Development and Weight of Leading and Lagging KPIs for Structural Integrity

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ABSTRACT

Leading and lagging Key performance indicators (KPIs) provide a means for assurance that risk control systems, to prevent or limit major hazards. The relative importance degree of KPIs provides a theorical guidance for monitoring, inspection and maintenance of structural integrity. In this paper, structural integrity KPIs are classified into leading and lagging KPIs based on Bowtie methodology and the importance degree of the KPIs are evaluated by weight calculation on the basis of Fuzzy analytical hierarchy process (FAHP).

KEY WORDS: KPIs; offshore structural integrity; Bowtie; FAHP.

INTRODUCTION

Key Performance Indicators (KPIs) are widely used to assess the performance of technical, environmental or financial. With an increasing proportion of North Sea oil and gas production installations are reaching their original design life, offshore structural KPIs are normally established for assessing the asset integrity and safety performance. These KPIs are used to ensure that safety critical equipment are in place and are routinely measured and reviewed by both duty holders and regulators. Normally, the development of these KPIs are based on barrier concept (Graver, Saint-Victor, Lønvik, Høydal, Leinum and Skavås, 2013).

Barriers can be illustrated in bow-tie diagram. A barrier can be a preventive or control barrier and be presented on both sides of the bowtie. Leading indicators are normally barriers to prevent hazards event and lagging indicators are barriers to control consequences and effects. These KPIs have been gaining considerable prominence within the Oil and Gas industry in recent years.

Sharp, Ersdal and Galbraith (2008) developed KPIs for offshore structural integrity based on a hazard approach, which are important for both safety and asset condition. It only concentrated on KPIs for fixed offshore installations. Sharp and Ersdal (2015) extended the previous analyses to include mobile installations and also concerned on the assessment of the use of KPIs for life extension. The requirements are that a KPI must be specific, measurable and accepted. The limitations of the KPIs mentioned above are not specific in terms of classification and some of them are difficult to measure.

In this paper, structural integrity KPIs are classified into leading and lagging KPIs based on bowtie methodology. And the importance degree of these KPIs are evaluated and ranked by weight calculation on the basis of Fuzzy analytical hierarchy process (FAHP) to offer an alternative method for measurement of KPIs.

Offshore Structural Integrity Hazards

The generic hazards for structural will fall into two categories: Excessive loading hazard and Insufficient strength of structure, mooring lines, foundation etc. In addition to floating facilities, loss of station keeping systems, loss of buoyancy and water plane area and loss of control of center of gravity, weight and displacement.

10 key hazards evaluated here are listed below:

- Extreme weather: The environment loading due to the combined action of wave, current and wind involves constitutes the governing loading condition for the design of offshore jacket type structures, and hence constitutes one of the most significant hazards.
- Fatigue: The cyclic nature of wave or wind loading can lead to fatigue damage to welded structural components. Fatigue damage usually takes the form of cracking, mainly at welded connections, which can grow to a through thickness stage and eventually to member separation. Fatigue can also be relevant to mooring systems for mobile installations.
- Corrosion: Corrosion at a significant rate occurs with steel immersed in seawater, unless protected, usually by a cathodic protection (CP) system. For mobile installations the integrity of the hull can be affected by corrosion and monitoring of the wall thickness is important.
- Loss of buoyancy: this includes compartment flooding and the tolerability of multi compartment damage for mobile installations
- Geological/geotechnical hazards: The geological/geotechnical hazards which could result in structural failure are due to different settlement, subsidence and slope instability and scour around piles and anchors.
- Accidental hazards – Ship Collision: Collisions from vessels can be classified into either " Powered Collisions" from passing vessels or "in-field collisions" from supply and standby vessels

operating in the field. Jacket structures have generally been designed to withstand an impact energy of the order of 4 MJ for smaller installations in the Southern North Sea.

