Analysis of loss of position incidents for dynamically positioned vessels

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Objectives

1. Give an introductory assessment of the risks related to marine operations close to offshore installations and motivation for the investigation.
2. Develop a systems oriented description of a DP system and the related Class regulations.
3. Choose and present an approach for categorizing and analysis of human error.
4. Give an overview of the IMCA data, define the analysis approach and causal categories applied in the reports.
5. Undertake a frequency analysis of the causal factors.
6. Describe the BBN method: Model elements, conditional probability tables and analysis techniques.
7. Undertake a BBN based analysis of the dominating accident mechanisms in both qualitative and quantitative way by means of the GeNIe software package.
8. Discuss findings and propose plans for further work.

Introduction

When studying risk and safety lack of data is always an issue. Therefore approaches that may utilize qualitative knowledge in a systematic manner is always interesting. A company or institution often possess years of human experience and expert knowledge that can be hard to "transform" into facts and numbers in a risk perspective. Bayesian probability theory, and especially Bayesian networks, may provide the tools necessary to take advantage of this knowledge in a systematic way, when performing an analysis of a system such as the Dynamic positioning system of a vesse simplified illustration of the Dp-system is shown in figure 3.

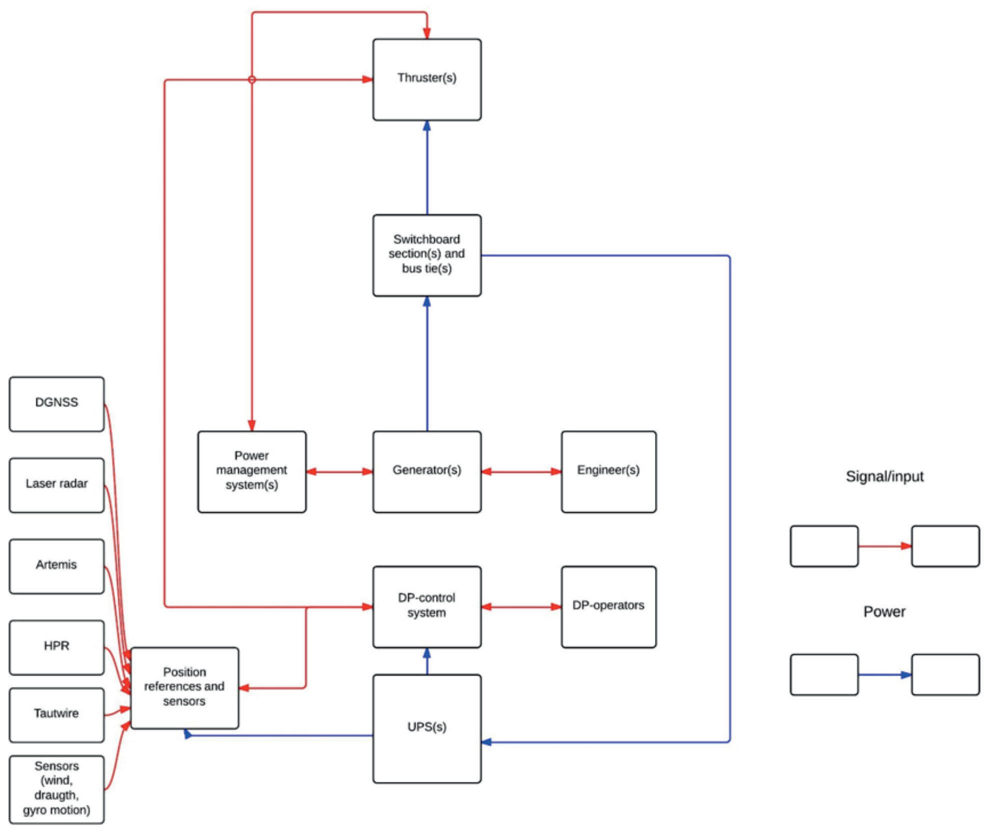

Figure 3 DP-system structure

Creation method for BBN

System knowledge

The first step of creating a BN that represents a physical system is to gain knowledge of the modelled system. This is necessary to sort causal factors and fully understand the description of an incident.

Data sorting

Loss Of Position incidents gathered by The International Marine Contractors Association (IMCA), were sorted after identified causal factors.

Causal flowcharts (figure 4)

After the data is sorted, causal flowcharts are created. These flowcharts are based on system knowledge, human factors and accumulated knowledge obtained through the data sorting.

