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Full Length Research Paper

Analysis of relationship indicators used to evaluate critical events in Bushehr nuclear power plant using DEMATEL method

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Bushehr nuclear power plant like other nuclear power plants in the world is influenced by various events. These events have internal or external origin. Each of these events in terms of occurrence can release considerable radioactive contaminants amounts that cause regional or global crisis. Internal and external events have common indicators, but what is important is relation between these indicators and its weights to each other. This relation and weights in external events are different from those in internal events. Based on the type of relations and indicators effects on each other and finally its weights, it is possible to reach various external and internal events. In this study, seven indicators are introduced to evaluate the crisis oriented events. These seven indicators can be used to prioritize external and internal crisis oriented events. In this research, using DEMATEL method, the relation and effect of each indicator has been investigated separately for internal and external events. Using this method, it is clear that the indicators, such as variety of effects, have the most effect on others and some indicators, such as reoccurrence, have the impressibility than other indicators. Determination of the main internal and external events is the most important step to investigate safety for each nuclear power plant, and doing each structural and process design is dependent on events that are potentially able to perform crisis in nuclear power plants. Therefore, further investigations considering reliable data are very vital for such power plants. Based on the International Atomic Energy Agency documents, response planning in critical conditions, crisis management system and international communication system planning at the time of crisis are bonds of nuclear power plants, and according to the critical situation of Bushehr nuclear power plant, which is close to the Persian Gulf, such plannings are the most important infrastructures of safety and usable nuclear power plants.

Key words: External events, internal events, nuclear power plant, DEMATEL, Bushehr.

INTRODUCTION

Generally, in nuclear power plants, the heat generated cause of nuclear fission in a confined environment is used to convert water to steam. In the next step, like other non-nuclear plants, when the steam enters into the generators, electricity is generated. Utility plants currently use nuclear fission reactions to heat water to produce steam, which is then used to generate electricity.

In 2009, 13 to 14% of the world's electricity came from nuclear power. Also, more than 150 naval vessels using nuclear propulsion have been built. In 2007, the IAEA reported that there were 439 nuclear power reactors in

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the world, operating in 31 countries. As of December 2009, the world had 436 reactors. Since commercial nuclear energy began in the mid 1950s, 2008 was the first year that no new nuclear power plant was connected to the grid, although two were connected in 2009 (World Nuclear Association, 2010).

Pressurized water reactors (PWRs) constitute a majority of all western nuclear power plants and are one of the two types of light water reactor (LWR); the other type being boiling water reactors (BWRs). In a PWR, the primary coolant (water) is pumped under high pressure to the reactor core, then the heated water transfers thermal energy to a steam generator. In contrast to a boiling water reactor, pressure in the primary coolant loop prevents the water from boiling within the reactor. All LWRs use ordinary light water as both coolant and neutron moderator. PWRs were originally designed to serve as nuclear submarine power plants and were used in the original design of the second commercial power plant at Shippingport Atomic Power Station. PWRs currently operating in the United States are considered as Generation II reactors, while Russia's VVER reactors are similar to U.S. PWRs (Glasstone and Samuel, 1994).

Iran, in the year 1974, signed a contract with West Germany to access nuclear power to produce electricity power. The Kraft Werk Union (K.W.U) company, one of the companies that depended on Siemens, was the company that was supposed to construct two reactors including the pressurized water reactor (PWR) technology, whose location is cited in the south of Iran and which was built 12 KM to the port city, Bushehr.

