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AMET Maritime Journal

An International Journal dedicated to maritime and marine-related disciplines

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Aim and Scope

AMET Maritime Journal is an international scientific journal published bi-annually. Its scope encompasses maritime and marine-related disciplines on-board, off-shore and on-shore, in keeping with the academic offerings at the university. It is committed to rigorous methodological analysis of the maritime and marine related sector. Articles present genuine research findings. Apart from research based articles, manuscripts on issues of contemporary maritime interests are also published as long as lessons can be learnt through critical discussions. Insightful viewpoints expressed by practitioners are also welcome. Conference reviews are also considerd if original/value-adding contents are reflected. All manuscripts are peer reviewed.

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From the Editor's desk

The AMET Maritime Journal is conceived to provide a means of publishing and disseminating the results of academic research and scholarship. In doing so it is aimed to serve the following purposes:

1. To provide a stamp of quality and be indicative of the fact that the article is worth reading. The blind peer review process by researchers active in the field while being judgmental on quality and standing at one level, is also developmental and provides feedback and advice to authors.
2. To partner with the research community and through its selected papers both on empirical and theoretical findings, stimulate debate about particular topics and issues.
3. To provide for the indexing and cataloguing of articles for its wider access and use.
4. To provide a means of managing intellectual property rights and permissions.

It is widely said that tomorrow's world belongs to those who create, nurture and own intellectual property. Such an asset though intangible, forms a superior basis for sustaining growth over the long run. This journal aims to be such a repertoire for the international maritime industry.

AMET moves ahead on this journey based on the strengths of its conviction, its proven capability and abiding vision to put industry before institution in creating enduring value for the maritime domain.

Suresh Bhardwaj

Editor

Guest Editorial

It is a rare event to have the opportunity to write a Guest Editorial for what will become a top quality, peer-reviewed international academic and professional journal and it is a task that I anticipate with much pleasure. This first edition of the AMET Maritime Journal represents an enormous accomplishment in bringing together professionals and academics from the maritime shipping and ports sector in a wide-ranging and topical discussion of issues that matter to the field. It is particularly valuable and has special relevance to the globalised maritime sector in all its forms as it originates from a premier university in India, a country with an increasing role to play in the maritime sector and one where future developments are likely to be as important as anywhere. It also benefits from the individual efforts and talents of Professor Dr Suresh Bhardwaj whom I have known for some years and without whom it could not have been created.

The papers presented here are a significant contribution to the literature and it is welcome that they should address such a range of maritime topics and issues. They provide much thought provoking debate required to ensure that an industry remains alert, responsive and meaningful. Academic journals in themselves do not solve much but provide the intellectual and philosophical background necessary for a sector to retain its professional credibility and adaptability and to be able to understand the factors that drive its progress or decline. The AMET Maritime Journal does just this.

I have no doubt that the AMET Maritime Journal will in time become a leading voice in the industry and it is consequently with both pleasure and respect that I will look back at the opportunity afforded to me to write this Guest Editorial with substantial pride.

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Drowning Piracy Threats: The Binary of Land and Sea

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Abstract

This ongoing research focuses on merchant seafarers who traverse major seafaring routes through the Indian Ocean and those with ports in and around the Gulf of Guinea. Within the international maritime industry, these areas are vital to the economic survival of the shipping business and infamous for piracy attacks.

Thus, for seafarers, sailing in these regions is very common and always carries some level of risk of being attacked by pirates. As such, piracy has become a condition for work at sea. Within the context of maritime piracy, this paper explores the social matrix of lies, secrecy and avoidance regarding piracy threats in which seafarers are entangled and how this may relate to binary cultural perceptions of land/sea. The sea/land binary socially constructs the sea as a natural and thus unruly space and the land is socially constructed as a place of culture and civility. In order to navigate between shore perceptions of piracy and their own experiences and perceptions - in order to make these inconsistencies somehow fit into the binary they contradict - piracy threats are downplayed, kept secret or even lied about.

Keywords: *Maritime anthropology, maritime piracy, secrecy, nature/culture*

1. Drowning Piracy Threats: The Binary of Land and Sea

> *"The basic paradox here is that people say: Piracy is a big problem, but nobody is worried about it. They all explain that their wives are 'crying ' and that they won't give them the information on where they 're sailing, as not to worry them. Today I had a class and I asked them if piracy was a big problem*

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> *and all the hands came up. Then I asked them how many of you feel that piracy is a big problem for you personally. Only one or two hands came up. "*
>
> -Field notes India, May 2013.

This paper is based on ongoing anthropological research[2] about how seafarers from Denmark, the Ukraine, India and the Philippines[3] working within the international shipping industry perceive and act upon threats of piracy. I wish to address what appears to be a clash of cosmologies about life at sea - including piracy threats - between seafarers and their employers, families, friends and the media.

Piracy is a real and modern phenomenon. For seafarers who spend many months at a time at sea, these threats are tangible and very serious. There is an important juridical difference between what counts as piracy and what is categorized as armed robbery. This has nothing to do with the character of the attack but everything to do with where the attack occurs: If an attack happens in international waters, it is termed "piracy". If the attack occurs within twelve miles of the coast, it is in national waters and is thus referred to as "armed robbery"[4]. For the seafarers with whom I have spoken thus far (over 500 from various countries), piracy can include anything from petty theft, robbery, armed robbery, kidnapping for ransom, violent attacks, physical and mental torture and in rare cases, death. In short, if an attack poses a serious threat to their physical welfare, seafarers often refer to this as "piracy", regardless of the legal definition. It is the seafarer's perception of piracy in which I am interested, and so it is their definition that I will use here.

In cases of kidnapping, the crew members become human commodities. They are held against their will, often for months or even years at a time, until a ransom sum is agreed upon, in exchange for their release. In many ways, this is 'good news' for the seafarers because their captors have an interest in keeping them alive. In the case of armed robbery, particularly when highly valuable cargo is involved - such as oil - the ransom value of the crew members' lives and the time in which this amount can be earned is insignificant in comparison to the re-sale value of the cargo (Oceans Beyond Piracy 2013 :13-15). This is not always good news for the seafarers who are confronted with this form of piracy: Crew members who resist or otherwise obstruct the

[2] Anthropological research entails, among other things, participant observation, semi-structured and informal interviews and focus groups. I have carried out my research at sea and on land.

[3] There are other nationalities represented in my data, but these are the main groups. They were chosen because they represent one of the most influential shipping countries in the world (Denmark) and the three largest groups of international seafarers in the world.

[4] The legal definition of piracy found in article 101 of the 1982 United Nations Convention on the Law of the Sea (UNCLOS): is "any illegal acts of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or a private aircraft, and directed:
(i) on the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft; (ii) against a ship, aircraft, persons or property in a place outside the jurisdiction of any State; (b) any act of voluntary participation in the operation of a ship or of an aircraft with knowledge of facts making it a pirate ship or aircraft; (c) any act inciting or of intentionally facilitating an act described in sub-paragraph (a) or (b)."
(http://www.imo.org/OurWork/Security/PiracyArmedRobbery/Pages/Default.aspx, accessed 8/16/2013
(Please note: all dates of access for online references in this paper will be dated in this order: month, day, and year). "High seas" refers to international waters. In other words, acts of armed robbery and violence that occurred within territorial waters are not categorized as piracy. I choose to describe all of these acts as piracy because this is how the seafarers with whom I have had contact refer to them. The legal aspect of piracy is an extremely important and lengthy topic, which lies beyond the scope of this paper.

pirates' successful robbery may be subjected to particularly rough treatment, such as gunshot wounds, severe beating, stabbing, and forced detainment (tied-up). Within the past decade or so, piracy that involves kidnapping has been typically associated with Somalis in the waters around the Gulf of Aden and has progressed into the greater Indian Ocean. Piracy involving violent robbery - which is on the rise - has occurred mainly off the Gulf of Guinea, in or around the territorial waters of Nigeria. Given the volume of shipping traffic worldwide, piracy attacks are rare, but the consequences of them are serious.

However, considering the severity of such attacks, I seem to have stumbled upon something quite thought- provoking in my data from seafarers around the world, as exemplified in the following field note excerpt:

> *"[H]e says the most important thing is to have security guards. They had razor wire too and fire hoses.*
> *He said that he really doesn't want to be taken by pirates because then he would have to sit in Somalia and wait and he really doesn't want to do that - it sounded more like a nuisance than a threat."*
>
> -Field notes Ukraine, April 2013

The threat of piracy does not appear to be a major personal concern for seafarers. To some, this may seem like a provocative statement. Some seafarers explain that they feel well protected by their ship and company, or simply see themselves as lucky or that an attack is not their "fate". For others, there are other concerns and dangers in their everyday lives on shore that cause a piracy attack to pale in comparison. Finally, there is often a great lack of information about these threats, which can lead to a false sense of security. Whatever the reason, seafarers often have to navigate between what the broader public on land and even their own families think about the threat - what I call a discursive threat - and the actual existential threats with which they must contend in their lives ashore and at sea. One way for seafarers to handle what is often a rather large discrepancy between the two is to tell lies, omit information or to keep secrets. This is not to say that seafarers as a lot are dishonest people. Keeping secrets or withholding information can often have noble intentions, but above all, they are a social strategy (Behr 2006; Horn 2011).

In the following, I wish to explore how this dishonesty and perceptions of the sea and shore as nature/culture opposites - what I have referred to above as a "clash of cosmologies" - may be connected. Drawing on ethnographic examples from Danish, Indian and Ukrainian seafarers[5], I suggest that seafarers' perception of piracy defies a widely held notion of "the 'nature' of the sea - contrasted to the grounded 'culture' of land, as 'fluid' (...)". [Or] as early anthropologists who travelled to 'the field' by ship might have had it, as 'another world...without human culture'" (Davis in Helmreich 2011:136). In other words, it seems that some kinds of events, behaviour

[5] Please note that this research is on-going. Upon submission of this article, I have not yet conducted research in the Philippines, which is why this significant group of seafarers is not addressed in this paper.

and conditions are constructed by onshore notions of an untamed nature - such as piracy - while other events, behaviour and conditions on land are couched in perceptions of culture, society and civility. Seafarers often explain that people on land don't understand what life is like at sea. Oppositions where the wild is juxtaposed with the controlled, nature with culture and danger with safety (cf. Strathern 1980:175) are common and are not reserved for those with ideas about the character of life as a seafarer. But seafarers' perceptions of piracy threats challenge these binaries. In their experiences, the controllable and the uncontrollable cohabitate on land *and* at sea, but the shore-side discourse surrounding piracy as a wild and uncontrollable threat does not embrace this complexity. And so, in order to navigate between shore perceptions of piracy and own experiences and perceptions - in order to make these inconsistencies somehow fit into the binary they contradict - seafarers lie, keep secrets and omit information. Although the practice of secrecy, lies and omissions seems to be consistent, seafarers' specific motivations are varied and are framed by the local contexts from which they come.

1.1 *Denmark*

> *"'There's too much hush, hush about it. The company didn't want it in the media (...). Had we been in [my hometown], it would have been different. Then I would have had someone to talk to. ' But then [Michael] told me that his best friend lives there and they've never spoken about this. "*
>
> -Field notes Denmark, February 2013

> *"[His] wife called to tell me that she was 'furious'. (...) [Janni[6]] was pissed at [him] for having spilled all his beans to me. She was worried that the recorded session would be used irresponsibly and that their story would get out (...) I was able to calm her down - it took a bit. When I told her about the anonymity and confidentiality, she said 'you can't convince me of that! ' She explained that she knows seafarers and she knows how little that world is and people would recognize him (...)"*
>
> -Field notes Denmark, March 2013

The above quotes are about one seafarer's and another seafarer's wife's traumatic meeting with piracy attacks and the impact that it had on their lives afterwards. Before the attack, Michael seemed to be the kind of herculean man that people could count on in any situation. But the personal problems that arose from this incident led to a total breakdown - including depression and unemployment - shame and silence. Most of the Danes I have spoken to tend to brush off

[6]All informant names, unless otherwise noted, are pseudonyms. Identifying characteristics of events, organizations and individuals may also have been blurred to protect their identity.

the threat of piracy. It's not so much direct dishonesty, but a gruff refusal to even entertain the idea of fear. Because of relatively good conditions - and dependable emergency response - worry seems out of place. Among the Danes with whom I've spoken, there is a great deal of faith in national structures. But any needs that fall outside of the well-structured welfare system are cast off as unreasonable. 'We must not ask for more - all of our needs are already covered.' As a result, worry, fear and stress connected to a piracy attack are kept silent and any show of fear is seen as shameful. As one industry professional explained to me, "A guy that bawls loses respect, most of all for himself' (Field notes March 2013). Thus, suffering is only the result of his own failure to tame his emotions. The shame of such a breakdown is too great to accept and so it is silenced, effectively closing off access to much needed consolation and help. Even within the most intimate of relationships, shame weighed in as the greater concern, as evidenced in my conversation with another piracy victim's wife, Janni, above. Someone could find out about the incident and her husband's reaction to it - an incident that was further complicated by ensuing marital problems. As a result, victims and their families continue to be held - metaphorically - captive, unable to move past the traumatic events surrounding the attack. In Michael's case, the company had washed their hands of the long-time effect that the incident had on him and he seemed unable to ask for help.

Why, in this case, did the reactions to a particularly brutal piracy attack - one that included severe beatings, stab wounds and being tied-up for hours have to be silenced at all costs? I think that we can find some answers in another piracy attack, the high profile highjacking of MV Leopard, involving two Danish and four Filipino crew members. The media and various other institutions on land constructed a story about this case that links acts of 'Barbary', almost exclusively, to an exotic Other. But it turns out that the victims were not as sick and maltreated as we were told[7].

> *"The family was against the [media] campaign. They were really frustrated. That's the way he always looks. The family knew that he was being treated well. He looked like himself. "*
>
> -Friend of hostage, Field notes Denmark, May 2013

The above quote refers to one of the hostage victims and my informant knows the gentleman personally. The victim was presented in the media as being severely ill, due to general rough conditions, malnutrition, and physical abuse at the hands of the Somali pirates who held him and his five colleagues for 838 days. The pirates should certainly be held accountable for their crime, but my errand here is not to choose sides or pinpoint a perpetrator[8]. Instead, I wish to draw attention to the notion of a dangerous and uncontrollable 'Them' and a law-abiding and civil

[7] http://www.dr.dk/Nyheder/Indland/2013/05/17/0517060924.htm, accessed7/11/13.

[8] The dust is still settling on this case and it is very difficult to know exactly who was involved and in which way and what consequences this involvement may have had for the victims.

'Us' that infused this case. These binaries do not correspond to the slowly emerging details surrounding the incident, where the ship owner has been blamed for negligence, criticism of the ship owners' organization has begun to emerge and the Danish media have been accused of abusing the hostages by using them in printed and television media without their permission[9]. Afore mentioned binary is not representative of Michael's story, either. I will return to this shortly. The media claimed that they focused on this crew because they felt that not enough was being done to get them free. However, there is documentation that the media's involvement caused the hostages to be abused physically by their captors and there is serious speculation about whether the extraordinary length of their captivity was directly linked to the media's involvement[10].

In addition, film footage of the hostages was presented in "documentary" form on national television, explaining that "Conditions for the hostages have been brutal and inhumane. But it is necessary to show this reality"[11]. The footage and explanations that went along with them was aired on prime time Danish television. The reporter who filmed the footage was however not a proverbial fly on the wall and the pirates had an errand in granting access to and presenting the situation in a way that would serve their cause. This aspect was not addressed or criticized in the moderation accompanying the footage. What perceptions about the situation inform the television company's decision to present the footage to the broader public in this manner? The video begins with several written sentences. One of them reads as follows: "No other Danes have ever been held captive for so long," a statement that ignores the fact that there were four other hostages from the Philippines, whose compatriots have been in pirate captivity for even longer periods of time, as have other nationals. So why this particular *national* focus?

On land and within territorial waters, our civil rights are protected by a physically demarcated jurisdiction - a national border. Within this line, the rule of law is valid and powerful. There are however other political spaces on our planet that do not fall under *national* jurisdictions. They are no less political for that reason and they are governed by other juridical frameworks, such as international maritime law and an expectation of ship-owner responsibility. "Water…" Helmreich writes, "…moves faster than culture, with culture often imagined in a *land-based idiom* (...)" (132:2011; my emphasis). Again the sea/land - nature/culture binary emerges. I

[9] The captain has sued these media, as described in *S0fartens Ledere* 3/2013, page 28-29.

[10] Ransom negotiation can be a long process and pirates' perception of the hostages value can have an influence on what demands they make. If there is heightened media focus on the kidnapping, the pirates will adjust their demands accordingly (http://www.counterpiracy.ae/upload/Briefing/Mary%20Harper-Essay-Eng.pdf; accessed 8/16/2013).

[11] The video is no longer available on Danish websites, but I was able to locate it here: http://bajarmp3.net/video-mp3_32iZk_-5bvQ; accessed 7/16/2013. The quote from the Danish was translated into English by the author.

suggest that what lies behind the Danes' shock that a 'westerner' could be held hostage by pirates for so long is that there is an expectation that the state's all-encompassing and protective arm should be able to reach them wherever they are in the world. In Jenkins' words, the state is "omnipresent (...). Benign or not, there is no escape. Being Danish means being numbered, named, cared for and monitored" (171: 2012). If this is the case, how on earth was it possible for two members of the nation - through no fault of their own - to fall outside of her protective embrace?

In connection with their liberation, we could also read such statements in the Danish news:

> *''Thereby, Eddy Lopez and Soren Lyngbjorn[12] hold the record for being the westerners who have been held hostage longest by pirates."*[13]

What is thought-provoking about these two examples is the focus on being "Danish" and "Western". Of course, we are confronted with yet another binary here, where certain national groups are expected to be treated in a particular civil - in the sense of secured civil rights - way, while that expectation does not exist and is accepted as 'natural' with other groups. But given the same amount of protection (armed guards, razor wire etc.), all merchant ship crew members who transit piracy regions are literally, in the same boat. Their national or 'civilizational' affiliation makes no difference for the likelihood of being taken hostage. Nationals from all over the world have been taken hostage by pirates and no reliable sources indicate that attackers know in advance where their victims come from. Neither does the swiftness of their release relate to their citizenship or 'westerness' - as demonstrated in the Leopard case. In addition and in terms of release, what matters is how the ship owner handles the situation and what economic resources are at their disposal. Again, citizenship or civilizational affiliation does not appear to be a game-changer. But in the Danish media, the idea that some people should be - based on their group belonging - exempt from piracy, was often heard.

Returning to Michael's secrecy and Janni's suspicion, it seems that Danish citizenship gave access to a basic level of care that other seafarers and seafarer's families do not have. For example, they did not suffer extreme economic hardship due to lack of income. But their specific social needs in connection with the attacks effected their lives intimately and profoundly, were evidence that being a 'westerner'- and land-based notion- did not guarantee any kind of civility within their own national borders. Michael's employer did little to follow up

[12] Because this case has been given such heavy media attention, these gentlemen's names are very well-known to the Danish public. They have thus become public figures and for this reason I choose to use their real names. This puts me in an ethical bind. I hope that my representation of the Leopard case, how it was written about and how the hostages have been treated is sensitive to their situation and does not represent them unfairly.

[13] http://www.dr.dk/Nyheder/Indland/2013/05/01/131055.htm; accessed 7/16/2013. Translation from Danish to English by the author.

on his needs post incident and Janni clearly had no faith in the seafaring community to be supportive of her and her husband's situation. The barbary that they experienced at sea *and* at home again meant that the 'wild nature of the sea' and everyone on it could no longer stand in opposition to the 'civility of life within national borders'. But instead of challenging binary sea/land cosmology, both Michael and Janni chose to protect the construct by staying silent.

1.2 *India*

My impressions from many of the Indian seafarers with whom I have spoken, is that the family functions as *the* structuring element of civility in society (Krishna Rao 2005:68). In a way, it seems to fulfil a similar function that the welfare state does in Denmark, providing protection, care, and belonging (Jenkins 2012). Turning your back on this institution and its ability to protect its members is tantamount to treason, just as is subjecting oneself willingly to threats that could undermine the coherence of the family - such as piracy threats. But what counts as trustworthy or threatening at sea is different than the way threats *about* the sea are discursively constructed on land. The sea/land binary can be identified again - albeit in a slightly different trope.

One seafarer confided in me during a break in a lecture I was giving at a maritime school[14], telling me this is "confidential".

> *"He doesn't answer questions [in class] because his company says to keep it quiet. The company told him if they're taken, they will get them free - don't worry. Just three days.*
> *They don't want them talking about it because of what they're carrying to Basra, southern Iraq. "*
>
> -Field notes India, May 2013

During the lecture, he assured me that, despite the fact that he sailed a bulk carrier with a very low freeboard in the HRA without armed guards, he felt quite safe with his company and later wrote to me:

> *"Everybody on board were safe, all the crew stayed on their allotted cabins, only work was affected (...). [They] were accessed to call home*

[14] In this case, a "maritime school" refers to an institution - private or public - where professional seafarers can take courses that will certify them to carry out specialized tasks and to be promoted in rank. As such, the students often have many years of experience at sea behind them.

> *weekly once. They had their provision supply every week. After this incident also company refused to have arm guards. Basically these Greek people were working on illegal cargo so they don't want disclose anything. Company advises to vessel crossing HRA try to clear and even if fought not to worry we will clear. These are things I got through my friends who were in Somalia. "*
>
> -Field notes India, May 2013

This story suggests that the land-based notion of thelawless shippingcompany that does not care for its seafaring employees and the barbaric pirates who abusetheir victims does not quite hold water. This gentleman did not tell his wife or family anything about his company's policies or the threats he faced at sea, as not to worry them. He did not think they would be able or willing to absorb the truth regarding his work conditions but he felt safe. And just as Michael stayed silent about the lack of civility on land, this gentleman kept quiet about the civility he met at sea. The cosmology that sees sea/land as opposites, stays firmly intact.

1.3 *Ukraine:* Challenging the Binary

For many of the Ukrainian seafarers with whom I have spent time on board and on land, piracy at sea is no different from *"piracy"* on land.

> *"[He] said that for Ukrainians, Somali and Nigerian pirates are no worse than what they've seen in their school, their police and their government. 'Being afraid of pirates is like being afraid of cats and dogs, ' he explained. "*
>
> -Field notes, April 2013

Talking about such threats only attracts *"bad fortune",* I was told by others. It's better to stay unnoticed and trust no one. Life in the Ukraine, the country that brought us the secrecy of Chernobyl and the devious dioxin poisoning of politician Viktor Yushchenko, is harsh, untameable and unreliable. As one crewing agent explained, "Ukrainians are brave people. Maybe our lives on shore is too hard. " One activist told me the story of a cadet who was highjacked and held hostage by Somali pirates.

> *"He was not paid while he was held hostage and when he came home, they threw him out of the academy because he didn't pay his tuition and was not coming regularly to classes after his return (...)"*
>
> -Field notes Ukraine, April 2013

Upholding an image of a wild and untamed life at sea, locating the sea as the unruly *space*

(cf. de Certeau 1984), allows us to turn a blind eye to the lack of civility on land, as my examples from Denmark and India have shown. For many of the Ukrainian seafarers that I met, *not* claiming piracy as a threat - despite the relatively high volume of piracy victims among their nationals - was a strategy to stay employed, to avoid being blacklisted[15] and to safeguard them from corruption and blackmail. Thus, something just as, if not more threatening underpinned their efforts to brush off the threat of piracy.

> *"This whole idea of the hardened Ukrainian and not trusting anyone etc. It occurred to me when Katarina said to me that her son knows her and 'He knows I can take it' that this stone face outlook is perhaps a way of caring. What I mean is that if life is hard here - and everyone says it is - then it is important to show the people you care for that you can take it. In this way, they are consoled and don't have to worry about you. If you show your emotions, then you are also showing your vulnerability. This is perhaps dangerous in the way that others could exploit this "weakness" but also because it shows the ones you love that you might not be able to "take it" - and this causes concern. "*
>
> -Field notes Ukraine, April 2013Ukraine

My impressions from the Ukraine are that chaos and unfairness are expected. In other words, they do not seem eager to uphold any illusion that life on land is any more tame or wild than life at sea. Drawing attention to tough conditions anywhere shows weakness and could make them more vulnerable. Secrets, lies, and omissions are strategies to control the damage and protect them - whether on land or at sea. Perhaps, precisely because they do not attempt to uphold the sea/land construct, Ukrainian (and Russian) seafarers are often seen as uncontrolled and dangerous themselves, being described as people who *"have a total lack of respect for life"* (Field notes Denmark, April 2013).

