

# Safety at Sea – Applying Pareto Analysis

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## SYNOPSIS

A close investigation of casualty analyses particularly focusing on the causes of accidents clearly indicates that standards are not applied correctly. When human factor issues are studied carefully it is evident that there are omissions in the education and training programmes received by the seafarers involved in accidents.

International Maritime Organisation's (IMO) priority in recent years has been to revise the most important international treaty dealing with crew standards – the International Convention of Standards of Training, Certification and Watch-keeping for Seafarers (STCW). But IMO does not oversee the implementation of STCW or assess conformance to the requirements. IMO cannot work alone. According to Ziarati<sup>2</sup>, governments and related industry should show the same determination to implement these standards and, monitor and/or assess or accredit the education and training of seafarers, to a given norm acceptable by all concerned.

This paper reports on a major European Union funded project instigating an integrated programme of education and training for merchant navy officer including higher ranks. The project has adapted cross-referencing techniques and an analysis methodology viz., Pareto, to identify the problems that offer the greatest potential for improvements by showing their relative magnitudes and frequencies.

## INTRODUCTION

Accidents are very unfortunate but some of these have led to major international conventions such as SOLAS and MARPOL to name but a few, making sure lessons are learned and that seas are safer as a result. There are reports stating that water transportation is safer than air transportation. Comparison of airline and shipping safety records OECD<sup>1</sup> is considered inappropriate, but if there are lessons to be learned from the efforts in making airline operations safer and this has an impact on the safety at sea, then lessons should be learnt.

This paper has only taken note of recent reports by IMO<sup>2</sup>, Lloyd's Register<sup>3</sup>, OECD<sup>1</sup> and, advantage of the outcomes of several European Union (EU) education and training initiatives (See bibliography). These include several Leonardo pilot projects HIICOSS I, 1997; SAS, 1998; NORAY, 1999; ORION, 2001; CIVILPRONAVY, 2001; FISHTRAIN, 2001; SECURETAS MARE, 2002; HIICOSS II, 2002; NETOSKAR, 2003. The results of a number of research and development programmes such as METHAR (2002) also have been taken into consideration exploiting, in addition, the outcome of the EU funded METNET (2002) Project.

The following are several results from those papers and reports that highlight the main problems as well as those elucidating a way forward, in remedying these problems.

**What** are the problems? - According to IMO<sup>1,4</sup>, 80% of accidents at sea are caused by human error. It is reported that mistakes are usually made not because of faulty, deficient or inadequate regulations, but because the regulations and standards, that do exist, have been ignored. The IMO accident analysis reports (Ziarati<sup>2</sup>) clearly indicate the causes of many of the accidents at sea are due to deficiencies in education and training of seafarers or disregard for current standards and regulations.

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### Author's Biography

Professor Ziarati is presently the Principal of The Institute of Maritime Studies a position he has held since September 2003. He has held several senior positions in academia and industry and developed, as part of a funded project, a novel variable geometry turbocharged diesel engine and was the designer of a marine engine management system. He has supported the establishment of several education and research centres in the UK and overseas.

**How** can problems be solved? - A recent study (Torkel<sup>5</sup>) reports that 25% of the world fleet was responsible for more than 50% of shipping accidents around the world. The study notes that the top 25% of the safest ships were involved in just 7% of all accidents. The study, published by the University of Technology and Science (NTNU<sup>6</sup>) in Norway, reports that by improving the quality of the world fleet to the same level as those in the safest 25% category, there might be an overall reduction of 72% in shipping accidents.

This paper describes an approach to improving safety at sea through improved education and training for Merchant Navy Officers in the identified 25% of the world fleet responsible for 50% of shipping accidents. It also provides a review of education and training programmes in the safest 25% category that may lead to identification of good practices that could reduce overall shipping accidents by 72%.

