviews were undertaken and time was spent aboard nine ships ranging from a couple of days to a month in duration. The aim of this part of the study was to gather data to further elucidate the findings of the questionnaire survey. Based on provisional analysis of the case study data, this paper will point to a number of features that appear to contribute to how those in the maritime industry perceive work-based risk.

Findings

Training, Experience and Situated Knowledge

As would be expected training represents one of the key factors in shaping perceptions of risk. During the interviews we conducted with seafarers they

repeatedly referred to their training and experience of doing the job. Reference was made to a number of forms of training including: STCW training, familiarisation or induction training, specific Health & Safety courses relating to particular activities - such as welding or the use of grinding wheels, and practice-based training understudying colleagues. As one Chief Engineer commented, it is through hands on experience, time served, that individuals develop an appreciation for risk, and he lamented the fact that sea-time has been reduced as a requirement for obtaining STCW certificates.

> [W]e're going away from training people with practical hands on experience to deal with things, and then cos that would then go back to the risk assessment, you'd learn by being on the job, you learn by working with people, the risks and everything… you're taught safe practices. (A, CE1)

Likewise an AB stated that he first learnt of shipboard hazards while undertaking his initial training.

> From school of course. First from school then training centre. Then you need to apply on the ship when you arrive. (A, AB2-1)

In addition to general pre-sea and STCW training, as one manager pointed out, individuals also learnt of risks from undertaking specialised training such as fire fighting and welding courses.

> There's targeted health and safety training such as you know welding courses, grinding wheels, that sort of thing, but not so much here as a general health and safety course… (C, Manager2)

From analysis of the transcripts it was also evident that individuals make reference to their technical knowledge acquired during the course of their training and time doing the job. The knowledge, thus gained, informs what they see as hazards and how they assess risks in the context of their work. For instance, the following comment by a Chief Engineer makes reference to the perceived risks of fire due to a possible rupture of a high pressure fuel pipe and lack of sheathing. In explaining why he sees this as a risk, he draws on his technical knowledge of trends in the industry and applies it to the specific situation onboard.

> *In terms of the main hazard to the ship itself?*
> I would say high pressured fuel at high temperature
>
> *That's leading to potential fire?*

> Yes, I mean the main engine, the lower pressure fuel rails are at 10 bar pressure, both with the main engine and with the generators, and if you have a failure on one of those then… There's been big moves over the years to double sheath pipes, for a long time, pipes are now becoming more and more frequently sheathed … (A, CE2)

In the same way this captain draws on his general technical understanding of tank cleaning operations and applies it to the conditions onboard his ship.

> *Just in general what do you think is most the dangerous hazard, or the greatest hazard on these types of ships?*
> I think it's probably the tank cleaning operations, yeah the tank cleaning operations, because we do tank cleaning operations in a non-controlled atmosphere, we don't have inert gas on these ships, so you have to be very, very, careful when you do tank cleaning operations… (E, Cpt1)

Reference to training and experience of doing the job appeared repeatedly in individuals' accounts of how they "knew" about the risks they faced.

Awareness of Incidents

Risk communication is recognised within the academic literature as an important factor in raising risk awareness and modifying the ways in which groups perceive risk (Fischhoff, 1995; Gowda, 2003). Governments in particular utilise this strategy with the presentation of risk information through advertising campaigns in the various media of television, radio and print. The aim is to modify behaviour by making individuals more aware of the risks they face, as for example with the current campaign highlighting the risks of using mobile telephones while driving. In the same way organisations like the UK Maritime Accident Investigation Bureau (MAIB) publish reports that describe maritime incidents in order to raise awareness of how things may go wrong and to highlight potential lessons that can be learned to avoid such events. In a similar manner, many companies collate their information relating to numbers and types of incidents as part of their procedures for safety management.

From the findings it was apparent that awareness of actual incidents was a key factor in informing risk perceptions. The way in which individuals gained such information varied from formal statistical data and written accounts of incidents, to stories heard and personal experience. Interestingly different sources of information appeared to

have differing degrees of meaning for workers occupying different positions in the occupational hierarchy.

The companies in this study all collected accident data, and clearly for those in management charged with managing OHS, this information was a central factor informing their perceptions of risk. As one manager commented, he had access to a wide range of detailed information about safety within the fleet, and as such believed that he had a well informed overview.

> Yes we have review meetings, in fact what we've just instigated recently is a formal review meeting once a month now before the monthly management meeting to review all the safety related issues such as the near miss hazard alerts, non-conformances, safety management meeting issues …I'm intimately linked with what's happening on the ships so I understand all the issues, and I think it's the closeness to the ships, the regular meetings, the regular flow of information, I see the defect reports, I see the condition reports, I see accident statistics, near miss hazard alerts, all the masters' reports, so there's a broad flow of information across my desk which keeps me in contact with what's going on. (C, Manager2)

With access to fleet wide data managers claimed to have a good sense of the operational risks associated with their vessels, at least in terms of the types and frequency of incidents that occur.

While individuals at other ranks within the participating companies generally had access to a version of this information, either in statistical form or as accounts of accidents often attached to advisory circulars, they appeared to draw on such information to a far lesser degree when accounting for their understandings of shipboard risk. Such information was typically circulated through the safety committee meeting and made available in mess rooms or pinned to the safety officer's notice board, as this captain stated:

> Well that's their main thing, they have this quarterly review which lists all the accidents, lists their advisement, what they see … we have the safety meetings and it goes through that, feedback to the ship through the safety committee. (A, Cpt1)

In general senior officers were the most likely to refer to these formal accounts of incidents and several commented that they were aware of incidents within the wider fleet from attending office-based seminars or talking to senior officers aboard other ships. As one Captain commented the office-based seminars drew his attention to

incidents on other ships that caused him to re-examine potential hazards aboard his own vessel.

> Oh yeah, and it's not just that, you can meet people as well and exchange ideas…you hear pretty much what's going-on on every vessel because you know people talk, it's the grapevine, so in a way that's instructive because it makes you think, when something happens on another vessel, an unfortunate event, then you tend to go and check, make sure it won't happen on your vessel. (E, Cpt1).

As well as company reports, individuals made reference to incidents that they had learned of from more general publications such as newspaper accounts and MAIB reports. For instance, a senior captain expressed his concern about the risk of fire. In explaining his concern, he referred to two other ships that had experienced serious fires and the problems they had in dealing with them. From knowledge of these cases, he was able to extrapolate from their experience and relate it to the particular conditions aboard his current vessel.

> But another big hazard would be if you had a dangerous cargo fire, you know, there was [company name], had one, heard alongside they towed the ship out to anchor, took about 5 days to put the fire out and 300 containers damaged, it was just a hazardous box caught fire in the middle of the stack, you haven't got the manpower to … Something like a million tonnes of water were poured on that to put the fire out, well there's no way we can put .. something like that, I think fire at sea is everybody's biggest fear, ship's don't sink, the ship is the biggest lifeboat, ships don't normally sink. (A, Cpt1)

In a similar manner when asked to identify the main shipboard hazards, a number of senior officers (typically those that also served as shipboard safety officers) made reference to their knowledge of the more common types of injury that actually occurred aboard their vessels and their causes. As this Chief Officer pointed out:

> *On these particular types of ships, where would you see the main hazards being, what would be the main concerns?*
> I guess slips and trips are the common injuries, the engine room is usually a good source of injuries. (A1, CO)

As the shipboard safety officers, these individuals were responsible for investigating any incidents and for maintaining incident records, and so they tended to be aware of the frequency and consequences of such events. Given this aspect of their job, such information thus appeared to have meaning for them.

By comparison the larger portion of the shipboard crew seldom referred to these formal accounts of incidents as informing their perceptions. Indeed some individuals denied knowledge of them, even when a copy had been observed by the researcher to be pinned to the nearby safety notice-board. Thus while formal accounts of incidents and statistics had significant meaning for managers and to varying degrees senior officers in terms of their understanding of risk, for many workers they had little meaning in terms of informing their risk understandings.

Of crew members who acknowledged having read incident reports, a number commented that in general they had little impact in terms of raising risk awareness. The reasons given were that the reports constituted just another set of documents that had to be read amongst all the other paperwork onboard, and secondly that one can become de-sensitised to such information, as the following comment makes clear.

> [W]hen I was with [name of previous company] you know every ship, the number of near misses reported, you were quoted to achieve near misses and blah, blah, blah and all the rest of it and statistics, pie charts and God knows what else arrived in the sort of, you eventually end up desensitising to you know a big raft of things and do I really have to look through all of this like you know. (E, CO1)

Other safety related information to be found onboard that was referred to included safety posters. In one company, in particular, these were mentioned by a number of individuals. At least one seafarer reported that he had been influenced by a safety poster.

> *Do you ever read any books or anything on the ship that tells you about jobs and things you should do?*
> Yes here in the bridge, and we have one poster that show you how to lift buckets, you do like this… (A, AB2-1)

The issue of becoming de-sensitised to risk information, however, was also cited in relation to safety posters, with crew members claiming that they simply became blind to them.

A further factor that emerged in relation to such formally presented information, in terms of how they were seen and the impact they had on risk perception, was that of relevance. When asked whether such information contributed to their understanding of risk, many seafarers commented that the information provided was not relevant to

their particular ship or situation. Specifically, it was often claimed that the advice presented failed to take account of the practicalities of the actual situation onboard, as the following comment from a second engineer illustrates.

> *I saw some signs, I think for manual handling and lifting.*
>
> Yes we have got information on manual handling, and tells you to use all these bits and pieces but you haven't got these bits and pieces. But you can't use them on the ship anyway because everything's in the way, you know you can't use a sack trolley or anything else because it wouldn't fit through half the spaces you want to take things. Cranes obviously don't reach everywhere on the ship. There's a lot, you do, do a lot of manual handling. (C, 2E1)

In a similar manner, Company risk assessments and formal procedures are a central feature of Safety Management Systems and as such might have been expected to play a role in raising awareness and in shaping how individuals perceived work related risk. From the interviews and observation it was found that while some crew members made explicit reference to the formal system of procedures and risk assessment when accounting for their understanding of shipboard hazards, in general, although shipboard personnel tended to act in accordance with the procedures and requirements outlined in these formal documents, they seldom made explicit reference to them in their accounts of work-place risk.

Sharing Information between Peers

As well as learning through formal training and from company communications, individuals also learned from interactions with colleagues. Such interactions generally took the form of work instructions, toolbox talks or, more commonly, informal discussion. Reference was made to all three forms of learning by interviewees. For example, one AB described learning from his senior colleagues, in this case a bosun who pointed out the dangers during mooring operations.

> *So how do you know that's what you have to do?*
> I know that you know, before you do that you have to be careful and put your safety first, always safety first.
> *So who told you that, how do you know about it?*
> I learnt at the mooring station, the first time you know, my own bosun, I was very young, safety person (A, AB1-1)

Other ratings commented that the risks, associated with a job, were pointed out routinely when they received their work instructions. But equally, as this AB stated, such exchanges could go both ways, dependent upon an individual's experience.

> Yes my experience, his (the Bosun) experience and my experience, so that I learn from him, he learn from me. (A, AB2-1)

From both the interviews and onboard observation it was noted that break times (smokos) were often utilised as an opportunity to discuss work in general and particularly forthcoming tasks and possible risks involved. More generally, these informal occasions provided the opportunity to share stories, remembered or heard, and thereby to forge a common work-based understanding of risks faced.

The Role of Personal Experience

By comparison with formal informational systems, 'experience' appeared to play a central role in the development of workers' understandings of risk. Reference to personal experience, in terms of having learnt the risks from doing the job, from experience of different companies and ships, and from experience of actual incidents or the lack of them, all occurred regularly in the accounts of shipboard workers when explaining how they knew about work-based risk. Experience of doing a job was a theme returned to time and again, as this comment from a Third Engineer illustrates:

> [It] depends on who's doing the job, some people may risk something quite high, some others might think it's medium, depends where your safety lies really…it changes with experience, maybe a younger person might think oh that's not really dangerous, somebody who's more experienced who's obviously done the job, depends if you've done the job before, that's a lot to do with it… (C, 3E1)

Thus when explicitly asked whether formal risk assessments and company procedures contributed to understandings of risk, it was commonly suggested that practical learning was more central to understandings of risk than engagement with the formal safety management systems. The following quote illustrates this point clearly:

> [I]t's probably not the right thing to say, I know they are good but I think when you've been doing the job a dozen times, or twenty or thirty times, you're not going to suddenly look at a risk assessment, you know, perhaps where I go wrong, I can't, you know it's something you do everyday, it's like getting in your car, you're not going to sort of read a risk assessment before you get in your car are you, you know some of them jobs you are literally doing every day, you're not going to start reading a risk assessment after doing it for 5 years or something.

So do you go back yourself and look at them at all?

No... they're perhaps useful to somebody, a cadet or somebody, somebody new perhaps to the company, but I mean an experienced engineer, a load of that's all in built you know, you're checking this and doing that and checking it out before you start, and if you don't do that you shouldn't really be here anyway you know. A lot if it's you know, if you've been at sea a while and you've got all that experience, a lot if is you should know it, and a lot of them wouldn't want to read a risk assessment anyway. (C, CE1)

As well as experience of doing the job, a number of individuals related their perceptions of work-based risk to their experience of other ships. In some cases the differences in perceived levels of safety (including the provision of PPE) led individuals, especially ratings, to declare that there were no hazards aboard their present vessel. For example, several interviewees commented that, by comparison with their former company, the provision of PPE and the implementation of safety procedures meant that 'all was safe' as captured by the following remark from an AB.

[**T]his ship is safety**, in my opinion yes, **I've not see any dangers**…*So you were telling me on [Other] ships it's not like this?...* Yes [Other] I have experience …is very old ships, we don't have safety shoes, we have just one overall for 10 months you know …a dire condition onboard, one ship we don't have also control and engine room just this ship is very, very old (C, AB1-1)

While some individuals in accounting for the risks they perceived drew comparisons between companies or ships, others were influenced by changes within companies over time. This was particularly evident where they had witnessed the introduction of control measures or more generally a greater emphasis on safety within the organisation.

In terms of risk of injury to yourself when down the engine room or walking about the ship, what would you think would be the most likely causes of injury?
Trips and falls I suppose, the rest of it is pretty well sorted out; everything is guarded. (C, Eng. Rating1)

What emerged from these comments was a sense that conditions have improved and that individuals no longer see risks, believing that they have all been dealt with via the introduction of protective measures, i.e. the installation of guarding or the provision of PPE. A particular concern here may be that this relative sense that 'everything is

safety', or hazards are controlled, could lead to an underestimation of, or lack of engagement with, work-based hazards. This is an area worthy of further investigation.

Reference to one's own experience appeared to be an important touch-stone for individuals in making sense of the risks they faced. Arguably the factor that had the greatest impact on how seafarers perceived risk related to the occurrence of incidents that they had personally witnessed or, of which, they had heard first-hand accounts. Reference to recent experiences, or lack of them, was commonly given as the basis for judgements about hazards faced, as the following two comments from second engineers show.

> I think the weather plays a big factor…I mean it's calm now, but we may have to turn sharply that can throw you off balance that sort of thing. We've had some rough weather actually this trip before you joined, it was quite nasty… (E, 2E1)

> I can't really imagine what the greatest threat would be sort of thing as the accidents that sort of cause great injury are so few and far between it is really difficult to gauge which one is the sort of worst potential one. (E, 2E2)

Like the above interviewee, for this Chief Officer the lack of a major incident, or at least his awareness of such, combined with a sense that control measures were in place, informed his perception of the shipboard hazards.

> *What about all that fuel out there is that of a concern to you?*
> Well no because I don't you know, in this day and age the safety procedures in place have now more or less tended to circumvent likely explosions. You don't tend to hear of cargo operational explosions very often nowadays. (E, CO1)

From the frequency with which officers and ratings in identifying hazards referred to personal accounts of incidents or stories heard, such events clearly made a significant impression on them in relation to their appreciation of risk. For example, one engine room rating described how his perception of the need to wear safety goggles changed after he experienced a long term eye infection which was caused by a particle of cargo getting in his eye while walking on deck.

> The goggles, at first I was really pissed about, sorry. I was really fed up with that, really, really like fed up and was like here we go again, dressed like this spaceman … but I had a problem with my eye. I went to the doctors and …he says you have got something in your eye, it is [a small particle of cargo] anyway he cleared it up and I thought that, you know, if you had the goggles on then it wouldn't have happened. (C, Eng Rating2)

A Bosun also explained why he was concerned about the risk of fire. Despite the fact that the crew regularly conducted drills, his experience of an actual incident led him to understand that things could quickly become disorganised and to be concerned about the prospect of future fires.