2. Concluding thoughts

Similar to other sectors, such as the construction industry (Cf. Baarts 2009), a seafaring career carries risks, such as that of serious accidents. Accidents at sea - as opposed to piracy attacks - are framed by seafarers as natural, involving the elements which are beyond our control, such as the wind and weather and 'human error'. They do not defy the notion of the sea as "uncontrollable and unruly" (Helmreich 2011:137). Through training and good seamanship, seafarers are able to deal with a rough storm or fight and eliminate, for example, a fire on board.

[15] Seafarers are often evaluated while on board and this evaluation is sent back to the manning agency or ship owners. Many seafarers are worried that if they complain they will be "blacklisted" and thereby not be re-hired. This is of particular concern for seafarers who are hired on a voyage to voyage basis.

Piracy, on the other hand, like all crime, is social at heart. It is not a force of nature and seafarers are not trained to fight and eliminate such threats.

Crime involves interaction between human beings or notions that human beings have created, such as society, morality and law, and is, as such, a social act. But on shore, the crime of piracy - and its effect on victims - is often perceived as uncontrolled and exotic - as a kind of force of nature. As such, shore-based policy makers often place it in a category of its own when considering the effects of such an attack on the victims. As one representative from the Danish military put it, the victims of piracy will "never be normal people again. They will never work again." This however, is not the picture I am getting from many of the seafarers with whom I have spoken. The widespread criminalization of seafarers (SRI 2013) supports the idea that there is a shore- based perception that all that comes from the sea is unruly and must be civilized once it reaches our shores. This notion is also evidenced by laws about customs, immigration, and stacks and stacks of maritime codes that govern how seafarers must behave once they reach territorial waters. In land-based notions of the sea, sailors are often seen as burly, rough characters. My meeting with seafarers - many of whom I would describe as mild- mannered family men - contradicts such myths.

I have argued that the vast matrix of secrets, lies and omissions connected to piracy is a strategy and reaction to a set of perceptions on land that constructs the sea as the land's inherently dangerous binary. But my data suggests that the sea as a place where sociality unfolds is no wilder than any other social setting and as a result, individuals and groups that are part of a sociality at sea are no wilder than those on land. At the beginning of this article, I stated that telling lies, keeping secrets and omitting information were part of a "social strategy" (Behr 2006; Horn 2011). Why do seafarers employ such a "strategy"? Why do they choose to blur the truth rather than share their perceptions and experiences openly? Family members, friends, employers and the media are powerful actors in the seafarers' lives. They provide care, employment and authoritative voices on how our social world is constructed: what is wild vs. controlled and what is dangerous vs. safe (cf. Strathern 1980:175). This cosmology categorizes their social world and offers them a basic sense of control. The sea/land binary - part of the nature/culture construct - appears to be part of "the modern quest for control". Drawing attention to the defects of this construct "undermines the system as a whole (Van Loon in Clark 2005:170). Such an action would reveal the construction of the cosmology, rendering it a kind of "poisonous knowledge", where danger and security can no longer be anticipated from certain social fields and actors (cf. Das 2000). It opens up for the possibility that danger and threats may emerge in any setting - not just the ones that the construct has pre-determined for us. Seen from this point of view, challenging the binary perception of sea/land may be the most dangerous aspect of piracy of all.

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Beyond the ethic case: a value proposition of proactive human factors management

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Abstract

This paper is based on the work presented in Österman, C. (2012), 'Developing a value proposition of maritime ergonomics', PhD thesis, Department of Shipping and Marine technology, Chalmers University of Technology, Gothenburg, Sweden.

There is a large body of knowledge available on the role of human factors for successful (and unsuccessful) systems. Domain specific handbooks, guidelines and standards can be found also for the maritime industry. Yet, the deteriorating figure of maritime casualties and the high incidence of occupational accidents suggest this knowledge is not utilised to its full potential.
The purpose of this paper is to present a value proposition of maritime human factors, positioning the potential core values that can be delivered to stakeholders within and outside the maritime transport system. The paper adopts an exploratory research approach, investigating the link between human factors and operational performance from several different angles. Methods for data collection include literature studies, individual and focus group interviews, and a case study involving a shipping company.

The synthesis of the results is presented in terms of a value proposition that describes the value for the employee in terms of improved health and well-being, learning, skill discretion and independence in life. Values for the company include increased operational performance and

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flexibility, advantages in recruiting and retaining personnel. Values for the sector include competitive strength, attractiveness of work and increased learning across the industry. Values for the society include reduced costs for health care and social security, reduced environmental impact, and a sustainable working life.

These results are a first step to make visible the effects of human factors management on overall systems performance in the maritime domain.

Keywords: *human factors, safety, participatory design, maritime, performance, value proposition.*

1. Introduction

The main theme of this paper is the value proposition of maritime human factors, positioning the potential core values of human factors that can be delivered to employees, customers, and other stakeholders related to the maritime transport system. Value propositions are not just about selling. They are part of operational strategy, guiding many levels of an organization towards satisfied constituents and sustainable value creation (Barnes et al., 2009).

The maritime transport system is the life-blood of the world trade and plays a key role in the global economy and in supporting economic growth. While basic economics of commercial shipping have remained largely unchanged through history, the ships and commercial infrastructure have gradually evolved towards a tightly knit global industry (Stopford, 2009). Continuously, the world fleet has expanded in number, size and sophistication. Technological developments of hull, propulsion and cargo handling systems have increased speed and improved capacity, versatility and reliability of maritime transports. Mechanization, automation and communications technology have made many manual tasks redundant, enabling efforts to perfect crew size and composition in order to curtail operations costs (Ding and Liang, 2005). However, there is yet an area of potential to develop in the effort to optimise maritime operations: human factors the interplay of human, technology and organization in the process of design and organization of tasks, technology and work environments.

As technological systems increase in complexity, the gap between the human operator and the technical system tends to increase as well. Increased automation and the introduction of new technology have reduced transparency of work operations on board. Out-of-the-loop unfamiliarity, automation induced errors, complacency, behavioural adaptation and loss of skills are but a few common problems associated with the introduction of novel technology (e.g. Lee, 2006, Stanton et al., 2010, Kaber and Endsley, 1997). These issues have also been observed within the maritime domain (e.g. Lee and Sanquist, 2000, Lützhöft and Dekker, 2002). The transformation of technologies place new demands on the human operators at work who must control, diagnose and solve new kind of situations. We need to learn faster, more actively, but also ethically in order to be economically, ecologically and socially sustainable in a global world.

There is a large body of generic knowledge available on the importance of human factors to successful (and unsuccessful) systems. Domain specific handbooks, guidelines and standards can be found also for the maritime domain (e.g. Grech et al., 2008, Ross, 2009, Rumawas and Asbjørnslett, 2010). Yet, it seems this knowledge, and the application of human factors principles and methods in practice, is not utilised to its full potential. Recent statistics show deteriorating figures for maritime casualties (IUMI, 2012), and despite significant changes in work tasks, towards more monitoring and administrative work, the industry is still suffering from a high level of occupational accidents and morbidity (Ellis et al., 2011, Rodríguez and Fraguela Formoso, 2007). This high incidence of occupational accidents and injuries means that many individuals are afflicted with aches, pains and sometimes lifelong disability and relegation from the labour market, but it also means disruptions of output and heavy expense to businesses and community.

In a world of competing financial priorities, human factors specialists have apparently not succeeded in selling the systems approach of human factors management as a tool towards improved overall systems performance and employee well-being (Dul et al., 2012). Rather, there are islands of knowledge and pockets of practice that still remain to be linked.

In order to achieve better communication between major stakeholders in maritime operations and human factors specialists, efforts must be directed towards an increased understanding of the relationship between commercial value generation and human factors.

2. Research design and overall aim

The purpose of the research work presented in this paper was to develop a value proposition of maritime human factors, describing the core values of a systematic human factors management from individual, organizational and societal perspectives.

In all, seven exploratory studies were performed, investigating the link between maritime human factors and operational performance from different angles. The studies were structured around three themes:

2.1 ***Maritime human factors*** – investigating the key issues in the maritime domain from two perspectives. The theoretical perspective turned to the scientific literature to examine which major issues that have been addressed in previous research. The practical perspective turned to the industry to examine if the economics of human factors was known in the industry and which factors were considered important.

2.2 ***Effects of human factors*** – investigating the effects of human factors on operational performance in the maritime domain on individual, company and societal level respectively. A multi-metric approach was applied, adopting the concepts of productivity, efficiency and quality from the production industry paradigm. The concepts' relation to human factors were reviewed and further investigated in terms of availability and applicability in the setting of a real shipping company.

2.3 ***Knowledge of human factors*** – the development and transfer of human factors knowledge between stakeholders in the maritime domain. This part of the study was designed to explore how human factors knowledge can be developed and transferred within the industry. Specifically, the issue of crew participation during design and introduction of new workplaces or new technical systems on board.

Methods for data collection include literature studies, individual and focus group interviews, and case study. The research work is based on an overall triangulation of perspectives across studies to provide different images of understanding: from the macro perspective, studying the maritime transport system as a whole, to a micro perspective, studying one single technical system on

board a vessel. Within the studies, methodological triangulation has been employed through the use of different methods for data collection and analysis. The gained understanding from each research activity has been reflected upon moving between multiple levels of abstraction during the research process.

The overall aim is to increase the knowledge base of the value of human factors in the maritime domain, thus contributing towards improved working conditions for seafarers in a safe and sustainable maritime transport system.

3. Science and practice of human factors

The science of human factors is multi-disciplinary systems and design oriented, sometimes referred to as the science of fitting the task to the human (Kroemer and Grandjean, 1997). It implies the design of tasks, artefacts, systems and environments to be compatible with our physical and mental needs, abilities and limitations (Chapanis, 1996). According to the International Ergonomics Association (IEA), human factors is:

'*the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance*' (IEA, 2012).

This definition demonstrates a holistic approach embracing all aspects of human work, indicating both an individual and social aim (human well-being) as well as an organizational and economic aim (overall system performance). Thus, human factors can be viewed as a way to ensure goals of improved system effectiveness, safety, ease of performance and the contribution to overall human well-being and quality of life (Karwowski, 2005).

Domains of specialisation embody deeper competencies, often grouped in physical, cognitive and organizational factors (IEA, 2012). Physical factors refer to anatomical, physiological, anthropometric and biomechanical characteristics related to human activity. Relevant topics include working postures, work-related musculoskeletal disorders, workplace layout, product design, safety and health. Physical human factors are also concerned with how the physical work environment (e.g. noise, vibrations, light, climate and hazardous materials) can affect human

performance. Cognitive factors are concerned with mental processes such as perception (the process of interpreting information from our senses), cognition and motor response. It can be described as the science of designing tasks, artefacts and systems to fit the human mind. Relevant topics of cognitive human factors include mental workload and performance, decision making, human error, human reliability, work stress, and training. These topics all relate to operator performance in a human–machine system (Wickens and Hollands, 2000). Organizational factors establish the organizational context and are concerned with the optimisation of socio-technical systems, including their organizational structures, policies, cultures and processes for communication and decisions on who knows what, who will do what and who has done what. Relevant topics include communication, human resource management, teamwork, design of working schedules, participatory design, organizational culture, and quality management.

Poorly designed workplaces from a human factors perspective are known to have negative monetary and other effects for individuals, companies and for the society as a whole. At an employee level, poor working conditions can lead to accidents and illnesses that affect their income, lead to short term and long term costs such as treatments and rehabilitation and can affect their lifetime wages (Hendrick, 2003, Mossink and De Greef, 2002). On company level, the relationship between human factors and operational performance have been demonstrated in terms of increased production (Abrahamsson, 2000, De Greef and Van den Broek, 2004), improved level of quality (Axelsson, 2000, Falck, 2009), and reductions in work-related musculoskeletal disorders, personnel turnover and absenteeism (Goggins et al., 2008).

At societal level, the direct and indirect costs associated with occupational accidents have been estimated to 1–3 per cent of gross national product in the EU member states (Mossink and De Greef, 2002) and about 3 per cent of the US gross national product (Leigh et al., 2000). These societal costs consist of the total loss of resources and productive capacity, and reduction of welfare and health.

Within the maritime domain it is common to use the term human element when referring to the interaction of human, technology and organization. In November 1997, the International Maritime Organization (IMO) Assembly adopted Resolution A.850 (IMO, 1997) that defines the human element as: '*a complex multi-dimensional issue that affects maritime safety and marine*

environmental protection. It involves the entire spectrum of human activities performed by ships' crews, shore based management, regulatory bodies, recognized organizations, shipyards, legislators, and other relevant parties, all of whom need to cooperate to address human element issues effectively.'

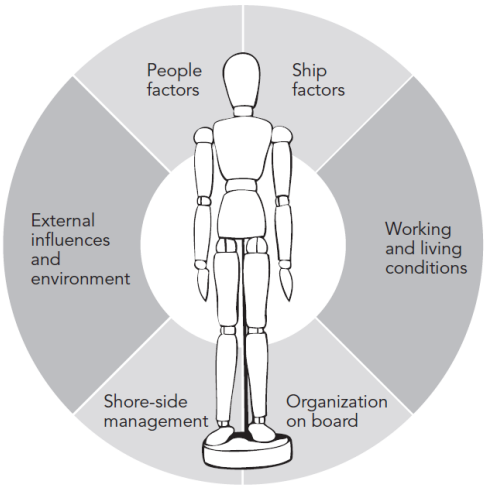

Figure 1. An overview of factors that have an impact on the human element

Over the years, the role of human element in maritime safety has evolved from what Reason (2000) labels the person approach, that focuses on the unsafe acts of people at the sharp end, to the system approach, that concentrates on the conditions under which individuals work. As a result, the revised IMO guidelines for investigation of marine casualties and incidents (IMO, 2000) provide a general overview of factors that have a direct or indirect impact on the human element (Figure 1). People factors include, but are not limited to, skills, knowledge (outcome of training and experience) and mental and physical condition. Ship factors include design, state of maintenance and availability and reliability of equipment. Working and living conditions include design of working, living and recreation areas and equipment as well as opportunities for recreation and adequacy of food.

Organization on board includes factors such as division of tasks and responsibilities, crew composition, manning level and workload, while shore-side management concerns safety and recruitment policies, management commitment to safety and ship-shore communication. External influences and environment factors include sea and weather conditions, port and sea traffic conditions, various stakeholder organizations, and national and international regulations and inspections.

4. Results and analysis

This section presents a cross-study analysis of the results structured around the three topics. It is followed by a section on the application of human factors management in the maritime transport system.

4.1 Key issues in maritime human factors

The literature review of the maritime human factors indicated a focus on physical human factors and occupational health issues from a medicinal perspective (Österman, et al., 2010). An explanation to the emphasis on physical factors is undoubtedly that seafaring still is a hazardous occupation with a high incidence of accidents and illnesses compared to many other industries (Ellis et al., 2011). Few studies report on organizational and psychosocial factors, indicating that the systems view of humans at work is scarce in maritime human factors research. However, a reason for the limited number of studies can be the practical difficulties in designing and carrying out studies on the maritime domain. Especially to arrange visits to the ships and meet the people working on board in their daily working situation and not only meet the shore based part of the organization.

Moreover, the literature shows a strong focus on the work performed in the deck and engine department while the catering department is largely invisible. Although the daily work of the catering personnel might not be perceived as immediately safety critical, it naturally affects customer satisfaction. Further, as demonstrated for instance in the sinking of the Costa Concordia, the catering crew plays a vital role in emergency situations where they are often responsible for the safe evacuation of passengers in case of fire or abandoning of ship.

The human factors emerging from the interviews were all organizational issues: leadership, knowledge, culture and values, human resource management, communication, and employee participation. Well managed, the informants consider these issues to yield fewer marine accidents, personal injuries and damaged equipment, or as an informant put it: '*fewer surprises*'. A motivated, skilled crew is thought to do a better job operating and maintaining the vessel, and if an accident occurs, to be better prepared for mitigation; thus limiting costs and time off-hire.

Several of the interviewed informants use the expression '*firefighting*' when describing safety and human factors, that priority is given to the most necessary tasks as they appear and that there is not sufficient time for proactive work. There is however a risk that solely being able to respond to what happens, being limited to reactive behaviour, will ultimately lead an organization to lose control. Irrespective of each other, two informants representing different marine insurers both maintained that the '*visible owners*' with a tight relationship with the crew and successful communication policies have fewer insurance claims. This statement corresponds well to conditions known to influence performance of an organization, and when and how an organization loses control. These conditions include defective leadership leading to unattainable demands, inadequate or overoptimistic planning, lack of knowledge and competence, and lack of resources (Hollnagel and Woods, 2005).

Manning of ships is a pivotal element in the shipping industry, a topic touched upon by all informants in the study. Although the gap between the demand for seafarers and their availability has narrowed in the wake of the recent financial crisis, appropriately qualified seafarers are still high in demand (Drewry, 2012). Rather than shortage in number, the weak point seems to be the absence of competent seafarers, with good command of English and communication skills (Xhelilaj et al., 2012). A major concern is the future availability of senior management level officers, engineers and seafarers in specialist segments of shipping which normally require a higher level of competence (BIMCO/ISF, 2010). Moreover, it is just as important that people remain within the industry. Seafaring is no longer a lifetime employment, but rather a stepping stone for a future career ashore. Many organizations such as marine insurers, classification societies and maritime administrations regularly employ people with seagoing experience. These people bring not only factual, but vital contextual knowledge and skills of maritime operations and the work on board. Hence, it is fair to assume that it will be increasingly important to adequately address human factors that contribute to attractive workplaces to which people want to apply for a job and where they want to stay.

In sum, it seems research on the maritime domain so far has had predominant focus on physical rather than organizational factors. A shift towards a more holistic approach in future research, covering all dimensions of human factors (physical, cognitive and organizational) and

encompassing all members of the crew should be appropriate to meet the needs of tomorrow's shipping industry.

4.2 *Effects of human factors on operational performance*

In order to be able to evaluate the effects of human factors management on performance, detailed modelling of maritime operational performance was needed. Three main productivity indicators were found to be under the control of the ship operator (Österman and Osvalder, 2012):

(1) accidents or injuries,
(2) operational disturbances of machinery and equipment, and
(3) inspections and detentions.

Accidents and injuries have a disruptive effect on operations both at the time they occur and in the aftermath with investigations, repairs, replacement of personnel, training and familiarization of new personnel. According to the European Maritime Safety Agency (EMSA, 2011), both the number of ships involved in accidents and lives lost increased in 2010 following a decline during 2009, suggesting a link between accident numbers and economic activity. During 2010, 644 vessels were involved in 559 accidents, and 61 seafarers lost their lives on ships operating in and around EU waters. The high occurrence of occupational injuries compared to other industries and the high costs for incidents involving crew members suffering from mental ill-health (NEPIA, 2006) implicate a high potential for improvements in this area.

Operational disturbances of machinery and equipment due to unplanned maintenance or breakdowns are costly in terms of direct costs for repairs, as well as for loss of productive time for ship, crew, and technical and administrative support ashore. Machinery damage and engine room problems remain the primary cause for serious losses, accounting for 35 per cent of all losses between 2006 and 2011 (IUMI, 2012). Alleged causes for these problems are found at the physical, psychological and organizational levels: the complexity of modern onboard systems that are not always fully understood, maintained or repaired, skill deficiencies among crew members, and neglect of technical inspection at management level. This phenomenon was illustrated also in Österman and Magnusson (2013) concerning design, installation and operation of selective catalytic reduction systems (SCR) to reduce the emissions of nitrogen oxides from

ships. The paper reports numerous anecdotes of things falling apart, personal injuries and ineffective operation. Using Reason's (1990) analogy, within the *blunt end* of the SCR systems (where managers, system architects, designers, and suppliers of technology are found), there appeared to be a lack of sufficient factual as well as contextual knowledge of technical and environmental prerequisites for a well-functioning system. This lack affects both the technical functionality and maintainability. To continue Reasons analogy, in the *sharp end* (where the actual operation and maintenance takes place), the operators tended to view the SCR largely as a '*black box*' with no one to tell what actually happens inside. The restricted space for installation further implies that routine and repair work are performed with an increased risk for human errors and occupational accidents. The SCR is but one example of a technical system on board, but the above described phenomenon can be seen in many other systems as well. Due to large costs and logistical challenges associated with the development of new systems for marine applications, the ship operators and their crew routinely take active part in this development, both technically and economically. When various prototypes and preproduction models are installed on board, the ship operators and crew also carry part of the development costs in terms of necessary re-engineering, material, working hours, energy and waste.

Operational efficiency in shipping can be seen as a function of costs, time, and customer satisfaction. Crew costs are a significant part of the operating costs, along with the increasingly important fuel costs. Generally, crew costs are seen as one of the most flexible costs (Leggate and McConville, 2002, Stopford, 2009), making strategies to improve individual and team performance high on any shipping company's agenda. Knowledge, skills and structures for communication are internal determinants of efficiency depending on managerial functions (Barthwal, 2000). As such, it is related to organizational factors and the design of the socio-technical system, providing the work environment and prevailing conditions necessary for optimal crew performance.

On a political level the intrinsic manning structures in the global manning industry can be seen as a risk factor in itself and have a negative impact on the efficiency of operations at sea. Commonly, seafarers have longer tours of duty on board than time off ashore. This leads to an inevitable turnover of crew and in turn an increased risk for accidents and operating errors. Contrary, stable crews returning to the same ship show reduced risk for accidents (Bailey, 2006, Carter, 2005, Hansen et al., 2002), findings that are consistent with research from other domains

on temporary workers (Quinlan et al., 2001). A constant flow of new crew members also poses a psychosocial stressor on the individual in having to adapt to new colleagues on and off working hours on board. In addition, it can involve a perceived sense of inequality due to differences in wages, length of tours of duty, and employment benefits. In addition, crew turnover is also associated with substantial costs.

Quality systems in the maritime industry have emerged principally from regulation, such as the International Safety Management (ISM) code (IMO, 2010), rather than from a company-centric or product-based mindset (Bichou et al., 2007). A ship is regularly subjected to inspections by various regulatory regimes and customers. Depending on executor, a failed inspection can result in the ship, or ship operator, being excluded for certain business opportunities, detention of ship, conditions or withdrawal of class, or a ban to enter certain ports or regions. In 2011, the Paris MoU reported deficiencies in 56 per cent of the inspections and 20 ships were banned from the region (Paris MoU, 2012a). A detained ship has significant cost implications for the shipowner in terms of loss of revenue and schedule disturbances, and because unplanned work undertaken at short notice is more expensive. Paris MoU regularly publishes a list of deficiencies and detentions along with photographs and particulars of ships in poor condition which have been '*caught in the net*' (Paris MoU, 2012b). Thus, even if a ship is not delayed, a failed port state control reflects poorly on both vessel and its operator and can imply commercial consequences on customer relations and loss of future employment.

Over the years, several shipping sectors have initiated self-regulating vetting systems to enhance quality driven by commercial interests. This especially applies to the liquid bulk market due to the high media profile of tanker accidents and associated corporate image repercussions for any well-known brand involved. Notorious examples are the grounding of the supertanker Exxon Valdez in 1989, and the tanker Erika that broke in two and sank off Brittany in 1999. Due to a perceived absence of economic incentives, similar market driven systems have been less prominent and have taken longer to develop within other segments (Tamvakis and Thanopoulou, 2000). But, in recent years there has been an increased customer interest for safety and environmental issues also within other shipping markets. Spurred by a combination of international pressure and separate incentives from a range of stakeholders, such as port state control regimes, classification societies and labour unions, the safety and quality standards are continuously raised (DeSombre, 2008).

In sum, effects of human factors on operational performance are found at all interrelated system levels. In the sharp end, crew performance benefits from a decreased risk for occupational and maritime accidents, improved individual health and well-being and increased learning. At an organizational level, the effects on company performance are related to the productive time at sea in terms of accidents, operational disturbances and inspections, operational efficiency, and quality of the sea transport service. Several effects at company level ultimately spill over to the entire maritime sector, for example, costs for insurance claims are carried by all policyholders in a mutual insurance company. Less tangible are the effects of maritime accidents, pollutions and other high-profile events that influence the image and perception of the industry in the eyes of policy makers and the general public with consequences for competitive strength towards other modes of transport and recruiting of new personnel to the sector. At a societal level, immediate effects of occupational injuries and ill-health can be seen in costs for medical treatment, health care and social security. Poorly managed and operated *green technology* systems may also have societal environmental effects through unnecessary emissions to air and water (Österman and Magnusson, 2013).