An earlier paper (Ziarati<sup>2</sup>), identified several education and training problem areas for analysis:

- Knowledge of English
- Correct application of maritime terms and terminologies
- Ability to use navigation tools
- Conformance with standards or rules and conventions
- Application of current standards or conventions by third parties
- Inadequate standards
- Other reasons

### PARETO ANALYSIS

There are many improvement/analysis/chart techniques, for instance Pareto, fishbone and so forth. However, Pareto was chosen for good reasons. Pareto focuses efforts on the problems that offer the greatest potential for improvement, showing their relative frequency or size in a descending order. It helps a team to concentrate on those causes that will have the greatest impact if remedied. The analysis is based on the proven Pareto principle that 20% of sources cause 80% of the problems. Pareto prevents shifting the problem where the solution removes some of the causes but worsens others.

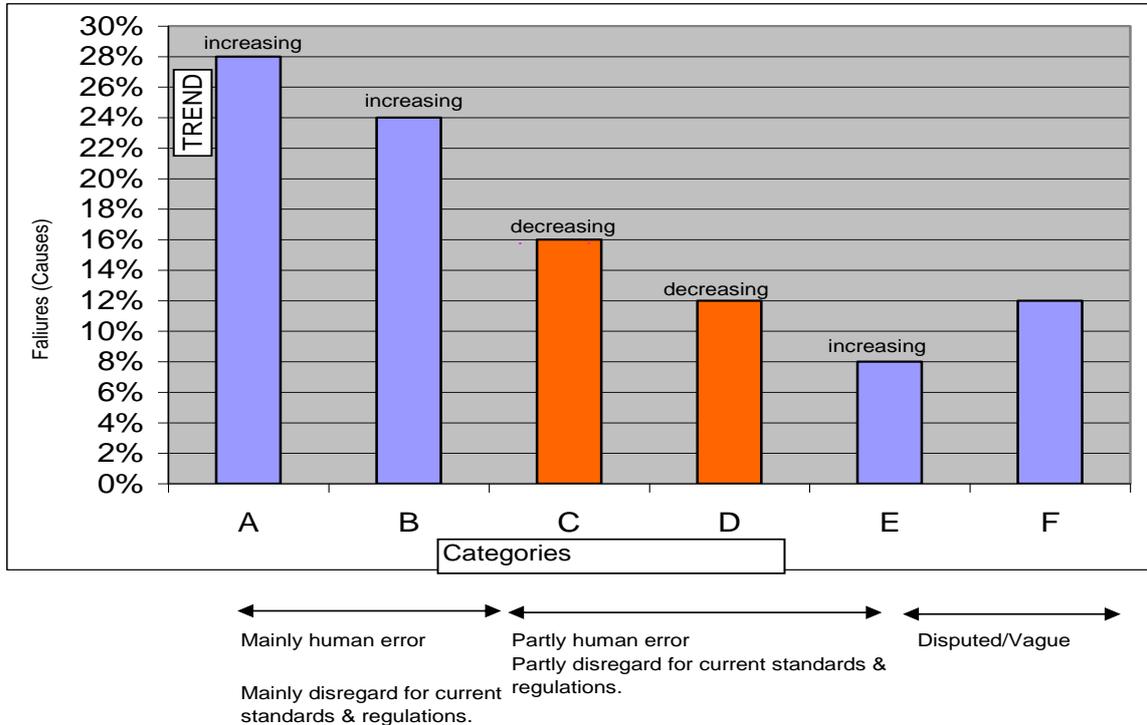
Problems need to be identified and more information obtained about them. This has already been done as reported earlier (Ziarati<sup>2</sup>). The next action is to rank the problems, based on size or frequency. The following is an attempt to re-arrange and rank them based on the frequency of their occurrence.