> Well fingers crossed we haven't encountered any real big emergency in terms of fire, a big fire but from what I saw when there was an incident, we were going alongside [name of berth] and the bow-thruster blew up, the circuitries… the after spring is on the main deck and so I am stood there … the off duty AB was at the accommodation door, was that the alarm? What do we do? … I think the mate was on the bridge. The second mate went off without a radio, I think that perhaps an engineer went as well but the second mate came legging it past me about 10 minutes later, shouting fire, fire, fire. … it just seemed that nothing that you drill for occurred in that instance. **So I dread to think**. (C, Bosun2)

Tellingly, two ABs (serving aboard the same ship at the time of the interviews) both identified different activities when asked what they considered the main risk onboard to be. In each case they accounted for their perception with reference to an incident that they had previously witnessed aboard other vessels. In the first case the AB referred to the dangers of mooring lines parting, and he described an incident that happened on one of his former ships.

> [We] were in Brazil, and then the tug, it was a tug, the tug used the ship's line to pushing and pulling the ship, then this OS he arranged the mooring and the tug pulled the mooring so the rope slapped the head of the OS, then the OS died on the bridge. (A2, AB2)

By comparison the second AB thought that working in enclosed spaces posed the greatest risk and he illustrated this with an account of an incident that he had witnessed of a fitter falling inside a forepeak space.

> *What do you think is the most dangerous job that you do on the ship, which is the one which is most likely to hurt you, is it the tug lines or ?*
> Well when I experience more dangerous job, I work when we work enclosed space…[T]he one fitter … he said just go stand by there, anything we want for you just lower it …[but] he wants to help them and he doesn't know the place, he's not familiar, steep down …he just want to help them, falling down because he stepped on the hole …so the man on the top standing by with the radio, he called on the bridge and the captain made the alarm then we go for rescue, he experienced the actual rescue on the tank … it's already real (A2, AB4)

The ready reference to incidents witnessed, and stories heard, in explaining shipboard risk fits with previous research in other sectors which has shown that "people assess

the frequency of a class or the probability of an event by the ease with which instances or occurrences can be brought to mind" (Tversky and Kahneman, 1974, cited Gowda, 2003: 321). This appears to be an important finding and may help to explain why exposure to 'facts and figures' may impact so little upon more junior sea-staff.

Conclusion

A common understanding of safety within an organisation is central to the effective management of OHS. However, research shows that different work groups are likely to see risk differently. Hence for managers concerned to implement company OHS policy, it is necessary to appreciate the various ways in which different work groups perceive work-based risk, in order that safety initiatives are implemented in ways that are sensitive to such differences. What the data presented show is that managers and seafarers within organisations tended to utilise different resources in making sense of the risks faced by workers onboard ship.

The data suggest that, in the participating companies, many managers were able to draw in a meaningful way on knowledge of regulatory requirements, statistical information and fleet wide incident reports. By contrast, shipboard workers tended to refer to a wide and complex range of factors relating to their technical knowledge but also, and arguably far more significantly, to their local situated experience of actual conditions onboard informed by personal experience and engagement with their co-workers. That is, the terms of reference for the two groups in general appeared to be different. Managers appeared to draw meaning from the formal, the documented, whereas what had meaning for shipboard workers was more the personal, the experiential – a realm of information not directly available to managers. Recognition of these different broad ways of seeing risk is clearly essential for the effective management of OHS and the development of appropriate strategies. To this end, it would appear to be prudent for managers to engage in a meaningful way with workers to gain an appropriate understanding of differences in the way in which risk is perceived. As stated at the outset, these findings are based on an early analysis of the LRETRU data and a further in-depth report exploring these issues will be forthcoming.

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Investigating and Reporting Accidents at Sea

Mohamed Ghanem

Abstract

In order to prevent accidents from repeatedly occurring it is useful to understand and locate their causes. Models for analysing and determining the causes of accidents have been developed by various scientists since the early twentieth century. The maritime industry depends upon Accident Investigation Boards to investigate accidents and identify their causes. The public availability of Marine Accident Investigation Reports (MAIRs) is seen as an important step towards the improvement of safety in the maritime sector. As such, MAIRs are extremely valuable documents. This paper tries to shed some light on the relationship between existing accident causation models and the production of marine accident investigation reports to consider what, if any, is the relationship between them.

Introduction

There is some debate as to whether accidents are decreasing across the board in the maritime sector, to what extent, and at what rate. For example, the IMO's awareness bulletin in May 2009, under the heading "Doubts raised on data despite fall in accidents" states that:

> "A fall in the number of tanker incidents last year has been welcomed but doubts continue to be expressed about the accuracy of the statistics. The reported falls follow increases in 2007 of 22% and 62% in 2006 according to Intertanko. Similarly, the CDI, which represents charterers, recorded a 42% rise in 2007. That sharp increase in incidents that include groundings, collisions and engine failures prompted the vetting body to step up its inspections." LLOYD.S LIST, 22 May 2009, p 8

This paper is not concerned, however, to establish the accuracy of existing accident statistics. Rather, it focuses upon the construction of MAIRs and the extent to which they appear to be influenced by existing theoretical accident causation models. In doing so, the

paper considers the consistencies within, and/or the differences between, three selected investigating boards in investigating and reporting accidents in the maritime industry.

Methods

As part of my PhD thesis I have studied the progression and development of accident causation theories. These could be said to have started with the Domino theory of W. H. Heinrich in 1931 and to have developed all the way through the years to James Reason's 1997 'Latent Conditions and Active Failures' model, widely termed the 'Swiss Cheese Model'. Within this study I have considered the analysis of the content of MAIRs in relation to Reason's highly influential Swiss Cheese Model to identify whether or not MAIRs are produced with the model in mind. Accordingly, I had to establish a link between the classification of ranks onboard, positions in the shipping organisation and organisations beyond the shipping organisation concerned, with the levels established within Reason's model. This required a minor adaptation of the 'Swiss Cheese Model' and the addition of a further level within it as a result of the importance to shipping of organisations outside, or beyond shipping companies but, directly associated with particular accidents, (port authorities for example). I termed this new level, the '*Beyond* Organisational Level' (BOL) and it was included to allow for the consideration of those organisations exterior to the shipping organisation but having an influence on ships and their crews, their operation and their organisation. On this basis the analysis of MAIRs proceeded by identifying ranks onboard ships, positions within shipping organisations, and other related organisations mentioned in the reports and linking them with the following levels which are established by Reason and (in relation to the 'Beyond Organisation Level') within my adaptation of Reason's model:

- Operational Level (OpL),
- Supervisory Level (SL),
- Managerial/ Organisational Level (ML/OL),
- Beyond Organisational Level (BOL).

In conducting my research, it was most helpful to consider different maritime administrations alongside each other. In order to facilitate this comparative analysis I thought it was possible and necessary to conduct a content analysis of the reports of similar cases (I selected groundings and collisions) produced by three different maritime

administrations. In doing so I considered each of the report's sections separately and I then aggregated my results to generate an overall perspective. Therefore, there are content analysis results for the reports section by section as well as aggregated results for each report and aggregated results for the 10 collision cases and 10 grounding cases for each of the three investigating boards.

This method helped to identify any emphasis or apparent omissions in the MAIRs when considered in relation to accident causation theory. This paper will highlight Reason's Model and will go on to present the aggregated results for the collision reports considered, followed by a description of a single collision case to further clarify the findings.

The Swiss Cheese Model – Reason 1997

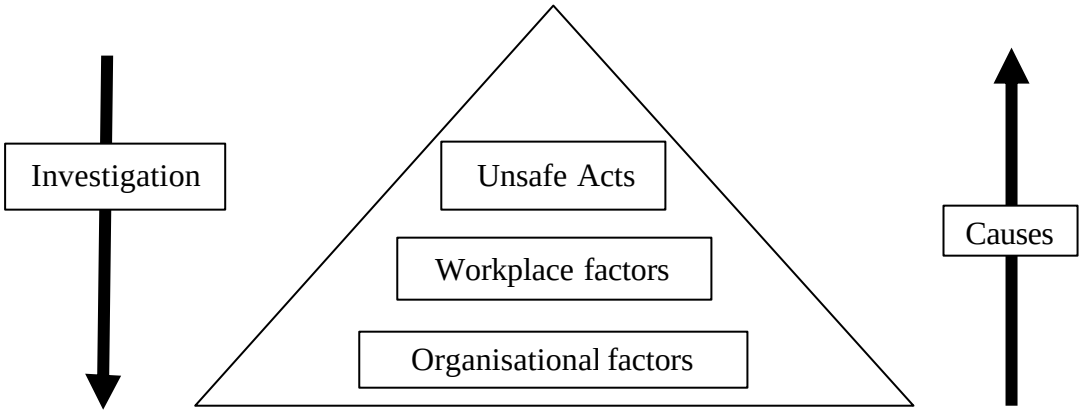
It is interesting to note that whereas investigators, generally speaking, begin with an accident and work backwards through a sequence of events to establish an understanding of causation, accident causation theorists tend to work in exactly the opposite way. Reason explains these differences in approach as follows:

> "This model seeks to link the various contributing elements into a coherent sequence that runs bottom-up in causation and top-down in investigation. The causal story starts with the organizational factors: strategic decisions, generic organizational processes forecasting, budgeting, allocating resources, planning scheduling, communicating, managing, auditing, and the like. These processes will be coloured and shaped by the corporate culture or the unspoken attitudes and unwritten rules concerning the way an organization carries out its business. The consequences of these activities are then communicated throughout the organization to workplace. These include … under-manning, poor supervision, low pay, unworkable or ambiguous procedures, poor communication and the like." (Reason 1997 pp 16)

In considering reports on accident investigations therefore, it is worth bearing in mind that investigators take their lead from the final unsafe act which caused the accident, and attempt to follow the chain of causes backwards. In contrast, the bottom-up approaches of accident causation theorists emphasise the radiation of latent conditions within organisations and present connected chains of events deemed to produce accidents (see Figure 1).

Fig 1 - Stages in development and investigation of an organisational accident

Reason 1997



Content Analysis Findings (30 collision cases)

Collision cases generally result from errors in navigation and manoeuvring. These errors are most usually produced by navigators and those associated with on board navigation (as opposed to engineers). As such these ranks are: the master, navigating officers, pilot and Able Bodied seamen (the Bridge Team). Possibly, where a collision was a result of engine related failure, engineers may be involved. However, after the content analysis for the collision cases were conducted, I had to separate the Ranks related to merchant ships from those related to non-merchant ships. The total number of Ranks mentioned as members of the operational level (as per the Reason model) in all the 30 collision cases amounted to 22. Of those 22 Ranks, 15 were related to merchant ships (7 were mentioned as cause) and 7 were related to non-merchant ships (4 were mentioned as cause).

The Operational Level

The results of the content analysis which I conducted clearly showed that the total number of times a rank classified as 'operational level' within the accident causation model was mentioned in reports of collisions is very high compared with the number of times the same rank is mentioned as causing the accident concerned (Table 1). In other words, operational level members of staff are mentioned very many times within a report despite the fact that they are stated to be involved in causing an accident much less often. This very high number is due to highly detailed and descriptive information within reports about what, how and why the accident happened in relation to members of the operational level.

Table 1 – showing 22 different operational ranks associated with 30 collision cases

Merchant Ship							
Serial	**Rank**	**Total times Mentioned**			**As Cause**		
		Inv. 1	**Inv. 2**	**Inv. 3**	**Inv. 1**	**Inv. 2**	**Inv. 3**
1	**Master**	**525**	**209**	**569**	**21**	**3**	**22**
2	**Chief Officer**	**386**	**0**	**129**	**17**	**0**	**12**
3	**Second Officer**	**218**	**227**	**79**	**16**	**12**	**1**
4	**Pilot**	**146**	**76**	**58**	**2**	**1**	**0**
5	**OOW**	**141**	**19**	**90**	**11**	**2**	**4**
6	**Bridge team**	**10**	**23**	**56**	**0**	**0**	**4**
7	**AB/Lookout**	**218**	**161**	**34**	**9**	**5**	**0**
8	Third Officer	14	74	12	0	0	0
9	Cadet	19	0	45	0	0	0
10	Chief Engineer	18	3	14	0	0	0
11	Second Engineer	0	0	9	0	0	0
12	Engineer	13	4	15	0	0	0
13	Electrician	0	3	0	0	0	0
14	Crew	175	106	141	0	0	0
15	Helmsman	0	0	18	0	0	0
Total	15 Rank	1873	905	1269	76	23	43
Other than a Merchant ship							
1	**Skipper**	**172**	**420**	**275**	**14**	**22**	**32**
2	**Deckhands**	**77**	**162**	**103**	**3**	**0**	**4**
3	**Tug Master**	**40**	**83**	**16**	**3**	**4**	**1**
4	**Coxswain**	**0**	**106**	**0**	**0**	**1**	**0**
5	Yachtsmen	1	0	0	0	0	0
6	Pump man	4	0	0	0	0	0
7	Boatswain	0	0	1	0	0	0
Total	7 Ranks	294	771	395	20	27	37
G. Total	**22 Rank**	**2167**	**1676**	**1664**	**96**	**50**	**80**

The Supervisory level Positions

The supervisory level is very important within an organization. This level has the characteristics of supervising the operational level and ensuring decisions made by upper levels are passed on to, and fulfilled by, the operational level (linking the upper levels with the operational level). The supervisory level in addition, passes over status reports, needs and requests made by the operational level to upper levels within organisations. In this way the stability of an organisation (including a shipping organisation) is maintained. However, the outcome of the content analysis shows that consideration of this level is almost entirely missing within maritime accident investigation reports (see Table 2).

Notwithstanding the absence of specific references to supervisory positions such as superintendents within the reports, it was sometimes implicit that there were deficiencies in supervision, i.e. at the supervisory level. For example where reports variously stated: "Neither bridge was manned as required by company orders" and "the watch keeper was distracted from lookout duties … unaware of developing situation … unable to fulfil his obligations" and "Operating with just two watch keeping officers, a master and a mate, in the coasting and near continental trade, will inevitably lead, on occasions, to the officers becoming fatigued. It is necessary to *adjust the vessel's programme to allow the officers to gain sufficient rest* before putting to sea" and "the AB never undertook bridge watch keeping duties. This was in contravention of STCW95", it would seem that deficiencies in supervision on board, or via superintendents are likely to have been associated causes of the resulting accidents.

Table 2 - Showing Supervisory Level positions associated with 30 collision cases

Serial	Rank	Total times Mentioned			As Cause		
		Inv. 1	Inv. 2	Inv. 3	Inv. 1	Inv. 2	Inv. 3
1	Superintendent	3	0	0	0	0	0
2	Not specified	3	1	1	0	0	0

The Managerial/Organizational level Positions

This level combines two levels as compared with other industries (Managerial level and Organizational level). The decision to combine these two levels is because Owners (OL)

can be managers (ML) and can also be the ship's Master is some cases. In addition, the number of Ranks which constitutes these two levels is few (see Table 3).

As I found in relation to the supervisory level it was also the case that some causes identified within reports which were not specifically identified by the authors as related to management nevertheless appeared to be so. Comments such as: 'greater consideration need be given … particularly in view of the ever increasing number of multinationals', and 'the employment of a dedicated lookout might well have prevented the collision' suggest that management decisions are more heavily implicated than the specific references to management within reports suggest. Clearly the employment of multinationals and employment of a dedicated lookout is Managerial/Organisational responsibility yet specific reference to management or management decisions in this context is obscured.

Table 3 - Managerial/ Organizational positions associated with 30 collision cases

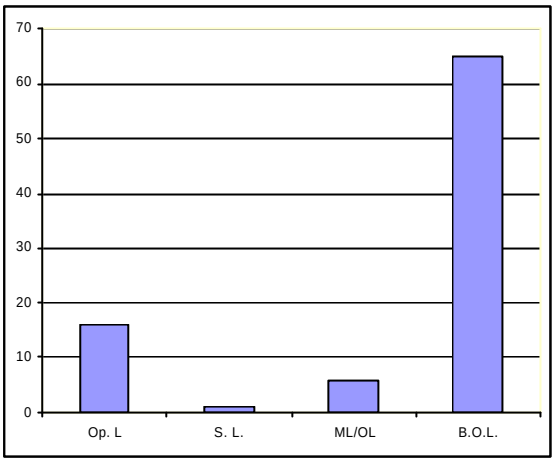
Investico one Rank/Mentioned/ Causes			**Investico Two Rank/Mentioned/ Causes**			**Investico Three Rank/ Mentioned/ Causes**		
Co. Manager	65	0	Manager	23	0	Co/Managing Co	50	1
Owners	33	0	Owner	23	0	Owner	24	0
Company	17	1	Operators	9	0	Operator	8	0
BRManagement	17	0	BRManagement	0	0	BRManagement	34	0
Agent	3	1	Agent	6	0	Operation man.	12	0
Not Specified	2	0	Not Specified	3	0	Not Specified	1	0
Total	**137**	**2**	**Total**	**64**	**0**	**Total**	**129**	**1**

The Beyond Organizational Level Organisations

The Beyond Organizational Level constitutes all authorities, organizations, councils, manufacturers, etc. with the power to influence and/or amend rules and regulations, and with the power to influence the environment within which ships operate (for example by providing accurate information e.g. charts, or by undertaking certain activities e.g. dredging channels, navigational aids etc). This level was found to be associated with the

largest numbers of different roles and titles, constituting 65 organisations/positions/ranks (see Chart 1).