4.3 *Development and transfer of knowledge*

Seafarers seldom participate in workplace design and development projects on board. Among the reasons given for this are the absence of an appointed crew when the ship is built, the different challenges of time and place that comes with the globalised nature of shipping, and a perceived lack of value of crew participation to a design team. Crew participation is further complicated by the differences in professional background, command of technical drawings and the ability to communicate in engineering terms with a design team.

When designing new workplaces or introducing new technical systems on board, there are many functional, technical and legal aspects regarding a ship's seaworthiness and operation to consider that demand special areas of expertise. Thus, the participatory approach and the inclusion of the crew as operators and maintainers of the working and living conditions on board is not a substitution, but a complementary resource to the multi-disciplinary design team.

During a course development project for seafarer safety delegates described in Österman (2011) the course assignments matured into a systematic method that could serve as an investigative

toolkit during a real design process. The method draws on theories and principles of participatory design and work task assessment techniques such as task analysis and link analysis (Stanton et al., 2005) that enabled the safety delegates to take active part in a (fictional) ship design process, despite limited experiences of technical drawings. The group work presentations, as a symbol for a design proposal, had a strong focus on functionality and accommodated for actual tasks and processes in the workspace. The results illustrate the kind of contextual knowledge and understanding that comes of practical experience. This knowledge is vital when designing a workplace or work system in order to minimise risks and optimise performance during normal and emergency operations (Vink et al., 2006). The drawing review was performed on a conceptual level, limited to physical and social environment factors on board. Although not immediately recognised as safety-critical, the living conditions on board can have serious effects on operator and team performance. By ensuring adequate quality of sleeping and eating quarters, as well as possibilities for the crew to have an active leisure time on board, vital psychosocial stressors can be minimised, increasing crew well-being as well as operator performance (Carter, 2005).

In the absence of an appointed crew '*typical users*' can be employed. In a participatory design study including 18 nautical cadets from a maritime academy, Österman et al. (2011) showed that despite the cadets' lack of familiarity with the prototypical ship used in the study, they related their relatively short seagoing experience from other ships to the use scenarios and discussed both details regarding the physical design on the bridge and the interplay between operators on the bridge and on deck. Many anecdotes were triggered, indicating that the participants interpreted and evaluated the models and scenarios as real ship bridges during the discussions. The elicited comments from the participants generated tangible examples on workspace design, prerequisites for installation, use and service of equipment, transport and evacuation routes, maintenance and cleaning. This was achieved through relatively small resources for time, materials for low-fidelity mock-ups and training efforts – especially considering the costs for re-designing a workplace at a later stage.

Apart from illustrating how knowledge can be developed and transferred between users and designers of shipboard work systems, the outcome of these studies can be discussed in terms of empowerment of participants and inspiring confidence to embark on future design projects in real life. Empowerment does not come automatically from participation, but through a

progressive process in which the participants can staircase their understanding of the remote and complex decision processes surrounding a design project. Relations to colleagues and skill discretion (the possibility for an employee to learn new things, utilize skills and creativity, and perform varying tasks) are closely related to perceived stress and mental health (Stansfeld, 2002, Karasek, 1979).

One of the most prominent findings to emerge was the importance of rapport (mutual understanding or trust) between the different actors– manufacturers of technical systems, shipyards making installations, owners and operators of ships, and cargo owners. This is consistent with Guinan (1986) who proposes that communication between designers and users is positively related to the outcome of the design, and Berlin (2011) who identifies rapport-building as an important strategy for influencing workplace human factors.

A participative design process involves an expansive learning of all actors involved. The operators convey experience and feedback regarding usage to the designers, and the designers provide understanding of the system's function and operation. This knowledge flow helps to close the feedback loop between end-users and designers – linking the islands of knowledge. A mutual understanding supports the supplier in designing more operable systems, and the operators to operate them more efficiently and reliably (Launis, 2001). A collaborative installation process, involving both operators and technical management contributes towards a deeper understanding of how a technical system works, thus enabling a more efficient operation. This lead to less time and resources spent on problem-solving and maintenance. In times of increasing fuel costs, this phenomenon could also be linked to the contemporary discourse on improving energy efficiency on board. Among the identified patterns towards successful management of vessel energy efficiency are lack of knowledge and resources, low level of project management maturity, fragmented responsibilities and lack of communication (Johnson et al., In press).

Another challenge on the theme of development and transfer of knowledge is the institutional barriers that come with the prescriptive rules on knowledge and training within the regulatory regimes. The mandatory training courses included in the IMO convention for Standards of Training, Certification and Watchkeeping (STCW) are naturally prioritised before other training courses. However, the ISM Code requires each ship to be '*manned with qualified seafarers*' and

the establishing and maintaining of '*procedures for identifying any training which may be required in support of the safety management system and ensure that such training is provided for all personnel concerned*' (IMO, 2010, Chapter 6). This requirement and its relation to the safety management system undoubtedly leave room for interpretation and a question arises: when does human factors management become safety management?

No specific training is required for a technical system (or task) that is not regarded as safety critical. Training is possibly given to the operators who are on board at the initial start-up, and these operators are then supposed to transfer this knowledge to their colleagues and successors. Thus, successful operation of the system depends on the instructor's pedagogical as well as technical skills. Situations in the working life become the arena where the learning and the knowledge transfer occur. Depending on the extent to which a new situation resembles previously encountered situations, the learning process may be short and easy, or long and challenging (Eraut, 2004).

In viewing an organization as a knowledge system, knowledge is constantly generated and transformed through different types of bearers: people, machines, technical and administrative systems, documents, computer applications, and so forth (Wikström and Normann, 1994). Hence, for safe and efficient operation and maintenance, the installation in general and its user interfaces in particular, must be designed for good guessability, so it is easy to correctly guess how something works and what happens when for example a certain button is pushed. And further for learnability, so it is easy for the operator to learn how it works and remember correct actions (Jordan, 1998). This is especially important considering the high personnel turnover levels within the industry, with a constant influx of new crewmembers to train.

Recognizing training as an investment rather than a cost in a longer time-perspective than the nearest tour of duty influences employability and attractiveness of work. The positive effects of improved individual and organizational learning will be seen right across the business, since many people in positions at classification societies, marine insurers, ship yards, manufacturers etc. have a background on board.

In sum, there is a large body of knowledge within the maritime domain on how to create successful systems. There is however an absence of formal structures for transfer of this

knowledge between the various system actors that causes costly operational disturbances and unnecessary risks for occupational accidents. Strategies must be developed for bridging these islands of knowledge on several organizational and political levels: within international and national legislative regimes, trade organizations in the maritime sector and ship operators. These strategies include improved integration of human factors in the pre-operational planning phase of new vessels, workplaces, technical and administrative systems, and early involvement of the sharp end operators. Further, institutional and regulatory arrangements must be made for ensure quality crew training and the retention of maritime know-how, setting a level playing field across all operators and segments in the sector.

4.4 *Managing human factors in the maritime transport system*

The results show that an inherent potential for improvements can be found within the physical and cognitive workplace layout and design of the ship system and its sub-systems. Many human factors issues causing accidents and injuries can be solved early in the planning and design phase of new vessels or when planning changes in organization, work tasks or equipment. It is therefore suggested that traditional human factors and design engineering tools, such as methods for task and function analysis, user profiles, anthropometric and heuristic evaluations and user evaluations (e.g. Stanton et al., 2005, Wilson and Corlett, 2005), are used routinely. The use of these tools is equally important for designing the social environment on board. Seafarers of today have evolved into knowledge workers, operating in an increasingly complex socio-technical system that demands high level of concentration during planning, operation and administration of work. With long working hours and composition of watch systems with few hours of rest follows a need for physical and mental recuperation in order to promote personal health and safety and minimise the risks for use errors and accidents by stressed or fatigued operators.

The last resort for any remaining unsolved problems or issues that cannot be solved in the design and installation phase of new vessels, workplaces or equipment, lies in training. Adequate education and training is paramount to ensure that operators understand any risks associated with the work and how these risks can be avoided. Operators also need sufficient knowledge and training of the systems they are set to control so that complex or unexpected situations can be attended and perceived, adequate decisions made and correct actions taken during stressful

conditions. In addition, it is important that not only the actual users receive training on how to operate a system and how to avoid accidents and injuries. It is just as important that any risks associated with a particular system or task are known by the nearest manager so the work can be planned and performed in a safe and efficient manner. The manager is responsible for ensuring that adequate work instructions and work permits are available and adhered to, and that necessary controls of exposures are carried out and that adequate personal protective equipment is accessible and used. Essentially, most crew positions and work tasks at sea can be seen as safety critical. Hence, poor crew performance, irrespective of cause, can lead to increased risks for accidents and damage to environment, cargo and ship.

5. Synthesis - a value proposition of maritime human factors

The following section consists of a synthesis of the results in relation to the purpose of the paper, tying the knot between human factors and operational performance in the development of a value proposition of maritime human factors.

While the ethical and moral cases for a systematic human factors management are clear, the preceding analysis shows a case also for business performance. A value proposition of maritime human factors is proposed (figure 2), positioning the potential core values that can be delivered at different levels within the maritime transport system: the employee, the ship operating company, the maritime sector, and society as a whole.

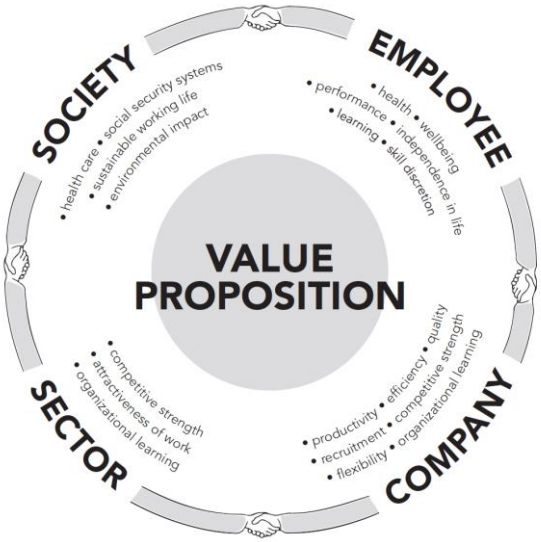

Figure 2. A value proposition of maritime human factors positioning core values at employee, company, sector and societal level.

Values for the individual include benefits regarding physical and mental health and well-being, but also regarding individual learning and skill discretion. Ultimately, maintaining good health and having the opportunity for personal professional development and career opportunities on board and within the industry contributes to an employee's power to make a living, provide for family and independence in life.

Values for the company include improved operational performance in terms of increased productive time at sea, operational efficiency and improved quality of sea transport services that in turn result in increased operational flexibility and competitive strength. This is achieved through a motivated and well trained crew, more efficient movements in operation and maintenance with reduced costs and time lost for accidents, injuries and operational disturbances, reduced costs for recruiting, less use of energy and other consumables. It is further achieved through improved corporate image affecting the company's ability to keep and attract business, the position on the labour market and attractiveness of positions in the company.

Values for the sector include competitive strength towards other modes of transport on a national and regional basis, attractiveness of work and the sector's ability to recruit and retain competent personnel and recruiting of new personnel to the sector. Values further include increased organizational learning across the industry through a flexible workforce on board and within shore based organizations.

Values for the society include reduced costs for health care and social security. Well operated and maintained systems further reduce the risk for operational and accidental pollution to the environment. Improved physical and psychosocial working conditions, that preserve health and reduce the risks for occupational accidents as well as ill-health, affect the human's ability to perform well during the entire working life, thus contributing towards a sustainable working life.

The presented value proposition can be seen as a tool for supporting informed management decisions and a guide for developing operational strategies on political, inter- and intra-organizational levels. It increases the understanding of why human factors management is important, to whom it is important and how it is linked to core business values and overall performance of the maritime transport system. The value proposition is not presented as

objectively assessed data. Nor does it pose as an absolute account. Due to the scarcity of previous work in this research area, it can rather be seen as a first piece in the puzzle, a first step to make visible the effects of human factors management on overall systems performance in the maritime domain. Increased knowledge of these effects has the potential to positively influence policy and decision making on political and organizational level towards improved working conditions for seafarers in a safe and sustainable maritime transport system.

There are many references in this work to measuring of various performance indicators and evaluation of effects. It is a human truism that what gets measured gets done, but it is obviously not the measuring and evaluation activities in themselves that improve performance or make seafaring a safer profession. The advantages of these activities lie in the increased understanding of the system that is achieved through a methodical definition, investigation and assessment of performance and objectives, justifying human factors and guiding management and operators on all levels to appropriate solutions.

There is a lack of complementary quantitative studies to empirically test the links between maritime human factors and operational performance proposed here. However, this research work constitutes a base for the design of future studies in knowing what to measure and how. Complementary studies are needed to investigate the feasibility in incorporating human factors methods and techniques in the toolboxes of naval architects, ship designers and suppliers of marine equipment. Continued research is also needed on the topic of crew participation on all stages in the development process when designing vessels, workplaces or other technical or administrative systems.

6. Conclusions

The research work presented in this paper proposes a link between human factors and the value creating process in the maritime transport system, and contributes with theoretical reflections and practical suggestions to the field of maritime human factors science.

The following conclusions are drawn from the work:

- Main focus of research on the maritime domain has so far been on physical and to some extent cognitive human factors, while an increased concern with organizational factors was noted among the practitioners that participated in the study.
- There is an absence of formal structures for development and transfer of human factors knowledge between the various stakeholders in the maritime domain. This absence increases the risk for accidents and operational disturbances.
- The following strategies for facilitating the development and transfer of human factors knowledge within the domain were identified:
    - Improved integration of human factors in the pre-operational planning phase of vessels, workplaces, and other technical and administrative systems
    - Early crew participation in design processes
    - Improved integration of human factors in the design of usable system documentation
    - Institutional and regulatory arrangements to ensure quality crew training and the retention of maritime know-how.

Finally, in order to support informed management decisions and highlight the potential value of maritime human factors, a value proposition was developed and structured around the employee, company, sector and societal levels.

Values for the employee include improved health and well-being, learning, performance, skill discretion and ultimately independence in life.

Values for the company include increased operational performance in terms of productivity, efficiency and quality, advantages in recruiting and retaining personnel, increased flexibility, and organizational learning.

Values for the maritime sector include competitive strength, attractiveness of work and increased organizational learning across the industry.

Values for the society include reduced costs for health care and social security, reduced risk for accidental and operational impact on the environment, and a systematic work towards a sustainable working life.

Suggestions for further work include complementary studies to investigate the feasibility in incorporating human factors methods and techniques in the toolboxes of naval architects and other system builders. Further work is also needed on the topic of crew participation when designing vessels, workplaces or other technical or administrative systems.

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A new strength model of shell structures for offshore applications

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Abstract

The major design codes are changing to LRFD (Load Resistance Factor Design) replacing traditional WSD (Working Stress Design) approach for offshore structural integrity assessment. The LRFD factors are partial safety factors obtained from structural reliability analysis. The reliability analysis needs a tool to predict the structural capacity very accurately. Hence the strength analysis of structures with a higher degree of accuracy is quite important. Although the numerical methods can be used for reliability analysis, the computation cost involved is quite high. It further demands great effort and expertise for acceptable results. Hence an analytical solution with basic structural design parameters predicting structural capacity is more suitable for the reliability analysis. Rule based design codes are available for the assessment of structural capacity for the stiffened cylindrical structures under different loading conditions. This paper establishes a modified version of a strength model which was proposed earlier for ring, stringer and orthogonally stiffened cylindrical shells. The mean and COV (Coefficient of Variation) of model uncertainty factor of a large population of experimental data are used to compare the proposed strength model and other major practicing codes.

Keywords: *Stiffened cylinder, buckling, streth, reliability*

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1. Introduction

Stiffened cylinders are extensively used in buoyant semi-submersible and Tension leg type offshore platforms. The legs of these structures are designed as Stiffened cylinders because of its inherent capability to resist high axial loads and bending moments with lateral pressure loads.

The modern LRFD design approaches are based on structural reliability analysis for the determination of sensible load and resistance factors. The structural reliability analysis needs a tool to predict the structural capacity very accurately. This make the strength analysis of structures with a higher degree of accuracy is the key aspect in the reliability based design processes. Although the numerical analysis tools validated with reasonable model uncertainty factor are absolutely suitable for this purpose but the time and cost of computation become a major factor to prefer an analytical method. Hence an analytical approach in terms of basic structural design parameters to predict the structural capacity is more suitable for the reliability analysis. There are various rule based design codes available for the assessment of structural capacity of stiffened cylindrical structures under different loading conditions. DNV-RP-C202 and API BUL 2U are two of the major industry recommended codes in practice.

Author proposes a modified version of existing RCC (Rule Case Committee) formulation for the strength assessment of ring stiffened and ring-stringer stiffened cylinders (ABS, 1984). The bias for knockdown factor for both the ring and orthogonally stiffened cases are modified based on experimental results for similar structures conducted within last century. The codes and the proposed formulation are compared statistically with respect to mean and COV of a large population of screened test data.

2. Analytical strength model for stiffened cylinders

Figure 1: Elements of a typical analytical strength model of stiffened cylinder

The general philosophy followed by most of the codified rules for the ultimate strength of stiffened cylinders is nearly same. The strength evaluation of the structural element starts from the assessment of the elastic critical buckling strength of perfect cylinders.

The variation to this theoretical value is then accounted by applying appropriate shell knockdown factor so that the elastic critical buckling strength of the Imperfect cylinder (real structure) is obtained. A reduction factor is then applied considering the slenderness of the structure and material strength to achieve the ultimate strength of the stiffened cylinder.

The shell knockdown factor represents the effect of geometrical imperfections on the buckling strength of the structure. The reduction factor includes the effect of residual stresses and structural slenderness.

2.1 *Buckling of cylinders*

Basically the stiffened cylinder structure can buckle and eventually fail in two ways. Snap-through buckling occurs by a sudden reverse of the curvature locally at certain combination of axial loads and the successive bending moments and results in a total failure as there is no chance of moment redistribution. Other failure type is the classical type of bifurcation buckling. The mode which most dominates design and structural weight is variously referred to as 'bay instability' and 'panel buckling; but inter-frame collapse is less ambiguous and is used here.

The approach taken is to liken the failure model to that of a flat stiffened panel wrapped up into a stiffened cylinder, as illustrated in Figure 2. The curved shell between stringers is the most important load carrying element. The analysis will follow that established for flat panels, but with stabilising effects of curvature included. As with flat panels, an effective width approach is fundamental to achieving the best accuracy.

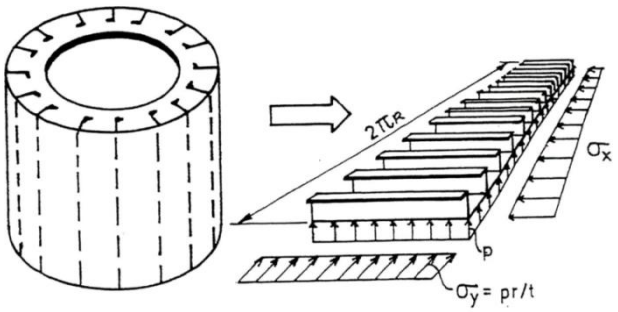

Figure 2: Stringer Stiffened Cylinder between Ring Frames

2.2 *Knockdown factors in RCC code*

The analysis revel that there is large variation exists between the experimental test results and the theoretical bucking strength prediction for both cylinder and curved shells. This deviation is predominantly a consequence of initial imperfections. The reduction from the theoretical

buckling load is addressed with a term called knockdown factor denoted by ρ. So the elastic buckling strength of imperfect cylinder can be represented as,

$$\sigma_e = \rho\sigma_{cr} \tag{1}$$

where σ_{cr} is the lowest critical stress for cylinders and curved shells.

Ring stiffened cylinder

RCC proposes the knockdown factor for unstiffened and ring stiffened cylinder as,

$$\rho = B\rho_n C \tag{2}$$

where ρ_n is the structural knockdown factor and C is a length dependent coefficient.

The results show some scatter with the above factors and then introduced the parameter B which is the Bias for knock down factor to account the deviations.

$$B = \begin{cases} 1.2 & \text{for } \lambda_n \geq 1 \\ 1 + 0.2\lambda_n & \text{for } \lambda_n < 1 \end{cases} \tag{3}$$

where, $\lambda_n = \sqrt{\dfrac{\sigma_y}{\rho_n C \sigma_{cr}}}$; σ_y is the material yield stress

(4)

Stringer stiffened cylinder

Similar to the case of unstiffened and ring stiffened cylinders, the stringer and orthogonally stiffened cylinders also shows the effect of imperfection with a reduction in the buckling strength. As shell slenderness, which is the Batdorf width parameter (Zs) increases, the behaviour becomes more unstable and imperfection-sensitivity is greater. RCC proposes the knockdown factor for stringer and orthogonally stiffened cylinder as,

$$\rho = B\rho_n \tag{5}$$

where ρ_n is the structural knockdown factor as given below.

The scatter in the results is managed with a Bias for knock down factor B.

$$B = \begin{cases} 1.25 & \text{for } \lambda_n > 1 \\ 1 + 0.25\lambda_n & \text{for } \lambda_n \leq 1 \end{cases} \tag{6}$$

Where, $\lambda_n = \sqrt{\frac{\sigma_y}{\rho_n \sigma_{cr}}}$ (7)

3. New knockdown factors for elastic buckling strength

The RCC code has taken the bias for knockdown factor B straight from the aerospace industry. The loading, support, material, fabrication, environmental conditions etc. are quite different in the offshore industry. So the direct adaptation may not fully acceptable for the design purposes as the empirical factors need suitable modifications. The strength performance under different loading conditions could be addressed differently for offshore design purposes. The author proposes modified bias for knockdown factors (Pretheesh Paul C, 2011) considering various loading conditions particularly applicable for the offshore industry. The coefficients are obtained using a least square fit to match the predictions close to the experimental values.

Ring stiffened cylinder

The results for the ring stiffened panels are separated and the predicted results with the RCC formulation is compared with the experimental results. While fitting the curve with the predictions, the bias shows more sensitivity with the type of loading. The least square fitting process has been performed for the sets of results with different loading conditions and the bias for knockdown factor for ring stiffened cylinder is expressed as,

$$B = \begin{cases} D_1 & \text{for } \lambda_n < 1 \\ 1 + (D_1 - 1)\lambda_n & \text{for } \lambda_n \geq 1 \end{cases} \quad (8)$$

$$D_1 = \begin{cases} 1.40 \text{ - for Axial loading} \\ 1.20 \text{ - for Radial loading} \\ 1.30 \text{ - for Combined loading} \end{cases} \quad (9)$$

The scatter of the results has brought down significantly with the above Bias factor which is illustrated latter in the next section.

Stringer stiffened cylinder

Similar to the previous analysis the bias for knockdown factor for stringer or orthogonally stiffened cylinder is expressed as,

$$B = \begin{cases} D_2 & \text{for } \lambda_n > 1 \\ 1 + (D_2 - 1)\lambda_n & \text{for } \lambda_n \le 1 \end{cases} \tag{10}$$

$$D_2 = \begin{cases} 1.60 \text{ - for Axial loading} \\ 1.25 \text{ - for Radial loading} \\ 2.10 \text{ - for Combined loading} \end{cases} \tag{11}$$

Again, the scatter of the results has found to reduce significantly with the above Bias factor which is illustrated in a following section. The coefficients can be further modified subjected to the availability of suitable test results.

4. Statistical comparison of test data

Reference	Ring Stiffened			Stringer Stiffened		
	Axial	Radial	Combined	Axial	Radial	Combined
Dwight, J.B. (1982)	3	-	-	-	-	-
White, J.B. and Dwight, J.B. (1977)	7	-	-	-	-	-
White, J.B. and Dwight, J.B. (1978)	9	-	23	-	-	-
Sridharan, S. and Walker, A.C. (1980)	4	-	-	-	-	-
Walker, A.C. and Davies, P. (1977)	8	-	-	-	-	-
Agelidis, N.A., Harding, J.E. and Dowling, P.J. (1982)	26	-	-	-	-	-
Dowling, P.J. and Harding, J.E. (1982)	-	35	-	-	-	-
Weller, T., Singer, J. and Batterman, S.C. (1974)	-	14	-	-	-	-
Becker, H. and Gerard, G. (1962)	-	-	7	-	-	-
Das, P.K., Faulkner, D. and Guedes da Silva (1991)						
ABS/Conoco	-	-	-	14	8	22
CBI	-	-	-	1	1	4
Imperial college	-	-	-	6	-	-
Glasgow	-	-	-	3	-	-
DNV	-	-	-	4	-	-
Seleim, S. S. and Roorda J. (1986)	-	10	-	-	-	-
Ralph, E.E. (1963)	-	14	-	-	-	-
Walker, A.C. and McCall, S. (1987, 1988)	-	1	3	-	2	-
Birch, R.S. and Norman Jones (1990)	-	-	-	11	-	-
Ross, C. T. F. and Johns, T. (1998)	-	3	-	-	-	-
Ross, C. T. F. and Sadler, J.R. (2000)	-	9	-	-	-	-
Total	57	86	33	39	11	26

Table 1: Source for test data

The experimental test results are collected from a wide literature survey over the last century (Pretheesh Paul C, 2011). It is observed that majority of the experimental works on stiffened cylinders are being undertaken during 1960's to 1980's and there is not much experimental works available recently as the researches are comfortable with the numerical results with the increased capabilities and accuracy. This work incorporates data from various experimental programs undertaken across the world for stiffened cylinders as illustrated in Table 1.