After the war of Iran-Iraq, both Iran and West Germany regarding the aforementioned projects had no agreement. Based on the disagreement, Iran signed a contract with Russia to complete the Bushehr’s nuclear power plant, and Russia was responsible for its completion within 55 months. After some period, the contract changed and Russia was responsible for the building of a power plant including PWR technology, but with the passing of time and considering different problems, the construction of the power plant was delayed and a good progress was not achieved in its construction. Safety in nuclear power plants is very important and by the start of the location and considering all preventive actions to keep and control potential losses in nuclear power plants, it is not possible to prevent all events; as such, there is always an occurrence for events statistically (Neuvel and Zlatanova, 2006). Therefore, enough readiness to react in urgent conditions and complete care to preventive actions and reducing the effects are all essential and non removal aspects. At the time of occurrence of the events, one suitable response may keep all human and financial resources and by the next step recovering services to back normal conditions are done more easily (Kevany, 2005). In nuclear power plants, like other many industries and dangerous processes, any event with internal and external origins can cause emergencies and eventually crisis. The cause of such events and the amounts of radioactive contaminants arrive into the environment and threaten humans and other elements in the environment. The most important potential hazard in nuclear power plants is to expose people with radiations. Therefore, at the time of planning a nuclear power plant, there is need to identify and evaluate the domain of probable effects carefully, and all factors which could be a potential in the process of performing crisis should be identified (Jeffery, 2004).

MATERIALS AND METHODS

Decision making trial and evaluation laboratory (DEMATEL) method

The DEMATEL method, by Battle Memorial Institute (BMI), was used to review the global complex issues at the end of 1971 and aimed at strategic planning invented in the Geneva research center in Switzerland (Gabus and Fontela 1973). This technique was widely used to organize indicators and to create a visual to determine the complex relationship between indicators using diagraphs (Asgharpoor, 2004). This technique, using matrixes and diagraphs, shows the logical relationship that exists between the designed indicators and the numbers that are drawn on the directed lines. Therefore, these numbers are written in a matrix using mathematical calculations on matrixes, while the different kinds of indicators’ influence on each other are investigated. In fact, using this method, it is possible to denote different reasonable relationships and effects that originated from the indicators in a conceptual structure (Chi-Jen, 2004).

Assuming a set of different indicators such as $C = (C_1, C_2 \ldots Cn)$ in a pair-wise relationship between these indicators is defined within the matrix. Using mathematical relations, it is possible to model relations and effects between indicators. The scale of pair-wise comparison between indicators is possibly four-levels, or from zero to 10 or 0 to 100. The first matrix that is created in the DEMATEL method is M matrix which is an n*n matrix and finally, couple comparison between indicators are defined based on effects and relationships between indicators. m_{ij} indicates the effect that an indicator such as C_i can have on indicator C_j. Therefore, matrix M will be a matrix assuming diameter 0 (Ryuichi et al. 2002).

		C_1	C_2	$C_.$	$C_{..}$	C_n
	C_1	0	$m_{1,2}$	$m_{1,.}$	$m_{1,..}$	$m_{1,n}$
	C_2	$m_{2,1}$	0	$m_{2,.}$	$m_{2,..}$	$m_{2,n}$
	$C_.$	……	……	0	…….	
	$C_{..}$	……	…….	……	0	
$\hat{M} =$	C_n	$m_{n,1}$	$m_{n,2}$	$m_{n,.}$	$m_{n,..}$	0

Each number represents the effects caused by a direct relation of the row on the column; as such, if there is no effect, zero is assumed. In the next step, elements of each row summed together and the maximum value of the total rows is reversed and each element of matrix M is multiplied by it. Finally, direct and indirect relations caused by the related effects of each indicator are calculated by the following formula:

Table 1. Hierarchy of indicators based on effects (Asghar, 2004).

Criteria hierarchy over maximum row summation (R)	Criteria hierarchy over maximum column summation (J)	Criteria hierarchy over maximum (R + J)	Criteria hierarchy over maximum (R-J)

$$S = \max_{1 \le i \le n} (\sum_{j=1}^{n} m_{ij}) \quad (1)$$

$$M = \alpha . \hat{M} \quad (3)$$

Using the following relation, it is possible to determine the direct and indirect effects of indicators on each other:

$$\frac{M(I - M^{t)}}{(I - M)}$$

Geometric progression = $M+M^2+M^3+......+M^t=$; lim $_{t\to\infty}$ M^t =0 (4)

$$\frac{M}{(I-M)} = M(I-M)^{-1} \quad (5)$$

At last, using the following formula, it is possible to calculate the relative effects that originated through the direct and indirect relationship between indicators:

Geometric progression = $M + M^2 + M^3 + ... + M^t =$; Lim = 0 (6)

Finally, based on Table 1, the results of the calculations should be recorded hierarchically. In this table, R indicates priority and hierarchy of effective indicators on others, while J indicates priority and hierarchy of effected indicators by others. In Cartesian coordinates page, (R-J) denotes coordinates of indicators status on X axis. If R-J is positive, that indicator is certainly an effective indicator and if it is negative, the mentioned indicator is certainly affected by others. R+J indicate the status of the indicator on Y axis and it also indicates the effectiveness and affectedness of the indicator. Finally, the hierarchy status of indicators and its status to each others are visible in Cartesian coordinate page based on (R-J) and (R+J) (Asgharpour, 2004).

Selected indicators

An external event has a root outside the site and may have an influence on the insight of the site by undesirable and negative effects, assuming that it has an external origin. Such events originated from nature or human activities. Identifying and considering these in the design of power plants are the most important (IAEA, 2003).

Hazardous conditions with internal origin are conditions rooted within the site area and in fact due to the operational potential conditions of in-site, it can create emergency and crisis status. At the time of the needed process design in a coral nuclear site and layout, all safety considerations should be attended (IAEA, 2004).

There are different kinds of internal and external events which cause emergency situations within the site when they occur. If there is no preventive act for such events, and if there is on time response to these events, these events possibly cause or create crisis in a vast area. The most important step in crisis management is to identify and classify risky potential factors IAEA (2002).

Some organizations trustees in nuclear safety have provided a list of internal and external potential risky factors (IAEA, 2007). In this research, different kinds of internal and external events, extracted and related to the topic of Bushehr nuclear power plant have been selected by 10 nuclear engineering experts and Delphi method. The Delphi concept may be viewed as one of the spinoffs of the defense research. "Project Delphi" was the name given to an Air Force-sponsored Rand Corporation study, starting in the early 1950's, concerning the use of expert opinion. The objective of the original study was to obtain the most reliable consensus of the opinion of a group of experts by a series of intensive questionnaires interspersed with the controlled opinion feedback (Linstone and Turoff, 2002). In Table 2, a list of events was provided.

RESULTS

Reasonable relationship between indicators

Indicators related to external events have different effects and relations on each other. Although fixed indicators are used to classify internal and external events, effectiveness and relationship of indicators on each other are quite different according to external and internal events. To assess the effectiveness of indicators on each other, interval 0 to 10 was considered and the relationships and effectiveness of these on each other were determined using expert judgment. Then, the various expert judgments that were compared with one another, using geometric mean, were converted to a matrix. In order to determine the relations and impacts of the indicator on others, relevant diagraphs were drawn. Figure 1, which is the direct effect of the indicators together, shows the impacts of these indicators and relevant relations between these indicators for external events, while Figure 2 shows the impacts of these indicators and relevant relations between these indicators for internal events. However, these relations are shown by diagraphs.

Relative impacts of indicators on each other in external events

To calculate such impacts, firstly the matrix of direct impacts for indicators should be necessarily drawn in external events. In this regard, the mentioned relations in Table 4 are shown as a matrix. This table originated from the direct impacts of indicators in Figure 1.

In the next step, rows of Table 4 are summed together and the maximum value of the results is converted and elements of the matrix are multiplied by the converted

Table 2. Internal and external important events in Bushehr nuclear power plant.

External event	No.
Earthquake or landslide	1
Hurricanes	2
Tsunami	3
Severe weather changes	4
Internal event	
Loss of coolant	1
Internal fires	2
Secondary coolant failure and other failures in piping and fittings	3
Unwanted Boron dilution	4
Corrosion on top of PWR vessel	5
Loss of electric power supply of the station	6
Rupture of reactor pressure vessel	7
Violence of procedures and rules	8