Chart - 1 showing number of Ranks and Positions connected with 30 collision cases



As with the SL and the ML/OL there are some causes within the reports which were not specifically discussed in relation to specific individuals or organisational responsibilities but nevertheless clearly hinted at these. For example; "No formal guidance was given to pilots concerning the capabilities and limitations of tugs in the port" and "Had the locating beacon not been corroded and had functioned correctly, it might have …" and "large majority of vessels transiting choose tracks which run parallel and close. This causes bunching of traffic in this area" and "The reported … unreliability of buoyage, probably adversely affected confidence" and "Many fishing vessels display lights and shapes to indicate that they are engaged in fishing when on passage, and it is not surprising that many seafarers are becoming increasingly sceptical of their validity".

Despite the fact that there are clearly a large number of organisations at the BOL which are implicated in the shipping accidents considered (65 different organisations), nevertheless, BOL organisations do not receive a great deal of emphasis in the main bodies of the reports of accident investigators.

Table 4 - showing total aggregated results for 30 Collision cases

Levels	No of Ranks mentioned		No of times mentioned		Mentioned as a cause		Repetition	
Investico	**1, 2 & 3**		**1, 2 & 3**		**1, 2 & 3**		**1, 2 & 3**	
Op. L	22	23.7%	5507	88.3%	226	92.6%	108	98.2%
S. L.	1	1.0%	3	0.01%	0	0.0%	0	0.0%
ML/OL	5	5.4%	324	5.2%	3	1.2%	2	1.8%
B.O.L.	65	69.9%	404	6.5%	15	6.1%	0	0.0%
Total	**93**		**6238**		**244**		**110**	

If we move away from a consideration of the number of times individual ranks are mentioned to data related to causation, the picture changes dramatically. The 22 members of the operational level are mentioned 5507 times in the reports and 226 times as a cause of accidents. This compares to 404 mentions of Beyond Organizational level members and only 15 mentions of Beyond Organizational level members as causes of accidents. This clearly shows the emphasis on the operational level in their presence in the report and in attribution of cause.

Emphasis on the Operational Level can also be noticed in the use of repetition within reports. The content analysis findings identified 108 instances of repetition of cause (Table 4). For example, in one section of one report the following repetitions were identified: "the chief officer relieved the master on the bridge; about thirty minutes later he fell asleep" and "The chief officer fell asleep through fatigue", and "The chief officer was alone on the bridge".

In order to provide further clarification in relation to the content analysis findings of the aggregated results which I have presented so far, I thought it useful to present an illustration of the findings using an individual collision case as a specific example of the tendencies identified. This allows for the further examination of the kind of language used in the reports and the ways in which explanations of accident causation were developed or obscured.

Investigation of a collision between a passenger ferry and a private vessel

The selected report relates to a collision that occurred between a Passenger Ferry (31 crew members and 71 passengers) and a Private Launch (2 crew members) in 2005. It would appear that the Private Launch impeded the safe passage of the Passenger Ferry whilst navigating in a narrow channel. In brief, when the Private Launch was about 0.8 miles ahead of the passenger vessel, its lights were detected and when it was 0.6 miles ahead of the passenger vessel, the Master of the Passenger Ferry turned the control wheel to alter course about 10 degrees to starboard and sounded 5 short blasts. It seems that soon after the whistle signal, the Private Launch altered course to port in front of the Passenger Ferry which was still turning to starboard. The Master of the Passenger Ferry realised that a collision was imminent and adjusted the control wheel further to starboard and the engine controls to full astern. However, the bridge team onboard the Passenger Ferry lost sight of the Launch and although they did not hear or feel the impact, they realised, when wreckage was seen, that the two vessels had collided. The accident resulted in one fatality - the skipper of the Private Launch - and injuries to his partner. In addition, the Private Launch was a total loss (split in half) and some minor damage occurred to the Passenger Ferry.

The report into this accident contains a highly detailed narrative and descriptive information relating to the two ships. It includes details of their design and actions as well as personal information relating to the crew (including their certification), and actions that were taken well before the collision. The report contains clear details of the circumstances surrounding the collision, topography and local traffic, climatic conditions, medical pathology and toxicology for the Master of the Passenger Ferry and the Skipper of the Private Launch. The report also includes details of Nation State District Council Bylaws. It is worth noting that this was the third accident of this kind to have occurred in this Maritime Administration's waters in the previous three years.

Content analysis results - *Factual Information Section*

The data provided in the *Factual Information Section* of accident investigation reports vary in their importance. In order to provide a sense of the *less important* and the *most*

important details and how they are reported and to give life to the content analysis findings, two quotes from the report are selected. The first quote from the *Factual Information Section* states:

> "The actual times involved in the collision sequence were less important to the accident than the chronological order of events. The most reliable record of the order of events was the playback of the ENC log files; consequently this report uses the times from that system. The ENC computer was about one minute slow compared with the times recorded in the logbook, and 2 minutes 4 seconds slow compared with those from the GPS."

The second quote from this section states:

> "There was no requirement in any [Country name] legislation requiring a person in command of a private boat to be qualified, or to have had any training, or for the boat itself to be registered. The [Country name] District Council Navigation Bylaws 2002 sections [number] did require that a person operating a powered boat capable of a proper speed of 10 knots be over 15 years of age."

Here we see that although the first quote implies the presence of *time errors* these are actually of no significance to the investigation and have no direct or even indirect bearing on the accident. Yet, the detail provided of the *one minute slow* and the *two minute four seconds slow* in the first paragraph of the *Factual Information Section* serves to lend a spurious thoroughness to the investigation as well as focusing attention upon the Operational Level. On the other hand, the second quote which might be seen to be of central interest to the investigation is not presented as such. Rather it is obscured within seven pages of detailed quotations from National Bylaws and International Rules and Regulations. Such National Bylaws, International Rules and Regulations are very well known to qualified, trained and licensed mariners, not to mention legislators themselves. Their presence in the report serves to do little more than undermine the significance of the finding in relation to the collision and the Private Launch.

Table 5 - shows content analysis results of the *Factual Information* Section

Levels		Indicators from MAIR	Quantifier	
Ranks/Positions/ Organisations Involved		Possible indication	No. of times	As a cause
Op.L.	Master		48	
	Second officer		26	
	Cadet		22	
	Engineer		1	
	Second engineer		1	
	Bridge team		4	
	Crew		3	
	Helmsman/Lookout		3	
	Skipper		23	
M.L./O.L.	BRM		11	
	Shipping company		1	
	Owner		2	
B.O.L.	District council		1	

The content analysis results for this *Factual Information Section* identify the Ranks, Positions and Organisations mentioned in the report of this collision case with no attribution of cause (Table 5). In this particular report the factual information section avoids attributing causes altogether. However, in describing the sequence of events, the results clearly show an emphasis on the OpL. When we look at the other levels we see that:

- The Supervisory Level is missing in terms of a consideration of both the Passenger Ferry and the Private Launch.
- There is limited reference to the Management Level. The Bridge Resources Management (BRM) can be categorised as ML/OL which refers to the management within the Passenger Ferry (Master, Bridge team and Bridge Resources Management quotes in detail). There is one mention of the "shipping company" meaning the management company of that Passenger ferry. There are two mentions of the "Owner" which refer to the former Owner (on one occasion) and the skipper/owner of the private Launch (on one occasion).
- The sole mention of the District Council in the BOL refers to the national Bylaws quoted and provided by the nation state.

Thus analysis of the *Factual Information Section*, illustrates the fairly typical emphasis placed in MAIRs upon a detailed description of OpL ranks and their actions alongside the mention of other relevant information such as relevant National Bylaws, International Rules and Regulations.

Content analysis results - *Analysis Section*

In the *Analysis Section* of the MAIR for this incident some of the actions of related parties were analysed. However, to highlight some of the important points relating to the investigation, the section (Point One) begins by stating that the Nation States District Council's Navigation Bylaws of 2002 were quite clear. That is, firstly, small vessels shall not impede the passage of large vessels and that it was reasonable for the Master of the Passenger Ferry to expect that the Private Launch would not impede his progress. Secondly, Maritime Rules section *"Narrow Channels"* as quoted in the report (Point Two) required that vessels of less than 20 meters shall not impede the progress of vessels that can only navigate within a narrow channel or fairway. However the report further explains that while there was no definition of what constitutes a narrow channel, the confined waters of the collision area could well be considered narrow for vessels of the size of the Passenger Ferry.

Thirdly, the Private Launch which was 10 meters long did not have radar reflective material and therefore wasn't clearly identifiable by the Passenger ferry (Point Five) in addition, the lights of the Private Launch might have been difficult to see (Point Six). Interestingly (Point Eleven) states that neither vessel actually determined whether a risk of collision existed by taking relative bearings either visually or by radar and that the Passenger Ferry did have an ARPA facility, but when the target of the Private Launch was established there would not have been enough time to engage the ARPA and get any meaningful information from it. Furthermore the report states that had the Passenger Ferry's speed been reduced (Private Launch 0.8 miles away and closing speed was 24 knots when detected), there would have been slightly more time to better evaluate the situation and react accordingly. On the other hand (Point Twelve), had the skipper of the Private Launch reacted by increasing engine speed and altered course to starboard rather than to port the collision might have been avoided.

These points serve to illustrate the extent to which the investigation tried to locate causes for the collision within the operational level. After a considerable journey through these operational details the report finally states (Point Twenty):

> "At the time of the accident, [Country] had no requirement for private boats to be registered or their skippers to be qualified, trained or licensed. The only law pertaining to the operator of a private boat was contained in the Bylaws, which required a person in control of a boat that could exceed 10 knots to be over 15 years of age. Consequently, it was possible for an untrained person to be in charge of a private vessel of any size and power. Such a situation resulted in masters of large and generally less manoeuvrable vessels being unsure whether the skipper of a small boat knows the collision regulations and whether the appropriate action will be taken not to impede the larger vessel."

In addition, (Point Twenty Two):

> "Having no registration or compulsory identification marking on private boats made administering the Bylaws and collision regulations difficult. The virtual anonymity of private boats also reinforced the belief by masters of larger ships that little improvement would be gained by reporting every close-quarter incident that occurred."

These paragraphs clearly indicate that the accident might well be attributed in major part to the lack of adequate regulation pertaining to small private vessels. The report acknowledges that the Master had stated that he had reported several similar close-quarter incidents but the authorities had taken no action. This statement and the apparent lack of action taken in relation to the Master's report were not however further considered in the report. The report in addition does not elaborate on how the points made within its pages and relating to his actions could have been expected to be understood/appreciated by the skipper of the Private Launch, given that there were no requirements for him to possess or have received qualifications, licensing or training as stated.

The content analysis results for the *Analysis Section* again illustrate the emphasis on the Operational Level (Table 6). This is quite clear in the number of times the OpL ranks are

mentioned. Of most importance is the reference to the skipper of the Private Launch "if altered course to starboard rather than port the collision might have been avoided". In addition, the lack of consideration and emphasis given to the statement made by the Master of the Passenger Ferry that the authorities had "not taken any action" when he had previously reported close-quarter incidents with private boats is very telling.

Table 6 – shows content analysis results of the *Analysis Section*

Levels		**Indicators from MAIR**	**Quantifier**	
Ranks/Positions/ Organisations		**Possible indication**	**No. of times**	**As cause**
OPL.	Master		26	
	Second officer		5	
	Cadet		6	
	Second engineer		1	
	Bridge team		7	
	Crew		4	
	Helmsman		6	
	Skipper	- if altered course to starboard rather than port the collision might have been avoided	23	1
M.L./O.L.	BRM		2	
B.O.L.	District council		2	
	Authorities	- Had not taken any action	1	1

Content analysis results - *Conclusion Section*

The results of the *Conclusion Section* begin by stating that the findings are listed in order of development (chronological order) and not in order of priority. Nonetheless, for example, the sequence of points is as follows:

> "1 - The 2 vessels collided just south of [place name] shortly after 1911, but the precise position and time could not be determined."
>
> "2 - The Skipper of the Private Launch did not suffer any major physical trauma in the accident, but drowned following the collision between the 2 vessels."

> "3 - The Private Launch impeded the progress of the Passenger Ferry in contradiction to the Navigation Bylaws and the collision regulations."
>
> "4 - Prior to the collision the vessels were approaching each other on nearly reciprocal courses."

With respect to chronology it is clear that these points should have been in the point order 4 – 3 – 1 then 2. This chaotic pattern continues however as is clear in the order of the following points which would be more logically ordered as 17-16-14 then 15:

> "14 - There was no specific legislation requiring private boat operators to be trained or certified, or for their boats to be registered or certified seaworthy."
>
> "15 - The high density of traffic in the waters of the [place name] gave rise to frequent close-quarter situations. Although bylaws and collision regulations were in place, it was almost impossible to police such a large area effectively, particularly when private boats were unregistered and unlikely to be identifiable, thus reducing the likelihood of their being called to account for contraventions of the legislation."
>
> "16 - Drugs and alcohol did not contribute to the collision."
>
> "17 - More effective BRM on the Passenger Ferry might have allowed the bridge team to better evaluate and react to the situation."

Clearly this is neither laid out in order of development nor in order of priority, neither does it conform to any known accident causation model. Furthermore, and most importantly, the content analysis findings of this section demonstrate once again the emphasis on the OpL which I have identified as typical in my overall analysis (Table 7).

Table 7 - shows content analysis results of the *Conclusion Section*

Levels		Indicators from MAIR	Quantifier	
Ranks/Positions/ Organisations Involved		Possible indication	No. of times	As a cause
OP.L.	Skipper	altered course to port rather than starboard	5	1
	Master		4	
	Second officer		1	
	Bridge team		1	
ML/OL	BRM		1	
B.O.L.	Not specified	No specific legislation req. boat operators to be certified and trained	1	1

Content analysis results - *Recommendation Section*

The *Recommendation Section* of this report stands in contrast to the previous sections with a sharp shift in emphasis away from the Operational Level. It consists of two parts: previous safety recommendations and final safety recommendations.

The *previous safety recommendations* relate to the investigation of two similar cases which occurred in 1999 and 2001. They take the form of reported correspondence between Investico Three (the maritime investigation board concerned) and the Director of Maritime Safety, the Pleasure Boat Safety Advisory Group (PBAG) and the Manager of Recreational Boating. These Recommendations state:

> "In line with the recommendations made by the Pleasure Boat Safety Advisory Group in 1999, continue to monitor for the five-year period to December 2004, the impact of education initiatives introduced in [Nation State], against set safety targets. Further, that the systems of compulsory boating safety education in the [another Nation State] and other jurisdictions, continue to be monitored for success through the same period, with a view to implementation of such a system in [Nation State]."

The PBAG reply was:

> "Recommendation [number/year] is a continuous action in support of other initiatives now in place to address accidents in the recreational sector."

The Manager of Recreational Boating informed Investico Three that:

> We are reviewing the Pleasure Boat Safety Advisory Group report at this time after 5 years in effect. The draft review is largely complete and will be considered at the Dec 2005 meeting of the National Pleasure Boat Safety Forum. All recommendations in the report have been examined and I would be happy to send you a copy once the draft has been looked at by the Forum and their collective input is included, decisions regarding where we go will be made May 2006 when the Forum meets again."
>
> "The purpose of the review is to look to the future and also to look at what has been done from the PBSAG recommendations and how effective this has been, especially in preventing fatalities."

On the basis of these recommendations Investico Three noted that these recommendations are equally applicable to the current accident and they await its outcome (December 2005).