- |  |    |
|--|----|
| • Use of navigation equipment                        | 28 |
| • Communication                                      | 24 |
| • Equipment failure including engines                | 16 |
| • Confusion due to standards and regulations         | 12 |
| • Inadequate standards/applications by third parties | 8  |
| • Unknown  | 12 |

To understand the problems in greater detail a pilot project (Safety On Sea<sup>7</sup>), funded by the EU Leonardo programme, a partnership consisting initially of Turkey, Scotland, England and Norway was formed to identify major problems and good practices in the partner countries. The partnership also works towards developing integrated and world-class programmes of education and training for both navigation engineering as well as marine engineering cadets, wishing to acquire internationally recognised qualifications as officer of watch. The Project also looks at opportunities to progress onto higher qualifications viz., chief mates and chief engineers as well as becoming a master and captain of ocean going vessels. Two other projects have been planned: Project Hello Sailor - to improve the communication skills of those embarking on a career at sea, and Project PICK-UP (Professional, Industrial, Competence and Knowledge-Updating) for those working in industry particularly those threatened by redundancies. The three projects viz., SOS, Hello Sailor and PICK-UP, are designed to address problems at the source and concentrate on the main sources causing them as identified earlier.

All partners in the project have been running programmes of education and training programmes for Deck Officers and Engineer Officers based on the IMO syllabuses for many years. One of the partners last year became the national examination centre for seafarers' competency qualifications. The partners have therefore many years of experience and are in possession of many case studies.

<b>Causes:</b>	<b>A</b> Use of navigation equipment	28%
	<b>B</b> Communication	24%
	<b>C</b> Equipment failure including engines	16%
	<b>D</b> Confusion due to standards and regulations	12%
	<b>E</b> Inadequacy of standards/applications by third parties	8%
	<b>F</b> Unknown	12%



**Fig 1** Pareto Chart identifying main sources of problems

The first task was to review the existing programmes in the partner countries to identify the differences and discover a methodology for harmonising educating and training systems and practices without upsetting the authorities in each of the member countries.

The review of the programmes led to many productive discussions and use of cross-referencing methods developed as part of an earlier EU programme, EUROTECNET<sup>9</sup>. The cross-referencing tables provided a means of comparing programmes in different countries in the partnership. In doing so, with no disrespect to organisations involved with validation and accreditation of these programmes, it has been realised that there are serious differences in standards being applied, and even in the pathways chosen to satisfy the requirements of the same awarding body or even the same licensing authority. Many examples of these differences and in some cases deficiencies have been highlighted in Ziarati<sup>2</sup>. The content and standard of the sea service record books are also very different!

The unifying factor was the IMO syllabuses<sup>10</sup> which are the basis of all programmes in the world. The partner countries' programmes have integrated these syllabuses to varying degree of complexities into their own national programmes. To harmonise and at the same time to improve the standard, for instance, the Turkish project team using the syllabuses developed by northern European countries, which in turn are based on IMO's, revised its programmes and at the same time, applying cross-referencing techniques also satisfied the requirements the national authorities as well as those of a major international awarding body (BTEC/Edexcel) for the award of a higher national diploma (HND). HNDs are internationally recognised technician qualifications and HND graduates can continue their studies for two more semesters to obtain a degree in relevant subjects in many universities worldwide. HND graduates who also carry out their sea training according to recognised standards, for instance, Merchant Navy Training Board (MNTB) as part of the National/Scottish Vocational Qualification (N/SVQ) programme provided they successfully conclude the required ancillary courses are exempt from any written examination when applying for their certificate of competency. The MNTB and N/SVQ requirements are based on Occupational Standards (100-500 series).