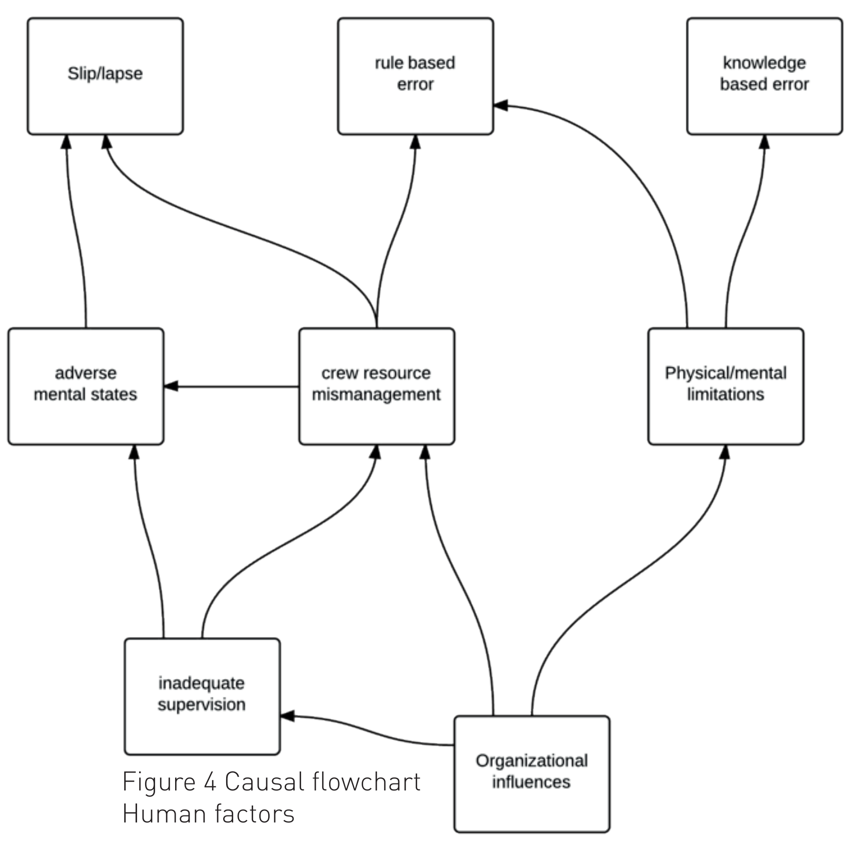

Figure 4 Causal flowchart
Human factors

BBN based on quantitative analysis of data by computer

By the use of a software package named GeNIe, a BN may be directly created based on data dependencies.

Comparison of causal flowcharts with quantitative BBN:

The BBN drawn by GeNIe is compared with the created flowcharts. When the results coincides no further change is required. If the results are deviating, further study is necessary in order to determine the most corect dependencies. (Direction and placement of arcs in the BN).

Drawing of final BBN:

When all potential deviations between flowcahrts and data dependencies are "solved", the final BN will be manually drawn as the resulting combination of expert judgment and data dependencies. Then GeNIe will be able to determine probabilities based on network strcuture and data.

