FUZZY ASSESSMENT OF VITAL ASSETS RISK IN OIL INDUSTRY

Mohammad Nematigoodarzi
Planning manager of Institute for International Energy Studies (IIES), Tehran, Iran
Mehdi Tavakoli
HSE, NIOC ,National Oil Company

Abstract
Chemical industry because of having a large volume of chemical materials, is always in danger of terrorism and man-made menaces. Therefore, it is too important for such an organisation to have a master plan in security risk management, which includes: new assessment of vital assets risk techniques in industries, specially oil and gas industries. In this research, assessment of security risks done by assets Security Risk Factor Table (SRFT). Important factors of security risk such as: situation, possession, visibility, stock and etc, are used in this model. In this essay, by using logic, the security risk factor table changes its form and it reduces assets risk uncertainty assessment. The transformed model, uses two scales of 3pointed and 4pointed, based on trapezium numbers. At last, the numbers of experts defuzzified and the results were expounded.

Key words: Terrorism, Vital assets, Security vulnerability assessment, Security risk factor table , logic.

1~ Introduction:
Before the terrorism attack to the world trade center in New York, September 11, 2001 A.D, the emphasis is on the risks of natural and technological events and incidents analysis, at assessment of oil industry and other related industries risks. In other words, before the September 11, man-made events did not count into common risks assessments. It was after the September 11 that the terrorism events were placed on the center of chemical and petroleum attention. Chemical industry such as oil industries, store and carry out a large amount of chemical materials. Therefore, potential menaces, are always dangerous because of economic, life and environmental considerable damages, which lead to explosion, poisonous materials releases, and fire. So, vital assets risk assessments results from security menaces, is nowadays an origin. Chemical industries depends on circumstances, may increase security processing and/or may content to existing circumstances, but often, chemical sites which are in danger of considerable menaces and/or are near to populated centers, do need to increase maneuvers against security and man-made menaces. So, in sensitive industries such as Chemical industry, it is too important to use continued security risk management plans, containing security risk assessments techniques and execute these techniques.
It is necessary for security risk assessments to be flexible in compare with technological events and natural circumstances risk assessments, that is the main different between these two. In other words, making uncommon and unpredictable decisions, in order to surprise the
menaces, is one of the most important points in security risk management. For example, change in protocol of stocking the chemical materials in stock tanks, and/or change in time of some parts of campaign. Learning suitable confronting against potential menaces, can be helpful to increase the assets resistance. In fact, most of the security and risk assessment common ways with logic changes, can be useful as confronting method.

2~ Security risk management

Security risk management plan, as it shown at figure number 1, needs a systematic approach for vital assets risk analysis. It is necessary for this plan to have ability of recognizing sensible assets, & natural & unnatural considerable menaces, & also vulnerability & existed risks assessment, & stationing confronting plans. The most important part of Security risk management in each assets, is SVA (Security vulnerability assessment). SVA is not necessarily a quantitative method & almost it uses from qualitative methods, specially experts judgments. Assessment output by the experts, is useful for risk computing & then risk priority, in order to make new confronting methods, & geographical positions, campaign kind, & chemical materials kind & volume, have very important rule to optimize SVA approach.

Figure number 1: SVA(Security vulnerability assessment)

SVA at chemical industries vital assets concludes below steps:

Assets specifications: the purpose of this step is to recognize sensitive assets. Sensitive assets are those assets which need more security resistance against potential menaces.

Menace Assessment: in this step, recognizing & distinguishing potential menaces, & assets assessment according to their attraction volume & also probable consequence evaluation in case of menaces to be successful.

Vulnerability assessment: is to recognize potential security vulnerability which menaces the vital assets.

Security risk assessment: this step, is for determining the risk of each menace according to their correctness & their consequences. After determining the risk of each menace, the risks classified & if the volume of the computed risk is high, some recommendations will present in order to reduce it.

Suggestions: after compute & classify the risk, in order to recognize & evaluate methods of reducing risks effects, present options will adopt. Also if it is needed, the confronting methods reconsidered.

In this essay, as it shown at table number 1, we use SRF (security risk factor table) as a tool for security risk assessment in chemical industries.

This model uses from security risk factors such as: situation, visibility, possession, & so on.

Also, effort is to reducing human errors scoring to this factor, using with fuzzy logic. In the way that, we have got a fuzzy mark to each risk factor, in form of two verbal scales (3pointed
& 4pointed) with a domain from zero to five, & then total achieved fuzzy mark, will defuzzified in order to evaluate the situation of risk site with more attention.