Two *final safety recommendations* were made by Investico Three. These were directed to the Director of Maritime Safety and the Passenger Ferry Shipping Company. The first recommendation is to determine the feasibility of private boats being registered, marked accordingly and required to meet the requirements of minimum standard seaworthiness. However, the Director of Maritime Safety replied that "This recommendation will be included as an agenda item for discussion at the next meeting of the National Pleasure Boat Safety Forum. The next scheduled meeting of the forum is in May 2006". They noted however that the fitting of radar reflector is often impracticable.

The second recommendation was to the Shipping Company Managing Director requiring the company to put in place procedures to reinforce the need for effective Bridge Resource Management onboard the company's ships. This recommendation, although

directed to the ML/OL, was not strongly supported by causes presented in the previous three sections of the report.

Table 8 – shows content analysis results of the *Recommendation Section*

Levels		**Indicators from MAIR**	**Quantifier**	
Ranks/Positions/ Organisations Involved		**Possible indication**	**No. of times**	**As a cause**
ML/OL	Company managing director		2	
	BRM		2	
B.O.L.	Director of Maritime safety		4	
	Pleasure Boat Safety advisory group		2	
	Manager of recreational boating		1	
	Pleasure boat safety authority		1	
	The Commission		2	
	Strait managing director		1	

The content analysis demonstrates that BOL organisations are introduced and addressed throughout the recommendations (Table 8) suggesting that in fact they are considered by the authors of the report to be key to the avoidance of further similar accidents. Furthermore, OpL ranks whilst continually emphasised in the main body of the report and other report sections were absent from this crucial section.

The findings from the content analysis of this collision case, as with other cases, show that the Operational Level is made central in the process of the investigation and reporting. The first two sections of the MAIR *Factual Information* and *Analysis* lay out and analyse in detail all of the information, Bylaws, Rules and Regulations relating to the Operational Level and detail in minutia actions of the relevant crew members. In addition, the *Conclusion Section* is neither presented in chronological order nor in order of importance allowing ambiguity to creep in to the interpretation of the accident and its causes.

The report's *Recommendations Section* however contrasts with the main body of the report. Whereas in the other sections of the report the BOL organisations mentioned are not discussed as part of the cause of the accident, within the recommendations section it is

possible to infer that BOL organisations have been interpreted by the author as being implicated in the causes of the accident. Clearly the recommendations are made in the hope that they will prevent a reoccurrence of similar accidents. Thus the recommendations can reasonably be understood as an attempt to address the underlying causes or contributing causes of the accident. The Operational Level ranks were missing from the *Recommendation Section* in spite of being the entire focus of the first three sections of the report.

Conclusion

Content analysis as a method utilised for analysing the accident reports demonstrated that reports strongly focus on the operational level and activities at the "sharp end". A common feature of all reports was the inclusion of highly detailed and sometimes repetitive narratives and descriptions relating to the operational level whilst in relation to the higher levels elaboration, and analyses of actions and inaction, was notably absent. On a number of occasions there were also some activities relating to *Beyond the Organisational Level* organisations which might be expected to be described in the reports and which were neglected. This was made particularly clear in the analysis of the reports' recommendation sections where there tended to be a sharp shift from addressing the operational level to addressing the upper levels. Moreover, the content analysis demonstrated that there was no follow up of recommendations made in previous cases.

The findings also demonstrated that a unified format is not utilised in reporting accidents in the maritime industry. This was made clear by the lack of chronological order, lack of organisational level order and/or lack of priority order used in structuring reports. In many instances there were shifts between levels and back again in the presentation of information, analysis and conclusions presented in the reports.

Contemporary accepted and respected theoretical models of accident causation emphasise that accidents are complex events. They do not occur simply as a result of a single problem or shortcomings relating to workers at the operational level (seafarers). The study of such models - lastly Reason 1997 - showed that there are chains of events which

are usually triggered at the highest level in the organisation creating latent conditions which may ultimately result in accidents.

If Reason's model relating to accident causation is valid, then it may be that one of the explanations for the repeated occurrence of similar accidents within the maritime sector is the tendency for maritime accident investigation reports to place an emphasis, whether intentionally or unintentionally, on the operational level when reporting causation rather than upon the underlying causes of accidents which are frequently embedded in the supervisory, managerial, and beyond organisation levels. There may be a number of explanations for such emphasis and these are not the focus of consideration here. What is important is to highlight the extent to which the repeated mention of operational level personnel in reports of accidents (even when they are not regarded by reporters as associated with causing the accident) and the omission, or only brief mention, of individuals and bodies at other levels serves to produce a strong impression that causation may be identified by focusing upon the actions of operational level personnel (such as Masters and officers on watch) and that it is these that need to be addressed. In fact in many reports the authors reveal, in relation to their specific recommendations, that it is not the actions of individuals alone that need to be attended to but procedures, regulations, management, and supervision. Regrettably because such recommendations do not emerge from the accounts given in the main bodies of the reports it may be that key stakeholders overlook their centrality and that readers of the reports are nevertheless left with the impression that what is at fault in any given case is an individual or a number of individual seafarers. This emphasis on the individual may lead to a failure to address the systemic causes of many accidents particularly when such failures lie within shipping organisations whose managers may not have close contact with regulators or maritime investigators and may rely solely upon their own reading and understanding of accident investigation reports in seeking to better understand the causes of the accidents which they seek to avoid.

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Supply chains and best practice in the management of health and safety at sea

David Walters

Abstract

This paper explores the role of supply chains in influencing health and safety management. It draws on a recent review of research findings on the subject more generally and considers their relevance to managing health and safety in the maritime industry.

The paper outlines findings concerning the direct and indirect effects of supply chain business strategies on health and safety arrangements and outcomes. While it reveals a remarkable lack of systematic and rigorous evidence on the way in which the internal dynamics of supply chains impact on health and safety management and performance, it suggests that the broad thrust of the literature points to the negative impact of these strategies on the health and safety of many of the workers involved. At the same time it identifies some strategies that target supply chains as a focus for improving arrangements for health and safety in modern business practice. The paper discusses these in terms of their effectiveness, and coverage and considers the drivers behind their implementation.

Although most of the research that has considered supply chain management and health and safety is focused on economic sectors other than the maritime industry, this paper argues that many related findings can be applied to the industry and are relevant to understandings of the way in which the current organisation of work in the maritime industry impacts on health and safety

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Introduction

Traditional approaches to improving the work environment and protecting the health and safety of workers have relied on the development, implementation and operation of employers' legal duties located within the framework of law governing relations between employers and their employees. Such requirements often originate in discourse involving economic actors representing the interests labour and capital,

mediated by political processes, leading to legislative standards and arrangements to seek compliance with them through the intervention of state regulatory inspection agencies. However, current approaches to achieving best practice in occupational health and safety have developed against a background of quite fundamental change in the structure and organisation of work and its regulatory, political and economic contexts. Such change as has come to characterise the so called 'new economy' globally. The maritime industry is widely regarded as a sector in which (for a host of reasons to do with its economic structure and organisation, its global reach and the limitations of both international regulation and organised labour) the impact of these changes is comparatively advanced.

In this scenario, established norms that influence the way in which health and safety management is conducted across a whole range of economic sectors are acknowledged to no longer hold sway in the same ways they did when traditional approaches to its governance and regulation were developed. Instead, where these approaches are seen to have failed, or to be no longer relevant, business practices and market regulation are increasingly seen as containing the appropriate drivers to stimulate and sustain best practice on health and safety at work. Business relationships operating within supply chains are an example frequently cited as possessing such capacity. Here again, while such features are common to many economic sectors, the maritime industry is in many ways an extreme case. In this paper I examine the evidence for the role of supply chains in health and safety and the claims made for it, with a particular focus on their relevance to improving health and safety management practices in the maritime industry.

To do so, it is first important to establish what I mean by supply chains and their effects and secondly why they are especially significant at the present time. Having done this, I consider the effects of an increased business focus on supply chains for the health and safety of the workers involved — in the maritime industry and elsewhere. In this part of the paper I outline some findings of a recent review of the research literature on supply chains and health and safety – considering both positive and negative effects — before turning to examine the implications of these findings for the future of health and safety at sea.

What are supply chains and why are they so important for health and safety management at the present time?

Supply chains describe business relationships in which goods and services are produced, bought and sold, and increasingly, the logistics necessary to maximise the flow of these processes. They cover simple transactions between buyers and suppliers as well as complex arrangements in which there may be multiple links in supply chains. Most business organisations are likely to be located within a nexus of buying and supplying relationships for goods and services that may be quite different in character according to the nature of the goods or services involved. They will, therefore, be likely to be involved in multiple supply chains and engage at different levels within each.

This has pretty much always been the case, but current business and organisational practices have served to increase the importance of supply chains to business strategy as well as within national and global economies. A range of wider economic and regulatory factors have also influenced the evolution of these practices, including developments in information technology and logistics, neo-liberal economic, political and regulatory strategies, and the related withdrawal of the state from command and control regulation, reduced power and influence of organised labour, weakening of the traditional employer-employee contractual relationship, and the increasing prominence of so-called 'porous organisations' and flexible work patterns (See for example, Kersley et al 2006, Millward et al 1992, Wiggins 2002, Colling 2005). Conceptually, these changes can be viewed as comprising developments that have served to make outsourcing more feasible for organisations and those that have driven it in 'business terms'.

At the general level, a central feature of the growing importance of supply chains in the production and delivery of goods and services, and hence the outsourcing on which this growth has been built, is the way in which it has involved a move by organisations to place less reliance on 'management through hierarchy'. In effect, this growth has encompassed a move towards the wider adoption of decentred and fragmented forms of management control that are more directly based on, and informed by, market logics and dynamics.

Supply chains and health and safety in maritime transport

In this scenario transport industries occupy a particularly significant position. On the one hand they, like many business organisations in other sectors, have sought to maximise their business advantage by manipulating features of supply chains to improve their profitability, efficiency and market position. On the other, they are also a key element in providing the logistics efficiencies that have helped make the focus on supply chains attractive to business in the first place.

Both these factors impact on health and safety. The first, as in other sectors, has especially involved a shift to greater use of outsourced labour supply in transport. In road transport for example, studies of accidents have drawn attention to the link between unsafe driving and work patterns imposed upon drivers through sub-contracting in the industry (Belzer 1994; Belzer 2000, Braver et al 1999, Mayhew and Quinlan 2006, Johnstone et al 2006). Negative health and safety effects of fragmentation and contracting out are not confined to the private sector, but feature in the public sector too as Danish research on bus drivers has shown (Netterstrom and Hansen 2000, Hasle 2007). Similarly, in rail transport there have been several major accidents, resulting in significant loss of life, that have been linked to multi-contracting in the supply of services. Less well known, is the toll of injury and fatalities suffered by the railway workers caught up in such changes of business practice (Baldry 2006).

However, maritime transport represents perhaps the most extreme example of a fragmented relationship between labour supply and company operation in transport. Here, the last two decades have witnessed major changes in both the nature of the labour force, its relationship with the ownership of ships and the way in which work in the industry is organised. Even though the largest share of ownership of the industry remains within the so-called 'embedded maritime states' of Europe and North America, its labour force does not. As is well known, the large majority of the more than one million seafarers working on merchant ships worldwide now comes from a small number of southern hemisphere countries such as the Philippines, India and China and from former communist Eastern Europe. They are recruited through crewing agencies on short-term contracts and work on ships managed by ship

management companies (Alderton et al 2004). This is a vivid illustration of a labour supply chain, in which the outsourcing allows buyers to contract labour at favourable prices and thereby reduce costs and raise their profitability. But the working conditions experienced by this outsourced and largely non-unionised labour force are extreme by land-based standards, involving long working hours, shift work and intensive work patterns as well as serious physical hazards (Bloor et al 2000, Nielsen and Roberts 1999). At the same time, the organisation of the labour process for seafarers has changed profoundly, with simultaneous drives towards work intensification through the employment of smaller crews and the operation of faster ships. A response to this shift in labour supply is found in requirements for seafarers to be in possession of particular qualifications in an effort to ensure standards of competence in the new, outsourced labour force. However as Bloor and Sampson (forthcoming) have vividly demonstrated in their study of training provision and off-shoring, the possibility for abusing this system is considerable

The maritime industry even better illustrates the effects of the second aspect of increased business focus on supply — the emphasis on logistics. Key to the success of supply chain management is speed and efficiency in transportation. The central role of merchant shipping in the logistics of global supply chains has meant that to increase profitability, as well as the above changes, the containerisation of goods has taken place on a fairly widespread scale in relation to the transportation of non-bulk dry cargoes. This has led to profound changes in operating practices and the redesign (and relocation) of ports to achieve shorter times spent in loading and unloading cargoes (DeSombre 2006, Kahveci and Nichols 2006, ILO 2001). Arguably the consequences of these changes are seen in the way in which occupational mortality and morbidity rates for seafaring remain among the highest for all occupations (Roberts 2000, Roberts and Marlow 2005). They are further seen in the high incidence of shipping incidents ascribed to seafarer fatigue, and the range of psycho-social health effects caused by working patterns and the social isolation experienced among seafarers, both at sea and in modern port facilities ILO/WHO 1996, Wadsworth et al 2006).

Chartering arrangements further demonstrate the way in which a business focus on supply chain management helps to disrupt the legally constituted relationship between

employer and employee, on which, as in other industries, most approaches to the safety management of ships are based, with results that sometimes lead to serious incidents to ships and threaten the safety of seafarers. For example, as Sampson (2008) describes in her analysis of the effects of the direct relationship between a charterer and the captain of a ship (*Kodima*) involved in a major incident at sea, how direct pressures from charterers can lead captains to undertake actions that are against their professional judgement. How frequently the commercial interests of charterers, which demand a speedy delivery of goods, feature in the underlying causes of such major incidents is not known and would be worthy of further investigation. However the essential point here is that it represents a situation typical of the growth in 'porous organisations' in which buyers are able to deal directly with the employees of the company with which they have commercial contracts and, in so doing, impose demands on them that are based on these commercial interests. This circumvents a legal relationship determined in the contract of employment, which is the basis for employer responsibilities for health and safety and the primary driver for health and safety management at sea as elsewhere. Such situations therefore undermine the theoretical protection for seafarers provided by these responsibilities and the systems they engender, make the implementation of systematic approaches to health and safety management more difficult to achieve in practice and increase the vulnerability of seafarers.

The logistics revolution that has enabled the 'efficiency successes' of supply chains management in the maritime sector has not only had a profound impact on the structure and organisation of the life and work of seafarers but also on that of dockworkers and related labour Bonacich and Wilson 2008).

While some dockworkers and their trade unions (such as those on the West Coast of the US) have managed to hold onto a favourable labour market position in the logistics revolution, it is evident that this has not been the achievement of all dockworkers. Even where it has been the case, it has by no means prevented the considerable job-losses that have accompanied the port redesign and relocation that has occurred on a major scale in North America, Europe and elsewhere in recent decades. Moreover, such redesign has led, not only to changes to facilitate

containerisation, but also to widespread change in port design generally, with specialist terminals for handling oil, chemicals and other cargoes.

What all these developments have in common is a focus on speed, efficiency and economy in the carriage of cargo. Their results have had major implications for the dockside labour force, with a significant reduction in the number of workers involved, destruction of docklands social communities and, for those fortunate enough to be retained in work, relocation of workplaces to 'transport hubs', sometimes considerable distances away from previous worksites and major changes in the nature and level of intensification of the work involved. As a result, with a much reduced labour force and technological development, the overall incidence of harm from the hard physical labour associated with the work of loading and unloading ships could be anticipated to have reduced in scale. But as is evident from the incidence of major and fatal accidents, in fact, the work remains hazardous and the occurrence of serious and fatal injuries continues to be a problem – as does the hidden health effects of all these changes on the populations affected by them.

For seafarers too, the redesign and relocation of ports adds not only to the intensification of work but also to social isolation, as they are no longer able to enjoy the extent of shore leave that was once the norm, nor are many of the ports in which their ships berth found near the centre of cities today. The result is a further contribution to the institutionalised and isolated lifestyles of seafarers, which has been noted to contribute to poor mortality and morbidity outcomes.

Wider evidence of the impact of supply chains on health and safety at work

While the maritime industry represents a fairly extreme case, none of these examples from maritime transport are particularly surprising if the wider literature on the consequences of the business focus on supply chains is considered. In their recent review of over 250 studies, Walters and James (2009) found they pointed overwhelmingly to poorer working conditions, seen as 'indirect' consequences of supply chain management arising, in the main, from the manipulation of price and delivery conditions by those in powerful market positions within supply chains, and from the complex and fragmented webs of relations between contractors and

subcontractors, also often the product of outsourcing, who are engaged at the same worksites.