- Accidental hazards – Dropped Objects: Impact by dropped objects or swinging loadings during lifts by cranes and similar devices constitutes an important hazard for an offshore installations.
- Fire and blast: Fires and explosion are now recognized as one of the most important hazards offshore and arise mainly from hydrocarbon leaks.
- Change of Use: This topic is highly relevant to structural integrity but has received little attention to date.

Definition of Leading and Lagging KPIs

The lagging indicator represents the situation when one or more barrier fails simultaneously and resulting in a consequence. Lagging indicators are in general reactive and outcome based. The leading indicator represents the number and the size of holes in the barriers. A leading indicator can represent the performance of one barrier or more barriers at the same moment, depending on the description of the leading indicator. Leading indicators tend to be forward-looking and input based.

The earlier work (Sharp, Ersdal and Galbraith, 2008) described the derivation and functionality of the offshore structural KPIs and developed 35 KPIs for both offshore fixed installations and mobile installations based on a hazard analysis. The hazard approach had been used to develop 15 KPIs only for mobile installations. The hazard analysis used “barrier analysis” to both identify safety critical elements for offshore installations linked to develop performance indicators for structural barriers. When the barriers are classified into preventive and reactive barriers, it can be illustrated in so-called bow-tie diagrams. For an example, the corrosion bow-tie diagram is illustrated in Fig. 1.

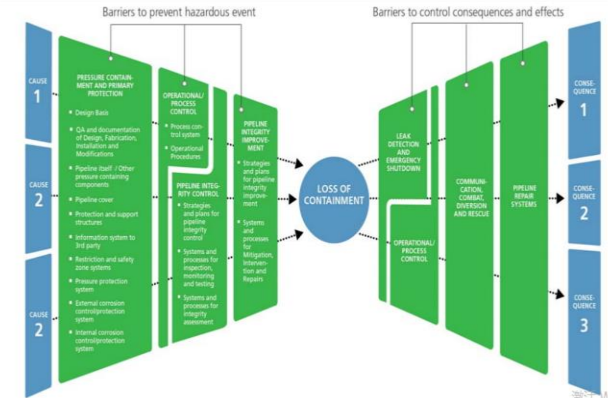


Fig.1 Bowtie Diagram

The preventive barriers are shown on the left side of the bow-tie diagram, and the reactive barriers are shown on the right side of the diagram. The center of the bow-tie diagram presents a top event illustrating the hazardous situation that could occur. Leading indicators are normally barriers to prevent hazards event shown on the left side and lagging indicators are barriers to control consequences and effects shown on the right side, but sometimes it can be both a leading and lagging KPI.

Leading and Lagging KPIs Determination Based on Bowtie Methodology

A bowtie is an easy-to-follow diagram for visualizing risk. The diagram is shaped like a bowtie, creating a clear differentiation between threats and consequences. In the diagram each individual threat is representing a unique likelihood and each consequence as a risk (likelihood of the contributing threats multiplied by the effect). The risk can be assessed and visualized for inherent as well as residual risks. The main advantage of bowtie diagrams is their ability to be understood by personnel at all levels within an organization. The bow-tie diagram provides an overview of multiple plausible scenarios in a single picture. The development of leading and lagging KPIs based on bowtie’s can be described as follows:

- Develop a bowtie involves defining the hazard
- Define the top event
- Define different barriers

A hazard has the potential to cause harm. Examples of offshore structural hazards include extreme weather, lack of structural redundancy, corrosion, fatigue, wear and abrasion, fire and blast etc. Bow-ties’ are then developed only for those hazards. Once the Hazard has been chosen, the next step is to define the top event. This is the moment when control is lost over the hazard. There is no damage, no negative impact or a consequence. This means that the top event is chosen just before events start causing actual damage. The Top Event is equal to loss of containment (LOC) and it must be verified using all threats and consequences. Threats barriers are whatever will cause the Top Event. There can be multiple Threats that can lead to the top event. Keep in mind that failed barriers are not threats. Consequences barriers are the result of the top event. There can be multiple consequences in relation to a top event. Leading key performance indicators should include barriers to prevent hazard and lagging key performance indicators include barriers to control consequences and effects. The definition of a lagging indicator is the equivalent to the definition of a consequence of the Bow-tie model so as to leading indications.