In the simplest way, a good analytical strength model should predict the strength of the structure accurately under the imposed loading and support conditions. As mentioned earlier, because of the assumptions and approximations considered in the analytical relations along with the unaccounted factors, there always remain a certain percentage of error in the structural strength prediction. So a strength model can be rated based on the deviation from the experimental results. The best way to quantify this uncertainty is with the modelling parameter. This modelling parameter is also known as the model uncertainty factor Xm.

Model uncertainty factor,

$$X_m = \frac{\text{Experimental Value}}{\text{Predicted Value}} \tag{12}$$

5. Analysis results

The data collected are carefully arranged and tabulated with all the necessary inputs for the code based design. The data is then pushed through the analytical relations of DNV, API, RCC and the Recommended Models for stiffened cylinders. The strength predicted by each of the models is then compared with the experimental results to evaluate the model uncertainty factor Xm which is the ratio of experimental value to the theoretical prediction for each set of data. The mean and COV of the model uncertainty factor Xm is then evaluated for each case. The predicted and experimental strength (ϕ-Predicted and ϕ-Test) which are normalised with respect to yield stress are then plotted to show the closeness of experiment with prediction and the scatter in each case. For combined loading cases, the model uncertainty is plotted against L/R ratio as it is not straight forward to represent the strength for a combined loading case.

5.1 *Ring stiffened cylinders*

Ring stiffened cylinders under axial compression

The Ring stiffened cylinders are basically checked against the local shell buckling which is the dominant failure mode in this type of structures.

Table 2 Illustrate the statistical results of model uncertainty factor Xm for DNV, API, RCC and the Proposed strength model. The values indicate that the Proposed model has better statistical parameters compared to other strength models for the axial strength of ring stiffened cylinders. There is a 10% variation in the mean value and nearly 0.5% reduction in the spread of the results.

	DNV	API	RCC	Proposed Model
Mean	1.28	1.15	1.10	1.00
COV	17.94%	11.84%	11.04%	9.62%
Population	40			

Table 2: Statistical comparison of Xm for Ring Stiffened Cylinder under Axial Loading

Figure 3 and Figure 4 show the comparison of predicted and experimental data for the different strength models. The strength prediction of the Proposed model is more accurate compared to the other approaches in terms of its statistical measures. Figure 4 shows the spread of the results about its mean line having a low bias to the unity with less COV.

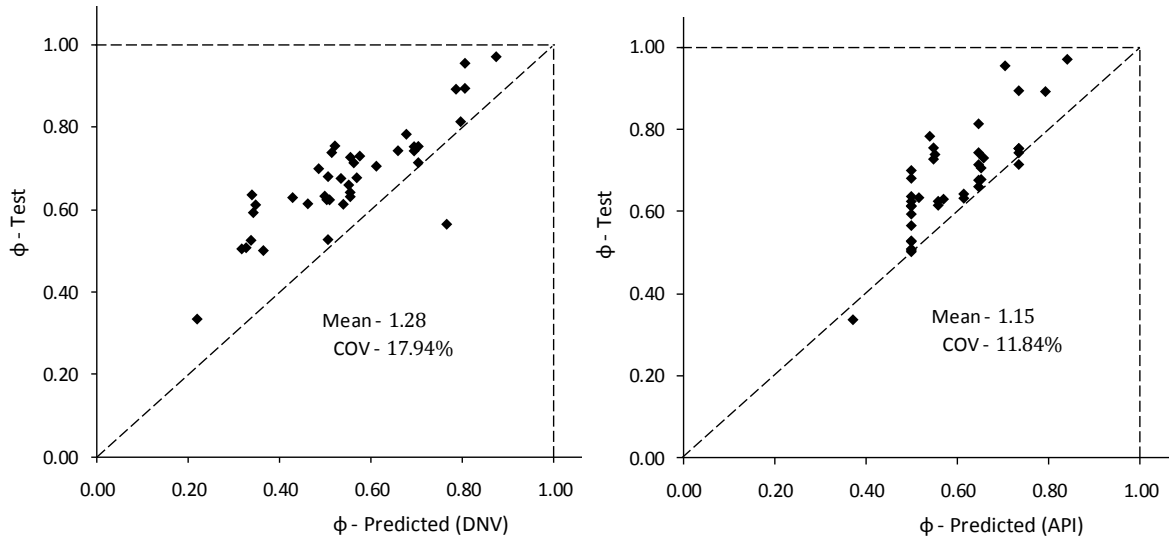

Figure 3: DNV and API prediction for Ring Stiffened Cylinders under Axial Compression

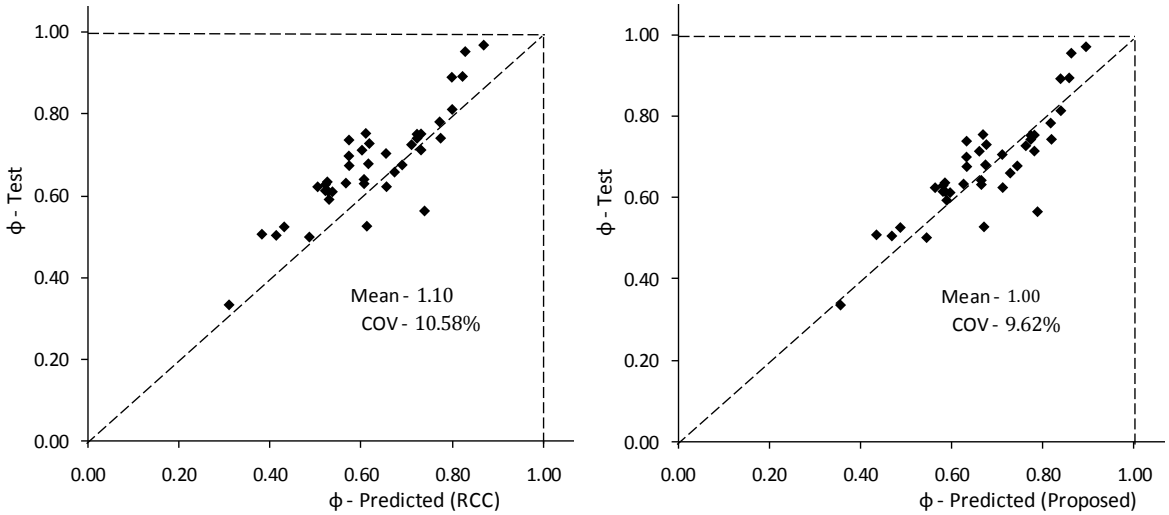

Figure 4: RCC and Proposed prediction for Ring Stiffened Cylinders under Axial Compression

Ring stiffened cylinders under radial compression

Table 3 shows the statistical analysis results for DNV, API, RCC and the Proposed strength model. It shows the comparison of predicted and experimental data for different approaches. The average and spread of the population shows better central tendency compared to the other approaches.

	DNV	API	RCC	Proposed Model
Mean	0.98	1.35	1.03	1.00
COV	19.43%	19.09%	21.19%	17.67%
Population	65			

Table 3: Statistical comparison of Xm for Ring Stiffened Cylinder under Radial Loading

Ring stiffened cylinders under combined axial and radial compression

Table 4 shows the statistical results of the ring stiffened cylinders under combined axial compression and Radial pressure for a population of 27 data for DNV, API, RCC and the Proposed strength model. The API model shows the lowest bias. The proposed strength model shows less scatter compared to all the other strength models.

	DNV	API	RCC	Proposed Model
Mean	1.46	1.07	1.14	1.17
COV	19.49%	21.71%	18.34%	16.41%
Population	27			

Table 4: Statistical comparison of Xm for Ring Stiffened Cylinder under Combined Loading

5.2 Stringer or Orthogonally Stiffened Cylinders

Stringer/orthogonally stiffened cylinders under axial compression

Table 5 shows the statistical results of the ring-stringer stiffened cylinders under Axial compression for a population of 30 for DNV, API, RCC and the Proposed strength model.

	DNV	API	RCC	Proposed Model
Mean	1.02	1.07	1.05	1.01
COV	21.57%	14.67%	14.01%	14.17%
Population	30			

Table 5: Statistical comparison of Xm for Ring-Stringer Stiffened Cylinder under Axial Loading

Figure 5 and Figure 6 show the comparison of predicted and experimental data for the different approaches. The Proposed model predicts the strength almost similar to that of the API and RCC model and which is better compared to API and DNV models.

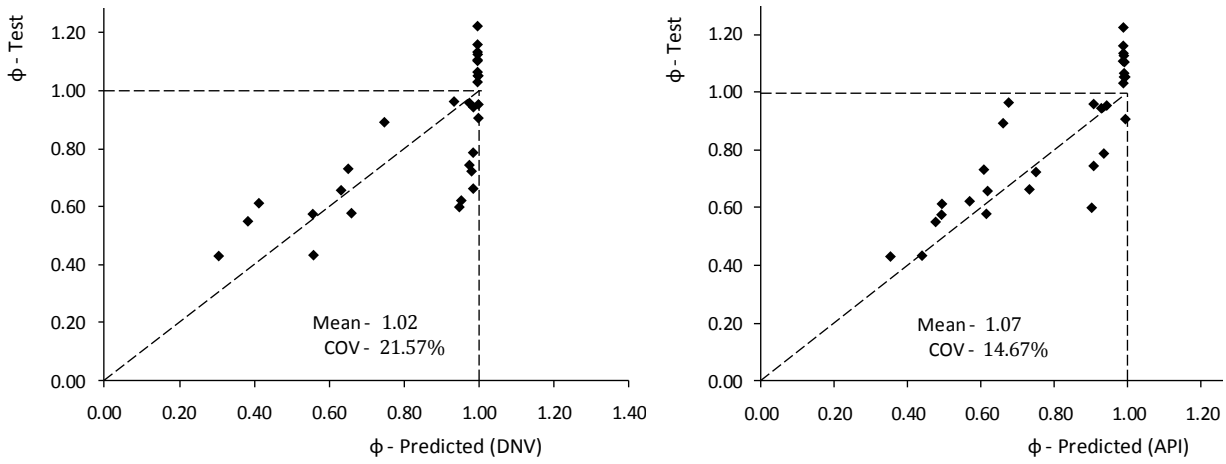

Figure 5: DNV and API prediction for Ring-Stringer Stiffened Cylinders under Axial Compression

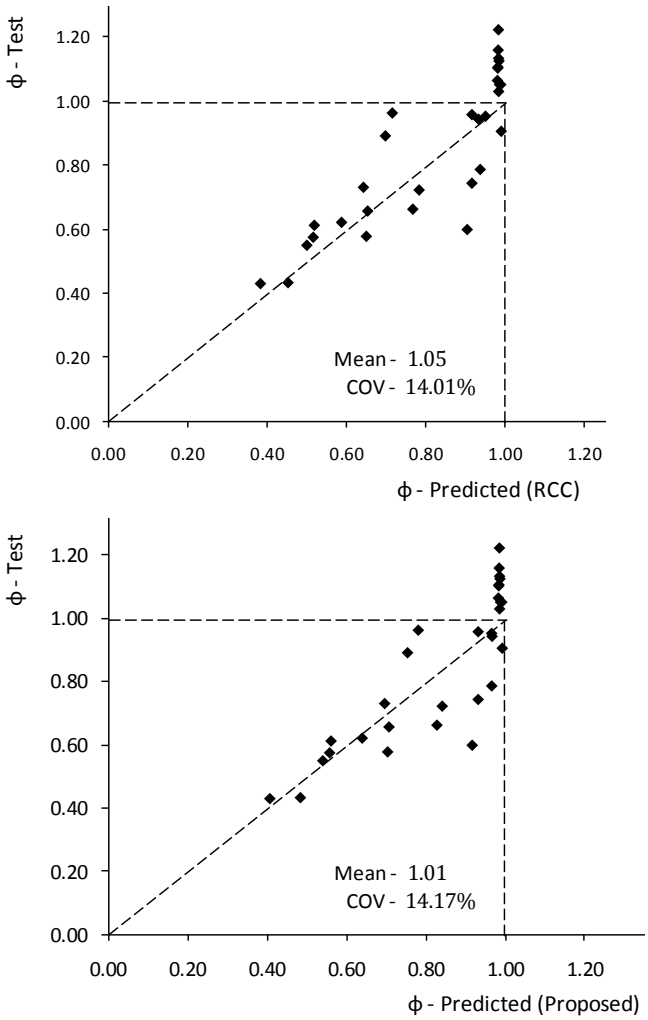

Figure 6: RCC and Proposed prediction for Ring-Stringer Stiffened Cylinders under Axial Compression

Stringer/orthogonally stiffened cylinders under radial compression

Table 6 shows the statistical results of the ring-stringer stiffened cylinders under radial pressure for a population of 9 for DNV, API, RCC and the Proposed strength model. The recommended approach is same as that of RCC and it is quite similar to the API formulation. The Proposed model appears better compared to DNV and API codes in terms of mean and spread of the model uncertainty factor.

	DNV	API	RCC	Proposed Model
Mean	1.33	1.12	1.06	1.06
COV	47.38%	21.54%	18.38%	18.38%
Population	9			

Table 6: Statistical comparison of Xm for Ring-Stringer Stiffened Cylinder under Radial Pressure

Stringer/orthogonally stiffened cylinders under combined axial and radial compression

Table 7 shows the statistical results of the ring and stringer stiffened cylinders under combined axial compression and radial pressure for a population of 25 for DNV, API, RCC and the Proposed strength model.

	DNV	API	RCC	Proposed Model
Mean	1.84	1.33	1.34	1.18
COV	43.82%	22.19%	21.02%	19.87%
Population	25			

Table 7: Comparison of Xm for Ring-Stringer Stiffened Cylinder under Combined Loading

6. Conclusions

The analyses with the experimental results illustrate the fact that the Proposed model which is a modified RCC Model, predicts the structural capacity more accurately in most cases compared to API and DNV codes. The statistical parameters of the analysis show that the Proposed model is more stable in predicting the strength of the stiffened cylinders compared to the DNV and API codes. The experimental data available for the radial pressure load cases for ring-stringer stiffened cylinders are very less and it is required to do further investigation to acquire more data. The design equations and the model uncertainty factors presented in this study are suitable for reliability analysis, sensitivity analysis and evaluating the partial safety factors for similar structures.

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Development of partially hydolyzed polyacrylamide based gel system for its application in profile modification jobs

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Abstract

The gelation time and gel quality are the important considerations of any gel system for its suitable placement in the high permeable or fractured formations during profile modification jobs in the oilfields. Keeping these in view, an attempt has been made to study the effect of chromium acetate and thiourea crosslinkers on the gelation time of the polyacrylamide based gel. The crosslinkers are mixed with base partially hydrolyzed polyacrylamide suspension and gelation time for the formation of stiff /rigid gel was determined. The experimental studies show that with increase in concentration of crosslinkers the gelation decreases. These studies help us for the optimization of the concentration of the organic polymer and chromium acetate and thiourea crosslinkers for successful profile modification jobs.

Keywords: *Polymer gel system, profile modification, gelation time, in-situ gelation*

1. Introduction

Inadequate sweep efficiency due to reservoir heterogeneity often causes poor oil recovery during water flooding in matured reservoir. The presence of fractures and high permeability streaks in

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heterogeneous five spot pattern reservoirs are responsible for undesirable influx of water into well bore and early breakthrough of injection water. This excessive water production from the producer leads to raise handling and disposal cost and reduces economic life of the well (Marty et al., 1991; El-Hadidi et al, 2000; Nguyen et al., 2004; Ma et al., 2007; Mahto et al. 2010**)**.

Profile modification is a means of enhancing oil recovery by diverting flood water into previous upswept zones. The method comprises emplacements of a gelant slug into the highly permeable flooded out layers of the formation close to well bore. The gel is designed to reduce the permeability of the target zone to the flooding fluid, there by modifying the flow profile and diverting injected fluid into zones of greater residual oil content (Mahto, 2008; Mahto and Seikh, 2009;Mahto et al. 2009;Nguyen et al., 2012).

Polymer gel system can effectively improve the sweep efficiency in reservoirs. A gel treatment reduces the water production and increases oil production from upswept zones. Gel is normally formed by adding a cross-linker to polymer solutions. The base polymers like polyacrylamide or xanthan gum are cross linked with eithers inorganic or organic crosslinkers. Inorganic crosslinkers include Cr (III), Al (III) and Zr^{+4} and have been mostly utilized to crosslink partially hydrolyzed polyacrylamide. Inorganically crosslinked gels result from the ionic bonding between the negatively charged carboxylate groups and the multivalent cation. The organic cross linkers used in acrylamide based polymers include phenol, formaldehyde and its derivatives. The gelation mechanism of organic cross linkers is done by covalent bonding, which is much more stable than the ionic bonds (Huang et al., 1986; Syndask, 1988; Marty et al., 1991; Stokke et al., 1995;Brayant, 1997; Jain et al, 2004; Nguyen et al., 2004; Al-Muntasheri, 2006; Al-Assi et al., 2006; Ma et al., 2007; Mahto et al. 2009;).

In this study, the partially hydrolyzed polyacrylamide polymer is cross linked with chromium accetate and thiourea crosslinkers to form the polymer gel and the effect of cross linkers on gelation behavior of the partially hydrolyzed polyacrylamide are thoroughly analyzed. The plugging ability of this polymer gel system in the barea sand stone core was thoroughly investigated at 80°C for the study of the effectiveness of gel system in the profile modification jobs.

2. Experimental procedure

Initially, the stock solutions of partially hydrolyzed polyacrylamide polymer and chromium acetate cross linkers were prepared, and from these stock solutions further polymer solutions and cross linker solutions of appropriate concentrations required to form the gel were prepared. The polymer stock solution was prepared by dissolving the polymer in NaCl solution containing 200 ppm of sodium sulphite and kept for hydration for 24 hours. Proper salinity of the solution was maintained so that it should be compatible with the formation water. The appropriate amount of cross linkers was mixed with this polymer solution and pH of resulting mixture was maintained using NaOH and HCl solutions. The resulting mixture was kept in small bottle in hot air oven at 80^{o}C for gelation and inspected the quality of gel visually at regular intervals.

After Bottle testing, core flow studies were carried out using Core Flow Apparatus manufactured by Vinci Technologies, France. Using this experimental set up, the permeability of the core sample before injection of gelant solution and after injection and setting of gel in the core sample at reservoir conditions was determined using Darcy's Law. The Berea sandstone core sample was kept inside the core holder which was further housed in a constant temperature oven at the simulated reservoir temperature under confining pressure. The required concentration of brine solution was initially filled in a cell and connections were made and pressure gauges were set in place. A proportionating pump was used to generate the pressure required at desired flow rate of brine solution through the core sample. The diesel was used as the displacing medium for the brine or gelant solution. The pressure drop across the core plug was measured by a pressure transducer. After brine flooding, absolute permeability of core sample was measured. Once the base permeability was established, a gelling solution was injected at slow rate, and then core treated with optimized gel solution shut in and aged for five days at 80 ± 2^{o}C to give ample time for the gelling solution to set. Following the shut-in, brine was again re-injected and return permeability was measured at reservoir simulated conditions for calculating reduction in permeability.

3. Results and discussions

The chromium acetate and thiourea crosslinkers can build a complex network with carboxylate groups of partially hydrolyzed polyacrylamide and form a three dimensional gel network. The crosslinker concentration has a significant effect on gel strength. Several samples were prepared

to investigate the effect of cross linker concentration on network gel strength. Bottling Test result shown in Table 1 indicates that when the concentration of both cross linker was decreased, the gelation rate and gel quality were also decreased. In other words, when cross linking agent concentration was increased, the stage of polymer gel changed from a state of flowing gel to stiff/rigid gel in lesser time due to increase in cross linking sites.

Polymer (ppm) A	**Cross linker (ppm)**		**Brine Concentration (ppm)**	**pH**	**Gelation time (hrs)**
	$K_2Cr_2O_7$	**Thiourea**			
6000	3000	3000	10000	6.9	7
6000	2500	2500	10000	7.1	10
6000	2000	2000	10000	7.1	13
6000	1500	1500	10000	7.2	13
6000	1000	1000	10000	7.4	No gel

Table 1. Effect of cross linkers on the gelation time of 6000 ppm PHPA polymer solution at 80 ^{o}C

The cross linked partially hydrolyzed polyacrylamide polymer gel system give better physical properties (viscosity and gel strength) than the polymer solution that facilitates physical plugging of porous media. The experimental investigation under insitu gelation and core flooding are shown in Table 2-5. It was found that porosity of the Berea sandstone core was 20% and initial permeability was 115.34 mD (Table 3-4). For the determination of permeability of the core sample, Darcy's law was used which was as follows:

$$K = \frac{Q.\mu.L}{\Delta P.A}$$

K = Absolute permeability to brine (Darcy)

Q = Flow rate of brine (ml/sec)

μ = Viscosity of brine (cP)

L = Length of core holder (cm)

ΔP = Pressure drop (atm)

A = Area of core holder (cm^2)

Components	Units	Composition
PHPA Concentration	ppm	6000
Brine Concentration	ppm	10000
$K_2 Cr_2O_7$	ppm	1500
Thiourea	ppm	1500

Table 2. Composition of Polymer Cross linker solution for insitu gelation studies in cores

Parameters	Units	Value
Core Length	mm	60.85
Core Diameter	mm	37.66
Pore Volume	cc	13.5
Porosity	%	20

Table 3. Core Parameters

Brine flow (cc/min)	Differential pressure (psi)	Permeability of core(K_i) (mD)
1.0	1.20	111.50
1.5	1.70	118.06
2.0	2.30	116.35
2.5	2.90	115.34
3.0	3.50	114.69

Table 4. Absolute permeability of core before polymer treatment with respect to brine

After passing the gelant solution through the Berea sandstone core, the core was kept inside the oven for 5 days. After insitu gelation, the brine was injected into the core at different pressure drops to determine the plugging ability of polymer gel system.

Brine flow (cc/min)	**Differential pressure (psi)**	**Permeability of core(K_i) (mD)**
0.6	13.90	7.58
0.8	18.10	7.24
1.0	22.00	7.16
1.2	24.70	7.51
1.5	30.60	7.35

Table 5. Return permeability of core after polymer treatment with respect to brine

The reduction in permeability in the core after insitu gelation was calculated using following formula:

$$\text{Reduction in Permeability} = \left(1 - \frac{\text{Absolute permeability after gel treatment}}{\text{Absolute permeability before gel placement}}\right) \times 100$$

The post gelation permeability and permeability reduction for brine were 7.36 mD and 93.61% respectively which shows the suitability of this gel system for profile modification jobs.

4. Conclusions

The following conclusions are drawn for the present investigations:

1. With increase in crosslinker concentration the decrease in gelation time of partially hydrolyzed polyacrylamide-chromium-thourea gel system decreases.
2. The partially hydrolyzed polacrylamide -chromium acetate –thiourea gelant has good plugging ability. The reduction in permeability in the Berea sandstone core sample observed due to this system was 93.6% at 80^{o}C which shows the potential of this crosslinked polymer gel system for its application in the profile modification job.

Nomenclature

K	*permeability*
Q	*flow rate*
μ	*viscosity*
L	*length*
ΔP	*pressure drop*
A	*area*
mD	*milli Darcy*
cc	*cubic centimeter*
mm	*millimetre*
psi	*per square inch*
ml	*millilitre*
cP	*centipoise*
min	*Minute*
ppm	*parts per million*

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Environmental characterization of marine surface sediments in Adyar river mouth traverses off Bay of Bengal, Chennai

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Abstract

The study of heavy metal distribution in coastal surface sediments is an important component in understanding the exogenous cycling as well as in assessing the cause of anthropogenic influences on the marine ecosystem. The bottom sediments serve as a reservoir for heavy metals and therefore deserve special consideration in the planning and design of aquatic pollution research studies. The study of the geochemistry of sediment requires handling of a large data set that includes the concentrations of various ions; classification, quantification and interpretation of the data are important steps in the assessment of sediment quality. The textural distribution of the surface sediments reveals the predominance of sand in all seasons during the three year study period in the study area. The total heavy metal concentrations from different station studied in the surface sediments of the study area showed significant variations. Metal concentration was higher in the shoreline region when compared with distance away from the shoreline. The enrichment in the concentration of heavy metals in the samples that are close to the shore line indicated that higher concentration was attributable to the anthropogenic activities in coastal area.