Table number 1: SRF (security risk factor table)

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Risk marks domain</th>
<th>Real marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>Rural</td>
<td>Urban 1,2,3,4</td>
</tr>
<tr>
<td>Visibility</td>
<td>Sight disability</td>
<td>Low 0</td>
</tr>
<tr>
<td>Extant</td>
<td>Low 1</td>
<td>Middle 2</td>
</tr>
<tr>
<td>Possession</td>
<td>Private 1</td>
<td>Public 2,3</td>
</tr>
<tr>
<td>Terrorism background in region</td>
<td>Non-existent 0</td>
<td>Rarely 1,2,3</td>
</tr>
<tr>
<td>Exist security actions</td>
<td>High</td>
<td>Ordinary</td>
</tr>
<tr>
<td>Availability control</td>
<td>1</td>
<td>2,3,4,5</td>
</tr>
<tr>
<td>Environmental support</td>
<td>1</td>
<td>2,3,4,5</td>
</tr>
<tr>
<td>Reduce the risks effects</td>
<td>1</td>
<td>2,3,4,5</td>
</tr>
</tbody>
</table>

As a conclusion, as it shown at table number 2, total achieved risk mark, is shown the situation of assets security vulnerability.

Table number 2: security risk ranking

<table>
<thead>
<tr>
<th>Exit security risk situation</th>
<th>Achieve risk mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>&lt; 15</td>
</tr>
<tr>
<td>Middle</td>
<td>16 – 30</td>
</tr>
<tr>
<td>High</td>
<td>31 – 45</td>
</tr>
<tr>
<td>Very high</td>
<td>45 &gt;</td>
</tr>
</tbody>
</table>

3~ fuzzy system theory:
In making decision process of security management & security risk, always there is a degree of uncertainty in available data. Also, establishing quantitative data base is challenging, because of many reasons such as: lack of frequency in security events risk, human errors & economic circumstances. Even if the data is available, has considerable errors & uncertainty. So, establishing a suitable data base is impossible in this situation. Therefore, in such a situation, fuzzy logic theory is useful & helpful to reduce uncertainty of the data. This theory was discussed by Mr. Lotfizade for the first time, which is so helpful to solve complicated
issues & useful in industries. But to increase security risk assessment exactness, using with fuzzy logic, many attempts is done.

3-1~ Fuzzy concepts:
Orisp sets, in fact are usual & common sets. Making difference by adding adjective orisp, easily helps us to use a vital & innovative concepts in fuzzy logic named membership function. Orisp sets model, membership function can just get two amounts: yes or No (1 & zero) these two are those possible in classic 2valued logic. So, fuzzy set defines based on membership function which contains an all embracing set of (1 to zero). In other word, each member has a different membership. Fuzzy set is established with generalize classic sets theory. In classic sets theory, membership of a set member is based on the Binary system, which shows a member is, or is not a member of a set. While in fuzzy theory, proportional degree of a set member is permitted. Members evaluation with marking them by functions, shows the degree of their membership.
If membership degree of an element in a set is zero, that member exited from the set & if it is equal 1, that member is completely entered in the set. As a conclusion, we can say classic set is a mode or a subset of fuzzy set. If membership degree of a member is btw 1 & zero, this mark shows gradually membership degree. So, according relation 1 we have:

\[ M_A(x) = \begin{cases} 1 & \text{if } x \in A \\ 0 & \text{if } x \not\in A \end{cases} \quad (1) \]

Which in this relationship, \( M_a(X) \), is element feature function (x) at (A) as an orisp set. Also, membership function for fuzzy set(A) is as relation (2) as below:
\[ M_A : U \rightarrow [0,1] \quad (2) \]
Which in this, \( M_a \), is membership degree of (x) at fuzzy set (A).

3-2~ Membership functions:
In fuzzy logic, uses different kinds of functions (MF) such as triangular, trapezium, Gamma, & rectangular. One fuzzy number include a fuzzy set, which is a set of real numbers with different membership degree btw zero to 1. Towards, triangular & trapezium membership functions (TFN) because of simplicity & understandability, is used widespread in order to compute & interpret data.
Although, using complicated relations such as Gaus relation, gives us more meticulous description.
But these relations are so time-consuming, & in compare with other methods in this essay their additional complication, without presenting any considerable concession, reduce their validity.
A trapezium membership functions, which is used in this research, shows with \( A:(a,b,c,d) \) & members of this function define as relation 3 as below:
So, according to numbers domain used in SRFT, using trapezium membership function is the best fuzzy method.