According to this method, the offshore structural KPIs will be divided into leading KPIs and lagging KPIs shown in table 1. It shows that some KPIs seem to be both leading and lagging KPIs. To face this kind of circumstance is to furtherly define these KPIs. For example, when the current structural capacity value is higher than its design according to monitoring, inspection, maintenance, etc, it will be a leading KPIs to prevent loss of containment. If the value of structural capacity is lower than design, it can be a lagging KPIs.

Fuzzy Analytical Hierarchy Process

The risk level of the KPIs mentioned above are evaluated by weight calculation on the basis of Fuzzy analytical hierarchy process (FAHP) to offer a new method for measurement of KPIs. It can determine the rank of KPIs and select the most important KPI of structural integrity to provide theoretical guidance for operation, monitoring, inspection and maintenance of offshore structural integrity.

AHP is a convenient method for solving large and complex multi-criteria decision making (MCDM) problems. However, it has been used in very limited applications in petroleum problems. One of the strengths of this technique is the need to structure the problem in a hierarchical manner where the different criteria and sub criteria are compared in pairs to ensure a consistency in the expert's judgment. The sub criteria are ranked among themselves considering the mother criterion to which they belong and finally the alternatives are ranked against each sub criterion. Preferences are selected using the "preference scale". However, when uncertainty and subjectivity do not allow a precise selection of preferences, the use of fuzzy sets theory is convenient for this purpose. Fuzzy theory allows the consideration of uncertainty and subjectivity in the decision-making process. Several researchers have combined the Fuzzy theory with the AHP, combining the advantages of each methodology, leading to the creation of a new multi-attribute decision technique called Fuzzy Analytical Hierarchy

Process (FAHP). The first application of this new methodology was) used to triangular fuzzy numbers (TFN). Subsequently, further improvements were proposed and this technique has been applied in several fields of knowledge, such as: marketing, security, informatics, communications, among others.

The steps of the establish model of FAHP are shown as follows:

- Define research object.
- Establish hierarchical structure diagram
- Establish judgment matrix
- Weight calculation of different hierarchical
- Rank of Weight

For the measurement of the importance degree of offshore structural integrity KPIs by weight ordering, a model and method of offshore structural integrity assessment is designed by fuzzy analytic hierarchy process method, with target layer, criteria layer elements, and indicator layer elements.

The fuzzy consistent judgment matrix ***M*** is to compare the relative importance degree of two lower level elements which related to one upper level element. Assuming that an upper level element M is related to its lower elements in the next level, the fuzzy consistent judgment matrix is shown in table 2.

Table 2 A fuzzy consistent judgment matrix

M	a_1	a_2	…	A_n
a_1	m_{11}	m_{12}	…	m_{1n}
a_2	m_{21}	m_{22}	…	m_{2n}
…	…	…	…	…
A_n	m_{n1}	m_{n2}	…	m_{nn}

m_{ij} represents the important degree of element a_i and element a_j to the related element M, which is determined by the comparison of each other. The 0.1-0.9 scale method shown in Table 3 is used to the quantitative description of the important degree between two elements in the same layer. $m_{ij} = 0.5$ means a_i is quall impotant to a_j. When $m_{ij} < 0.5$, it means a_i is more important than a_j and a_i is less important than r_j when $0.5 < rij < 0.9$

Table 3. 0.1~0.9 Scale

Scale	Important Degree
0.5	Equally Important
0.6	Weakly Important
0.7	Fairly Impotant
0.8	Very Important
0.9	Absolutely Important
0.4~0.1	When compared a_i and a_j, $r_{ji}=1-r_{ij}$