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Key words: *Pollution study, marine sediments, physicochemical characteristics, heavy metals, Bay of Bengal.*

1. Introduction

The distribution of metals within the aquatic environment is governed by complex processes of material exchange affected by various natural and anthropogenic activities (Leivouri, 1998; Ip *et al*., 2007). Although metals are natural constituents of the earth's crust and are present in all ecosystems, their concentrations have been dramatically increased by human activities (Guerzoni *et al*., 1984). Since heavy metals are toxic, persistent and non-degradable in the environment, the contamination of sediments by these elements represent the greatest ecological risk to coastal marine ecosystem (Garcia *et al*., 2008). Such pollution has several distinct biological effects, including diseases in plant and animal species (Lamb *et al*., 1991), local or complete extinction of some species (Vermeij, 1993), and loss or modification of habitat (Nee and May, 1992). The study of the geochemistry of sediment requires handling of a large data set, which includes the concentrations of various ions; classification, quantification and interpretation of the data are important steps in the assessment of sediment quality.

2. Materials and Methods

Surface sediment samples from 5 locations were collected Adyar River Traverses (ART) (Fig. 1) during cruise program by Sagar Purvi, NIOT, MOES, India at >10 meter water depth and in shallow waters by engaging fibre glass boat during pre-monsoon (PRM) (June – August), Monsoon (September - November) and post-monsoon (POM) (December - February) seasons using Van Veen Grab sampler from 5 locations in Bay of Bengal, off Chennai (Plate. 1). Samples were taken from the central part of the grab sampler to avoid any metallic contamination from the metallic sampler and were frozen at -4ºC immediately onboard until further analysis. The samples were homogenized following cone and quartering method and were ground, mixed and powdered in an agate mortar (ASTM 230) before analytical procedures were conducted.

Textural studies of sand, silt and clay (Ingram, 1970), Carbonate content (Loring and Rantala, 1992), Organic carbon (OC) (Gaudette *et al*., 1974) were carried out standard procedure. For

total metal analysis a known quantity of sediment was digested with an acid mixture of $HClO_4$ and HF and the final residue was leached with HCl and made up to the required quantity (Tessier *et al*., 1979). Trace metal concentrations (Fe, Mn, Cr, Cu, Ni, Co, Pb and Zn) were measured using flame atomic absorption spectrophotometer (Perkin-Elmer AA700) equipped with a deuterium background corrector. The flame was employed except in the instance of Cd, which required the use of a Graphite furnace because of its much lower concentration. Suitable internal chemical standards (Merck Chemicals, Germany) were used to calibrate the instrument. All the reagents used were of analytical grade and high purity.

3. Results and Discussion

3.1 *Surface sediment texture from the ART*

The relative abundance of sand and mud (silt + clay) contents of the surface sediment samples, the sand percentage of sediment samples collected during the three consecutive years was characterized by the range between 9.65% to 97.72% with an average of 61.86% to 71% (Fig. 2). POM season samples showed high sand content than MON and PRM season samples. The mud percentage of the surface sediment samples collected during the three consecutive years was characterized by the range 2.28% to 90.35% with an average range of 29.8% to 38.2% (Fig. 3). Samples of PRM seasons showed high mud content than POM season sediment samples. The textural distribution of the surface sediments reveals the predominance of sand in all seasons during the three year study period in the study area. The textural distribution of the surface sediments reveals the predominance of sand in all seasons during the three consecutive years. Although, difference in the textural parameter indicates that they are mainly dependent on the dynamic process that affects the shallow region, rather than the deeper region which acts in an opposite way during all seasons (Jonathan *et al*., 2007).

3.2 *Calcium carbonate ($CaCO_3$) and Organic carbon (OC) of surface sediment from ART*

Analytical results of both $CaCO_3$ and OC complement each other depending on the textural parameters. The surface sediment samples showed a value of carbonate percentage range of 3.26% to 7.24% with an average range of 4.07% to 6.27% (Fig. 4). While the PRM season samples showed high carbonate content than POM seasons. The OC percentage of surface

sediment samples was characterized by a range of 2.18% to 3.24% with an average range of 2.46% to 2.96% (Fig. 5). Samples of POM seasons showed high OC content than PRM seasons samples. An accurate interpretation of the marine sediment record requires that the processes controlling the preservation of $CaCO_3$ (Muthuraj and Jayaprakash, 2007). The $CaCO_3$ content in the surface sediments of the study area was generally low during all seasons of three consecutive years. The various carbonate values observed at different stations were due to changes in the percentage of sand and the flow of water from the coastal industries that bring the non-carbonated materials. Relatively moderate values of carbonates at certain depths may be due to the sturdy currents leading to non-deposition of terrigenous materials (Rao, 1978).

Organic carbon has a significant role in geochemical cycles of major and trace elements that accumulate in sediments; it may be used as an index of depositional environment and sedimentary processes (Seralathan *et al*., 1993). Distribution of OC also indicated that the concentration was dependent on textural parameters of the sediments. The minor variations in OC values in the near-shore samples indicated that they are moderately influenced by the minor input and deposition of organic debris from local industrial sources where a higher terrestrial and anthropogenic input is always expected due to the relative proximity of rivers that drain into the BoB (Bay of Bengal). The $CaCO_3$ contents are high where the sand dominance was high, which indicates that carbonates are attached with coarse sediments. However, it has been observed that most of the OC is preserved in fine grained sediments (Salomons and Forstner, 1984). The high inputs of terrigenous material from the adjacent land mass and industrial effluents nearby have increased the OC values close to the shore; others have also reported similar observation (Muthuraj and Jayaprakash, 2007).

3.3 *Total heavy metal distribution in the surface sediments from ART*

The results of average concentration of total heavy metal in the surface sediments are marginally higher concentrations are recorded in PRM samples than POM samples. The percentage of iron in the surface sediment samples collected during the study period was in the range of 0.49% to 1.21% with an average range of 0.67% – 0.82% (Fig. 6). Manganese ion content of the surface sediment samples collected during the three consecutive years was in the range of 269 to 453 µg/g with an average range of 336.5 – 396 µg/g (Fig. 7). The indicated iron and manganese in

the medium may get converted to complex hydroxyl compounds that may eventually precipitate (Riley and Chester, 1971). It is further possible to infer that higher concentration of Mn^{2+} in the surface sediments might have derived from its mobilization (Karbassi and Amirnejad, 2004). Since Mn^{2+} is lithogenous in origin, its association with Cr^{6+}, Zn^{2+} and Hg^{2+} allow us to infer both lithogenous and anthropogenic source contribute to the Mn^{2+} content in the study area. It is well established that iron and manganese oxides are excellent scavengers for trace metals (Tessier *et al*., 1979) and thus these metal ions would lead to the co-precipitation of other metals in the water column and increase the concentration of many metals in the sediments.

The chromium content of the surface sediment samples collected during the three year study period was in the range of 51 to 97 µg/g with an average range of 77.5 – 90.67 µg/g (Fig. 8). PRM samples showed higher Cr^{6+} content than the POM and MON samples. The observation of high distribution of Cr^{6+} of the study ART indicated that the enrichment of Cr^{6+} is mainly due to the dumping of effluents from the tannery industries located in the nearby study area. The discharge from electroplating industries has been responsible for the enhanced concentration of Cr^{6+} in estuaries and tidal zone sediments (Hema Achyuthan *et al*., 2002). The higher values of Cr^{6+} could also be due to the corrosion of steel industries and chrome alloys which are used by number of industries (Jonathan *et al*., 2004).

The copper concentration in the surface sediment samples was relatively high during PRM seasons but low during POM seasons for all the three consecutive years. Copper content of the samples collected during all the three consecutive years was in the range of 27.46 to 90.87 µg/g with an average range of 43.31 – 73.62 µg/g (Fig. 9). Copper is mainly of anthropogenic origin, which may also be probably controlled by sedimentary features such as organic matter and grain size (Harbison, 1984). The copper ions are found to be occurring in higher amounts near the ART regions indicating these metals are used as markers of metal industries (Loska *et al*., 2004; El Nemr *et al*., 2006). Copper, Pb^{2+} and Zn^{2+} elements are probably sourced from vehicular emissions. Besides, the existence of mechanical workshops and factories along the draining rivers also may play an important role as an input of the sediments (Wang and Qin, 2006). The agricultural materials, sewage sludge as well as human activities are some of the sources of Cu^{2+}, Pb^{2+} and Zn^{2+} input in soil (Alloway, 1995).

The nickel concentration in the surface sediment samples was relatively high during PRM seasons but low in the samples of POM seasons. Nickel content of the surface sediment samples collected during the three year study period was in the range of 24.37 to 41.35 µg/g with an average range of 25.45 – 38.49 µg/g (Fig. 10). The Ni^{2+} content of sediment is due to probably petroleum-related activity (Vazquez and Sharma, 2004). The anthropogenic input was an important source for these elements, through the extensive use of the antifouling paints by shipping activities (Bothner *et al*., 1998). Chromium and Ni^{2+} were reported to be enriched mainly by industrial inputs (Rigollet *et al*., 2004). Further industrial wastes from the Power Plants and other industrial effluents and atmospheric deposition were also reported to be among the sources of these elements (Mucha *et al*., 2003).

Cadmium content of the surface sediment samples collected during the three consecutive years was in the range of 0.32 to 0.78 µg/g with an average range of 0.51– 0.65 µg/g (Fig. 11). Cadmium enrichment was high in the samples of PRM season compared to POM season. Cadmium enrichment is independent of the accumulation rates of terrigenous detrital input (Muthuraj and Jayaprakash, 2007). With regard to enrichment factor the cadmium contamination is very severe in the study area and mainly implies that the sources are the major industries and shipping activities, atmospheric deposition of finer particles, domestic effluent discharges and the extensive use of paints. Cadmium compounds are used as stabilizers in PVC (Polyvinyl chloride) products, colour pigment, several alloys and, now most commonly, in re-chargeable nickel–cadmium batteries. Metallic cadmium has mostly been used as an anticorrosion agent (Cadmiation). Cadmium is also present as a pollutant in phosphate fertilizers. Natural as well as anthropogenic sources of cadmium, including industrial emissions and the runoff from fertilizer applied lands and sewage sludge dumped in the rivers may lead to contamination of the study area (Lars, 2003). It has been observed that destruction of batteries in bulk quantities by craftsmen to recover Pb^{2+} and Cd^{2+} is also being carried out adjacent to the study area, thereby contributing to the enrichment of heavy metals in the sediments of the study area (Jayaprakash *et al*., 2010). The cobalt content of the surface sediment samples collected during the three consecutive years was in the range of 12.81 to 25.37 µg/g with an average range of 14.09 – 18.43 µg/g (Fig. 12). The surface sediment samples of PRM seasons showed high Co^{3+} content than POM samples during the period of study. Lead content of the surface sediment samples collected during the three consecutive years was in the range of 16.27 to 25.37 µg/g (Fig. 13). Lead

concentration in the surface sediment samples was relatively high during PRM seasons but low in the samples of POM seasons. Cobalt and lead elements are known as markers of paint industries (Lin *et al*., 2002) and many are present in the study area. The concentration of lead in the sediments of this region should have originated from the atmospheric deposition of automobile exhaust (Jayaprakash *et al*., 2010).

Zinc content of the surface sediment samples collected during the three consecutive years was in the range of 43.6 to 78.4 µg/g with an average range of 62.27 to 67.95 µg/g (Fig. 14). Concentration of Zn^{2+} in the surface sediment samples was relatively high during PRM seasons but low in POM seasons. Zinc is used as markers or tracers of motor vehicles. The sources of pollution include industrial effluents such as food and beverage factories, and also domestic effluents. Zinc pollution is also traced from the mixing of runoff from agricultural activities and it is also an indicator of oil pollution (Karbassi, 1996). The mercury concentration in the surface sediment samples showed only marginal changes during the three consecutive years. Mercury content of the surface sediment samples during the three consecutive years was in the range of 0 to 0.006 µg/g with an average of 0 – 0.004 µg/g (Fig. 15). Mercury content was very low in general, at certain seasons it was at very low concentration in the study area and similar observations have already been made (De and Ramaiah, 2007). A major use of mercury is in the chloralkali industry, in the electrochemical process of manufacturing chlorine, where mercury is used as an electrode (Föstner and Wittmann, 1983).

In the absence of very significant correlations with other metal ions this might probably come from limited non-point source pollution. In general, the surface sediment in the shoreline was found to be coarse in nature due to higher concentration of sand than mud which might due to tidal effects (Muthuraj and Jayaprakash, 2007). Further, the increase in fine sediments in the samples of the inner shelf region is an indication of fresh water input with finer particles that settle to the bottom when current and wind speeds reduce (Jonathan *et al*., 2007). The distribution of heavy metals in marine deposits was influenced by sediment texture, clay content, organic carbon, iron hydrous oxides and carbonates (Föstner and Wittmann, 1983). The higher values during the PRM season could be due to the low flow conditions of the coastal waters which are attributed to the change in current direction (Srinivasalu, *et al*., 2005). The enrichment in the concentration of heavy metals in the samples which are very close to the shore line

indicated that higher concentration was due to the anthropogenic activities in coastal area (Jonathan *et al*., 2004). Moreover, it may also be due to the recent development of industries and harbour activities (Jonathan and RamMohan, 2003). In addition, the high values are also attributed to the continental input and runoff from the minor rivers that drain in this region (Muthuraj and Jayaprakash, 2007).

The enrichment of Pb^{2+}, Zn^{2+}, Ni^{2+}, Co^{3+} and Cu^{2+} shows similar distribution pattern. The origin of the above metals can be traced to the surface runoff of the fertilizer remains of the adjacent agricultural lands as well as domestic and industrial effluents. Metal concentration was higher in the shoreline region compared distance away from the shoreline. This is due to the clayey nature of the sediments originated from the marine environment. Sediments in the near-shore area move along the coast due to the action of waves, which generate long shore currents and cause sediment transport of chemical constituents. This remobilization contributes environmental disturbance and likely to have a far reaching effect on the life and activities of marine biota in general and pelagic fishery in particular. The association of metals with sand particle suggesting that they are mainly due to the change in the pH condition and the increased input from chemical industries which are anthropogenic in origin (Jayaprakash *et al*., 2010). The organic matter is important as a controlling factor in the abundance of trace metals (Rubio *et al*., 2000). It is also understood that OC derived from decaying organic remains has a high capability of accumulating Pb^{2+}, Cu^{2+} and Zn^{2+} by absorption and by the formation of chelating compounds (Wedepohl, 1995). The concentrations of OC affect the trace metal geochemistry of the fine fraction. The strong association of Pb^{2+}, Zn^{2+}, Co^{3+} and Cu^{2+} indicates that these elements are of sewage sludge brought from nearby area (Jonathan *et al*., 2007). Source of the pollutants are primarily from domestic sewage and small industrial units located on the banks of the River Adyar. The distribution pattern of heavy metals reveals that the anthropogenic contribution of metals, sediment type and organic carbon are the major factors affecting the spatial variation of metals in this region. Thus, it is the anthropogenic input is the major cause of pollutions of heavy metal in the Chennai coastal zone.

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Dr. V. Kannan is a retired Professor of Centre for Advanced Science in Botany, University of Madras who is having more than 25 years of research experience. His research mainly focuses on microbial metabolites of extremophiles, plant disease control and microbial bioremediation. He received funds for many research projects from various funding agencies of Government of India. He has contributed and published more than 30 research articles in national and international peer reviewed journals with high impact factors. He has also guided 10 PhD scholars in the field of Botany and Microbiology.

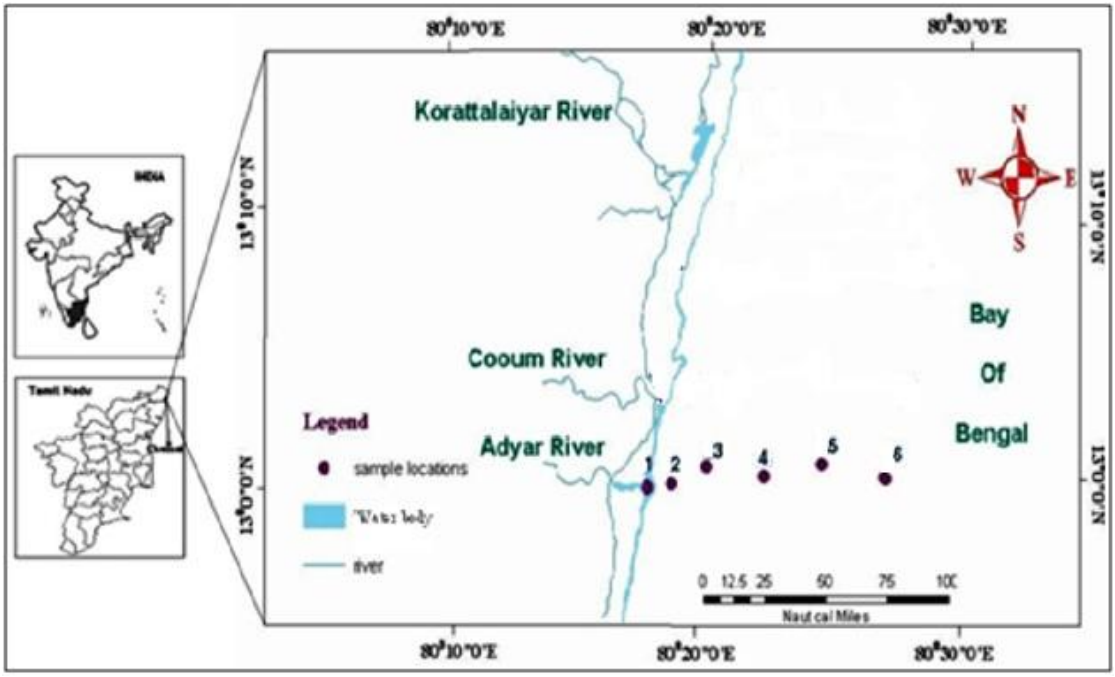

Fig 1: Study area showing sample locations in the inner shelf of Adyar River Mouth Traverses of Bay of Bengal off Chennai, Tamil Nadu, India

Plate 1: Collection of surface sediment samples by using Van Veen Grab sampler in the inner shelf of Adyar River Mouth Traverses of Bay of Bengal

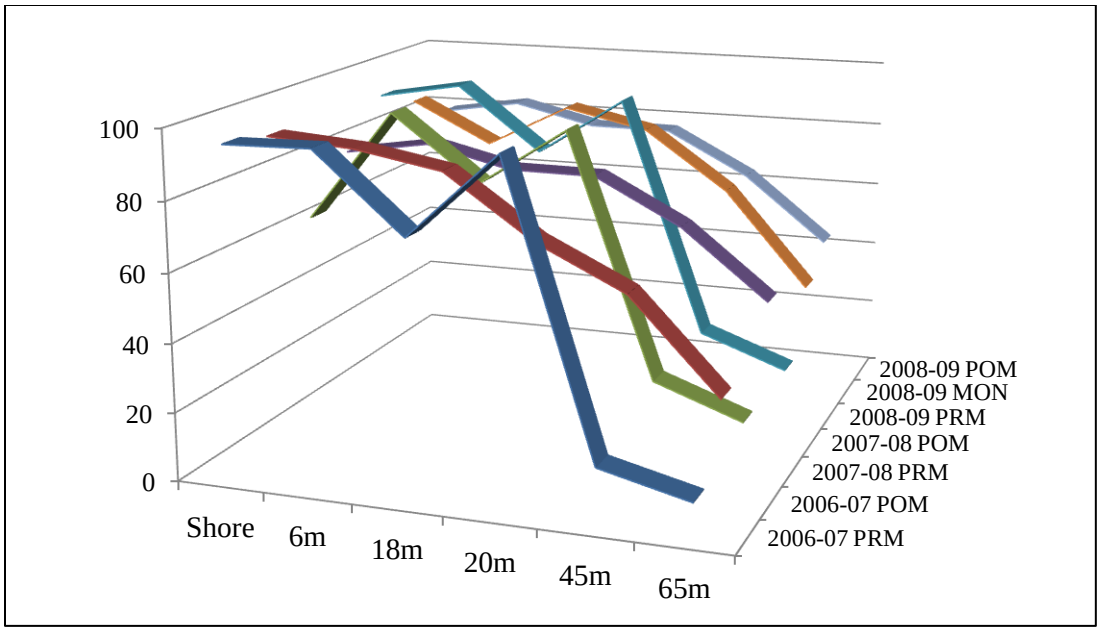

Fig 2: Surface sediments texture of Sand in three consecutive years in the study area

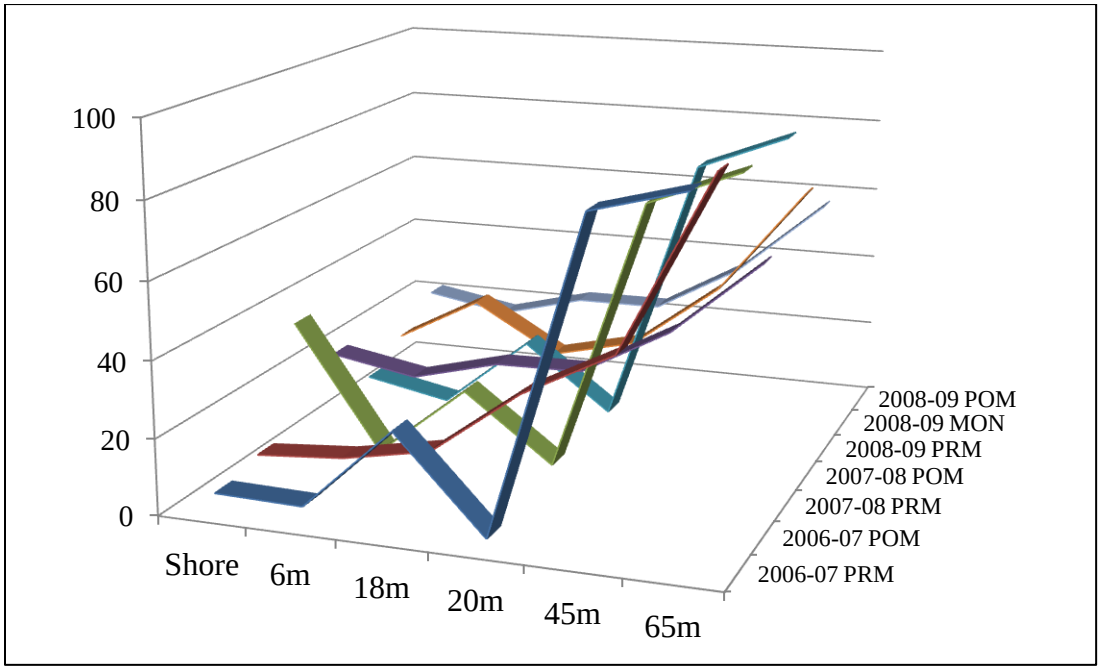

Fig 3: Surface sediments texture of Mud in three consecutive years in the study area