They report studies from a host of industries including construction, chemicals, motor manufacturing, telecommunications, the nuclear industry, food production and processing, textiles and footwear (as well as the studies in the various branches of transport already mentioned). Insofar as evidence on the health and safety effects of supply chains was identified in these studies they noted that it took three main forms:

- Analyses which explore, conceptually and on the basis of secondary evidence, the *potential for outsourcing, and hence supply chains, to have adverse health and safety effects*;
- Empirical findings which shed light on the propensity for workers employed in sub-contracting organisations, or on types of employment commonly associated with the growing use of outsourcing, *to experience work-related ill health and injuries*;
- Empirical explorations of *the way* in which the operation of supply chains in particular sectoral settings impacts on the working conditions of those who work for supplier organisations.

These sources of evidence, both individually and in combination, provided considerable support for the view that the dynamics of supply chains frequently lead to adverse health and safety effects. They also show how these effects are intimately connected to the way in which such dynamics serve to exert downward cost pressures on suppliers, thereby leading them to adopt more intensified and casualised employment regimes, and, more generally, act to engender poorer quality, and more fragmented, health and safety management arrangements.

For example greater control by market and related mechanisms in recent decades has led to significant changes affecting work organisation including restructuring/downsizing by large private and public sector employers and consequent effects on work intensity via changes to staffing levels/workloads, multi-tasking, increased hours of work/presenteeism and unpaid overtime, decline in the proportion

of the workforce in full-time permanent employment (especially for males) and increased part-time, temporary, fixed term and leased (agency) work, elaborate national/international supply chains and growing use of (multi-tiered) subcontractors and agency workers. Outsourcing in the private and public sector has led to growth of self-employment, growth in micro businesses and in the number of small business employers. Subcontracting/franchising as well as use of IT has facilitated the growth (sometimes re-emergence) of home-based work, remote, transient (such as short term call centres) & telework. There are further associations with increases in multiple job-holding — often associated with part-time and temporary work (Louie et al 2006).

Such findings are not exclusive to small firms and apply equally or even more so in the case of precarious forms of employment such as result from the supply of labour through employment agencies, through labour leasing or through subcontracting, Quinlan et al (2001) reviewed nearly 100 studies that had used indices such as injury rates, sickness absence rates, occurrence of cardiovascular disease, and knowledge of legal rights and responsibilities in OHS, as well as subjective measures of health outcomes. Nearly 80 per cent found an association between the type of employment in question and adverse health outcomes. In a more recent review that updated and applied more robust selection methods and quality criteria to the studies reviewed, the same authors confirmed these earlier findings and OHS was found to have been adversely affected in an even larger majority of relevant studies (Quinlan and Bohle 2008). Quinlan and his colleagues (2001) have argued that the economic pressures and reward systems encountered in these forms of employment result in poorer health and safety outcomes than might be anticipated in more traditional employment arrangements, leading them to comment that in 'any organisation where outsourcing has become common, OHS standards deteriorate…' (Mayhew et al 1996).

There are at least four sets of compelling reasons why the net aggregate effect of outsourcing are likely to be adverse that are generally supported by evidence from research literature. First, much of the externalisation of work activities has gone to smaller organisations, which possess less adequate and sophisticated systems of risk management than their larger counterparts and for which there is now substantial evidence that both health and safety management and performance is poorer than in their larger counterparts (Nichols 1997, Eurostat 2002, Nichols et al 1995, Cully et al

1990, Stevens 1999, Walters 2001, 2008). Second, problems arise with regard to the co-ordination of such management in situations where sub-contractor and temporary staff work in physical proximity to in-house personnel. Third, inter-organisational contracting can have a detrimental impact on conventional channels for the representation of the interests of workers. (Johnstone et al 2006, Walters and Nichols 2007). Finally, associated commercial contracts can limit the ability of those organisations engaged in the supply of labour or the provision of manufacturing and other services to invest in preventive health and safety measures for example, in a British study of health and safety in small firms, owner/managers reported how their ability to invest in health and safety was limited by the narrow profit margins that they were operating under as a result of the contract prices demanded by larger clients (Vickers et al 2003).

Evidence from a number of studies further suggests that the co-ordination of risk management is problematic in sub-contracting and labour outsourcing because overall management control and responsibilities are more diffused in these situations (Wright 1986, Wright 1994, Baldry 2006, Cullen 2001, Uff 2000, Loos and Le Deaut 2002). There is also some evidence to show that the direct and indirect effects that buyers have on suppliers can lead them, in turn, to seek similar changes within their own suppliers. There would, however, seem to have been surprisingly little detailed research undertaken which sheds light on these 'second tier', or 'downstream' effects, either generally or specifically in relation to health and safety elements (Scarborough 2000, Turnbull et al 1993).

There is also a considerable body of evidence relating the development of the kinds of work insecurity, intensification and flexibility typical of the results of supply chain pressures, to a variety of adverse health and health related outcomes, including increased incidence of cardiovascular disease, burnout and depression, (Kivimaki 2000) Ferrie et al 2002) and to poor workplace safety outcomes (Thebaud Mony 1999, Rouseau and Libuser 1997, Benach et al 2002, Blank 1995, Allan 2002). Factors associated with these poor health and safety outcomes again include greater job insecurity, poorer pay, lowered access to training among precarious workers, less control over working time, which in turn contributes to lack of knowledge and awareness of safety issues and complaints about lack of voice (Aronson et al 2002,

Draca and Green 2004, Feldman et al 1995, Bohle et al 2004, Walters and Nichols 2007).

Another way of looking at the impact of these structural changes in employment is to examine their influence on the achievement of a 'positive safety culture' by organisations. Research suggests that such a culture requires good communication, trust, the presence of OHS feedback systems and shared perceptions of commitment to OHS. Following an extensive review of the theoretical and empirical evidence of the likely effects of changing employment relationships on safety attitudes and behaviours and their implications for organisational safety culture, Clarke (2003: 49) argues:

> An overview of the evidence suggests that organisational restructuring may damage the mutual trust between core workers and managers, undermining the existing safety culture. Furthermore adding contingent and contract employees to the workforce threatens the integrity of the safety culture by further eroding the trust of core employees.

In summary then, the vast majority of studies in which the effects of supply chain business orientations on health an d safety have been studied demonstrate poor health and safety outcomes and a constellation of structural and organisational reasons why they occur. While this work has been undertaken predominantly in land-based economic sectors, it strongly supports the findings of the much more limited studies on the maritime industry reported earlier and suggests that, if more detailed and robust studies were undertaken in the sector, they would be most likely to expose similar details of poor health and safety outcomes and similar reasons for them.

A glass half full? — Harnessing supply chain management to improve health and safety

Despite this somewhat gloomy scenario, in some of the studies reviewed by Walters and James (2009), there is an acknowledgement that the economic relations involved may, in certain circumstances, lend support to improved health and safety arrangements for individuals or organisations in dependent relationships within supply chains. This is as a result of the ability of powerful supply chain actors to

require their suppliers to adopt certain specified policies and practices. It is these so called 'direct effects' that seem to have caught the attention of national regulators and policy-makers who are faced with developing strategies for achieving and maintaining compliance with health and safety standards and protecting workers in a rapidly changing economy. As a result, the supposed positive role of supply chains has become increasingly prominent in policy rhetoric concerning ways of reaching, supporting and sustaining good health and safety practice within small firms, among contractors and subcontractors, and in relation to the safe use of hazardous substances and machinery — especially within neo-liberal economic and regulatory constructs. They also feature quite extensively in public relations pronouncements concerning corporate social responsibility and fair-trading arrangements, especially among companies engaged in global trading.

Given their prominence and their clear attractiveness to policy-makers in current economic and regulatory scenarios – it is important ask what is the evidence for these claims, what are the drivers of good practice and — in relation to the particular focus of the present paper – what is the relevance of the answers to these questions for the maritime industry.

Attempts to improve health and safety management within supplier organisations vary in terms of their form and foci, but broadly encompass, procurement strategies that use health and safety standards to select contractors, certification schemes aimed at ensuring the competencies of contracting organisations and those working for them, and the imposition of requirements relating to the more general management of health and safety, including the utilisation of risk assessment and communication within multi-contractor/subcontractor work sites. They differ in terms of their level of operation, with some operating on an industry/sector basis, and others at the level of individual contracting organisations or, as in the case of construction, individual projects.

In general, systematic evidence regarding the impact of these types of initiatives is weak. Walters and James (2009) nevertheless identified a limited number of examples where there had been positive effects on standards of health and safety management and performance. None of this evidence comes directly from the maritime industry.

Indeed it is mostly restricted to cases in construction, in road transport, food production and in the textiles and footwear industries. Nevertheless it describes situations for which there are analogous cases in the maritime industry and which therefore suggest scope for further investigation. Essentially, these situations can be described under five main headings, each of which is briefly summarised below.

Procurement strategies: In theory, the power wielded by the purchaser of goods or services allows client/customers opportunities to influence improvement in health and safety management among suppliers. There is some evidence to indicate that procurement approaches used to improve health and safety arrangements by large construction concerns during major projects meet with some success. For example, during the building of the major land works supporting the land/sea link between Denmark and southern Sweden in the 1990s, evidence showed that initiatives on health and safety requirements in procurement helped to reduce the incidence of occupational accidents (EU OSHA 2000). Similar findings were reported in relation to the building of Terminal 5 at Heathrow Airport (Ewing 2006). They were prominent in the construction of the facilities for the Sydney Olympics – where, Government, business and trade unions agreed to collaborate to achieve a number shared objectives including 'the highest possible standards of health and safety' leading to an exemplary performance (Webb 2001) and are currently in use by the Olympic Development Authority for the London Olympics (Waterman 2009)

However, other research on procurement practices in construction for example, suggests that the achievement of such influence is far from the norm the industry. Findings of a survey by Davies Langdon (2007) for instance showed that while clients set contractual requirements on health and safety in the procurement of services, they were less engaged with efforts to monitor compliance or undertake post-completion review of such arrangements. In other words, opportunities to monitor and improve supply chain influence were being overlooked— despite its comparatively tight regulation the UK.

Research literature on selection issues in the procurement of contractors in construction more generally suggests that health and safety, while present, is not prominent. Findings in an early study (Hatush and Skitmore 1997) indicated that the

most common criteria considered by procurers during the prequalification and bid process were 'those pertaining to financial soundness, technical ability, management capability, *and the health and safety performance of contractors*' (my italics). Most studies, however, show that quality record, contractor experience and company reputation are the most influential criteria, with tender price exerting the most significant influence (Jennings and Holt 1998), while one study on the procurement and management of small building works suggested that the CDM Regulations in the UK had 'left ambiguities, primarily through specified exclusions to application, through which health and safety responsibilities may be downplayed or even simply disregarded' (Griffith and Phillips 2001).

Beyond the construction industry, the role of procurement in requiring improved health and safety from suppliers is cited in a number of accounts. For example, the European Agency for Safety and Health provides an account of the practices in the main electricity producing and distributing company in Belgium, where health and safety requirements are applied both to the procurement of labour and products (EU OSHA, 2000:94-99). This appears to be aided by the presence of national contractor certification systems in Belgium that enable the company to choose appropriately experienced contractors.

Consideration of health and safety in procurement strategies is also occasionally found in relation to products, such as with hazardous substances (Walters 2008) and in the hire of power tools in construction (Ponting 2008).

Certification, competency and supply chains: If customers are required to assume some responsibility for choosing contractors from among those qualified and competent to undertake work safely and without risk to the health, it follows that they need information to make appropriate choices. This requirement has stimulated the development of certification systems covering both organisational and individual health and safety competencies of contractors. For example, the Dutch *Sicherheits Certifikat Contraktoren* (SCC Certificate) used in several EU countries is an example of supply chain leverage on contractors to evaluate and certify their OSH and environment management systems. It is intended as a means to demonstrate that a contractor works in compliance with fundamental statutory requirements. Significant improvement has been reported as a result of its development (EU OSHA 2002). But

detailed evaluation of the underlying factors influencing its implementation, operation and outcomes appears lacking.

In the UK, where similar responsibilities are also the case under the CDM Regulations, their downside has also become increasingly evident, especially in relation to the over-bureaucratisation of supply chain management. Carpenter (2006) for example, provides details of a dozen schemes that are available for assuring individual competencies and more than twice this number for assuring organisational OHS competence. Not surprisingly, his report's recommendations concerns ways of standardising these approaches, echoing similar findings from others, such as the Better Regulation Unit, which warns of the growth of multiple schemes, and the confusion of, bureaucratic burden upon contractors (Better Regulation Unit 2008). Nevertheless, there is no sign of the recommended rationalisation occurring.

Inspection, auditing and monitoring: The importance of the inspection, auditing or monitoring of suppliers' performance in accordance with procurement criteria is identified in several of the above accounts. It also features generally in accounts of supply chain management influence. Two aspects are particularly pertinent, the first being the indication that buyers frequently do not follow through with adequate monitoring arrangements and the second, that when they do, they are often over-bureaucratic. Two HSE research reports that examined health and safety in supply chains in three sectors, food processing, health services and private events organising (Partnership Sourcing Ltd 2003) and on client/contractor relationships in six different economic sectors (Partnership Sourcing Ltd 2006) comment on the tight control — including regular audit and inspection — by supermarket chains in relation to food hygiene and note the obvious business reasons why this is so. But they further note the absence of similar messages in relation to health and safety, thus echoing more in-depth research into food retail supply chains (see James and Lloyd 2008).

Supply chains and other aspects of health and safety management systems: In Germany VW-Audi offers specific support for the management of the hazardous substances it supplies to about 2,600 small contractual car-dealers and garages, About 2,500 different chemical products are available under the VW-Audi label, the use of which is prescribed by VW-Audi. There is no published evaluation of the impact of

this support, but anecdotal observations suggest dealers and garages rely on it (Sul 2005 in Walters 2008). A reason given for this dependency is that the dealers and garages are obliged to comply with the quality management system of the company and this compliance is checked during annual audits. It is a good example of very close and contractually determined association between a large buyer and economically dependent dealers and garages allowing the latter little choice but to comply in order to retain business.

The chemical industry utilises supply chains to promote its programmes like Responsible Care and Product Stewardship, which concern the sound management of safety, health and the environmental effects of products. This necessitates co-operation between dealers and users and is intended to offer an early warning system for safety, health or environmental risks relating to a product, allowing problems to be tackled in good time. In theory it should lead to increased trust between suppliers and customers and greater confidence throughout the whole product chain, as well as acting as a motor for continuous innovation that will enable incorporation both of new regulatory and market developments. Limited evaluation of these programmes, has suggested they are successful within the industry itself, but there remains uncertainty concerning their reach, for example, to users outside the tight relationships within the industry (Walters 2008:143). Generally, work on the nature of inter-organisational relationships within the chemicals industry has highlighted the extent of integration that exists here and how it is governed by both the structure and the nature of the economic relations between customers and suppliers within the industry, the ways in which the development trust is supported in these relations and the role of individual 'boundary spanning' agents in maintaining co-operative practices between organisations (see Marchington et al 2005: 135-156).

This is an important point. The research literature on management more generally, when regarding supply chain relationships and the factors which influence them, draws a distinction between relations that are more transactional, and primarily cost-based, and those which are more collaborative and incorporate a greater degree of financial mutuality (Espino-Rodriguez and Padron-Robaino 2006). Strongly cost-based supply chain relationships have adverse implications for the employment conditions applying to those employed by lower level suppliers (Hunter et al 1996,

Scarborough 2000, Wright and Lund 2003). As James and Lloyd (2008) show, such conditions so negatively affected can include health and safety.

The wider literature also indicates that the existence of a substantial degree of trust between the contracting parties is crucial to the establishment of collaborative types of arrangements and that this is most likely to exist where a good deal of mutual dependency and risk sharing exists, and where power is relatively evenly distributed. It further notes that there are contexts within which those at higher levels within a supply chain may choose to impose employment-related conditions on to suppliers lower down them as a result of 'quality' considerations; such as concerning the qualifications of staff and the training that they should receive (Swart and Kinnie 2003, Kinnie and Parsons 2004). These are potentially beneficial in terms of health and safety but adverse implications can also arise — especially if these conditions are imposed on suppliers at the same time as strongly cost-based contracting practices (Beaumont et al 1996).

Infrastructural support: There is also evidence that not only are the direct relationships between suppliers/users, customers/suppliers important locations for leverage to improve health and safety but that related organisations in their business environment may also be useful in this respect – as is the case described by Walters (2008), where a German paint suppliers' association provides important supporting leverage to achieve the safe use of hazardous substances. This illustrates a further precondition likely to be important for the success of supply chain initiatives on health and safety. A well-established feature of German industry is its strong (and regulated) sectoral infrastructure. As Walters (2008) has argued, it is this feature that supports the inter-organisational arrangements for health and safety that are often apparent at sectoral level in Germany. In looser organisational contexts such as in the UK it is unlikely that such infrastructural support will be the norm.