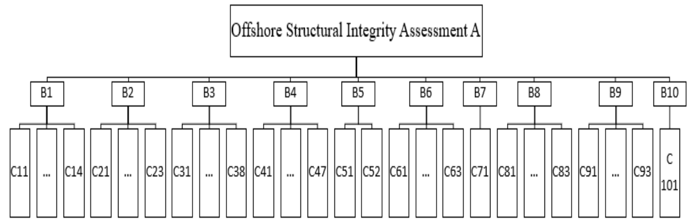
M is a fuzzy judgement matrix:

$$M = \begin{bmatrix} m_{11} & m_{12} & \cdots & m_{1n} \\ m_{21} & m_{22} & \cdots & m_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ m_{n1} & m_{n2} & \cdots & m_{nn} \end{bmatrix}$$

Application of FAHP on Ordering Weight of KPIs

The target layer A is the assessment of offshore structural integrity. The criteria layer B is structural integrity hazard including 10 hazards and the indicator layer C is offshore structural integrity KPIS including 35 structural integrity KPIs (C 11-C 101) mentioned above.

Fig. 2 Hierarchical structure diagram of offshore structural integrity assessment



In this paper, we compare 2 elements each other in a certain criteria layer B based on FAHP accoding to the hierarchical structure diagram and take the criteria layer for example. ***RB*** is a judgement matrix to criteria layer B.

$$R_B = \begin{bmatrix} 0.5 & 0.6 & 0.3 & 0.1 & 0.4 & 0.7 & 0.8 & 0.5 & 0.4 & 0.3 \\ 0.4 & 0.5 & 0.2 & 0.2 & 0.3 & 0.4 & 0.5 & 0.4 & 0.6 & 0.2 \\ 0.7 & 0.8 & 0.5 & 0.4 & 0.6 & 0.7 & 0.6 & 0.5 & 0.7 & 0.8 \\ 0.9 & 0.8 & 0.6 & 0.5 & 0.7 & 0.6 & 0.8 & 0.9 & 0.6 & 0.8 \\ 0.6 & 0.7 & 0.4 & 0.3 & 0.5 & 0.3 & 0.4 & 0.8 & 0.4 & 0.3 \\ 0.3 & 0.6 & 0.3 & 0.4 & 0.7 & 0.5 & 0.6 & 0.4 & 0.7 & 0.5 \\ 0.2 & 0.5 & 0.4 & 0.2 & 0.6 & 0.4 & 0.5 & 0.6 & 0.7 & 0.5 \\ 0.5 & 0.6 & 0.5 & 0.1 & 0.2 & 0.6 & 0.4 & 0.5 & 0.3 & 0.4 \\ 0.6 & 0.4 & 0.3 & 0.4 & 0.6 & 0.3 & 0.3 & 0.7 & 0.5 & 0.3 \\ 0.7 & 0.8 & 0.2 & 0.2 & 0.7 & 0.5 & 0.5 & 0.6 & 0.7 & 0.5 \end{bmatrix}$$

Weight vector ***WB*** is:

$$W_B = (0.0890, 0.0727, 0.1283, 0.1468, 0.0938, 0.1019, 0.0917, 0.0816, 0.0900, 0.1042)$$

The other judgement matrix and weight vector to indicator layer C are as follows:

$$R_{C1} = \begin{bmatrix} 0.5 & 0.6 & 0.4 & 0.6 \\ 0.4 & 0.5 & 0.7 & 0.4 \\ 0.6 & 0.3 & 0.5 & 0.3 \\ 0.4 & 0.6 & 0.7 & 0.5 \end{bmatrix}, R_{C2} = \begin{bmatrix} 0.5 & 0.7 & 0.4 \\ 0.3 & 0.5 & 0.6 \\ 0.6 & 0.4 & 0.5 \end{bmatrix},$$