## REMARKS

It seems that such adaptation, that is to say, HNDs and NVQ/SVQs in Turkey and hence international recognition, would now lead to the resolution of all problems encountered in the maritime community in the country. It is a well-known fact, however, that adapting a programme or methodology, from an external source, while helping to transfer good practices often does not solve the problems. Those familiar with the Laplas transformation know that such transformations are only possible if conditions exist or are created for them to take place. What is of importance and significance is how the programmes are incorporated and implemented. For instance, have previous case studies been carefully studied and taken into consideration? And what about areas where standards are confusing or crews are at the mercy of authorities/enforcers at sea or in ports. What about 'domino' or multi-collisions? Have these cases been carefully reviewed and incorporated in the assignments as part of the learning activities and are these assignments, if they exist, carefully assessed and externally verified? One thing is clear, that all concerned with the activities of the partnership and all those involved with revised programmes in Turkey are astonished at the outcome. The ship owners are much happier with the product of the new programmes and revisited processes. The sea service improvements are for everyone to see. The Turkish cadets having undergone external examination both for their HNDs and NVQs/SVQs and their ancillary courses will have the exact opportunities for receiving the same treatment as their counterparts in Scotland, England and Norway and indeed anywhere in the world as these qualifications are recognised by all major authorities in the western world.

The PICK-UP project was piloted to ascertain as to whether the findings of the paper by Ziarati<sup>2</sup> viz., the sources and causes of the problems, could be substantiated. It was also performed to see if those from industry would be willing to take part in remedying these problems. Four workshops were planned and delivered. In all cases the number of participants expected to attend was by far greater than anticipated. The feedback clearly indicated that the problems as ranked are valid and that the PICK-UP framework can help industry to reinvent itself, helping to make seas safer.

The Hello Sailor project was piloted as a series of short training programmes for industry and the outcome has been astonishing. In addition to helping industry to update the language competency of its personnel at sea and in ports, this initiative also concerns the development of a one-year language preparation course for cadets prior to the commencement of their main programme of study as well as the design and development of a programme of language modules for those on merchant navy officer programmes and for young cadets in the vocational maritime lycee schools. The programmes are in line with the recommendation of Loginovsky<sup>11</sup> which notes the significance of English as the working language of the international shipping industry and that the overall performance and safety of the international fleet depends on the skill to apply it correctly. He states that the ability of a non-native speaker to have a good command of maritime English is very much influenced by the ability to think in English in the framework of maritime profession. He concludes that one way to make the teaching and learning processes more effective is to power up the thought activity of a seafarer using English

The problems identified in earlier paragraphs, have on several occasions, been attributed to the shortage of seafarers mainly arising from the need to cut corners by companies when faced with a lack of manpower. These shortages have been reported by Ziarati<sup>2</sup>, Pourzanjani et al<sup>12</sup>, Schroder et al<sup>13</sup>, Zade<sup>14</sup> and IMO<sup>2</sup>. Despite severe unemployment in Europe these shortages remain and are predicted to substantially increase in the near future (Ziarati<sup>2</sup>).

The new programmes can help the young unemployed and the PICK-UP project can help smaller companies receive the support they badly need. These companies often do not have the resources for training or re-training their crews.

It is argued (Ziarati<sup>2</sup>) that diploma and/or add-on degree qualification(s) would help combat unemployment in the future, and at the same time, these qualifications are expected to help with competitiveness of the companies employing the graduates/officers from these programmes.

## CONCLUSION

1. The application of Pareto analysis has led to a methodology for identifying and ranking the problems that offer the greatest opportunity for improvement. The methodology has also helped find solutions to address these problems at source with the active involvement of main actors in the field.

2. The main problems have been studied and many case studies have been developed and incorporated into the curricula of newly revised and integrated programmes for education and training of merchant navy officer cadets in partner countries. Developments are on-going and it is expected that many other organisations involved with education and training of merchant navy officer including awarding, accrediting and licensing bodies would join the partnership. All that is needed is a short message to the Partnership site [www.maredu.co.uk](http://www.maredu.co.uk) and information on the projects would be forwarded to the interested parties.
3. The development of newly revised programmes is addressing the overall problems concerning safety at the source viz., education and training of cadets and those working in industry.
4. The success of the initiative has led to other projects being instigated and thus helping industry to update its skills and hence improve safety at sea and in ports.

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