Illustration of final BBN

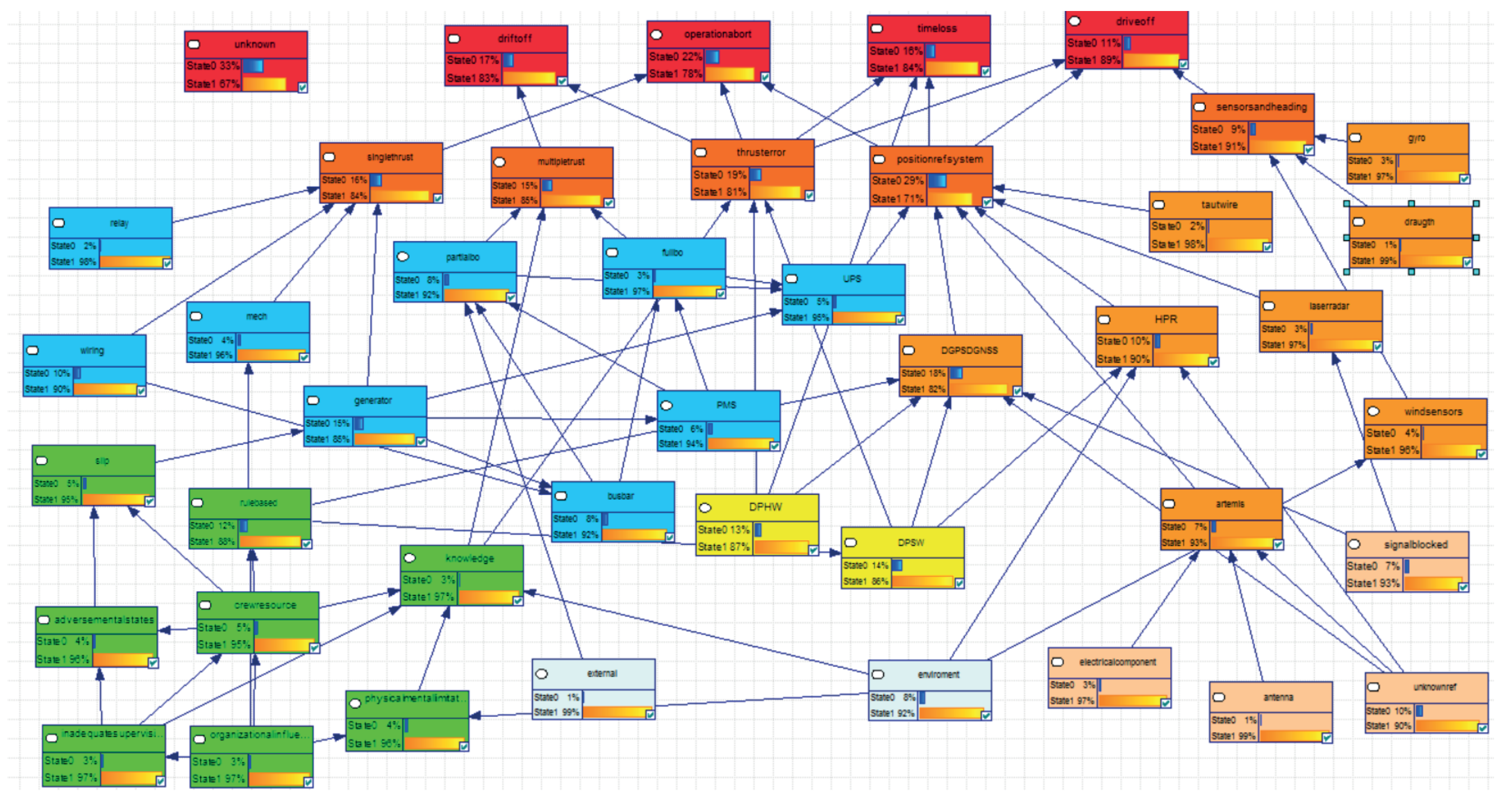

Figure 1
Illustration of BBN

Evaluation of BBN

A method has been developed for evaluating the most influencing dependencies in a Bayesian Network. This method combines the original failure probabilities of nodes in the network, with the relative effect of node failures as described by figure 2 and fomula 1.

Four terminal events have been discovered for Loss of Position incidents; Time loss, Operation abort, Drive-off and Drift-off. Formula 1 has been applied for evluating which causal factors that has the strongest effect on these events. The results for the terminal event "Drift-off" is shown in figure 5.

$$Evaluation\ of\ A\ on\ C = \frac{P(C|A) - P(C)_1}{P(C)_1}\ x\ P(A)_1$$

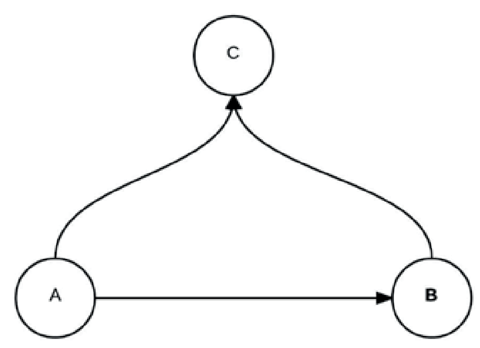

Figure 2 Example network

$P(A)_1$	Original probability (of failure) of A	$P(C)_1$	Probability of C given original probablity of A and B
$P(B)_1$	Probability of B given original probability of A	P(C|A)	Probability of C after probability of A is set to 100%