$$R_{C3} = \begin{bmatrix} 0.5 & 0.4 & 0.7 & 0.8 & 0.6 & 0.2 & 0.5 & 0.3 \\ 0.6 & 0.5 & 0.5 & 0.7 & 0.8 & 0.3 & 0.4 & 0.1 \\ 0.3 & 0.5 & 0.5 & 0.2 & 0.6 & 0.7 & 0.4 & 0.3 \\ 0.2 & 0.3 & 0.8 & 0.5 & 0.3 & 0.2 & 0.7 & 0.1 \\ 0.4 & 0.2 & 0.4 & 0.7 & 0.5 & 0.4 & 0.7 & 0.6 \\ 0.8 & 0.7 & 0.3 & 0.8 & 0.6 & 0.5 & 0.2 & 0.4 \\ 0.5 & 0.6 & 0.6 & 0.3 & 0.3 & 0.8 & 0.5 & 0.2 \\ 0.7 & 0.9 & 0.7 & 0.9 & 0.4 & 0.6 & 0.8 & 0.5 \end{bmatrix},$$

$$R_{C4}=\begin{bmatrix}0.5&0.4&0.7&0.1&0.3&0.8&0.6\\0.6&0.5&0.6&0.8&0.7&0.4&0.5\\0.3&0.4&0.5&0.4&0.6&0.8&0.4\\0.9&0.2&0.6&0.5&0.7&0.4&0.8\\0.7&0.3&0.4&0.3&0.5&0.7&0.6\\0.2&0.6&0.2&0.6&0.3&0.5&0.3\\0.4&0.5&0.6&0.2&0.4&0.7&0.5\end{bmatrix},$$

$$R_{C5}=\begin{bmatrix}0.5&0.7\\0.3&0.5\end{bmatrix}, R_{C6}=\begin{bmatrix}0.5&0.4&0.8\\0.6&0.5&0.6\\0.2&0.4&0.5\end{bmatrix}, R_{C7}=[0.5],$$

$$R_{C8}=\begin{bmatrix}0.5&0.7&0.2\\0.3&0.5&0.8\\0.8&0.2&0.5\end{bmatrix}, R_{C9}=\begin{bmatrix}0.5&0.9&0.6\\0.1&0.5&0.4\\0.4&0.6&0.5\end{bmatrix}, R_{C10}=[0.5],$$

$W_{C1}=(0.2676, 0.2467, 0.2125, 0.2732)$,

$W_{C2}=(0.3538, 0.3089, 0.3373)$,

$W_{C3}=(0.1226, 0.1172, 0.1124, 0.0921, 0.1272, 0.1362, 0.1193, 0.1730)$,

$W_{C4}=(0.1342, 0.1728, 0.1377, 0.1668, 0.1400, 0.1154, 0.1331)$,

$W_{C5}=(0.6042, 0.3958)$, $W_{C6}=(0.3711, 0.3878, 0.2416)$,

$W_{C7}=(0.2131)$, $W_{C8}=(0.3153, 0.3593, 0.3254)$,

$W_{C9}=(0.4500, 0.2056, 0.3444)$, $W_{C10}=(0.1210)$.

According to single hierarchy weight ordering, we get total sequence of elements shown in Table 4.

CONCLUSION

Offshore structural integrity KPIs are classified into leading and lagging KPIs related to both fixed and mobile structure based on bow-tie methodology. Leading KPIs is to prevent the cause of accidents and lagging KPIs are to control. There are 4 leading KPIs and 15 lagging KPIs. The other KPIs depend on the current data compared to design value. The importance degree of these KPIs are evaluated and ranked by weight calculation on the basis of Fuzzy analytical hierarchy process (FAHP) to offer an alternative method for measurement of KPIs. Corrosion and Fatigue are more important than other hazards. The KPI which has the maximum weight is more important than other KPIs based on weight calculation. The classification and ordering weight of KPIs can provide a theoretical and practical guidance to monitoring, inspection and maintenance of offshore structural integrity.

REFERENCE

Galbraith, D, Ersdal, G, Sharp, JV (2015). "Meaningful and Leading Structural Integrity KPIs," *SPE Offshore Europe Conference and Exhibition*, Scotland, SPE.

Herbert, IL (2009). "A Proven Methodology to Select and Validate Leading Process Safety Key Performance Indicators (KPIs)," *Offshore Europe*, Aberdeen, SPE.