To sum up then, it seems that intervention in supply chain management to support health and safety *can* work under certain circumstances. However, three features emerge from this overview. First is the sense that the evidence of this is limited because very few initiatives have been subject to any rigorous evaluative scrutiny. Second is that despite this, the various examples corroborate one another in terms of

the ubiquitous presence of internal 'regulatory' arrangements whereby dependent actors in supply chains are, in one way or another, subjected to processes of supervision and control. The third striking feature of these accounts is that they seldom offer much inkling as to *why* the dominant players chose to take these initiatives to promote and support health and safety management amongst their suppliers in the first place and *what* it is that drives them to maintain the scrutiny most accounts deem necessary for their success.

To answer this question Walters and James (2009) found it necessary to turn to literature on global supply chains and fair trading standards. Here, while drivers such as increased profitability and business efficiency, company reputational risk, and corporate social responsibility agendas, as well as compliance with regulatory requirements, are frequently cited by the heads of global supply chains as reasons why they subscribe to and promote fair labour standards, it is equally clear that awareness of the benefits of exerting such influence is not necessarily automatic on the part of the organisations concerned.

A more comprehensive reading of the literature on market regulation — and especially that on global supply chains — suggests that a striking feature of this environment concerns the involvement of a range of actors, structures and procedures beyond the immediate supply relationship, that act — or have acted — in concert to prompt and sustain the desired effects concerning improved working conditions for vulnerable workers at the end of the chain. For example in the global food, garment and footwear industries, the business case for supply chain controls to improve health and safety conditions in the supplying farms and factories of the southern hemisphere, does not emerge directly from the improvement of the health of the workers concerned— or even from the possible increased efficiency and quality achieved by this improvement. Rather, it comes from the potential for improvement in the public image of the client and the consequent selling potential of its 'labels' in northern hemisphere markets, which are otherwise threatened by bad publicity associated with exposure of poor conditions of labour in its supply chain.

Such threats to business and the freedom of capital emerge from the effects of the concerted efforts of networks of social interest groups, organised labour, regulators,

media and so on. They are further sustained by alignments of mutual interests among trades unions, non-governmental organisations, labour inspectors, consumer and community action groups and others seeking to represent the interests of exploited workers, in negotiation and consultation with representatives of the companies at the heads of the supply chains concerned.

The 'ethical trading partnerships' that result from such relations are further supported by various international bodies such as the ILO, WHO, donor agencies and NGOs and also enjoy a degree of arms-length approval from associated governmental bodies. The consequences are seen, for example in the more than 1000 corporate codes detailing labour conditions for corporate suppliers estimated in a World Bank (2000) survey and the 98 per cent of the world's largest 500 companies that are reported to have a code of ethics or similar (Wilson and Gribben 2000). They are also found in the flagship partnerships such as that between multi-national car manufacturer, Volkswagen AG, the ILO and the German aid agency GTZ aimed at the development of an international guideline for OSH and supply chain management (Fromman 2008, Kristjansdottir 2007). But as Rodriguez-Garavito (2003) puts it, the stimulus for their development is found in the efforts of interest groups to expose the abuses of labour conditions for workers at the base of global supply chains and spur the formation of transnational advocacy networks:

> '….aimed at re-establishing the link, blurred by global outsourcing, between brands and retailers in the North and workers in supplier factories in the South.'

Analysis of these interventions has led to the emergence of a theoretical literature in which they are regarded as part of a new form of global economic regulation which increasingly occupies the space between the perceived failure of state regulation and that of the market to achieve such ends in supply relations (see for example the work of Jessop (2002) Braithwaite and Drahos (2000) O'Rourke (2003), Weil and Mallo (2007) and others).

This is not only something that applies in the global relations between labour and capital but as Arup et al (2006), Heckscher (2006) and others have noted, it also has

resonance much closer to home. As the power of organised labour to confront capital has been weakened by changes in the structure and organisation of production, other forms of social resistance have emerged within civil society. Often isolated, ephemeral and issue specific, their impact is usually limited, but occasionally, and especially when they act in concert they are able to mount a more formidable challenge and force business organisations to modify their commercial strategies. Thus, in some of the examples of direct supply chain effects on health and safety management previously cited, the high profile of the activities involved — such as for instance, in the construction of facilities to host major sporting events or to build new airports — has meant that trades unions, environmentalist groups, victim support groups and others have been able to operate alongside state inspection agencies and persuade the heads of supply chains in the businesses involved to implement more rigorous health and safety standards in order to offset the reputational risks associated with very public evidence of the fatalities that could otherwise be anticipated on the construction sites in question. Thus, the significance for trades unions in influencing the terms under which the construction of sports stadiums and the like takes place, is that it results from their potential to act in concert with others to draw attention to the damaging effects on large contractor company reputations in such high profile situations, rather than stemming solely from their power in labour relations on construction sites.

These observations are especially pertinent in relation to the potentially positive role of supply chains in the maritime industry. It is to this we turn by way of conclusion.

Conclusions: the relevance to the maritime industry

At sea — as in other economic sectors — the predominant impact of increased business focus on supply chains is to worsen the conditions of labour (and hence health and safety) for seafarers, both because of the significance of current outsourcing and off-shoring strategies and because of the key position of the industry in terms of global supply chain logistics. However, there are also a number of supply chain based business strategies currently employed in the industry, that are analogous to those found to be helpful in promoting good health and safety management practices in other sectors. Based on the understanding of the wider supply chain

literature, I have argued that structural determinants of the nature of the business relationship in question — for example, the extent to which they are collaborative, trust-based and longer term, where the business interests of both parties are seen to be served well and where the risks to suppliers posed by their non-compliance are perceived by them to be high — are significant factors that help to determine the extent to which it may be possible for buyers to influence the health and safety practices of their suppliers, as are the institutional and regulatory contexts of the business relationship in question. This I would suggest, applies in the maritime industry as much as it does elsewhere.

For example, a combination of procurement and rigorous monitoring/ inspection in relation to the operation of health and safety management systems is already imposed on large parts of the tanker industry that operate under contract to 'oil majors'. As economically powerful purchasers of the services of tanker companies, the oil majors at the head of oil transportation supply chains are in a strong position to dictate health and safety management standards to their suppliers. Anecdotal evidence suggests that this is what they do, and moreover, they inspect and monitor compliance quite rigorously, with the result that their demands are prioritised and implemented by the shipping companies involved. That they bother do so is also easily explained, by their high profile and the reputational risks to their business that are threatened by ship incidents that might arise from poor safety management.

Other parallels potentially exist with direct supply chain effects found in other industries For example, certification processes adopted in the industry, whether they address the competency of individuals, the health and safety management practices of companies or the standards required for ship operation all have parallels with certification practices in land based industries in which supply chain leverage has been used to improve implementation. This is not to say that such practices necessarily have the same effects at sea, but rather to suggest that it could be useful to evaluate them in these terms in order to understand ways in which they might be made more effective. Equally, there are dangers within these practices. Over-bureaucratisation, ineffective or inappropriate monitoring and inspection, victim blaming, falsification of records and other fraudulent practices are all frequent subjects of anecdotal accounts of what goes wrong with some of these procedures

when they are applied at sea. Again, this suggests a better understanding of the preconditions for their successful operation might be useful.

A further point concerns the role of infrastructural support. As demonstrated in land-based scenarios, strategies to improve health and safety management that utilise supply chains to do so, work best in longer term, trust based business relationships located within supportive infrastructures. Such support potentially exists within the maritime industry in the many groups and associations representing the maritime trade. However, it may not be recognised as such and its potential may not be effectively harnessed. Similarly there is a strong message here concerning the potential for concerted actions from social actors concerned with the safety and well-being of seafarers including trades unions, charitable organisations, seafarers' welfare groups, NGOs, as well as environmentalist groups and international bodies such as the ILO and IMO.

Finally, one might ask why should we be bothered about all this? The answer would seem to lie in the fact that despite improvement, current mortality and morbidity records demonstrate that the maritime industry remains among the most dangerous economic sectors in which to work. Most health and safety analysts would agree that such dangers arise not only from the risks of the sea itself but also from the way in which work is conducted and as such, they are largely preventable. At the same time, the industry has moved a long way from the reach of conventional regulation and presents an enormous challenge to traditional command and control approaches to achieve this prevention, protect workers and improve health and safety. In this scenario, approaches that utilise other drivers that may exist within, and around, the business relationships that occur in the industry are obviously useful. If they can be shown be effective and if what makes them effective can be better understood, it might help to improve their application and evaluate the potential to transfer them to other parts of the industry. This would seem to suggest important lessons for a host of stakeholders in the maritime industry, lessons that could be gleaned from further research in this field.

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Vessel Design and the Well-Being of Seafarers

Neil Ellis

Abstract

Human beings now spend more time than ever indoors. However despite this, relatively little is known about the impact of the built environment on health and well-being, especially within the maritime sector. Studies that have been conducted onshore suggest that environmental and architectural features within buildings such as high noise levels, inadequate lighting, and poor quality materials/facilities may all negatively affect the health and well-being of those that live there. Many of these factors are those which a seafarer experiences daily. However, due to the remote and confined location they work within, there is little chance for respite from this environment. This paper reviews studies that have been conducted to date onshore, and looks at the implications they might have for those working at sea. It reflects the early stages of the development of a project which will ultimately consider changes that could be made onboard vessels in order to improve seafarer health and well being.

Introduction

As a consequence of rapid industrialisation in the 20th century and the recent increase in employment in the white collar, service, and retail sectors, human beings now spend the majority of their lives indoors (Zimring, *et al.*, 2005; National Research Council, 1981). Employees spend up to a third of their waking life in an office building (Neuner and Seidel, 2006; Zimring, *et al.*, 2005; Conrad, 1988), and this seems set to rise as average working hours are on the increase, especially in Europe. Not only is much of our working life spent in the indoor environment but, increasingly, so too is much of our home and leisure time (Samet and Spengler, 2003). As a species one might say that we are becoming more and more a "subterranean population".

For those onboard merchant vessels, there is little escape from the built environment, and the modern day seafarer frequently spends the majority of the day, both during work hours and rest periods, inside the structure of the ship, often for months on end. However despite this, relatively little is known about the effects of the built environment on health and well being (Zimring, *et al.*, 2005), especially for those in the maritime environment.

What little is known about the effects of the environment ashore may have important implications for the seafarer, as many of the negative aspects of the physical environment identified onshore can also be seen aboard ship. For example, studies have shown that factors such as quality of housing (Evans, 2003), noise levels (Salyga and Juozulynas, 2006; Riediker and Koren, 2004), light levels (Kuller, *et al.*, 2006), and colour schemes (Caspari, *et al.*, 2006; Baglioni and Capalongo, 2002) may all have effects on health and well-being. Other studies have looked at indirect factors relating to the built environment and their influence on well-being, such as social networks (Hawe & Shiell, 2000; Kawachi, 1999; Kawachi, *et al.*, 1997; Semenza *et al.*, 1996; Berkman, 1995), social support (Evans, 2003) and crowding (Van de Glind, *et al.*, 2007; Caspari, *et al.*, 2006). Similarly there has been research in clinical settings, and the built environment is now increasingly recognised as of relevance to the therapeutic process (Van de Glind, *et al.*, 2007; Caspari, *et al.*, 2006; Tyson, *et al.*, 2002; Gross, *et al.*, 1998). Factors such as aesthetically pleasing environments (Caspari, *et al.*, 2006; Evans, 2003) arrangement of furniture (Evans, 2003), windows (Van de Glind, *et al.*, 2007) light (Baglioni and Capalongo, 2002) and privacy (Nelson, *et al.*, 1998) have all been shown to influence patients well-being and recovery from illness.

Such factors equally impact upon seafarers, particularly as onboard they are effectively institutionalised with little opportunity to get away from the vessel.

Although vessels are built for specific purposes, which inevitably places constraints upon design (Salyga and Juozulynas, 2006), there is scope for some change which could beneficially impact upon seafarers. For example, accommodation and recreational facilities may be redecorated using more aesthetically pleasing colours, or facilities such as barbeques may be provided that encourage social interaction. Such change can play an important role in buffering against the negative impact of the environment of a vessel, and may also help seafarers to relax and restore themselves. Indeed research shows that several properties of the environment may be linked to more or less effective recovery from cognitive fatigue and stress (Maas, *et al.*, 2009; Kaplan, 1995).

Within this paper I will look at the land-based research that has been conducted relating to the built environment and its effect on health and well-being, and I will outline related implications for those who work on marine vessels. The possible impact of these factors will be illustrated, with some recommendations being made as to how accommodation and recreation facilities may be better designed or adapted in order to improve the health and well-being of those onboard.

Defining Health and Well-Being

Although 'health' and 'well-being' are everyday terms, defining them is actually very difficult, as definitions vary greatly depending upon context. In the past health was simply defined as the absence of disease (Emmet, 1991). However, nowadays it is seen as a more encompassing concept, including not only physiological well-being, but also psychological and social health. For example, the World Health Organisation (2009) defines health as, 'a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity' (World Health Organization, 2009). Well-being is generally seen as a more cognitive and subjective concept, and is frequently measured simply by asking individuals about how they feel. For example, Oswald, *et al.*, (1999) suggests that, 'subjective well-being addresses how good an individual feels about his or her life at a given time, and this construct includes cognitive and affective components' (Oswald, *et al.*, 2007, pg 97). These definitions will be used as the basis of how 'health' and 'well-being' are understood within the context of the current paper.

The Direct Influence of the Physical Environment on Health and Well-being

As discussed in the introduction, there have been a number of studies which have looked at the link between the built environment and health and well-being. Although some of the studies onshore were conducted in a clinical setting they, nevertheless, demonstrate the influence of the environment on the individual, and thus may be relevant to discussion of the built environment onboard ship. These factors, as well as

ways in which they may be modified or adapted in order to improve the health and well-being of seafarers will now be discussed.

Noise

An obvious factor that may have an effect on the health and well-being of seafarers, is noise. Ships are renowned for being noisy places, as Salyga and Juozulynas (2006) point out, 'Noise and vibration as well as the continual rolling and pitching of the ship are constant problems' (Salyga and Juozulynas, 2006, pg766). Not only may seafarers have to cope with continuous noise from engine and other machinery, they may also be faced with more distracting unpredictable noises, for example noise associated with cargo operations, or noise from hand tools in the course of routine shipboard maintenance. Although there is little information about the impact of such noise on those that work onboard, the affect of noise on well-being has attracted much attention onshore. For example, Reidiker and Koren (2004) suggest that, 'even at moderate sound levels it can cause serious psychological, social, and bodily effects' (Reidiker and Koren, 2004, pg194). Other studies have reported similar findings. For example, Stansfeld (1993) suggests that environmental noise exposure, i.e. noise from airports, may lead to increased psychological distress.

In the case of seafarers, the negative effects of noise may be exacerbated by the fact that they live where they work, and not only are they exposed to such noise levels at work, but also during rest periods. This is important as noise has been shown to have a negative affect not only on well-being, but also on sleep quality (Riediker and Koren, 2004), which may lead to increased levels of fatigue.

Light Levels

Another factor relating to the built environment that may be of concern for those working at sea is light. The effect of light on mood and well-being are well documented, for example there has been much research into the reduction of light during short days of the year, know as 'Seasonal Affective Disorder (SAD)', which has found that reduced exposure to light may cause depression, increased fatigue, and a lack of energy. For the seafarer, exposure to light will depend greatly on the

department they work within as well as ship type they are serving on. For example, a junior engineer may spend much of his day under artificial light in the engine room. By contrast, an AB may spend much of his day on deck, exposed to natural light. Although the Merchant Shipping (Crew Accommodation) Regulations (1997) state that marine crew accommodation must be adequately lit by natural light, and defines 'adequately lit' as enough light during day time to read a newspaper, simply meeting such predefined standards may not be enough. Research suggests that the affect of light is not straightforward, and that the amount of light required by individuals is variable. For example a study of light and colour in the work environment found that amount of light had a significant impact on mood (Kuller, *et al.* 2006). Mood was happiest when light levels were seen by individuals to be 'just right', but declined if levels were perceived to be too high or too low. Other studies have found comparable results (i.e. Evans, 2003), in relation to daylight. Similar results have also been found in clinical studies. Caspari, *et al.*, (2006) suggest for example that for patients light is important for recovery and rehabilitation, whereas for staff light levels influence health and well being.