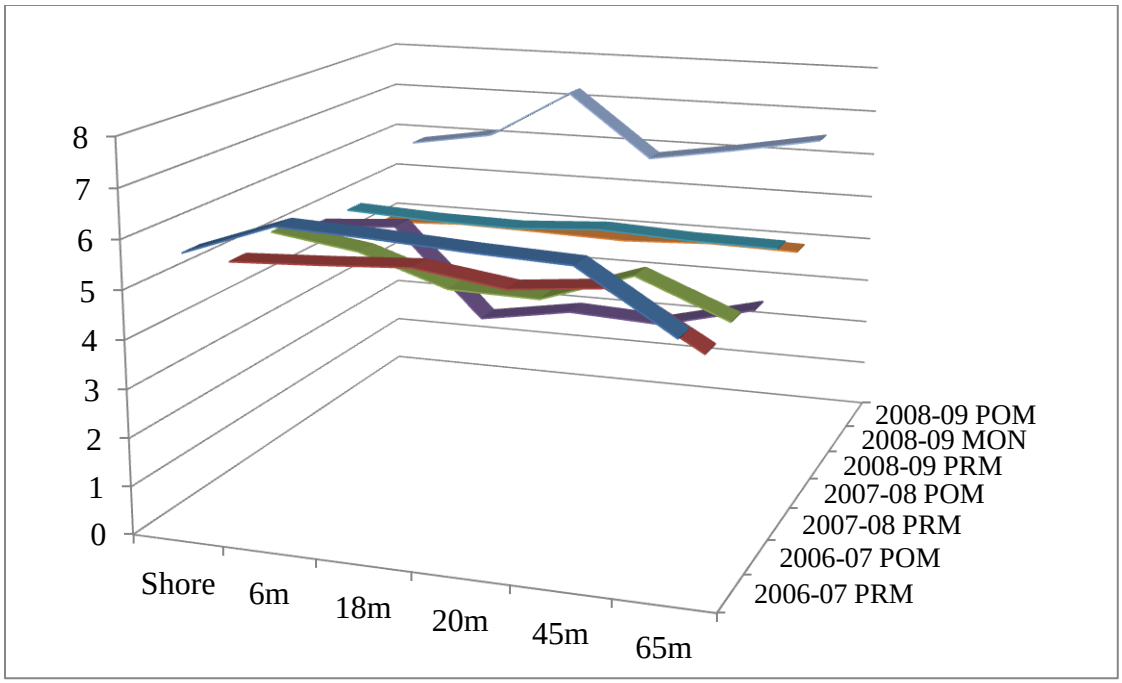

Fig 4: Calcium carbonate content of surface sediments in the study area

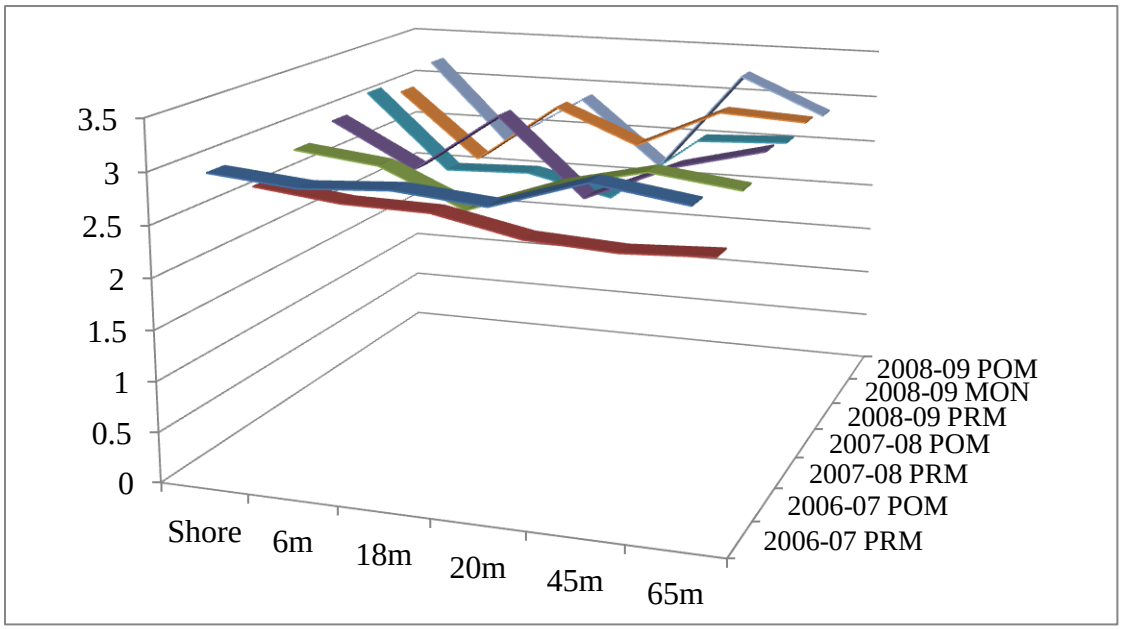

Fig 5: Total organic carbon content of surface sediments in the study area

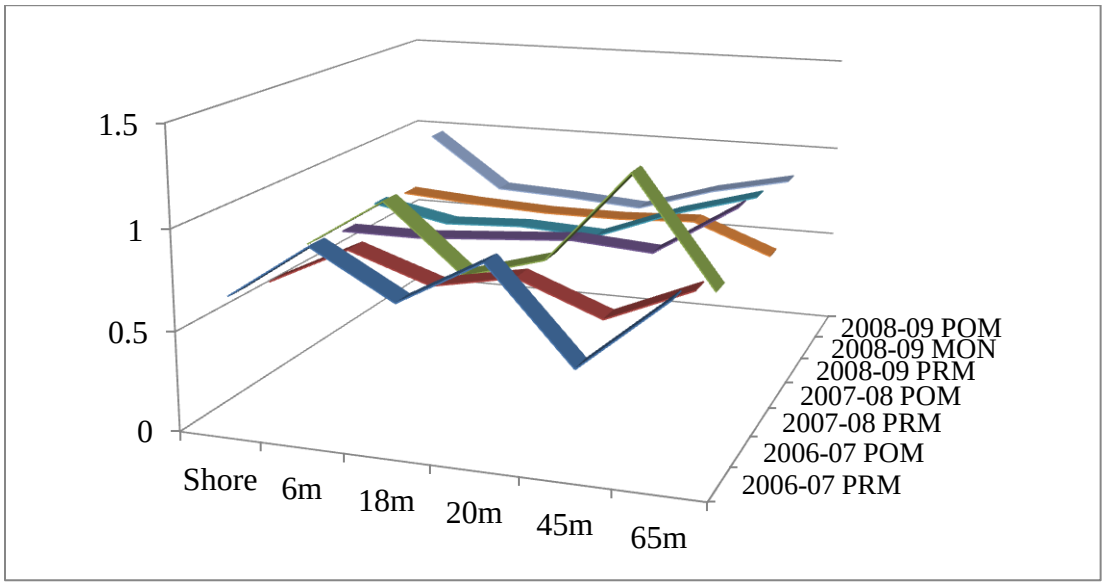

Fig 6: Iron concentration in sediment samples of the study area

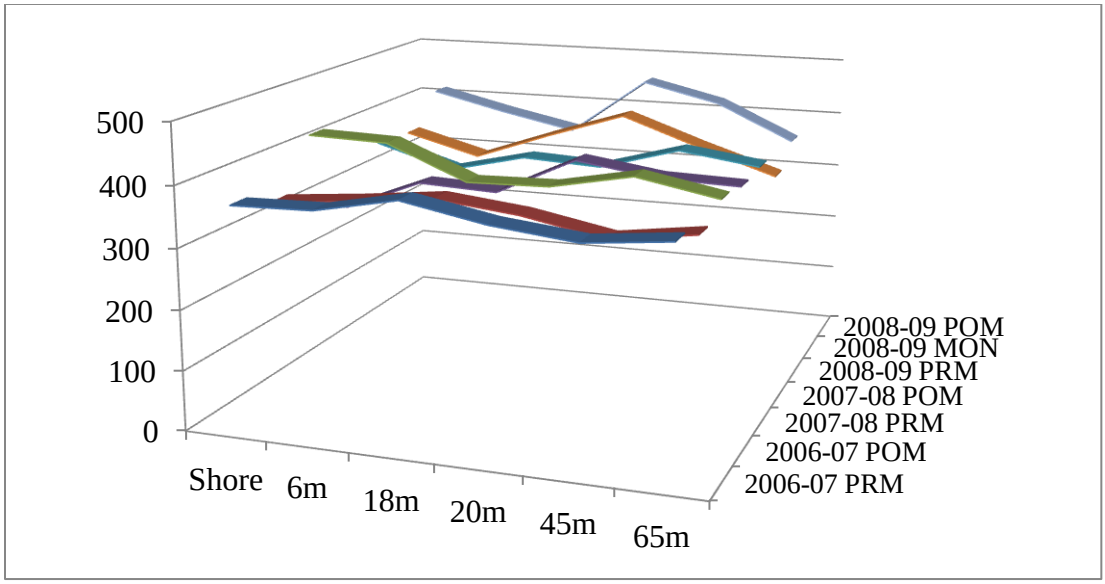

Fig 7: Manganese concentration in sediment samples of the study area

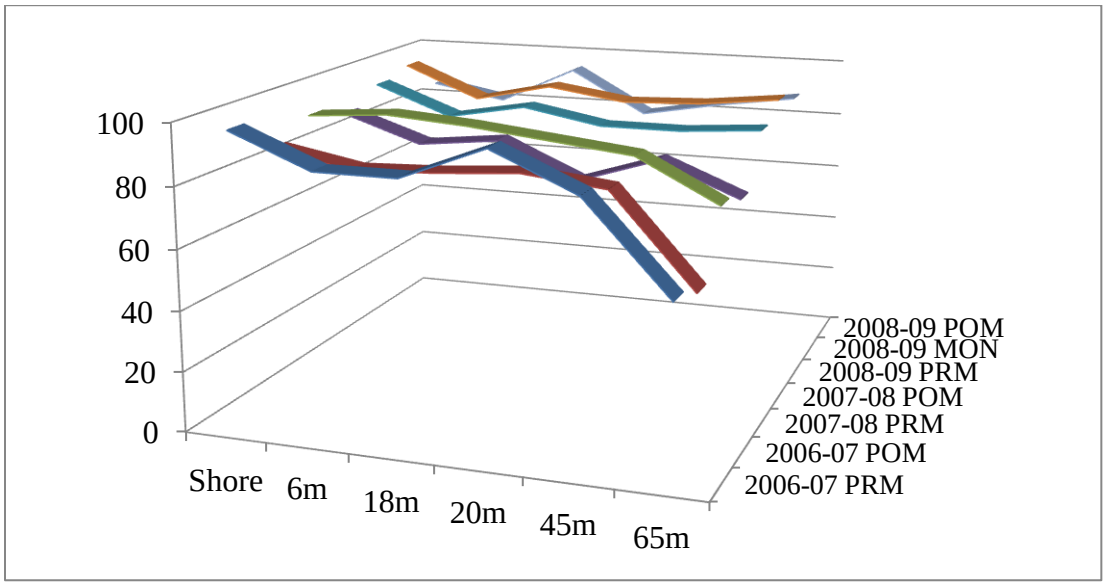

Fig 8: Chromium concentration in sediment samples of the study area

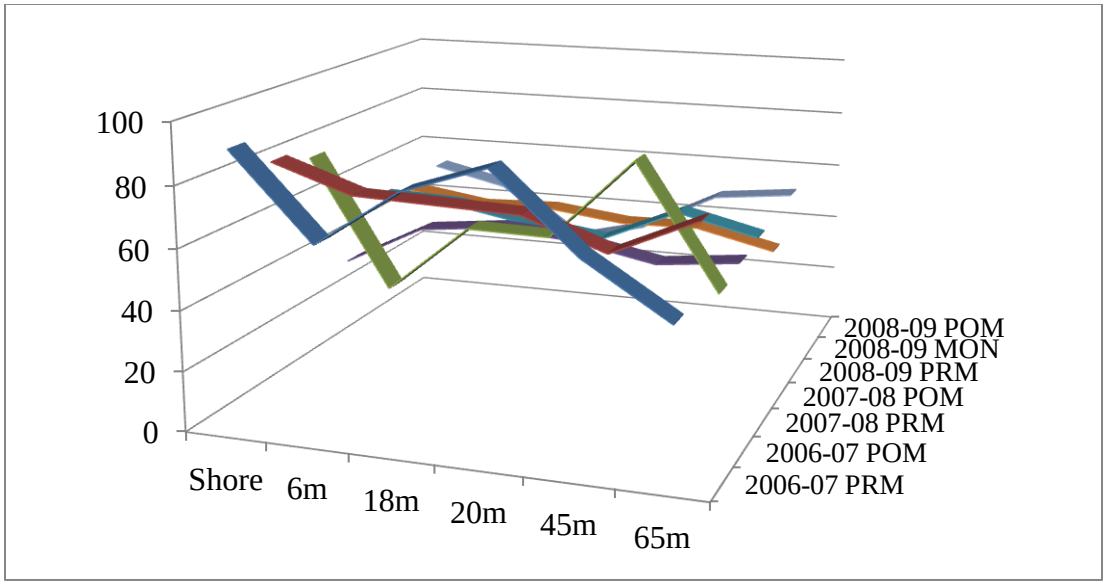

Fig 9: Copper concentration in sediment samples of the study area

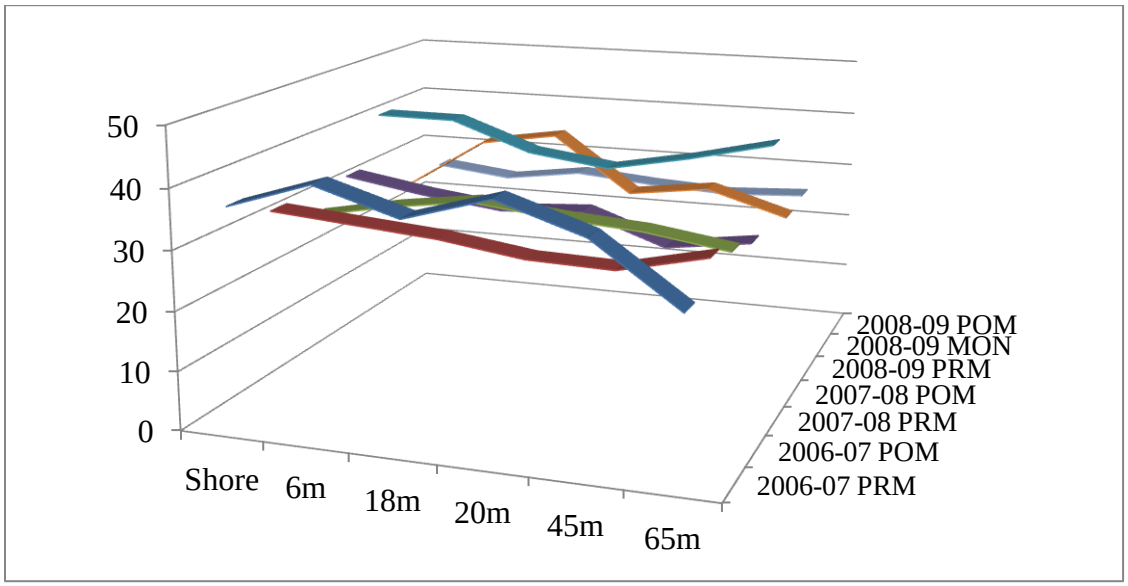

Fig 10: Nickel concentration in sediment samples of the study area

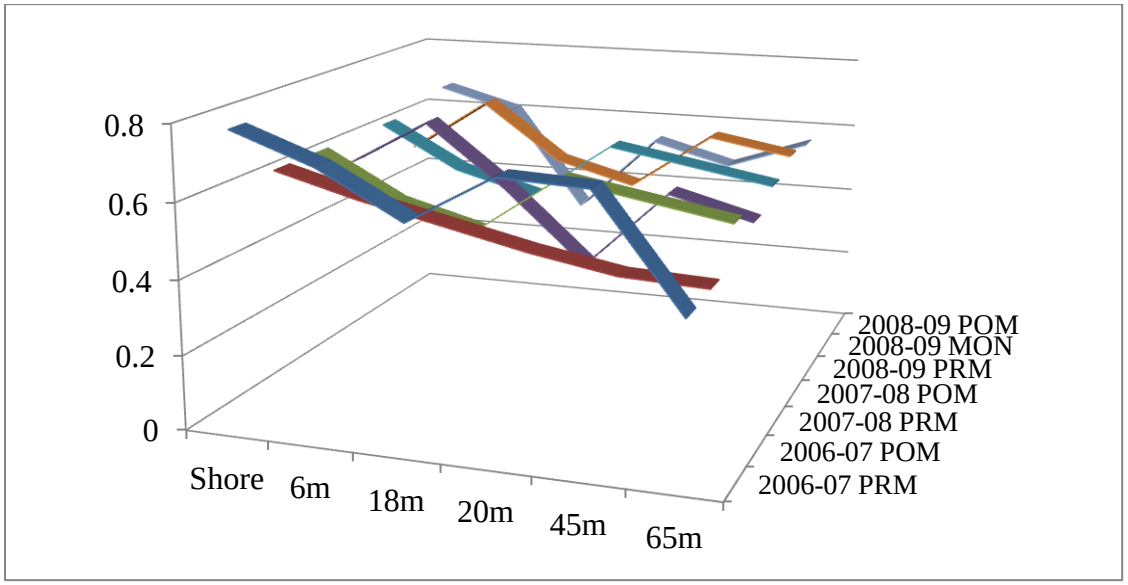

Fig 11: Cadmium concentration in sediment samples of the study area

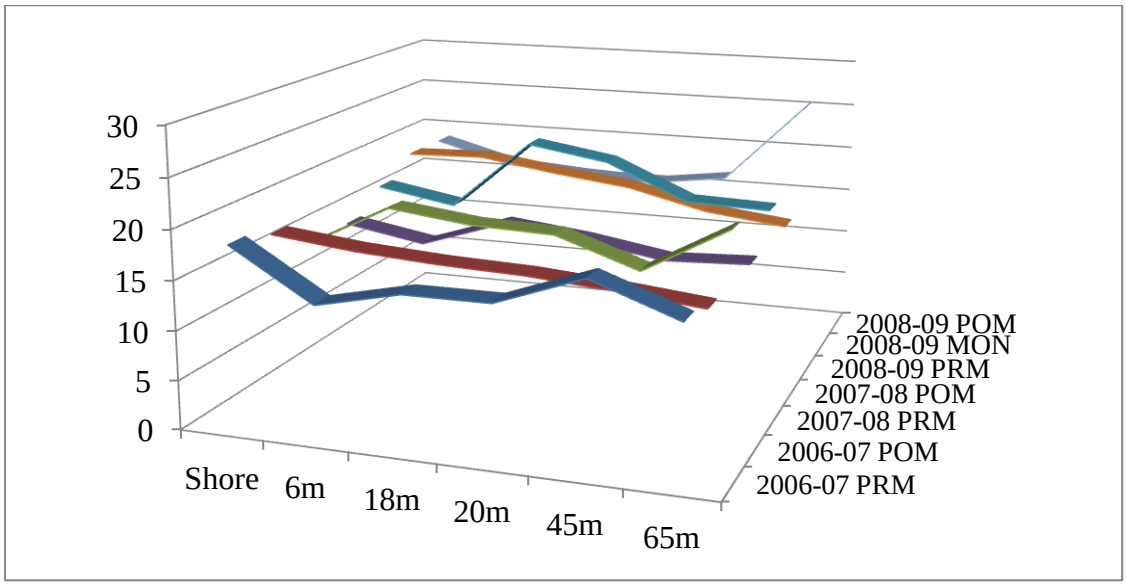

Fig 12: Cobalt concentration in sediment samples of the study area

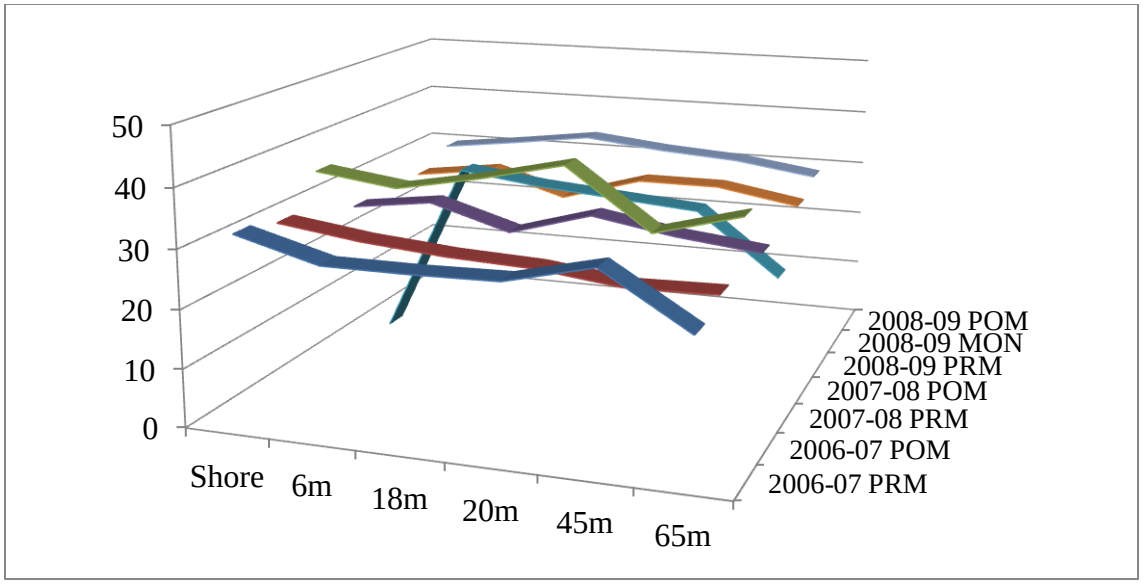

Fig 13: Lead concentration in sediment samples of the study area

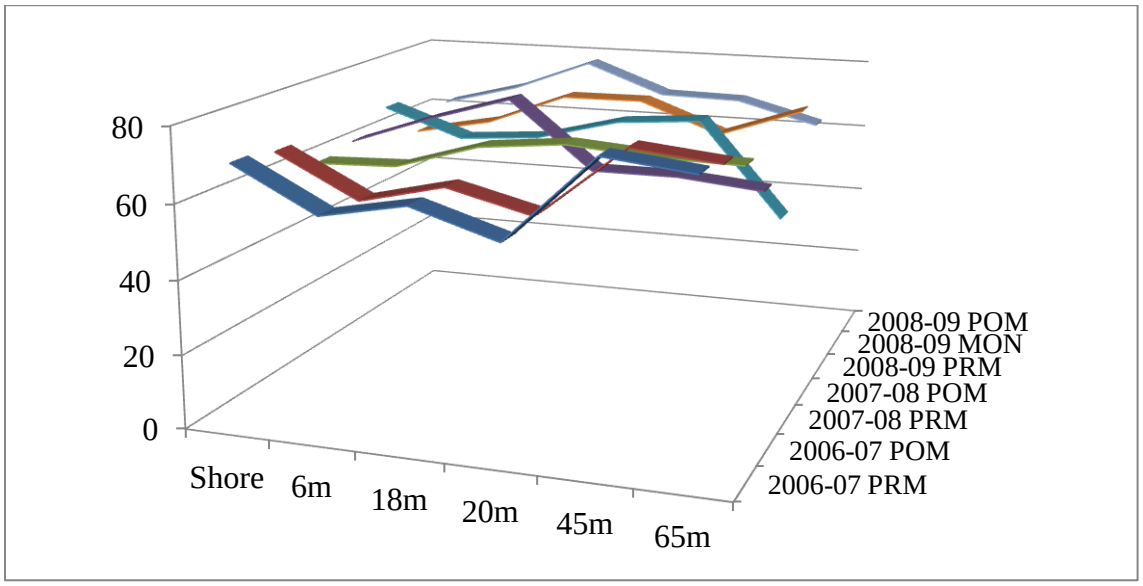

Fig 14: Zinc concentration in sediment samples of the study area

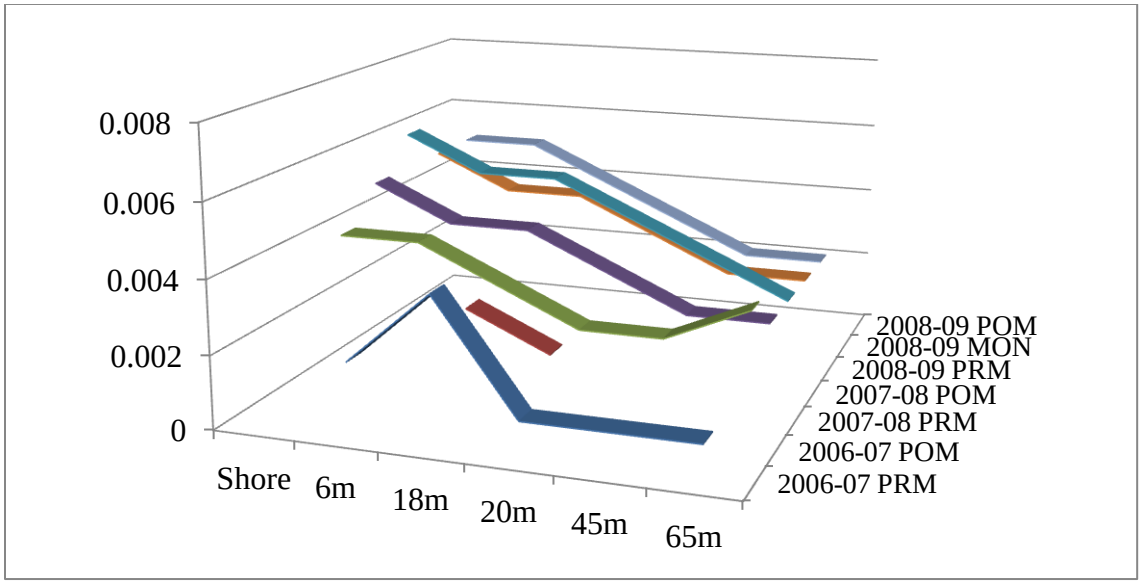

Fig 15: Mercury concentration in sediment samples of the study area

2013 World Maritime Review

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Abstract:

Many maritime economists and forecasters including this author had predicted 2012 to be a lacklustre year. There was no shortage of government inducements to turn the lacklustre tide around in 2012—stimulus spending in China and Japan, quantitative easing by the U.S. Federal Reserve, and multiple actions by the European Central Bank to strengthen the Euro zone. But as the year evolved, weak macro-economic fundamentals decisively trumped monetary policy initiatives and continued their chocking grip on global commerce and hence, the maritime sector. If at all one were to characterize 2012 as marginally better for shipping than the previous year, it would only be because the bar was set far too low. I will make a case in this annual review that 2012 and even 2013 will go down in maritime business annals as two bleak, monotonous and particularly long years of endless volatility that began in 2009. It has been yet another excruciatingly painful year for the global maritime community.