Galbraith, D, Ersdal, G, Sharp, JV (2008). "Development of key performance indicators for offshore structural integrity," *ASME 27th international conference on offshore mechanics and Arctic engineering*, Estoril, OMAE,123–130.

Groot, A and Bekker, N (2014). "Determination of Leading and Lagging Indicators Utilizing the BowTie Methodology," *Abu Dhabi International Petroleum Exhibition and Conference*, Abu Dhabi, SPE.

Høydal, AB, Graver, B, Leinum, BH, Skavås, E, Saint-Victor, F and Lønvik, K (2013). "Corrosion threats–key performance indicators (KPIs) based on a combined integrity management and barrier concept," *CORROSION*, Orlando, NACE International.

Li SX, Yang HL and Yu, SR (2009). "Based on risk of fuzzy hierarchical analysis of long pipelines," Journal of Lanzhou University of Technology,58-61.

Tao G, Wang FC and Zhang LJ (2016). "Comprehensive evaluation of corrosion of long - distance natural gas pipeline based on fuzzy analytic hierarchy process," Jiangxi Chemical Industry,82-84.

Table 1 Leading and lagging KPIs for Structural Integrity

<table>
<tr><th rowspan="2">Hazards</th><th colspan="4">Structural Integrity KPIs</th></tr>
<tr><th colspan="2">Leading KPIs</th><th colspan="2">Lagging KPIs</th></tr>
<tr><td rowspan="4">B1: Extreme weather</td><td colspan="2"></td><td colspan="2">C11: Probability of wave impact on topsides structure or equipment</td></tr>
<tr><td>Higher value than the design</td><td colspan="2">C12: Structural capacity</td><td>Lower value than the design</td></tr>
<tr><td colspan="2"></td><td colspan="2">C13: Probability of wave inundation (greenwater) and extreme wave damage to FPSO hull structures</td></tr>
<tr><td>Higher value than the design</td><td colspan="2">C14: Station-keeping capacity</td><td>Lower value than the design</td></tr>
<tr><td rowspan="3">B2: Lack of structural redundancy/robustness</td><td>Higher value than the design</td><td colspan="2">C21: Reserve strength ratio (RSR)</td><td>Lower value than the design</td></tr>
<tr><td>Higher value than the design</td><td colspan="2">C22: Damaged strength ratio (DSR)</td><td>Lower value than the design</td></tr>
<tr><td>Higher value than the design</td><td colspan="2">C23: Station-keeping redundancy</td><td>Lower value than the design</td></tr>
<tr><td rowspan="8">B3: Fatigue</td><td colspan="2"></td><td colspan="2">C31: Number of welded connections in the structure with fatigue lives less than the “design life”</td></tr>
<tr><td colspan="2"></td><td colspan="2">C32: Number of uninspectable components with fatigue lives less than the design life</td></tr>
<tr><td colspan="2"></td><td colspan="2">C33: Number of cracks identified during in-service inspections</td></tr>
<tr><td>Higher value than the design</td><td colspan="2">C34: Reliability of inspection method used</td><td>Lower value than the design</td></tr>
<tr><td colspan="2"></td><td colspan="2">C35: Accumulated fatigue damage (mobile units)</td></tr>
<tr><td colspan="2"></td><td colspan="2">C36: Fatigue of mooring system components</td></tr>
<tr><td colspan="2"></td><td colspan="2">C37: Fatigue of cracking of hull structure</td></tr>
<tr><td colspan="2">C38: Outstanding work on inspection and repair</td><td colspan="2"></td></tr>
<tr><td rowspan="7">B4: Corrosion</td><td colspan="2"></td><td colspan="2">C41: Number of CP readings outside an acceptable range</td></tr>
<tr><td colspan="2">C42: Percentage usage of anodes (maximum usage and average usage) compared with design life</td><td colspan="2"></td></tr>
<tr><td colspan="2"></td><td colspan="2">C43: Deterioration of the splash zone corrosion allowance</td></tr>
<tr><td>Good condition of the painting/coatings of topsides steelwork</td><td colspan="2">C44: Condition of the painting/coatings of topsides steelwork</td><td>Bad condition of the painting/coatings of topsides steelwork</td></tr>
<tr><td>Higher value than the design</td><td colspan="2">C45: Hull thickness</td><td>Lower value than the design</td></tr>
<tr><td colspan="2"></td><td colspan="2">C46: Corrosion of stiffeners, bulkheads etc.</td></tr>
<tr><td colspan="2"></td><td colspan="2">C47: Loss of thickness of mooring chain</td></tr>
<tr><td rowspan="2">B5: Wear and abrasion</td><td colspan="2"></td><td colspan="2">C51: Wear of steel mooring components</td></tr>
<tr><td colspan="2"></td><td colspan="2">C52: Abrasion of fibre mooring components</td></tr>
<tr><td rowspan="3">B6: Geological/geotechnical Hazards</td><td>Higher value than the design</td><td colspan="2">C61: Scour: max. value of scour in service and current level</td><td>Lower value than the design</td></tr>
<tr><td>Higher value than the design</td><td colspan="2">C62: Subsidence: degree of subsidence</td><td>Lower value than the design</td></tr>
<tr><td colspan="2"></td><td colspan="2">C63: Scour around anchors</td></tr>
<tr><td>B7: Ship impact</td><td>Higher value than the design</td><td colspan="2">C71: Impact absorbance capacity for both elastic and plastic (low energy and high energy impacts)</td><td>Lower value than the design</td></tr>
<tr><td rowspan="3">B8: Loss of Buoyancy</td><td>Higher value than the design</td><td colspan="2">C81: Tolerability of multi-compartment</td><td>Lower value than the design</td></tr>
<tr><td colspan="2">C82：Compartment flooding detection systems</td><td colspan="2"></td></tr>
<tr><td colspan="2">C83: Inspection and testing of flooding detection systems</td><td colspan="2"></td></tr>
<tr><td rowspan="3">B9: Fire and Blast</td><td>Higher value than the design</td><td colspan="2">C91： Fire resistance</td><td>Lower value than the design</td></tr>
<tr><td>Higher value than the design</td><td colspan="2">C92：Energy absorbance capacity for both elastic and plastic (low energy and high energy impacts)</td><td>Lower value than the design</td></tr>
<tr><td>Good Condition of structural PFP</td><td colspan="2">C93: Condition of structural PFP</td><td>Bad Condition of structural PFP</td></tr>
<tr><td>B10: Change of use</td><td>Lower value than the design</td><td colspan="2">C10: Comparison of the current weight with the design maximum</td><td>Higher value than the design</td></tr>
</table>