3-2-1-verbal variable:

A verbal variable shows as (X,T,U,M) from, which is in it:

X: is verbal variable
T: verbal volumes set which (X) is able to a chive them, as a model we have:(T-) very high, high, middle, low..
U: real domain which (X) variable is able to achieve it.
M:is a semantic law based on, each verbal volume at (T) is related with a fuzzy set in U. for example, (M) determine "middle" & "high" volume, shown in (T), as a certain membership function from.

(X) with (0/3) membership volume, may assess middle, & with (0/7) membership volume, may assess high.

3-2-2- Defuzzification

Defuzzification, is a situation within, numbers defuzzified from fuzzy mode. There are many different methods in order to defuzzify, but common methods in this field are Yager & Chen. This research uses from average fuzzy exit method, which compute parameters average volumes as relation (4).

\[
\text{Fuzzy exit volume: } \frac{\int MB'(y) \, dy}{\int MB'(y) \, dy}
\]

(4)

B`: is fuzzy set output & MB` is membership function.

4. Security risk fuzzy factor table:

(SRFT) can be used as a pre measurement tool in SVA model in other to security situations assessment in each site. In SRFT model, important parameters such as situation, visibility, possession and etc, rated by zero to 5 scale, which zero is "lowest risk" & 5 is "highest risk". Rating the parameters is based on experts, quantitative & experimental. Adding up the achieved scores, as it shown at table number 3, can be helpful for vital assets security situation assessment. If different experts help to score, because of human errors, answers uncertainty will increase. So, in order to reduce this uncertainty fuzzy theory is used. First, all of the parameters allocated scores, will be fuzzy, and then will be defuzzified. Achieved add up from security risk fuzzy factor table, have better conclusion in compare with un-fuzzy mode.

Table number 3: SRFT (Security risk fuzzy factor table)
In this essay, uses from 2 verbal scales, scale number 1 has 3 limits (figure 2) & scale number 2 has 4 limits (figure 3) as below.
Trapezium fuzzy numbers used in 3-pointed scale are: low(0,0,1,2), middle (1,2,3,4), & high (3,4,5,5) & for 4-pointed scale are : low(0,0,1,2), middle (0/5,1/5,2/5,3/5), & quite high (2,3,4,5) & high (3/5,4/5,5/5). SRFT is shown at table number 3.

For example, experts using with scale 1 gave score 5 to "possession" parameter. Governmental possession gets the highest risk with membership volume 1. The achieved volume of possession risk parameter for defuzzification, compute using with average method according to relation 5.

\[
y' = \frac{4/5 \times 1}{1} = 4/5(5)
\]

By fuzzy scale 2 also, we can fuzzy other parts of parameters. For instance, "stock" parameter gets 4/5 score. This amount, suggests high stock volume with 0/5, & very high with membership volume 1, on fuzzy scale, also, defuzzification campaign shows the same as "possession" parameter, present in relation 6.

\[
y' = \frac{4/75 \times 1 + 3/5 \times 0.5}{1 + 0.5} = 4/33(6)
\]

All of these computes shown in table number 3.

This is essential to say that, if several experts get their judgments for risk assessment, different scores will achieve in a parameter. The average of scores as the score of each parameter will determine & other parts of process will be unchangeable.

**Conclusion:**

Increase of recent terrorism attacks all over the world, makes it necessary to review the principles of security risk at vital assets. To store & to carry a huge amount of chemical materials, which some of them are very dangerous for human being, lead to increase security potential menaces at industries assets. So, in order to strengthen the plans of security risk management it is very important to improve risk assessment techniques having suitable, useful & with confronting method economic justify.

In this essay, we used security risk factor fuzzy table, design with 2 fuzzy scales (3-pointed & 4-pointed) based on trapezium fuzzy numbers. Also, considering fuzzy logic can reduce the human errors resulting from several expert judgments as much as possible.
At last, the conclusions will extract by defuzzification computes. This research shows that it is necessary to review the security & safety management standards before the September 11, 2001 A.D.

The most important aspect of this metamorphosis, is flexibility of security risk management facing with unpredictable purpose of security menaces such as terrorism attacks. In other words, security risk proficiency assessment of a chemical- industrial site, is possible when we consider all of the risk parameters. After considering the situation of vital assets security at chemical industry, we bear in mind the confronting methods against menaces according to computed risks at model in the shape of security system stationing into & around the site. The (SRFT) model is efficient when we consider all of the possible scenarios. The best situation in this model, is to improve models of "reducing the affects of menaces", compare with "making decisions based on new security systems establishing".

Economic consideration is one of the efficient principle models of risk assessment. So, security risk management at chemical industry is vital, & SVA model is considered as a tool to compute exist security risk at vital assets more than SRFT model at these assets.

References