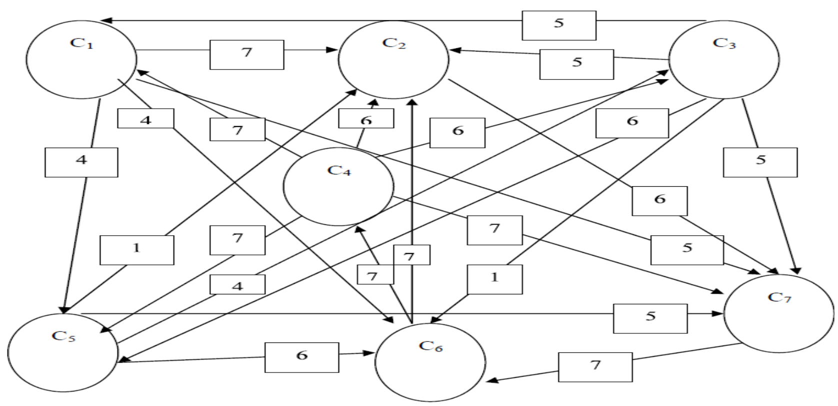


Figure 1. Diagraphs and the way of impacts of indicators on each other in external events

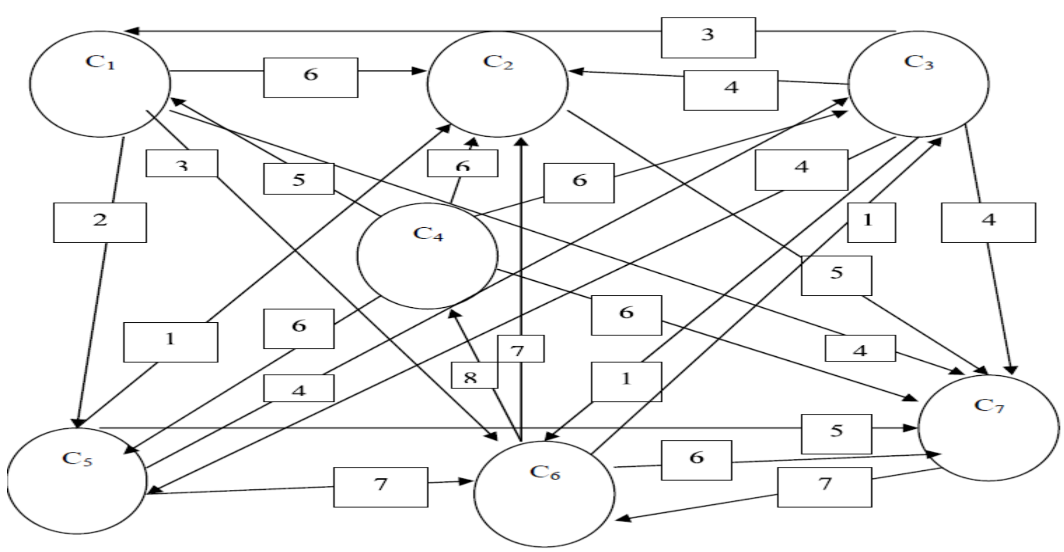


Figure 2. Diagraphs and the way of impacts of indicators on each other in internal events.

Table 4. Matrix of direct impacts for indicators on each other in external events.

	C 1	C 2	C 3	C 4	C 5	C 5	C 6	C 7
C 1	0	7	0	0	4	4	4	5
C 2	0	0	0	0	1	1	0	6
C 3	5	6	0	0	6	6	1	5
C 4	7	6	6	0	7	7	0	7
C 5	0	1	4	0	0	0	6	5
C 6	0	7	0	7	0	0	0	0
C 7	0	0	0	0	0	0	7	0

amount. Results are shown in Table 5.

Then the amount of $\frac{M}{(I-M)} = M(I-M)^{-1}$ was calculated. The result of this calculation is shown as a matrix in Table 6.

This matrix shows the direct and indirect relative impacts. Direct impacts are judged by experts and indirect impacts are calculated by the DEMATEL method. In this table, R is the sum of the rows and J is the sum of the columns. In the next step, M ^{2} (I-M) $^{-1}$ should be calculated. To do this calculation, the mentioned matrix is multiplied by the matrix of Table 4 via matrix multiplication (Table 7). This table shows direct and indirect relative impacts for indicators in external events.