Keywords: *Maritime economics, shipping markets, shipping trends*

1. Introduction

Initial estimates from the International Monetary Fund show a 3.2 percent growth in the 2012 world gross domestic product, one of the slowest growth rates in recent years. Remarkably, even the Chinese and the Indian economies cooled off in 2012 and did not reach their anticipated

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targets. Rampant wage inflation is holding back the Chinese manufacturing prowess and their containerized exports to the U.S. dropped for the second year in a row. India too is experiencing its slowest rate of economic growth in a decade. Russia's entry into the World Trade Organization in September 2012 did not have any perceptible effect on global commerce, unlike the Chinese entry a decade ago that unleashed an unprecedented shipping boom in 2003. Overall, worldwide sluggish economic growth along with prolonged excess capacity and escalating operating costs, worsened the market stagnation. The much-awaited resurgence in world commerce and maritime trade is still on hold, and instability continues to plague major trade regions and shipping routes.

The 2013 Price Waterhouse Coopers' annual Global Shipping Benchmarking Survey provides very revealing insights on the sector's current plight. They report one percent average return on net operating assets for the shipping industry in 2011, well below the 18 percent that existed in 2007 when the shipping boom was at its peak. For the dry bulk sector in particular, the return was 35 percent in 2007. The shipping companies included in this survey posted negative two percent average return on equity in 2011, versus 21 percent in 2007. The ratios for 2012 are currently not available but estimated to be worse. Not surprisingly, a recent Moore Stephens report rated one out of every ten British shipping companies to be a Zombie, a colourful addition to the shipping finance vernacular. These are companies with low asset base, barely covering their variable costs and in close proximity to bankruptcy. Trade journals report that the value of publicly traded shipping companies has declined on average 75 percent and in some cases, up to 90 percent. The general feeling among investment gurus is that few public shipping companies today have any equity value let alone goodwill value. The current risk exposure of banks engaged in shipping finance is $475 billion as per an estimate from Petrofin, a shipping consultancy. This explains the recent Lloyd's List finding that barely 15 banks are now actively engaged in new shipping finance initiatives.

Drewry Shipping Consultants espouse the school of thought that the unprecedented shipping business peaks experienced from 2004 to 2008 were "once in a lifetime" rarity, and unlikely to repeat. Readers of my annual review from those years may recall the debate among maritime economists about a paradigm shift in shipping markets. We know now with certainty that the "invisible hand" remains as potent as ever in shipping. As suggested by Drewry Shipping, we may indeed be back to the "old normal" market cycles with the last couple of years being extra-

ordinarily humbling. My 2013 annual review and analysis of market conditions and other domestic and international maritime developments of significance follow next.

2. Market Developments

All major shipping markets experienced tough conditions in 2012 and the year ended somewhat similar to 2011. There is however a wider acknowledgment that but for some extra-ordinarily unpredictable happenstance, we have indeed reached the nadir and there is nowhere to go but up. The liquefied natural gas (LNG) market was one odd exception in 2012 and registered strong performance. Overall, worldwide shipping capacity utilization dropped yet another notch to 84% in 2012 as per recent RS Platou statistics; this is the second lowest it has ever been during the last decade. Increasing labour and fuel costs and new environmental regulations are escalating operating costs while the freight revenue is declining or at best, remaining stagnant.

On the positive side, there has been a sharp decline in orders for building new ships although the cost of construction today is the lowest it has been in a decade. This is not because the owners have suddenly become more rational in their investment decisions. On the contrary, most of them are experiencing a tough cash-flow situation and as discussed, new bank loans are hard to get. Furthermore, shipping asset values are still declining although the rate of decline stabilized somewhat in 2012. Thirty-nine percent of the companies reported lowering the value of their ships, including two out of every three container shipping companies.

The recent Moore Stephens Shipping Confidence Survey has registered a slight uptick, indicating signs of optimism in the market. Other positive developments include improving Chinese domestic consumption and anticipated good economic recovery by leading non-OECD nations in 2013. The U.S. export of shale gas is another major positive change although there are indications that this may run afoul of domestic politics and seriously impact those making huge investments in LNG transportation. I will now analyze the major shipping markets.

2.1 *Dry Bulk Market*

The Baltic Dry Bulk Index (BDI), a barometer of dry bulk carrier earnings, averaged 920 points in 2012. This is the second lowest it has ever been, the worst being 715 in 1986, shortly after the

introduction of BDI in 1985. The main reason for this is the ship owners' indiscretion and their persistent overbuilding of the last four years. As example, Clarkson Research Services statistics show a 36 percent increase in the number of bulk carriers from 2009 despite worsening market conditions. In 2012 alone, while tonnage demand increased 7 percent, the fleet expanded 12 percent. The large bulk carriers (referred to as Capesize) that earned average $116,049 per day during the peak years in 2007, averaged a meagre $7,680 per day in 2012. The RS Platou weighted dry bulk index for 2012 dropped to $9,400 per day from $15,200 in 2011. Figure 1 below shows the decline in average daily freight rate for each of the four categories of dry bulk carriers. Ship owners attempted to control the excess capacity by slowing down their ships, and also recycling older tonnage. This led to the removal of 529 bulk carriers, 37% of the total 1,414 ships recycled in 2012.

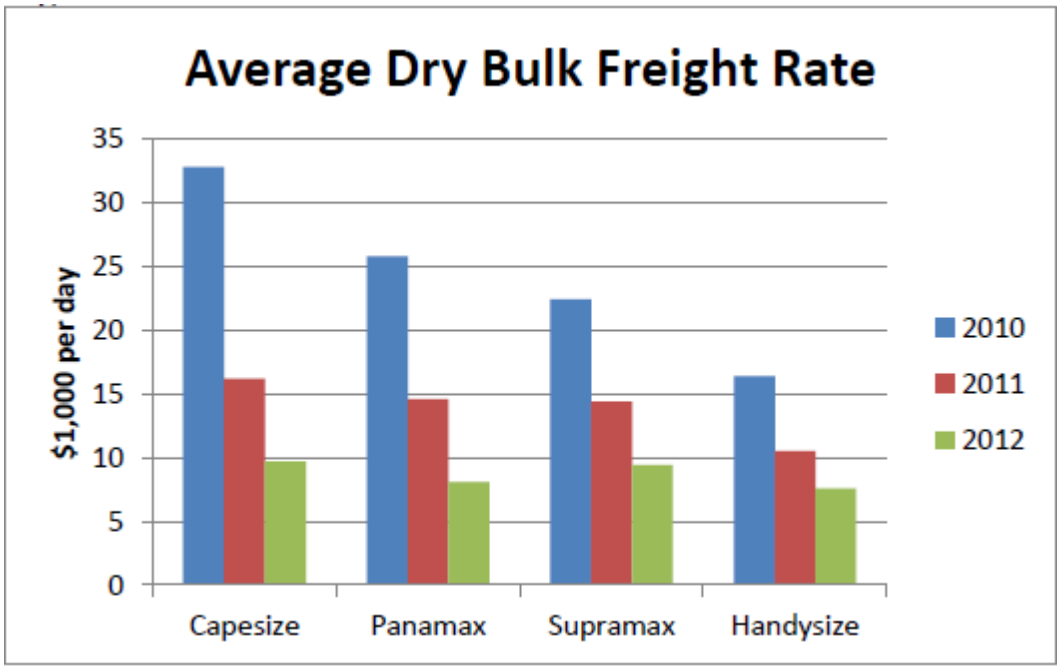

Figure 1. Average Dry Bulk Freight Rate**.** Source: RS Platou Annual Report (2013)

Vale, the Brazilian mining giant has also inadvertently contributed to the extremis situation faced by Capesize bulk carriers. Their strategy revolves around using 32 very large ore carriers (VLOCs) of around 400,000 DWT to better control their supply chain and lower the total logistics cost. Twenty-four of these giant ships are now in operation and 8 more are on order. A Lloyd's List analysis shows that the volumes shipped on Vale's own fleet went up from 30 percent in 2011 to 46.1 percent in the last quarter of 2012 as planned. However, contrary to

Vale's expectations, their supply chain costs including maritime freight costs escalated. There is widespread belief that the VLOCs are inefficient and costly in addition to having various operational challenges. Nevertheless, these massive ships have directly impacted the demand for Capesize bulk carriers and also worsened the excess capacity situation.

2.2 *Tanker Market*

This turned out to be the most complicated shipping market in 2012 for a number of reasons. There were major developments such as a wide embargo on Iranian oil and the near total return of Libyan oil as well as the stunning bankruptcy of tanker giant Overseas Shipholding Group (OSG), a venerable name in American shipping. AP Moller-Maersk, another tanker giant with 116 owned and 46 chartered ships, posted a net deficit of $314 million for the year, surpassing their $153 million loss incurred in 2011. The value of modern VLCCs continued their downward slide. Figure 2 shows the 56 percent decline in value of a trading fleet of 404 very large crude carriers (VLCCs) of less than 10 years age as estimated by VesselsValue.com. The older tankers are now worth only their scrap iron.

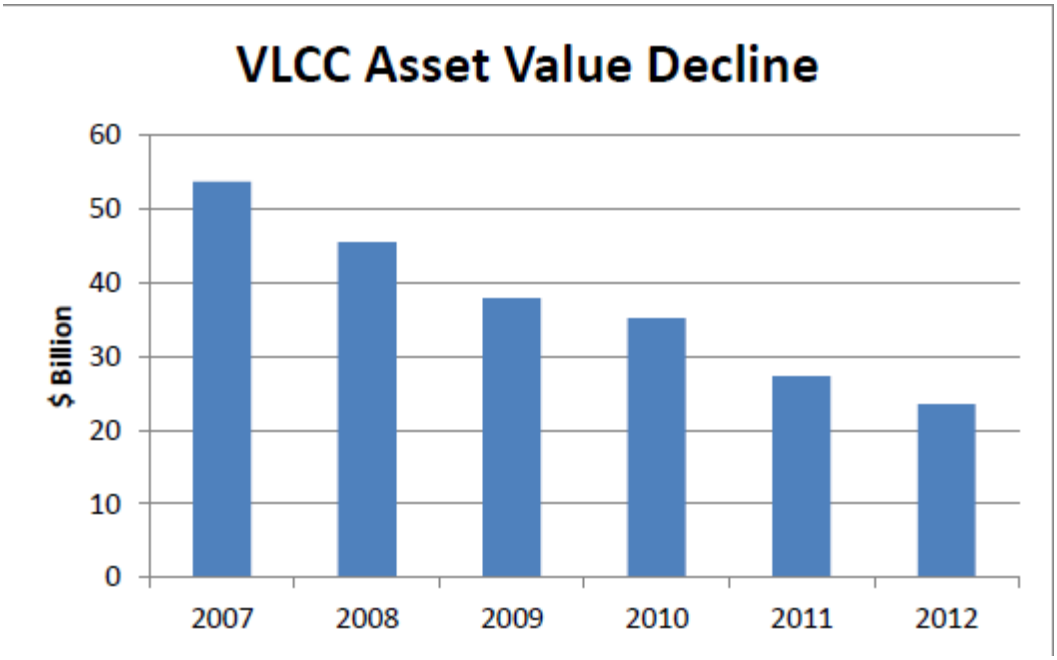

Figure 2: VLCC asset value decline, Source: VesselsValue.com

The first half of the year provided good trading conditions for crude carriers whereas the second half favoured product carriers. Both crude oil and refined products sectors benefited from

increased sailing distances that resulted from the big Asian importers substituting Iranian oil with West African crude and the U.S. replacing West African crude with Saudi Arabian exports. Sixty-seven percent of the 1.1 billion tonnes of crude oil exported from Middle East, the world's largest exporting region, went to the Indian subcontinent, Southeast Asia and the Far East. India in particular has also attracted sizeable crude traffic from the Caribbean region to source its one million barrels per day *super* refinery in Jamnagar from where the products are distributed globally. The combined effect of a small increase in total oil traded, greater sailing distances and lower fleet productivity through slow steaming (with average speed dropping to 12 knots from 12.5 as per RS Platou statistics) was not enough to build market confidence. The medium-size crude tankers in particular became a victim of the change in U.S. oil sourcing pattern.

The current tanker fleet is exceptionally young with an average age of eight years and in relation to its size, new orders placed in 2012 are the lowest it has ever been. Among notable new-building orders is the recent decision by BP to build 13 new "green" tankers. Another one is the Frontline decision to spend $2.6 billion on 53 new fuel-efficient tankers. This will help them emerge as the world's largest eco-ship fleet and hopefully, the most profitable one as well, taking advantage of the current low cost of new ship construction. The global fleet of small product tankers, (27,000-42,000 deadweight capacity, often referred to as handy-size tankers) is shrinking whereas the medium range tonnage is growing rapidly. This reflects the changing dynamics in oil trade caused as a result of India and China building huge refineries, and several older refineries shutting down in the Atlantic basin and in Europe.

2.3 *Liner Market*

This was a difficult year for the liner sector although a substantial improvement from the $5 billion collective loss suffered in 2011. Indeed the average freight rate per container registered an increase in 2012 although there was high volatility. The charter rate for containerships took a significant hit during the year because of surplus tonnage in the market. The operators appeared to exercise self-discipline and work toward rate restoration rather than pursue market share at any cost, their traditional Achilles' heel. Also they were successful in controlling the fleet productivity and capacity. In the Asia- Europe trade, one group of carriers lengthened their typical 63 day round trip to between 72 and 84 days by slowing down ships which provided employment for two additional ships. Maersk Line, the market leader, reported a profit of $525

million EBIT (earnings before interest and tax) compared to a loss of $482 million the previous year.

Some major operators like Neptune Orient Lines and Hapag-Lloyd remained unprofitable in 2012. At this point, carriers have done everything they could to enhance their market returns yet their prosperity seems far off unless demand picks up significantly, especially with the 11 percent new capacity infusion expected in 2013. Even Maersk Lines, the market leader, has announced new strategic moves to lower their network costs. They plan to serve U.S. East Coast ports from Asia through the Suez Canal, leveraging their bigger ships and reconfiguring the current Asia-Europe service. At least for Maersk, the ongoing political risk and associated Suez transit costs does not exceed the escalating cost of Panama Canal transits.

The first Triple-E Maersk ship (Economy of scale, Energy efficient, Environmentally improved) came out of the Daewoo dry-dock for fitting in early March 2013. These "dream" container ships will have a design speed of 19 knots, 21 percent slower than the 24 knots speed typical until recently. United Arab Shipping Company (UASC), another major container operator, took delivery of a fleet of nine 13,500 TEU ships and reported a network-wide savings of $200 million. UASC now plans to invest in even bigger ships similar to the Triple-E's. While carriers' benefits from slow steaming and energy efficiency are very obvious, the ultimate impact on shippers remains unclear. There are certainly additional in-transit inventories and associated carrying costs that shippers face. The offsetting benefits from enhanced reliability of a global supply chain built around a ship operating at 19 knots add value to the shippers' business strategy. However, the overall net effects may very well parallel the Vale VLOC supply chain strategy outcome.

2.4 *Shipbuilding Market*

The prolonged lacklustre market conditions have had a perceptible impact on Ship owners' investment decisions and induced a greater sense of rationality in their thinking. Furthermore, with all new shipbuilding orders, there is an emphasis on fuel efficiency and energy sustainability. The South Korean lead in ship building is now limited to tankers and LNG ships while the Chinese have surged ahead in other sectors including container ships. Overall, Chinese yards received 40 percent of all new orders in 2012 followed by South Korea with 38 percent

and Japan, 15 percent. However, it is far from smooth sailing for the Chinese yards. The massive 13 fold expansion in their shipbuilding capacity from 2002 to 2011, discussed in my annual reviews of previous years, is now a liability, and the country is unable to meet the planned $80 billion annual export value of ships constructed there. Three large state-owned Chinese shipping companies placed a $4.5 billion order for 50 super-tankers to be built in Chinese yards in 2012, a timely gesture of solidarity with their struggling yards! This is also an important strategic move as China will have greater control over her energy supply chain which is critical for that nation's continued economic growth.

The tight market conditions once again led to significant slippage in the delivery of new tonnage, and it is expected to continue. Furthermore, a number of dry bulk and tanker new construction orders were cancelled despite unavoidable financial penalties. Also, new construction prices have been dropping throughout the year because of surplus shipbuilding capacity, stringent bank financing conditions and a major drop in the price of steel. It is estimated that the cost of building new ships today is 40 percent below where they were in 2008; as evidence, the Clarksons' new-building price index dropped to 73 at the end of 2012 from 95 in 2011 and 124 in 2007. The 2013 RS Platou Report estimates that the worldwide decline in steel price alone has brought down the cost of constructing a Korean-built Aframax tanker by $8 million. New construction orders in 2012 were the lowest it has ever been in recent years and 40 percent less than in 2011. Furthermore, ship owners are becoming more demanding with the ships they order now rather than accepting series productions. Correspondingly, global shipbuilding capacity has shrunk one-third from its 2008 peak through yard closures and cutbacks.

2.5 *Cruise Market*

Although 2012 began on a negative note for the cruise sector (because of the Costa Concordia incident), it turned out to be another banner year and attracted 5.4 percent more passengers worldwide compared to 2011. As per Cruise Lines International Association (CLIA) statistics, the total cruise ship fleet today consists of 336 ships of 1,000 Gross Tons and above, and has annual passenger carrying capacity of upwards of 17 million. Two out of every three passengers that boarded a CLIA owned cruise ship in 2012 were from U.S. and Canada, and Australia is the fastest growing market. The average cruise fares dropped in 2012, reflecting prevailing market conditions. There are 24 cruise ships (valued at $15.8 billion) for delivery between now and

2017. All but six of these ships are of the megaship (2,000+ berths) type, the biggest being the $1.32 billion Oasis class ship for Royal Caribbean International due for delivery in 2016. Another anticipated delivery in 2016 is a nostalgic replica of the RMS Titanic.

Consequences of the Concordia tragedy continue to haunt the cruise sector. The cost of removing the ship's wreck alone is expected to exceed $800 million. Italy failed to complete the final technical report that was to be published within one year of the accident. A number of lawsuits have been filed related to the incident, including many in Florida. In order to regain consumer trust and confidence, the cruise industry voluntarily undertook a thorough review of their current operating policies. The panel of review experts has proposed 10 new policies that surpass current international regulatory standards. Regardless of the industry's resilience, a recent spate of technical problems on board four Carnival Cruise ships (Legend, Elation, Triumph, and Dream) makes one highly sceptical of the market leader's safety standards and quality assurance system. There are increasing calls in the U.S. for a (Cruise Ship) Passenger Bill of Rights.

3. The U.S. Merchant Marine

2012 was a year of serious ups and downs in the domestic maritime industry. While there were some remarkable positive developments and initiatives, overall the year was unpleasant and discomforting. The dispassionate fury of market forces was very visible and equally painful domestically as elsewhere. On the positive side, President Obama signed off on seven fast-track port projects in 2012. Five of these projects are expected to boost the competitive advantage of large East Coast ports when the Panama Canal widening is complete. A Maritime Administration report on Great Lakes Shipping found healthy signs of recovery in that region from severe recessionary effects that began in 2009. The report states that with the sole exception of coal, all other major cargos traded in the Great Lakes region such as iron ore and limestone are either fully back to prerecession levels or making significant inroads. The demand for medium sized supply vessels, supporting the Gulf of Mexico offshore oil and drilling industry rose significantly in 2012. With daily rates reaching $27,000, some U.S.-flag supply vessels returned back to the Gulf of Mexico.

Matson Lines acquired Reef Shipping, a regional operator that serves New Zealand and other nearby islands. This is new territory for Matson but an integral part of their global strategy that includes a network of Pacific Island services. Matson is the sole operator in the U.S.–Guam trade now and has also entered the China trade. TOTE, a Jones Act carrier, ordered two new ships to be built at the General Dynamics NASSCO (National Steel and Shipbuilding Company) yard in San Diego. These ships of 3,100 TEU each are to replace two 1,200 TEU vintage containerships in the Puerto Rican trade. The new ships will have LNG propulsion, the first such purpose-built vessels in the world. They will carry enough LNG for two and a half round-trip voyages between Jacksonville and Puerto Rico, and their GHG emission will be very low. It is perhaps poetic justice that LNG-propelled containerships would be pioneered by the very nation that introduced the whole concept of containerized shipping services in 1956. NASSCO has also finalized plans to convert two RO/RO ships (also owned by TOTE) to LNG propulsion.

Unprecedented drought conditions in the Midwest region and limited dredging of the Mississippi river from Cairo, IL to St. Louis, MO would have caused a cessation of river traffic this year and a major economic crisis for the region. It was resolved through timely actions by the U.S. Army Corps of Engineers. They began blasting rock formations in the affected areas in December 2012 and the river traffic continued uninterrupted. Kirby, the biggest coastwise barge operator in the nation, reported $209 million profit in 2012 because of high capacity utilization and robust pricing. A market leader in inland and coastwise barge transportation, Kirby has made a number of key acquisitions in the recent past.

On the negative side, there have been several developments during the past year. The automatic cuts to federal spending (sequestration) that began on March 1, 2013 will impact the nation's economic recovery, international commerce and the maritime economy including the nation's critical maritime security program. Bottlenecks are expected in cargo clearance and other essential functions carried out by the U.S. Coast Guard and the Department of Homeland Security. There were more additions to the long list of U.S. carriers delisted by the stock market in recent years in addition to OSG, the big tanker operator who had a market value of over $3 billion barely four years ago and now, under ignominious Chapter 11 protection.

The agony of Jones Act carriers continues unabated including an unanticipated legislative setback. The 2012 Surface Transportation Act in its final version has a provision to lower the

requirement to carry international food aid cargo by U.S.-flag ships. The Maritime Administration (MARAD) estimates that this will lead to a loss of $90 million in revenue and 2000 direct and indirect jobs, including 640 mariner jobs. There are concerns about the declining number of U.S.-based ship owners in the Maritime Security Program (MSP) that supports 60 commercial vessels with military use potential. True American ownership has declined among MSP carriers through mergers and acquisitions. The ongoing sequestration may further impact the motivation of some carriers to remain as MSP participants. A Government Accountability Office (GAO) cost-benefit analysis of the Jones Act on commerce in Puerto Rico was released recently. It is likely to rekindle highly emotive debates on maritime promotional policies in general and the Jones Act in particular.

In early 2012, there was an unsolicited bid from APM Terminals to take over all container terminal operations at the Port of Hampton Roads in Virginia. It is a natural deep-water port that can accommodate the large containerships likely to visit East Coast ports after the Panama Canal widening. For the last thirty years, the terminals were operated by Virginia International Terminals, a non-profit arm of the Virginia Port Authority. APM Terminals' offer is to lease the facilities for 48 years in return for potential $3.8 billion revenue for the Commonwealth of Virginia. The state also received another unsolicited competing bid from banking giant JP Morgan in partnership with Maher Terminals and Noatum Ports, a JP Morgan affiliate, proposing a similar option for $3.1 billion. The privatization proposals ran into considerable opposition from the local maritime community and the port authority's state-appointed board of commissioners decided to continue the status quo with a revitalized and restructured company operating the terminals.

American Petroleum Tankers, a fuel-shipping company majority owned by the Blackstone Group on behalf of their investors, has announced plans to build two new product tankers at the NASSCO yard in San Diego. The contract is contingent upon receiving a $340 million Title XI loan guarantee to refinance APT's existing five tankers. Those five double-hulled Jones Act product tankers were delivered by NASSCO in 2009 and 2010. Should the loan guarantee be approved, product tanker construction will resume in a U.S. shipyard after two-year hiatus.