Although more research is needed into light levels onboard ship, there may be a number of small changes that may be made in order to maximise the beneficial effects of light. For example fitting 'daylight' bulbs rather than neon strip lights may make the environment more naturalistic and pleasant. Lighting systems in areas such as accommodation and recreation may also be adapted so that they may be adjusted by individuals and set to levels that are seen as appropriate by them, for them.

The View From The 'Window'

Whilst the effects of light and noise on wellbeing are generally fairly well known, one factor that has been found to be linked with health and well-being, which may come as more of a surprise is the provision of, and proximity to, windows. Although on the face of it, this may seem to be associated with light, the relationship is not considered to be so straightforward. Research suggests that the importance of a window relates to the 'view' from it, rather than just the amount of daylight it delivers (Kuller, *et al.*, 2006).

The impact of a view on health and well-being is well documented. A number of studies have found that views of nature can be seen to have positive effects on well-being (Van de Glind, *et al.*, 2007; Evan, 2003). Similarly, the distance an office worker is seated from a window has also been shown to relate to mood (Kuller, *et al.*, 2006). For the seafarer, this paints a poor picture, as it is not uncommon for a seafarer's view from their cabin to be of a stack of containers or machinery on the deck.

Aesthetics

Through research that has been conducted onboard vessels within SIRC it is apparent that an area of the modern ship that often seems to be ignored or overlooked in terms of vessel design and management is that of aesthetics, specifically within accommodation and recreational areas. These areas are frequently furnished with dark colours, with little scope for personalisation, or modification, and colour schemes are often continued throughout the whole vessel, with little distinction between work and rest areas. Although such considerations may not seem important, especially as a vessel is primarily a place of work, studies looking at factors, such as, the colour of walls or the decor have shown that aesthetically pleasing surroundings may have important effects on well-being, mood and behaviour (Kuller, *et al.*, 2006; Caspari, *et al.*, 2006; Baglioni and Capalongo, 2002). For example, Caspari, *et al.*, (2006) in a review of the strategic plans for the aesthetics of hospitals suggest that, 'dark and gloomy colours can lead to an analogue state of mind, whereas gaudy colour can lead to irritability, aggressiveness, increases in blood pressure, and a general feeling of unpleasantness'. More generally they suggest that high quality working conditions reduce stress factors, strengthen immunity, and heighten the contentment factor' (Caspari, *et al.*, 2006, p856-857). Similar results are also found in non-clinical populations. Kuller, *et al.* (2006) found that the use of good colours in the work environment served to improve the mood of staff. Whilst Guite, *et al.* (2006) in a non-clinical population found that poor quality housing was associated with poor mental health.

These studies indicate that the aesthetics of a vessel whilst largely ignored may actually have a real impact on the well-being of those that work onboard. Positive

changes to the aesthetics of the environment may be relatively easily to undertake, for example, accommodation facilities may be refitted using more aesthetically pleasing colours in order to make them more stimulating and inviting areas to live and work in. Efforts may also be made to vary the use of colours so that work areas and accommodation and recreation facilities are visually distinct, re-enforcing the boundaries between work and rest. In relation to the quality of soft furnishings (including carpets and curtains) more attention could usefully be paid to cleanliness and maintenance.

Confinement

Before we look at social factors which are effected by the built environment are a final factor that we will look at, which has attracted much attention in the literature is that of (over) crowding. Research into crowding ashore suggests that it may cause psychological stress (Evans, 2003), and similarly in clinical studies it has been found that crowding is associated with increased anxiety and poor socialisation (Hellman, *et al.*, 1985).

Although crowding per se, may not be a problem for those working at sea, especially in light of the current trend to crew at near minimum levels, ships are confined spaces, and seafarers have little access to open spaces, with few chances to go ashore. The constrained lay out of the vessel also means that they have little private space. Therefore, seafarers may be seen in some respects, which are worthy of further exploration, to experience similar issues to those in crowded buildings.

Indirect Influences of the Physical Environment on Health and Well-being

So far the physical features onboard vessels that may have a direct influence on the health and well-being of those living and working there have been considered. However, it is also interesting to look at the interaction between the built and the social environment onboard. Ships should not simply be seen as geographical areas, they are complex spaces in which people conduct their lives (Neuner and Seidel, 2006; Airey, 2003; Hancock, 2002; Baldry, *et al.*, 1997).

The physical features of the ship environment may indirectly affect health and well-being through their impact on other factors such as socialisation, social support, and restoration (Neuner and Seidel, 2006). It has been argued that 'there is an association between features of the environment and perceptions of neighbourhood social functioning that may indirectly influence health outcomes. Therefore changes in the urban design may influence health and well-being' (Cohen, *et al.*, 2008, p206).

Social Networks

One of the things said to be beneficial to health and well-being and also argued to be effected by the built environment is the capacity for social networks to develop. Cotterell (1996) defines social networks as 'the structures and sets of relations found in an individual's social landscape' (Cotterell, 1996, pg14), and research suggests that there are a number of factors relating to the physical characteristics of the environment that may prohibit or encourage the development of these.

One such factor is the provision of, and access to, public gathering places. This has been shown to facilitate the formation of social networks, which may have a positive impact on mental and physical health (Maas, *et al.*, 2009; Leventhal & Brooks-Gunn, 2003; Hawe & Shiell, 2000; Kawachi, 1999; Dalgard & Tambs, 1997). However, my experience from research onboard suggests that there is often little 'public' or shared space (i.e. recreational spaces) which is not deemed to be a work space. In some cases, even when public or recreational space is available, it is used for other purposes, for example, storage. When there are shared spaces onboard, such as mess rooms, these are often solely available to particular ranks, and thus may not facilitate whole crew interaction. This may not only lead to difficulties in building relationships onboard, but also in some cases isolation (Sampson and Thompson, 2003).

Although it may be challenging to alter the amount, and nature of public space onboard, studies do suggests that interaction within such spaces as are available may be encouraged by the introduction of 'activity generators' such as food (Evans, 2003) and the arrangement of furniture (Tyson, *et al.*, 2002; Baldwin 1985; Melin & Götestam 1981). For example, the provision of barbeque facilities could encourage

crews to get together in order to celebrate national events, or individual milestones, such as birthdays. However, research does suggest that social interaction should not be forced, and that people should be able to decide whether they participate in such activities or not (Evans, 2003). The fact that the mess rooms are often the only public spaces onboard (Sampson and Thompson, 2003) may mean that it may be very difficult for seafarers to choose whether they participate in such activities, especially if they are organised by a senior officer, as there may be seen to be an expectation for all crew to participate.

Social Support

Another social factor argued to be effected by the built environment is that of social support (which is related to social networks). Cohen (2004) defines social support as, 'a social network's provision of psychological and material resources intended to benefit an individual's ability to cope with stress" (Cohen, 2004, pg 676). The possible link between levels of support and health and well-being is well established (see Chan and Lee, 2006; Franzini, *et al.*, 2005; Berkman and Syme, 1979), and research shows that there are a number of factors within the built environment that may influence the amount of support that people provide to one another. For example, although the impact of noise on those onboard vessels has already been discussed in relation to its direct effects, exposure to noise may also indirectly affect health and well-being through its influence in the amounts of social support offered by seafarers to other seafarers. For example, exposure to noise has been shown to interfere with communication and can cause irritability, which subsequently leads to people offering less support (Cohen and Spacapan, 1984).

Onboard there may be a number of situations where noise could be seen to inhibit communication, for example, a noisy engine room or machine space may severely affect the ability of people to communicate with one another. Although it may be argued that such areas are places of work, the benefits of conversation during work can be easily seen: conversation often makes a long and tedious job more tolerable, and allows good and supportive friendships to be established.

For the majority of us social support is usually provided by family members and friends (Chan and Lee, 2006). However, unsurprisingly for those at sea the ability to communicate with those at home is often severely restricted (Sampson and Thompson, 2003; Thomas, *et al.*, 2003). Such communication difficulty is not only due to the physical remoteness of the vessel, facilities such as telephone and internet access are often unavailable or severely restricted onboard. Even when such services are available they are often costly, which may be a particular problem for those is the poorer paid lower ranks.

Restoration

The final issue I am going to consider is 'restoration', and this is probably the most important in terms of those working at sea. Restoration refers the ability to recover from physical demands and psychological stress. Seafarers are often subjected to long hours, irregular shift patterns, and quick turn around times which are suggested to result in high levels of fatigue (Allen, *et al.*, 2005). Thus the ability to recover from such demands quickly, and effectively, may be imperative.

A number physical properties of the environment have been linked to restoration, and recovery from fatigue and stress (Maas, *et al.*, 2009; Kaplan, 1995), as well as physical recovery in a clinical setting (Van de Glind, *et al.*, 2007; Caspari, *et al.*, 2006). Many of these have previously been discussed in relation to direct environmental influences on well-being, for example, exposure to nature has been found to positively relate to recovery from stress and fatigue (Maas, *et al.*, 2009; Kaplan, 1995). Similarly aesthetically pleasing surroundings' have been shown to increase recovery rates from mental fatigue (Evans, 2003). Within a clinical setting light levels have been found to be important in the recovery and rehabilitation of patients following surgery (Caspari, *et al.*, 2006).

Conclusions

Although this paper reflects only the very early stages of the work that is being conducted, it does draw together findings from a wide range of studies onshore that

have looked at how the built environment affects the health and well-being of those residing within it. Although these factors were identified through research onshore, they can be seen to have direct relevance to the seafarer as there are many parallels to the environment onboard ship. Indeed, they may be of greater importance to the seafarer as compared to their onshore counterparts, because for seafarers there is little respite from any negative effects of the environment of the ship.

Although the layout of a vessel is fixed and relatively unchangeable due to the specific function that a vessel performs (Salyga and Juozulynas 2006), there is some scope for modification of the built environment which can be easily, and cheaply, made. For example, looking at easily changeable aspects of the environment, cabins and recreation rooms could be decorated using more positive colours and colour schemes and facilities and furnishings could be kept well maintained. Adjustable (dimmer switch) lighting might be introduced into accommodation areas and 'daylight' bulbs could be utilised in relevant areas of ships. In reference to the social environment onboard, karaoke machines and barbeques might be provided in order to encourage crews to interact more in such shared spaces as are available. Such changes to the physical environment whilst being relatively inexpensive may have positive influences on those that work and live within it.

Such efforts to improve the environment and consequently the health and well-being of the crew, may also have positive financial implications for ship-owners. Whilst modification of the environment may not be expensive, repatriating seafarers due to ill-health may be costly. Ashore it has been argued that "workers experiencing poor health and well-being in the workplace may be less productive, make lower quality decisions, be more prone to be absent from work" (Danna and Griffin 1999, pg 358). There may also be other consequences of ignoring the impact of the built environment. For example, research into restoration suggests that a poor built environment they may drastically reduces seafarers' ability to recover from the demands of their jobs, which may ultimately lead to fatigue. Therefore the design of accommodation and recreational faculties should be seen not just an issue relating to seafarers health, but also one that may indirectly affect ship operators as a result of the impact that such things have on work performance and the related possibility of accidents.

To date research in this area within the maritime industry is very limited, and the review of onshore research presented here only illustrates the possible factors that may be relevant within the maritime industry. This paper presents the beginning of a project and which is being conducted by the Lloyd's Register Educational Trust Research Unit (LRETRU). As the research develops further findings will be made publicly available.

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Training and Technology: Potential Issues for Shipping

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Abstract

Following a review of the literature on training and ICT implementation in various organisations, and preliminary analysis of a pilot study on training in shipping, this paper draws out some potential issues for shipping with respect to training and technology. The issues considered include: the acquisition of skills; motivation; and constraints on learning.

Key words: technology, training, shipping, motivation, knowledge transfer

Introduction

Over the past century, a large number of technologies have been introduced onboard ships (Winbow, 2002), for example, radio-navigation, radio-communication, electronic chart display and information system (ECDIS), automatic identification system (AIS), computer technology, and automation. New technologies offer a range of benefits. They help to increase productivity via the facilitation of reductions in crew size and turnaround times (Sampson and Wu, 2003). They also have 'the potential to improve the efficiency and effectiveness of watchkeeping and to improve the safety of operations' (IMO, 2003). Furthermore, new technical developments, for instance, electronic fuel injection (EFI) systems, can both reduce costs and protect the environment.

To reap the benefits of new shipboard technology, however, its users – seafarers – need adequate training. A quick search of Maritime Accident Investigation Branch (MAIB) reports suggests that inappropriate use of shipboard technology due to poor training can cause accidents. Lack of familiarity with the shipboard ECDIS equipment, for example, has been a contributory factor in a number of 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 causal factor (MAIB, 2007). A number of recent studies have likewise found that seafarers appear to be insufficiently familiar with/trained in the use of the new shipboard technology AIS which may lead to the transmission of erroneous AIS information (Bailey, 2005; Bailey et al., 2008; Harati-Mokhtari et al., 2007; Norris, 2007). Inaccurate AIS information can mislead seafarers when making collision avoidance decisions, and thus may have serious consequences.

Researchers, commentators, and policy makers have unanimously pointed out that training on new equipment is essential to avoid similar accidents in the future (Bailey, 2005; Gray, 2008; Grey, 2008; Hadnett; 2008; Harati-Mokhtari et al., 2007; IMO, 2003; *Lloyd's List*, 2007; Norris, 2007). With more and more sophisticated instruments introduced onboard ships, it is suggested that adequate training and ample familiarisation time are crucial for seafarers to acquire competence in operating them. Commentators also point out that seafarers need to be made aware of the limitations and potential errors of technologies. Further, Bailey (2005; Bailey et al., 2009) argues that training needs to take into account not only the operation and limitations of equipment, but also how the introduction of new equipment can potentially modify shipboard practices.

Thus, it is important to look into training provision and practice in shipping in order to improve it. This paper reports the preliminary findings of a pilot study on training and technology. It draws out potential issues for shipping in the light of these findings and also with reference to previous research undertaken in other sectors. The pilot study is part of a large on-going project which looks at seafarers' adaptation to, and training on, new technologies. The first part of the project which focussed on AIS when it was first introduced onboard ships has been completed (Bailey, 2005; Bailey et al., 2008). This pilot study prepares for the next stage of the project - a large scale survey examining seafarers' training on new shipboard technologies/equipment in general. It aims to identify issues that will be explored in detail in the survey. As part of the pilot study, thirteen interviews were conducted in the UK, two with college lecturers and eleven with officers undergoing training. Nine interviewees were deck officers,

including five chief officers and four 2nd officers. The other two were engineers, one 3rd engineer and the other 4th Engineer. The officers were asked about their training on, and experience with, onboard technologies, while the lecturers talked about the design, provision, and forms of training courses.

Acquisition of skills

Research on training and ICT implementation suggests that end users in general acquire ICT knowledge and skills from four sources: vendors, companies, colleges, and themselves (Benson, 1983; Nelson et al., 1991). Vendors, companies and colleges provide formal training which is structured, institutionally sponsored, explicitly planned and organized, led by instructors, and associated with assessment and evaluation. By contrast, self learning is informal. It is not institutionally planned but individually initiated in everyday life (Conlon, 2004). Informal learning activities can take the form of self-directed reading, experimenting with new equipment, and observing and/or consulting colleagues (Aiman-Smith and Green, 2002; Spitler, 2005).

Similarly, our interview findings suggest that seafarers acquire their skills with new equipment both formally and informally. Formal training is normally provided by external experts including training institute lecturers, company trainers, and equipment providers. User manuals, company circulars, and experienced colleagues onboard may help seafarers to acquire skills informally.

When the technology is simple, seafarers are likely to be left to their own devices and acquire skills by reading user manuals and in some cases with the aid of company circulars. Some deck officers learned to operate AIS in this way. Several interviewees mentioned explicitly that formal training for AIS was not necessary because it was simple. One second officer explained how he learnt to use AIS by referring to manuals and by a process of 'trial and error':

> Just by reading manuals and trying it yourself. It is like a new phone, if you know the basic operation of a phone, for example, off the hook means you have to call, and cancelling the call is the red button, then you can slowly, slowly

> learn from using it. Or maybe if you find a new button, "Oh, what is this?" Then you just refer to the manual. That's how, especially with the AIS, and I don't think there is any course for it. There may be a course, but it's not very necessary, it's just a piece of small equipment. I learned it just by looking at the operator's manual and just physically doing and checking and that is all.