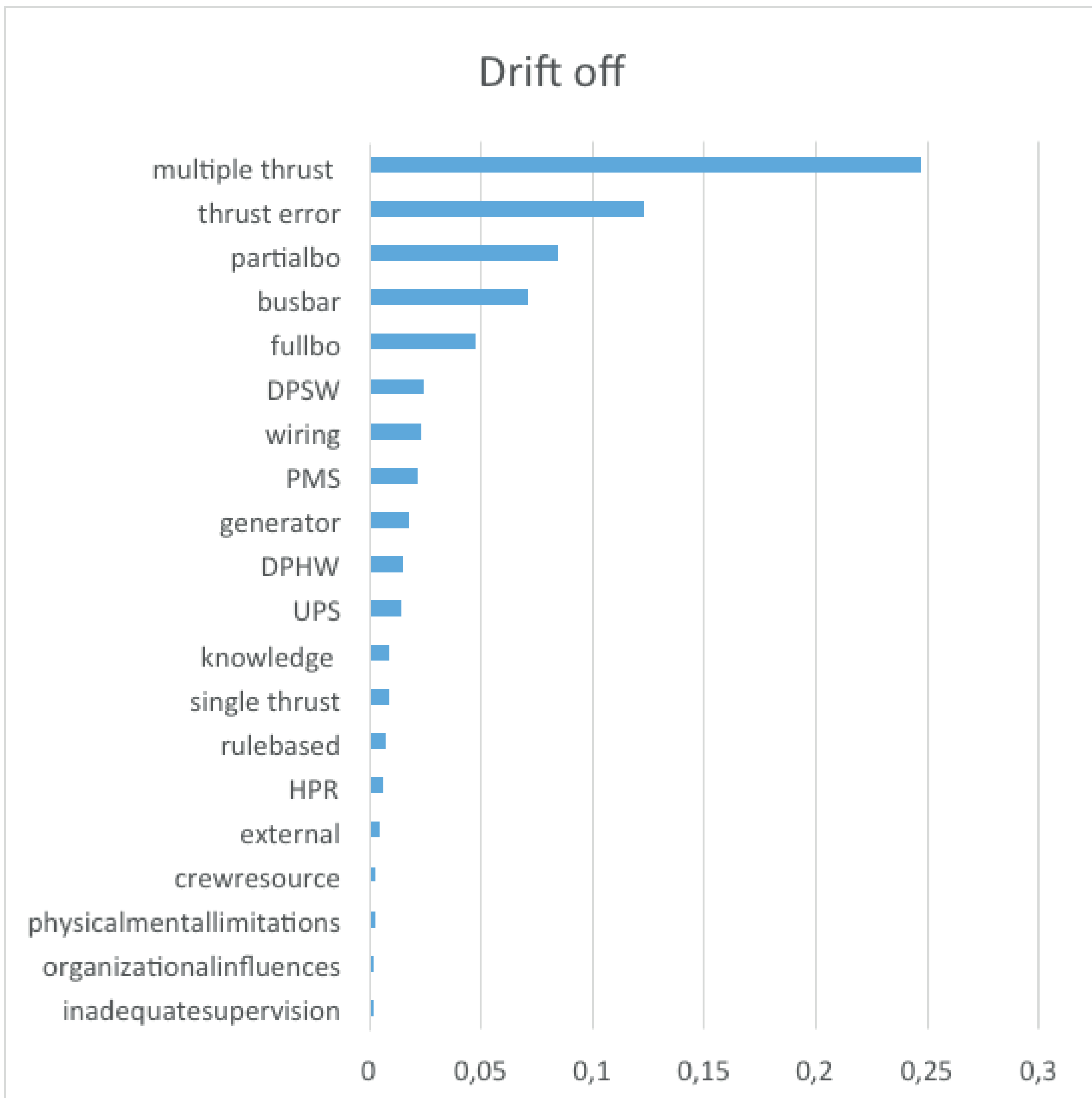

Figure 5 Evaluation of BBN: Drift-off

Conclusion

The study of the DP-system led to the creation of a sorting system, where three main categories of factors were identified leading to LOP; propulsion failures, reference failures and human factors. At least one of these factors were present in above 90 percent of all incidents analyzed.

The overall conclusion regarding the use of BN for modelling of LOP incident causes is a positive one. The method showed flexibility and allowed for a combination of both expert knowledge and available data in a systematic manner. The most useful aspect of this method is its flexibility. Sensitivity analysis regarding data is easily performed by a mouse click, and enable us to see the effect of changes visually and immediately.