The New York-based American Feeder Lines (AFL), an innovative marine highways operator discussed in my previous annual reviews, did not complete its first year of operation and went

out of business in April 2012. They abruptly cancelled their nine month long feeder service with a chartered 700 TEU feeder vessel between Halifax, Nova Scotia and Portland, Maine and Boston, Massachusetts, citing insufficient volume to support the endeavour. It turned out to be a money-losing operation and their German investors withdrew support although the province of Nova Scotia was willing to extend a $500,000 loan guarantee to support the weekly service. AFL was hoping to get a waiver from the build-U.S. requirement until they could raise funds to build ten ships in U.S. yards and commence weekly short-sea services linking 18 ports under the Jones Act.

3.1 *Regulatory Developments*

BP Exploration and Production Inc. pleaded guilty to 14 criminal counts (11 counts of felony manslaughter, one count of felony obstruction of Congress, and also violations of the Clean Water and Migratory Bird Treaty Acts) for illegal conduct leading to and after the 2010 Deepwater Horizon incident, the nation's worst environmental disaster to date. BP was sentenced to pay $4 billion in fines and penalties, the largest such penalty in U.S. history. In addition, civil proceedings are also underway against the company. The rig owner Transocean, another major player, also pleaded guilty to violation of the Clean Water Act (CWA) for its illegal conduct leading to the incident, and was sentenced to pay $400 million in criminal fines and penalties, making it second only to the penalty imposed on BP.

A U.S. District Court jury in San Juan, Puerto Rico, found the former president of Sea Star Line and a former Vice President of Crowley Liner Services guilty of antitrust conspiracy in the continuing saga of price-fixing by carriers in the U.S.-Puerto Rico trade between late 2005 and early 2008. Violations include colluding with others to rig bids, fixing rates and surcharges, and allocating customers through manipulation of bids. It follows guilty pleas by five other carrier officials — two from Sea Star and three from Horizon, and could result in a maximum penalty of 10 years in prison and a $1 million fine per individual. Sea Star Line, Horizon Lines, and Crowley Liner Services have paid upwards of $46 million in criminal settlements, and the investigation is continuing. Horizon Lines pleaded guilty to violations of international and national pollution laws relating to transfers and discharges of oil and oily waste onboard the container ship Horizon Enterprise, and was sentenced to pay a fine of $1.5 million.

Following the Costa Concordia disaster, a number of cases were filed in Florida against the Miami-based Carnival Cruise Corp. seeking redress. Given the many inefficiencies of the Italian legal system and the low probability of getting a verdict in favour of the claimants despite high costs, this was widely expected. As an example, Italy has a cap on damages, and claimants are required to post 10 percent of the expected damage award prior to filing a lawsuit unlike the U.S. where payment is made only if the clients succeed. A U.S. District Court Judge dismissed the case filed by affected Italian businesses, located in the Tuscan island of Giglio off which the ship ran aground and advised them to seek grievance under the Italian legal system. However, on February 15, 2013, two cases filed on behalf of 104 survivors were approved for trial under the Florida court system. The plaintiffs are seeking at least $2 million in compensation per passenger and $590 million in punitive damages.

In November 2012, 15 members of the Transpacific Stabilization Agreement (TSA) filed an amendment with the Federal Maritime Commission (FMC) to expand their scope to include the nine-member Westbound Transpacific Stabilization Agreement (WTSA). Under the provisions of the U.S. Shipping Act of 1984 as amended, a research and discussion carrier group such as TSA can make recommendations to member carriers in their service contract negotiations with customers, but has no rate-setting authority. Carriers expect the stabilization agreement's expanded scope to help resolve the traditional imbalance in capacity utilization between eastbound and westbound transpacific container movements. National Industrial Transportation League (NITL), the body representing major shippers, has asked FMC to "examine the ramifications and impacts" of the proposed merger although they support the consolidation in principle. The proposed merger is likely to be approved and will go into effect from mid-April this year. This will help bring down overheads and other avoidable expenses, and add efficiency in transpacific container services.

3.2 Overseas Ship-holding Group, Inc.

Five years ago, OSG stock was trading around $100 and even mentioning its name and bankruptcy in the same breath would have been a sacrilege. Nevertheless, in November 2012, the biggest U.S.-based shipping company with a fleet of 112 ships (67 owned and 45 chartered) sought Chapter 11 protection. The company's market capital value had dropped from a peak of

$2.7 billion five years ago to $38 million prior to its bankruptcy, an astonishing fall for the nation's first publicly traded ocean shipping company and one of the world leaders in oil transportation. Earlier, the Standard & Poor's rating agency downgraded its long-term corporate credit rating as well as its senior unsecured debt to CCC- (from CCC+). The company became a casualty of the highly volatile spot market for large tankers with weak liquidity and unsustainable financial leverage. They reported losses throughout the last four years and their $1.5 billion revolving line of credit was fully exhausted by the summer of 2012. OSG's attempts to raise funds through long-term bank financing and other arrangements such as sale and leaseback could not stop the inevitable and they joined the ranks of other recent U.S. shipping companies that sought Chapter 11 protection such as American Commercial Lines, General Maritime, Horizon Lines, Trailer Bridge and TBS International.

OSG reported pre-tax net loss of additional $20.5 million during the six weeks between Chapter 11 filing and the end of the year. Their attempt to repudiate some of their charter agreements to serve the best interests of creditors has received legal approval. By the same token, the unilateral plan by BP to liquidate Alaska Tanker Company (ATC) will be a major blow for OSG's bankruptcy estate if it goes through. ATC is a joint venture between BP, OSG and Keystone, and features four BP-owned tankers. BP and OSG own 37.5 percent each in ATC, and the rest, Keystone. Also, law firms that specialize in securities class actions are pursuing OSG for their likely violations of the federal securities laws. This relates to certain statements issued by the company between May 2009 and October 2012.

3.3 *Longshoremen Contract Negotiations*

There was considerable drama to the protracted master contract negotiations between International Longshoremen's Association (ILA) and U.S. Maritime Alliance (USMX), and strong indications of a massive port strike that was to begin on February 6, 2013. ILA represents the 14,500 dockworkers in 15 ports on the East and Gulf coasts of the country, and U.S.MX, the management. The tense negotiations, brokered by Federal Mediation and Conciliation Service, began in March 2012 and involved two contract extensions before reaching a tentative agreement on February 1, 2013. The final agreement would be subject to ratification by both parties and also to crucial local agreements notably in the Port of New York and New Jersey which employs roughly one out of every three ILA members. The local agreement between ILA

members and New York Shipping Association representing the management continued to be a tense challenge for another month, with other local chapters awaiting its outcome. A deal was finally reached in New York on March 8, 2013 and the master contract was approved in principle by the ILA rank and file on March 13, 2013 with ratification expected in April 2013.

4. International Developments

4.1 *Green Shipping*

As the year 2012 began, there was considerable consternation among shipping circles that the European Union might implement unilateral green shipping initiatives because of the slow pace of progress in global efforts toward emission control. Several nations and trade organizations were among those who feared the EU repeating what they did in the aviation sector in 2011. The subsequent decision by EU in 2012 to abstain from independent action was well received by the shipping community. The North American Emissions Control Area (ECA) went into effect on August 1, 2012 and mandates the use of one percent sulphur Heavy Fuel Oil (HFO) or residual fuel oil for ships within 200 miles of the continent of North America. The EPA interpretation of one percent fuel requirement has been of considerable help to ship owners and operators who were concerned about switching over to lower distillate that caused major engine problems on the California coast in 2009. The USCG has started enforcing the fuel oil regulations and two ships were detained in March 2013 for noncompliance. In all ECAs, maximum sulphur content will drop to 0.1 percent by 2015 (equivalent of gasoline or clean distillate) from the current level. The global standard for maximum sulphur content in non-ECAs will become 0.5 percent from 2020 although this will be mitigated in part by the introduction of energy efficiency measures in ships. Future plans to meet these requirements other than switching to low sulphur marine fuel oil include installing exhaust cleaning system and using natural gas propellant. The natural gas option is getting considerable attention worldwide including in the U.S. and EU. The EU is strongly pushing 130 LNG bunkering stations for coastal and inland ports. A recent report from Det Norske Veritas (DnV) states that 10 percent of all ships being built during the next eight years will have gas fuelled engines. The same report states that by 2020, new ships will emit up to 35 percent less CO2 than today. The Energy Efficient Design Index (EEDI) regulation went into effect in January 2013 and requires ships to be 30 percent more energy efficient than today's average ship by 2025. This will drive more ship owners to follow the TOTE leadership

in LNG propulsion. While EEDI applies to all new ships, the concurrently introduced ship energy efficiency management plan (SEEMP) will apply to all ships.

4.2 *Piracy*

Pirates attacked 239 ships in 2012, the lowest in five years according to statistics released by the International Maritime Bureau, a division of the International Chamber of Commerce. In contrast, there were 439 ship attacks in 2011. The number of incidents off Somalia dropped considerably with only 75 reported ship attacks in 2012 as opposed to 237 in 2011. However, East and West African coasts still remain most piracy-prone with 150 attacks in 2012. Pirates boarded 174 ships last year and hijacked 28 of them, 14 of them off Somalia; 585 crew members were taken hostage in 2012 (compared to 802 in 2011); six crew members were killed and 32 assaulted or injured. Vessels under most risk continue to be fully loaded tankers, bulk carriers, fishing vessels, smaller boats, and also container ships. As of 13 March, 2013, Somali pirates are holding on to 5 ships and 65 hostages. In 2013, there have been 47 attacks and 3 hijacks so far with four of the attempted attacks being off Somali waters.

One reason for the decline in piracy off Somalia is the adherence to best management practices by vast majority of ships transiting the area. Another reason is the presence of armed security guards; it has gone up from one in 20 ships in 2011 to two out of every three today. More than 50 percent of ships transiting the region are insured against piracy now and receive up to 50 percent reduction in premium for carrying armed guards. BIMCO (Baltic and International Maritime Council) is recommending minimum four-man security teams on board to provide adequate all-around coverage; this includes one person staying with the Master at all times. The case of the two armed guards on board Italian tanker Enrica Lexie who erroneously shot and killed two Indian fishermen off the coast of Kollam, India on February 15, 2012 caused a major diplomatic row between India and Italy. The Italian ambassador was prohibited from leaving India and his diplomatic immunity was in jeopardy, and restored after the marines returned back. It should be noted that piracy still remains a strong threat. In fact, hostage captivity is now longer than ever before; from 68 days in 2008, the average time now exceeds 320 days. Also, the average ransom payments have doubled from 2008 to well over $3.5 million today, with some exceeding $25 million. The barbaric torture inflicted upon the crew of MV Iceberg by Somali pirates is a sad illustration of man’s inhumanity toward fellow humans. The ship with its crew of

24, was captured on March 29, 2010 off the port of Aden in Yemen and remained under captivity for 33 months. The pirates broke off negotiations when owners turned down their $10million ransom demand and turned their wrath toward the helpless hostages. The prolonged severe physical and psychological atrocities committed against these innocent merchant mariners included starvation, hanging upside down and even sawing off the ear of one crew. The torture reached a new high when pirates threatened to take out the internal organs of hostages and sell them in the lucrative medical "black market." One frightened mariner jumped overboard and committed suicide. The security forces finally freed 22 of the remaining 23 hostages in December 2012, the second casualty being the ship's Chief Officer, presumably killed by pirates. The Greek owned MT Smyrni, a fully loaded million barrel crude tanker, hijacked by pirates in May 2012 was finally released on March 11, 2013. The owners reportedly paid a ransom of $9.5 million for the safe release of the ship and its 26 crew including Captain H. Upadhyay, my fellow classmate, who spent ten long months under captivity.

The Gulf of Guinea (off Nigeria, Togo, and Benin) is quickly emerging as the next hotbed of activities. There were 58 incidents in the area in 2012 including 10 hijackings and 207 hostages. Piracy on this side of Africa is particularly violent and there is frequent use of guns. Nigerian law prohibits the use of third-party armed personnel on board ships. The focus here appears to be on the petroleum cargo that is often sold off within 48 hours of capture. In the case of hostages, the average detention time so far has been eight days. In general, piracy is escalating rapidly here, and there is fear of considerable underreporting.

Bloomsburg Business Week reports that a private navy is being set up in the UK to deal with piracy and will recruit 240 former marines and sailors. The plan is to establish a fleet consisting of a UK-flagged mother ship, high-speed armoured patrol boats, and armed soldiers whose mission will be to deter pirates. It will be financed by shipping companies who are unhappy with the current level of protection available to shipping and the inefficiency in prosecuting captured pirates. The average daily cost of pirate court trials is estimated around $40,000 and on top of that, trials and incarceration have had little impact on bringing the ringleaders to justice or curtailing their activities. A more logical strategy is to rebuild Somalia and create jobs that will keep its youth legally employed. Shell International Trading and Shipping is taking the lead in promoting this cause. They have brought together many top tier shipping companies of the world

and donated $1million to support job creation and capacity building projects in Somalia, and pledged an additional $1.5million for the United Nations initiatives there.

4.3 *Mariner Issues*

The International Labour Organization (ILO) has been working for over a decade with the International Transport Workers Federation (ITF, representing the seafarer unions worldwide) and the International Shipping Federation (ISF, representing employers) to codify all previous rules related to seafarer employment on board ships. This compendium referred to as the Maritime Labour Convention (MLC 2006) is truly the long awaited *magna carta* of the fundamental worldwide rights and privileges of mariners. It is perceived as the fourth pillar of shipping regulation along with the Safety of Life at Sea (SOLAS) Convention, Marine Pollution Prevention (MARPOL) Convention, and Standardization of Training, Certification, and Watch-keeping (STCW) Convention and will go into on August 20, 2013. There are 35 countries that have ratified MLC 2006, France being the latest. The U.S. is not a signatory but this does not absolve U.S.-flag ships from compliance with its provisions when calling a port in a country that has ratified the Convention.

MLC 2006 will have far reaching impact on seafarers and the quality of their work life. Although vast majority of shipping companies provide a good professional work environment on today's ships, trade journals continue to report abuse of seafarers by unscrupulous owners, operators, manning agents, and senior officers on board. Such allegations typically include contractual violations including non-payment of wages earned, abandoning the crew in a foreign port because of owner's financial problems, inhuman working conditions and unsafe ships. The new convention will put an end to such abusive practices, long abhorred by civilized society, and provide a decent self-respecting work environment for the estimated 1.2 million seafarers worldwide often toiling in waters far off their native land and in pursuit of an honest livelihood. Once MLC2006 is implemented, seafarer employment contracts must provide basic health and social security benefits as in any other profession. Seafarer work and rest hours will be regulated as well as their training, medical care, and workplace safety.

From August 2013, Port State Control inspectors will inspect not only the ship's compliance with global safety standards of operation and maintenance but also the existence of minimum

acceptable working conditions for its crew. All ships over 500 gross tons operating in international waters must carry appropriate compliance documents issued by the flag administration after an inspection and demonstrate ongoing compliance. Hospitality crew on board cruise ships will also get the same protection as traditional crew. MLC will become part of the national maritime legislation of signatory nations and seafarers will have the ability to report violations without fear of retribution. In general, it is expected that Port State Control inspectors will pay increased attention to seafarer work and rest hours during their ship inspections. The Oil Companies International Marine Forum (OCIMF) is advising its members to invest in customized
computer programs to manage seafarer work and rest hours on board ships and demonstrate compliance with all applicable regulations. The USCG is proposing a voluntary inspection program for ships calling MLC-compliant foreign ports, with approved classification societies conducting the inspections.

The Manila Amendments, commonly referred to as STCW (Standardization of Training, Certification, and Watch-keeping) 2010 came into effect on January 1, 2012 with a five year transition period until January 1, 2017. They constitute major revisions to the original STCW Convention. In addition to a general tightening of educational and training requirements, the amendments include strict mandatory limits on alcohol consumption (not greater than 0.05 percent blood alcohol level or 0.25 mg/l alcohol in breathalyzer test) and at least 10 hours of rest in any 24-hour period and a minimum 77 hours rest in any seven day period. A USCG policy letter, issued in October 2012, lays the framework for implementing the new work hour rules and has warned that some ships engaged in foreign trade may need to amend their crew strength to ensure compliance. As per a recent survey of 2,000 shore and sea staff conducted by Faststream, an international maritime recruiter, only half of all deck officers would choose the same career if given a second chance. Such sentiments are not difficult to decipher. One simple example is the increasing difficulty in stepping ashore at many foreign ports even after long and often arduous voyages. The number of countries that requires mariners to have visas prior to ship arrival for going ashore is on the rise. While this might be a feasible option for seafarers working on a container ship, it is impractical for those working on tramps. The International Shipping Federation (ISF) has taken the position that if visas
are required, seafarers should have the opportunity to apply for it immediately upon arrival or just before. The common courtesy of allowing mariners to step ashore and visit the port of call is

a long established custom and also the humane way to treat them given the nature of their employment. It is time to review and reconsider shore leave privileges for merchant mariners.

Another de-motivating factor many mariners face is maritime criminalization. The tendency toward disregarding the basic legal principle of *innocent until proven guilty* is becoming disturbingly repetitive when shipping accidents occur. The increasing number of incidents, where seafarers were perceived guilty and treated like common criminals even after they took all possible measures to avoid an accident or an oil spill, is particularly troubling. This was clearly visible in the case of the Stolt Valor, a parcel tanker that was wrecked by a terrible fire and explosion in the Middle East Gulf in March 2012. The ship's master and chief engineer who survived the accident were served with arrest warrant prior to any investigation. The 77-year old Captain of the ill-fated tanker Prestige is now standing trial in Spain along with his chief engineer for the decade old 20 million gallon oil spill tragedy. Like a true professional and law-abiding global citizen, he sought port of refuge upon detecting structural problems on board. The Spanish authorities denied his request and asked him to steer farther away from the coast as if that would solve the ship's structural integrity problems. After seven tense days, with no coastal state willing to help, the ship broke apart and spilled oil in an environmentally sensitive area. When the captain was picked up from his sunken ship and brought ashore, he was treated as if it was a premeditated act on his part despite the weeklong tragic saga of irrational shore-based decisions. Although the Captain's actions in extremis conditions were exemplary, he was treated like a common criminal, denied legal help and prohibited from returning home. And now, a decade later, the prosecutor is seeking 12 years imprisonment for his impeccable professionalism. No wonder many deck (and engine) officers would choose a different career if they had a choice!

4.4 *Safety Issues*

An 11 year old container ship in distress, the MSC Flaminia met with almost a similar fate as the Prestige during the summer of 2012. Despite being badly damaged by fire and explosion on July 14, 2012, the ship was refused entry into a port of refuge for almost two months before she was finally towed into Germany, her flag-state on September 9, 2012. It is believed that the cargo-owner did not declare its flammable properties which led to wrongful stowage and the consequent fire that resulted in three deaths. The German Classification Society Germanischer

Lloyd is seeking the establishment of designated places of shelter for crippled ships which will be a welcome development. The 15,500 TEU Emma Maersk, the first ship in the world of that size and the torchbearer of the Ultra Large Container Ship (ULCS) breed was humbled when her engine room was flooded because of problems with her stern thruster. It is unknown whether there is a structural flaw or if this was a freak accident. The ship was towed from Port Said in Egypt, site of the accident, to Palermo in Sicily where water will be pumped out from the flooded engine room. *Emma Maersk*'s seven sister-ships have been ordered to stop using their stern thrusters until the cause of the accident is clarified. These E-Class ships were the last container ships built in AP Moller Maersk's Odense Steel Shipyard before it closed.

A recent report from the International Tanker Operators Pollution Fund (ITOPF) provides good endorsement of improving safety standards in the industry. They classified all oil spills from the last 43 years into three categories, viz., large, medium and small, and determined that only 5 percent of them were of the large category, exceeding 5,000 barrels. More importantly, 55 percent of those large spills occurred in the 1970s although oil volumes traded today are substantially higher. There were only 33 large spills in the 2000s, just 7% of all large spills recorded (see Figure 3). The rest of the oil spills (95 percent) were of either medium (50 to 5,000 barrels) or small (less than 50 barrels) category. Among these, ITOPF found that 40 percent occurred during loading and 29 percent during discharging operations. Furthermore, 46 percent of all operational spills (caused during loading and discharging) were from hull and equipment failures, and not human errors. Collision and groundings caused the rest of the medium spills category and also 2 percent of the small spills.

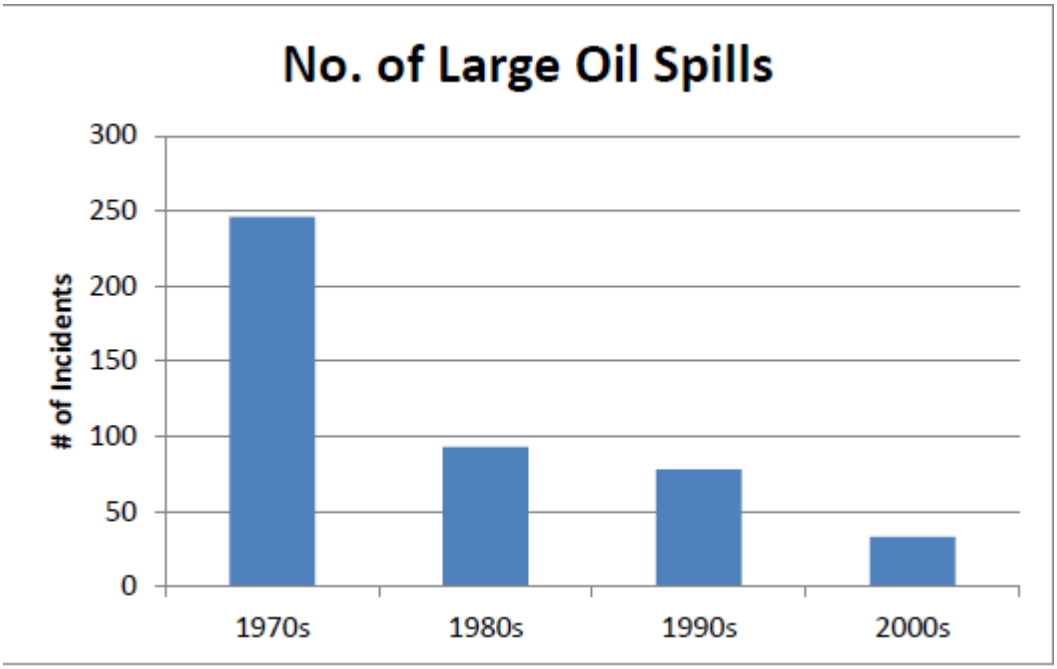

Figure 3: No. of large oil spills, Source: ITOPF

These excellent outcomes are a result of the various safety measures introduced over the last forty years including the International Safety Management (ISM) Code and more importantly, the professionalism and commitment to safety of the vast majority of men and women who sail commercial ships today. Regretfully, the ISM Code itself is coming under increasing criticism for its increasing propensity tendency to generate unnecessary paperwork for mariners. As per a recent survey of shipping experts, owners, managers, classification societies, surveyors, and senior officers by Capt. N. Singhal, a maritime quality assurance consultant, there is overwhelming consensus that seafarers are being tasked with excessive paperwork most of which is duplicative and difficult to read or understand. While survey respondents agree that simple, concise and effective documentation is essential, the prevailing sentiment is that the current level of ISM requirements are drowning the mariners in paperwork rather than assisting them in ensuring a safe and seaworthy ship. Capt. Singhal argues that the current trend is increasing crew fatigue and nonchalance and not engendering a safety culture, and articulates the crying need for a lean Safety management system and a thorough revision of the ISM Code.

5. Outlook

No drastic improvements are expected in 2013 other than getting a bit closer to the end of the tunnel. Although growth in OECD countries will continue to be anaemic, it is expected to pick up steam in other fast growing countries such as China and India. New capacity will enter all major markets but it will be at the slowest pace witnessed in recent memory with the exception of liner trades where once again record new levels of capacity will enter. This, along with the shifting world consumption patterns, will start turning the tide around in 2013. However, new maritime investments will remain highly volatile and risky unless it is in the offshore sector. So, 2013 will not be the year of salvation but should certainly start paving the way toward seemingly long-forgotten good times in the industry, and a more optimistic 2014. *Au revoire!*

About the author:

Dr. Shashi Kumar is a Master Mariner, Fulbright Senior Specialist Fellow and Professor Emeritus of International Business and Logistics. He is in his 26th year of distinguished leadership and educational services to the U.S. & global maritime community.

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