It is pointed out by IMO (2003), however, that technical manuals can constitute poor training material. One reason may be that consulting manuals takes time as the above quotation suggests. Furthermore, it may not be appealing to read manuals, especially when they are not written in seafarers' first languages and/or when their quality is poor. IMO (2003) suggests that computer based training (CBT) is a better training approach. Compared with manuals, CBT seems easier to follow, and it may demand less time and effort from seafarers. Interestingly, none of the interviewees mentioned the use of CBT in relation to new equipment, although CBT has become a common training strategy in the shipping industry (Ellis et al., 2005).

Previous research relating to training and ICT implementation suggests that peers play an important role in the learning process (Gallivan et al., 2005; George et al., 1995; Lambrecht et al., 2004; Spitler, 2005; Winter et al., 1997). In organisations, there are 'resident experts' (Nelson and Cheney, 1987) or 'master users' (Spitler, 2005) who are ICT users with advanced skills. They often give *in situ* help to users who are experiencing problems (Spitler, 2005). It is noted that the most common way for users to solve ICT related problems is to talk with colleagues close by (Lambrecht et al., 2004). More significantly, obtaining information from peers with technical expertise, rather than via formal training, has been found to be closely related to end users' computing skills (Winter et al., 1997).

Onboard ships, seafarers also transfer knowledge and skills to each other. Learning from manuals takes time as suggested earlier. To learn quickly and with less effort, some seafarers opted for advice from experienced peers. The 3rd engineer interviewed explained how he learned the principles regarding the operation of Dynamic Positioning Systems (DPS) from senior engineers onboard:

> Well, sitting down with the chief engineer and the second engineer, and we might drink coffee in the engine room, I can ask them [the principles], but we talk while we drink coffee. And that's the whole idea behind it. Plus the fact that as we use the equipment, the new guy kind of gets walked through and shown how everything operates.

Experienced colleagues can answer questions directly, which helps less experienced seafarers to avoid the trial and error process. Furthermore, peers are able to transfer knowledge which is not in manuals but acquired through long-term experience.

Knowledge transfer from senior officers to juniors not only helps the latter in the current job, but also prepares them for the future ones. One second officer mentioned this point in the interview:

> If the company want to promote a second officer to a chief officer, then that second officer, when he's onboard, should be able to learn [how to use the shipboard loadicator]. The company will not provide onshore training. Suppose I want to get promoted, I will ask my ex-chief mate or master, whoever, "teach me this." …

The seafarers we interviewed tended to suggest that formal training is necessary when new equipment is complicated. This view concurs with research finding in other industries which suggests that complex technology creates high "knowledge barriers" and that only formal training can provide users with the requisite knowledge to overcome the barriers (Robey et al., 2002; Sharma and Yetton, 2007). Amongst seafarers, formal training was reported to be delivered by external experts either from training institutions, equipment manufacturers, or in-house training departments. Compared with user manuals which detail operational procedures, training programmes also explain the theory behind equipment, the limitations and error sources. Furthermore, being delivered by experts, it was said that training opens trainees' eyes to the full potential of new technology. One chief officer reported the benefit of formal training as follows:

> [The training] gives us a good knowledge about certain things, even if you're using equipment for a period of time. Maybe we are not using it to its maximum potential. And because, okay, we may risk following a set pattern, I just use the equipment for whatever information I need or whatever I need to use. But maybe I don't want to try to find out what else it can do. But once we go back to college or a training centre, you know that's where we can get to know about more what it can be used for.

Another advantage of formal training is that it corrects misconceptions and the misuse of equipment militating against the transfer of bad practice from peer to peer. One college lecturer recounted how in one training session one trainee realised that his previous usage of AIS was wrong and dangerous:

> Last week, we were putting the AIS on. One guy commented, "You know I use that all the time for collision avoidance." Another guy said, "Well we've got a letter from the superintendent, it's not to be used for collision avoidance." The first guy said, "No, I use it all the time." Now that was brought to us, and I said "Well you're fighting on this, why your company sent out letters telling you not to use it?" The second guy said, "It's due to target swap." So he explained to the first guy. You see him now, "Oh, I didn't realise that. I didn't realise."

Though beneficial, formal training does not solve all problems; and it arguably needs to be complemented by informal learning. According to research findings in other sectors, formal training only provides an initial and short stage in the learning process when new technology is first introduced (Spitler, 2005). In the on-going use of the technology, new problems will continue to crop up and users will need to consult colleagues, technical experts, and manuals, or go through other forms of informal learning processes in order to solve those problems (Lambrecht et al., 2004; Santhanam et al., 2007; Spitler, 2005).

In shipping the issue of standardisation may make informal learning even more important. Onboard equipment is produced by different companies and therefore takes the form of different 'models' with different operational procedures. This places constraints on the onshore training provided by training institutions and/or company

departments, since the instruments in training centres may be different to those onboard ships. Therefore, training centres focus on the transfer of generic knowledge, which can be applied to different situations with the aid of operational manuals and/or experienced peers. One nautical college lecturer explained this point in the interview:

> We can teach generically the procedures of utilising the instrument, but you go on a ship and every ship has a different make of. So it's a different way of operating a system, say, GMDSS, of two different makers. But your generic knowledge of how to do it, that knowledge will be enhanced by going to the manuals to see what buttons to press.

These words indicate that formal training alone does not provide seafarers with adequate skills for the operation of new equipment due to the issue of standardization. When a well-trained seafarer joins a new ship, a process of familiarization is still required. He/she needs 'old timers' to pass on the relevant knowledge, and he/she may also need to refer to the manuals, in order to operate ship specific equipment.

The issue of standardization may also make long-term onboard training less viable, especially for big companies, as one chief officer explained:

> Interviewer: Does the company ever send people to the vessel and give you courses onboard?
> Respondent: It really isn't effective because with a fleet of 200 ships, you cannot get around everybody. And in six months, the whole crew will be on different ships, different systems, so the best thing to do is a common course for everybody.

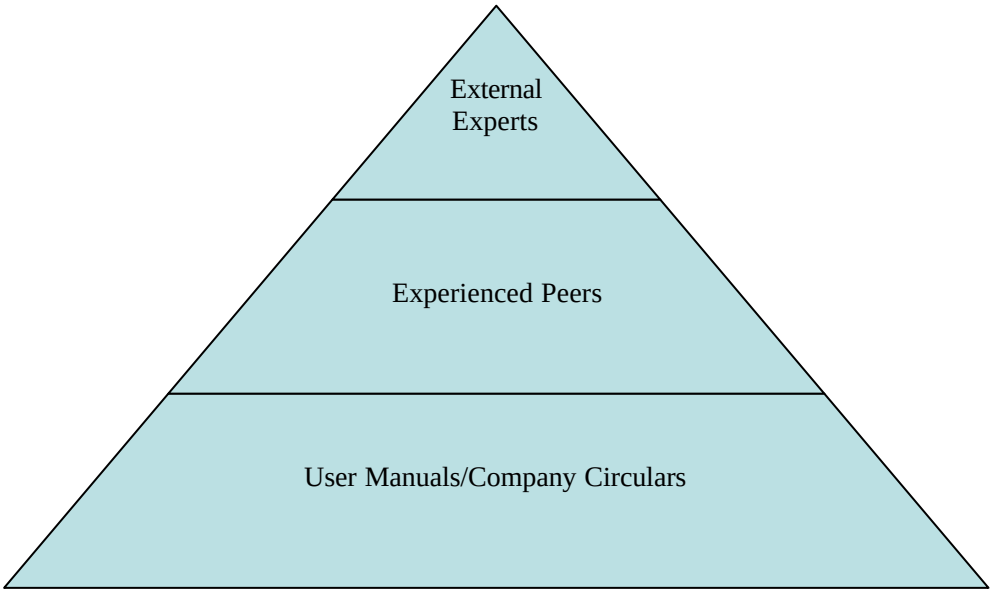
Clearly a common course is a generic one which may not provide seafarers with ship specific skills. To acquire the latter, seafarers need informal onboard learning.

The data indicate that onboard training was provided on some occasions. For example, manufacturers sometimes provided initial onboard training when new equipment was first installed on a ship. Sometimes companies were reported to send a technical officer onboard to provide training. In both cases, however, training can only be

provided to a few seafarers, who then pass on the knowledge to others. As such, the source of knowledge transfer quickly changes from external experts (formal training) to experienced peers (informal learning).

The above discussions suggest that there are three levels of knowledge transfer (see Figure 1). The most basic level is self-learning by reading – knowledge transfer from written materials. It is most effective when technology is simple and straightforward. Since written materials do not respond to learners' concerns, this level of knowledge transfer is a process of trial and error. When self-learning is combined with learning from experienced peers, knowledge transfer reaches another level – it is interactive and responsive, which, arguably, can be more effective and less time consuming. When the technology is complicated, knowledge transfer from external experts may be deemed necessary. Even when technology is simple, learning from external experts may have advantages, because experts have more knowledge of the full potential and limitations of the technology.

Figure 1: Three Levels of Knowledge Transfer[1]



[1] Computer based training (CBT) is not considered here because none of the interviewees mentioned it. Nevertheless CBT and other forms of video training seem to be common. If they are to be added to the model, they could be situated in between 'experienced peers' and 'user manuals/company circulars', since they provide a sense of interactivity.

Constraints on training and issues of motivation

To adopt new technology and to acquire relevant skills, individuals need to be motivated to learn. In other contexts, it is found that individuals are likely to have the motivation if they perceive the technology to be useful in helping them to achieve their goals (Davis, 1989; Davis et al., 1989; Zhao and Cziko, 2001). Our interview data indicate that this is also the case with seafarers: when they perceived that training was necessary for their careers for example, they expressed a willingness to attend courses. One chief mate reported that he was willing to attend some courses because they would give him confidence to do a proper job and help him with promotion:

> This [attending necessary training courses] is required for your promotion. One definitely would like to take the courses. … If there's a certain area in which I feel weak. I feel that I could have definitely gone for some more intense training, because at the end of the day we're masters, we're going to take over the ships so we must be very, fairly confident.

However individuals have different goals which may be mutually exclusive. If new technology helps them to achieve one goal but negatively affects others, they may not be motivated to learn (Zhao and Cziko, 2001). Research in other industries has shown that end users were reluctant to take ICT training if it demanded use of their own time even though ICT was useful for their job (Benson, 1983; Brand, 1997; Galanouli et al., 2004; Monk, 2004; Valcke et al., 2007; Waite, 2004). In shipping, similarly, time imposes constraints. Formal training is likely to take place in training centres ashore, which means training is undertaken when seafarers are 'on leave'. Several informants explicitly mentioned that they were unwilling to take training courses during their leave time. One chief officer, for example, stated:

> The human resource department arranges the courses and then the person involved has to go and attend courses. But the hitch point is: when do they do these courses? The courses are done in their time off. … Now, how else in this world, people go for training courses on Saturday and Sunday? I mean people who work Monday to Friday do not take training courses on Saturday and Sunday, do they? They only do training courses on weekdays, when colleges

> are running. But for seafarers, they have to do all the courses possible when they come home on leave, which they earn after working four months or six months away from home at sea, and then the employers expect them to train in their time when they're on leave, and then go back on the ship. So that's why you get rarely any seafarer volunteering to do courses and training to enhance their skills. What they want is a decent piece of leave.

In the case of onboard training when equipment is first installed, some seafarers may not even be able to attend due to time constraints. New equipment is placed onboard only when a ship is in port. At this time, however, seafarers tend to have busy schedules due to short turnaround times. As a result, not all seafarers can attend initial training given by the technician responsible for the installation. One chief officer recounted his experience:

> Informant: During my last assignment a piece of equipment was installed. We had it installed during cargo operations and the contractors came on. When they were ready to start testing it and show it how it worked, because of busy port turnaround, we were only able to spare the second mate. So he went up and found out how it worked. As I say, during a busy port turnaround we weren't able to spare anyone else, and another day we had to see what it does. It was just a PC with a feed, it gets connections. What else does it get? I don't really know what it gets, because I was the mate then, and that was the second mate's gig. It wasn't so much safety equipment, not something I played about with a lot.
>
> Interviewer: So you personally never got any training on how to use it?
>
> Informant: No. During this passage I would ask the second mate "So what does this do?" Give me a quick rundown. But it's not a piece of equipment I used a lot, although I could use it to find out the weather and stuff.

Thus, busy schedules in ports may negatively affect onboard training and seafarers' knowledge of some pieces of new equipment. To what extent this is the case, however, remains to be more fully examined.

On some occasions, training not only demands seafarers' leave time, but also their money. Formal training involves external experts and resources, and therefore incurs a financial cost. While well-established shipping companies were reported by some seafarers to be committed to training, one Indian second officer reported that one shipping company tried to transfer training costs directly to him:

> Once I was about to join one company, and they were paying very good, so I was planning to go to that company. But then, the person in the office, he asked me "Do you have this course?" Some bridge team management course. I said no. He said "You have to do that course." As a second mate I did not have to have that course, it's not mandatory. … So I said I don't have that course with me. He said "You have to do that course… But our company will not pay you. You do it off your own. Not a thousand, about 200 pounds in all, and when you do that course you can join us."

Of the eleven interviews conducted with officers, this is the only example provided where an officer was requested to pay for a training course out of his own pocket. However, eleven interviews is a small number and all of the interviews were done in the UK at a reputable maritime college. To what extent this practice exists around the world is therefore unknown and needs further consideration.

In the process of our research, one seafarer refused the interview request because he perceived that the research would result in the recommendation that more training was required for seafarers which he said that he would have to pay for and give up his leave time for. This suggests that great numbers of seafarers may be reluctant to take more training because currently it often requires that they give up some of their leave time and they may also have to pay for it themselves.

As discussed in the previous section, informal learning and peers play a crucial role in skill acquisition. The literature on training and ICT implementation suggests that learning is most effective when it takes place while doing the actual job in the presence of co-workers with whom to discuss problems and exchange insights and discoveries (Gallivan et al., 2005; George et al., 1995; Waite, 2004). Thus, a supportive environment, where peers exchange information, encourage each other to

use new technology, and actively provide useful guidance, can motivate individuals to learn necessary skills and to adopt the technology (Ertmer, 2005; George et al., 1995; Sein et al., 1987).

Whether or not the onboard environment supports and encourages informal learning, however, has not been examined. There are a number of preconditions that need to be met to foster a supportive environment. Firstly, knowledge transfer between peers needs input from both ends: the provider must be willing and have the competence to teach, and the recipient must not be afraid of revealing his/her weaknesses. The extent to which these conditions are met onboard is a matter for further investigation. Secondly, when the relieved worker transfers his/her responsibilities to the newcomer, he/she also needs to take time and effort to transfer the basic knowledge of equipment operational procedures. Given the brief handover process due to fast turnaround, however, it is questionable whether there is sufficient time for this type of knowledge transfer. Thirdly, while seafarers can learn operational procedures from manuals, the latter may not provide sufficient information about the limitations on equipment usage. In this context, seafarers may need some sort of training, CBT for example, or at least the provision of company circulars to provide relevant information. Do companies provide this or other sorts of support? Do companies have policies to encourage and facilitate onboard learning? Such questions remain unanswered and need to be further investigated.

Conclusion

New technologies have improved efficiency and productivity in shipping. Yet, they also have limitations and may be prone to technical error, which has safety implications. To reap the full benefit of new technologies and to avoid potentially negative effects, seafarers need training in order to acquire necessary skills. Through a review of the literature on ICT implementation and a preliminary analysis of a pilot study on training in shipping, this paper has drawn out some potential issues for shipping with respect to training and technology.

The literature suggests that while formal training is important for successful technology implementation, it is also crucial to create a supportive learning environment where peers exchange information, share experiences of using technology, and actively provide useful guidance to one another. The pilot interview data show that seafarers acquired their skills from three sources – user manuals/company circulars, experienced peers, and external experts – which imply three levels of knowledge transfer. Knowledge transfer from written materials is most effectively used when technology is simple and straightforward. When technology is complicated, knowledge transfer from external experts is arguably necessary. External experts may be assumed to have advanced technical knowledge and therefore are in a position to help seafarers use equipment to its full potential whilst retaining an awareness of its limitations. However, to convert the knowledge transferred from external experts into practical competence, seafarers may still need the help of experienced peers or manuals for the acquisition of practical knowledge, due to lack of equipment standardization.

To develop competence, seafarers need to be motivated to learn. While perceived usefulness can encourage seafarers to take training courses and to learn, demands on their own time and money may discourage them from doing so. Research on other industries suggests that a supportive learning environment can also motivate individuals to learn. To what extent the onboard environment is supportive, however, has not been studied. In the large scale questionnaire survey we intend to explore these issues in detail. Our findings will be reported in subsequent papers.

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