

Dynamic Management of Operational Risk and Compliance in Maritime Port Areas

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The need

Dynamic Management of Operational Risks and Compliance in Port Areas is a corporate software solution based on a powerful “rules engine” that monitors in an ongoing fashion the operational activity in a port. It controls, warns, aids, and creates structured responses as per pre-defined rules, whenever an irregularity from the port’s usual routine is detected. The link between the world of risk assessment and the management of operational activity in a port—both before and after an event—in an environment wherein the focal risks are mobile, and everything rests on regulatory constraints, is an innovation in the port industry.

Risk is a given that can affect the operational activity of the port and / or the corporate achievement of goals set therefor, and which can have negative, undesirable consequences. In most cases, the term *risk management* is used in a financial context, i.e., credit risk or market risk. Yet in this proposal, we focus on operational risks stemming from events involving hazardous materials, safety, security, or non-compliance with legal and / or regulatory requirements.

It is important to understand and to distinguish between risk management and compliance with legal and regulatory requirements. Regarding both, managerial failure may lead to a negative consequence for the company; yet the latter has added significance: Compliance with legal and regulatory requirements is in most cases an extra burden on the operational activities of the port. A company that aspires to maximize its profits must manage its activity in the regulatory environment, at any given moment finding the balance point between compliance on the one hand, and not compromising performance on the other.

Moreover, in dynamic risk management, examining the risks from the point of view of the company’s management and shareholders is not limited to what takes place in the arena of the actual event, but also has strategic and economic significance in the broader sense of the word, as well as legal and image implications.

A port that manages its risks with a dynamic system enjoys the following benefits:

- 1. Optimization of resources** - enabling it to assess investment of resources commensurate with both objectives and risks, thereby making effective, economical decisions
- 2. Reduction of operational risks and financial loss** - enabling it to predict

events liable to cause damage, evaluate them before they occur, and manage uncertainty, thereby in turn reducing potential damage without hampering operational activity

3. **High-level compliance with legal and regulatory requirements** - enabling ongoing followup of legal requirements or [identifying] non-compliance therewith, thereby reducing legal exposure without compromising the company's outputs
4. **An automated response based on pre-defined rules, rapid recovery from an event, and return to routine** - enabling reduction of port downtime, thereby maintaining a high level of service and continuity in operational activity

The maritime port provides service to shipping lines, which are obligated to meet timetables and to maintain a high level of service. Closure of a port in the event of emergency, or reducing activity therein, and likewise disaster recovery time, are undesirable scenarios for those using the port's services. Rapid and professional response to a risk's developing into an event is a commonplace requirement made by shipping companies—the port's end users—of those operating it.

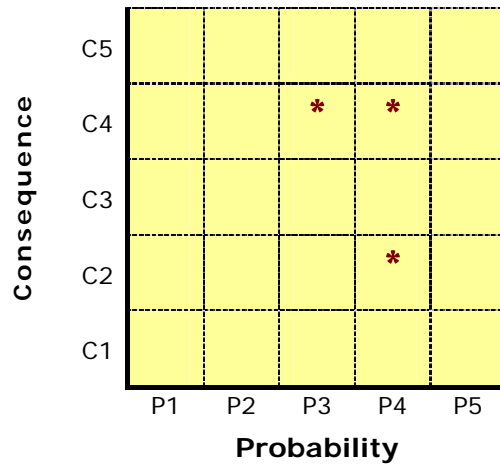
A maritime port is also a business environment, dense with both national and international regulations. Management of hazardous materials in ports, along with environmental, safety, and security requirements, is carried out as per a number of tools, including conventions published by the International Maritime Organization, such as the SOLAS and the IMDG Code, ISPS Code, and MAEPOL 73 / 78; national legislation; business licenses and certificates; permits and provisional documents; as well as industrial work practices and procedures.

All of these are worded in “do / don't” language, and they act as a “bible” that, together with risk assessment analysis, enable us to build the “rules engine” for *dynamic risk management*. In a port area, in contrast to any other industrial facility, the operational risks from hazardous materials (i.e., the types of materials and their quantities), as well as the operational activity therein, are dynamic. The average port conveys dozens to hundreds of thousands of containers containing hazardous materials of various danger levels, from explosives (Class 1) to materials that could cause environmental damage (Class 9). Management of and control over such a complex environment requires continuous information gathering and real-time decision-making based on that information.