Table 4 Total sequence of elements weight

Criteria layer B	Indicators layer C	Weight	Total weight
0.0890	C14	0.2732	0.0243
	C11	0.2676	0.0238
	C12	0.2476	0.0220
	C13	0.2125	0.0189
0.0727	C21	0.3538	0.0257
	C23	0.3373	0.0245
	C22	0.3089	0.0225
0.1283	C38	0.1730	0.0222
	C36	0.1362	0.0175
	C35	0.1272	0.0163
	C31	0.1226	0.0157
	C37	0.1193	0.0153
	C32	0.1172	0.0150
	C33	0.1124	0.0144
	C34	0.0921	0.0118
0.1468	C42	0.1728	0.0254
	C44	0.1668	0.0245
	C45	0.1400	0.0206
	C43	0.1377	0.0202
	C41	0.1342	0.0197
	C47	0.1331	0.0195
	C46	0.1154	0.0169
0.0938	C51	0.6042	0.0567
	C52	0.3958	0.0371
0.1019	C62	0.3878	0.0395
	C61	0.3711	0.0378
	C63	0.2416	0.0371
0.0917	C71	0.2131	0.0195
0.0816	C82	0.3593	0.0293
	C83	0.3254	0.0266
	C81	0.3153	0.0257
0.0900	C91	0.4500	0.0405
	C93	0.3444	0.0310
	C92	0.2056	0.0185
0.1042	C101	0.1210	0.01260