The methodology and the solution

Classic operational risk management is based on principles of probability and consequence. Its predicate is that every risk scenario, which exists by definition within operational activity, without our taking any protective measures whatsoever, carries with it an *inherent risk*. Such a risk will be represented by a point or square on a graph whereon the X axis represents the probability or frequency of an event's occurring (*probability*), and the Y axis represents the result or potential damage of the event's having occurred (*consequences*). Every risk scenario has its specific probability and consequence, upon an event's actually occurring (Fig. 1). The numerical values in the coordinate graph that characterize each and every scenario are set by professional personnel who specialize in risk analysis.

Fig. 1: Three inherent risk scenarios (indicated by red stars) in a probability \diamond consequence graph



Dozens of risk scenarios occur in a port environment: entry into the port area of containers containing toxic gases or liquids with high vapor pressure; exceeding the maximum permissible storage quantities of [materials of] a particular risk group; storage in a prohibited area and deviation from the segregation rules; conveyance of hazardous material containers in proximity to densely occupied buildings; a hazardous material-bearing tow vehicle's overturning; exceeding the maximum permissible time for storing hazardous materials; entry of explosives into the port; leakage; fire; explosions, and so forth. All these are examples of risk scenarios involving hazardous materials.

Nevertheless, not only these, but causing air pollution; marine pollution; soil contamination, and spills, or violations of any permits, all constitute deviations from the provisions of environmental law or regulations; and each constitutes a probability of

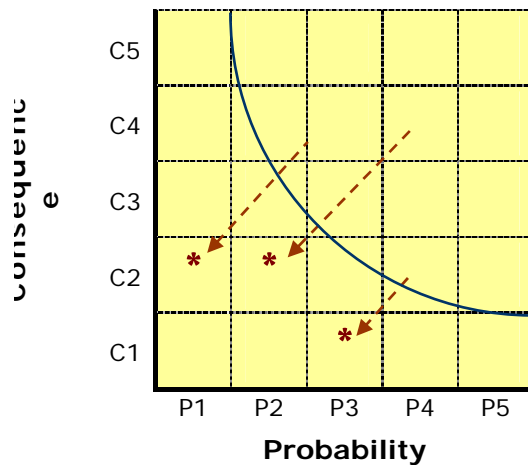
occurrence and consequence.

A port company, from the moment it commences activity, is exposed to operational risks. In an inactive company, the probability of a risk scenario and of any consequence whatsoever is zero.¹ Therefore, every company sets a *tolerability curve* for itself, which expresses the total level of risk that it can “bear”.

Classic risk management is a process wherein risk scenarios are presented on a probability < > consequence graph and measures are taken to prevent the risk or to reduce it to below the tolerability curve. The ways to achieve this are: compliance with legal and regulatory requirements; drafting work guidelines and instructions; worker training; proper equipment; and investment in infrastructures.

Alternatively, a port company may handle its risks by transferring them to a third party such as an insurer, outsourcing, or even accepting the risk (self-insurance) knowingly, for a finite period.

Fig. 2: Taking measures to reduce inherent risks to below the tolerability curve (blue)³



In classical operational risk management, a one-time analysis is conducted, and when all reduction or preventative measures have been taken, the business is left with *residual risk*, or that remaining underneath the tolerability curve. Thereafter, all that remains is to carry out checks in the field, to update the work practices and procedures accordingly, and to hope that

¹ **Note:** Even in an active company, risk scenarios located at the beginning of the axes can be found, if the company should invest infinite resources in risk reduction, bringing it to the beginning of the axes.

³ The risk remaining below the tolerability curve is the *residual risk*.

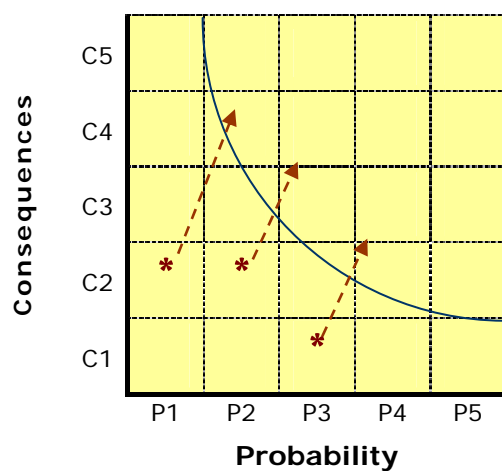
the measures taken are upheld. Yet such measures do not provide a response to the rapid and frequent changes that characterize operational activity in a maritime port, and do not provide the level of control and monitoring necessary in an automated system, or the decision-supporting mechanisms of such a system.

In the “real world”, in routine operational activity, rapid and frequent changes *are* the routine. Often, we cannot fulfill precisely all of the directives and procedures, and due to the needs of the moment, we fail to uphold one or another regulatory requirement. In an emergency, rapid and precise response is crucial; however in such a situation, due to stress, mistakes are made. Therefore, it is incumbent upon us to engage in dynamic risk management.

Port congestion, human error, and occasional lack of discipline all result in the segregation rules not always being observed for hazardous and non-hazardous materials, and between various risk groups; permissible storage times are not always observed, and irregularities and other scenarios occur.

Moreover, occasional events take place that are unrelated to that occurring in the port, such as prohibited entry of hazardous materials, shipping delays, or a ship’s refusal to load hazardous materials or to observe port rules. Such occurrences also cause violations of work practices that were established to prevent or reduce risk. In addition, such events lead to a rise in the incidence of risk scenarios above the tolerability curve, and to overall increased risk on the part of the port company (Fig. 3).

Fig. 3: A rise in residual risks over the tolerability curve, bringing with it overall increased risk at the port



But that's not all: Risk management using the classical method focuses on the chances of an event's occurring and its physical consequences in the event's arena; whereas in dynamic risk management, we anticipate a higher level of control and a more in-depth analysis of the size of the overall risk for the port company as a whole. From the manager's point of view, the overall risk to the company and its shareholders is analyzed from the viewpoint of a given activity's contribution to one or more of five types of risks:

1. **Safety risk** - the risk of physical harm caused to people; the chances of light or severe injury, or heaven forbid, death
2. **Economic risk** - the risk of losing property or the company's sustaining financial damage, such as having to pay to restore the situation to its former condition, compensatory payments, fines, legal fees, payments to a third party, or loss of markets
3. **Legal risk** - the risk of violating the law in the name of the company's officeholders and shareholders (meaning a criminal conviction or a fine, not legal fees or fines levied on the company, which are included in economic risk)
4. **Image risk** - the risk of negative publicity or exposure in the media or to the general public, both for the company and its officeholders and shareholders
5. **Security risk** - the risk of compromised security (terror acts or acts of war) at the port, a risk with political and strategic implications

In order to understand how the aforementioned methodology is implemented, take this example: As per the provisions in the directives of the port's permit, it is prohibited to store containers containing toxic gases for longer than 48 hours. The entry of 30 such containers creates a *risk scenario* for the port whose size and numeric value is comprised of the sum of the safety risk, economic risk, image risk, and security risk. As soon as we exceeded the 48-hour permissible storage period, the risk grew. The economic risk has grown, and added to it are now legal risk and image risk. The mathematical calculation of the **overall risk** can be expressed in the following formula:

$$C_i = \sum_j w_j c_j \quad \sum_j w_j = 1$$

Where C_i is the overall level of risk of scenario i ; c_j is the level of risk for each of the risk types; and w_j is the weight of the risk level in proportion to the other four risk types.

Therefore, a system that is capable of monitoring the overall level of risk at the port and warning of dangers is one facet of the overall system. A dynamic system is one that is also

capable of responding rapidly as per guidelines debriefed in advance and implementing decision-supporting mechanisms upon a risk scenario's occurrence, in order to restore routine activity in the port as quickly as possible.

Therefore, in a dynamic system, upon receipt of information on the occurrence of an event from the detection and identification systems, or even from a human source, notices are sent automatically to the emergency crews and key personnel in the company as per guidelines debriefed in advance. The system will know to check other data, to analyze the scenarios that could develop, and to present them as a 3D aerial image map of the port on a GIS.

Concurrently, aided by a wireless system, engineering information will be sent to the emergency crew's mobile computer system profiling the materials involved in the event and the recommended way to handle them. In the control room, the automated system will provide information on the container's owner, its source, and its destination. Video cameras will be aimed at the event arena to obtain a real-time picture of the situation.

Take, for example, a bromine gas leak. Gas spread scenarios are presented according to meteorological conditions and field conditions. Concurrently, bromine sensors pinpoint the spreading points, cameras are aimed at the event arena, engineering information from the material's safety data sheet (MSDS) is relayed to the emergency crews, and the event is handled as per practices and guidelines set in advance.

Such a system would reduce human error, initial response would be rapid and precise, the actions taken would be assimilated, and an efficient debriefing of the event would be enabled for drawing conclusions and formulating lessons for the future.

In conclusion

In this paper, we showed the need for, and how to achieve, dynamic risk and compliance management in maritime port areas. While we did not get into the details of how to implement the methodology in practice, relevant personnel are hereby invited to contact the author to discuss further action.