Finally, indicators were extracted hierarchically. In Table 8, the hierarchy of indicators is shown based on impacts of indicators in external events.

To display indicators graphically on the coordinates' page, indicators are drawn based on two amounts R+J which is Xs, and R-J which is Ys. Figure 3 indicates the positions of such indicators on the coordinate.

Relative impacts of indicators on each other in internal events

The impacts of indicators and relations between these are shown in Figures 1 and 2 which are different for internal and external events. Due to such differences, impacts and relations must be computed separately. Table 9 shows the direct relationship between the indicators of seven branches as a matrix.

In Table 10, each row in Table 9 was summed together and the maximum amount as a reversed value was multiplied by each amount in Table 9. Elements of this matrix that shows the relative impact of direct relationship in internal events are shown in Table 10.

As it was described for external events, using the formula $\frac{M}{(I-M)} = M(I-M)^{-1}$, the relative impacts that originated from indicators, calculated based on direct and indirect relationships, were shown in Table 11. In this table, R denotes the sum of the rows and J denotes the sum of the columns.

To calculate the relative impacts indicators directly and indirectly on each other using formula M ^{2} (IM) $^{-1}$, different values were calculated and were shown in Table 12. Thus, the hierarchy of indicators was calculated for internal events and was extracted consequently.

Finally, like external events, the graphical figure of indicators was drawn on the Cartesian coordinate page. This graph is shown in Figure 4.

DISCUSSION

Planning infrastructures for crisis management requires numerous considerations and among this fact, safety considerations are important and should be attended to, except the economical aspects. Considering safety experts, it seems unlikely that expert comments are used to plan infrastructures. Subsequently, using decision methods, it is possible to use safety experts' comments to solve safety problems and issues (Rosmuller and Berrgg, 2004). Using a decision group of experts to analyze events and safety in risky industries (like nuclear power plants and dangerous industries) are very important. However, application of these procedures in crisis management, especially technological crisis and safety management are new approaches. The reason for this research is to verify the relationships which are related in external and internal events among indicators in Bushehr nuclear power plant. The assessment done, using the DEMATEL method and seven important indicators related to Bushehr nuclear power plant, was used as an effective indicator to prioritize different various internal and external events, but the important aspects which were considered to determine the relations were as follow:

Firstly, the relationship among indicators related to internal and external events are different from each other and as such, should be considered.

Secondly, as shown in Figures 1 and 2, various indicators which are involved in internal and external events have different effectiveness on each other; in other words, each one has its specific weight. As shown in Tables 8 and 13, extension of the effects indicator that is shown by C_4 has the maximum effectiveness on other indicators. In other words, this indicator is the most important main effective indicator. Effectiveness of this indicator in external event is more than that in internal events. In fact, in nuclear power plants, due to the released radioactive pollution, effectiveness of this indicator on other indicators is higher. The second effective indicator in external events is the occurrence severity of the event, but in internal events, the second effective indicator is the destructibility. Regarding the external events and the probability to release pollution in a wider level in the environment, severity of occurrence is important for an effective indicator; therefore, it is placed

Table 5. Matrix of relative impacts for indicators on each other in external events.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	0	0.212121	0	0	0.121212	0.121212	0.151515
C_2	0	0	0	0	0.030303	0	0.181818
C_3	0.151515	0.151515	0	0	0.181818	0.030303	0.151515
C_4	0.212121	0.181818	0.181818	0	0.212121	0	0.212121
C_5	0	0.030303	0.121212	0	0	0.181818	0.151515
C_6	0	0.212121	0	0.212121	0	0	0
C_7	0	0	0	0	0	0.212121	0

Table 6. Matrix of direct and indirect relative impacts for indicators on each other in external events.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	R
C_1	0.009125	0.261055	0.011135	0.037117	0.140889	0.152179	0.258116	0.869616
C_2	0.000294	0.002577	0.000371	0.001485	0.031289	0.00656	0.191693	0.234269
C_3	0.158984	0.216515	0.006495	0.02227	0.239403	0.092792	0.415399	1.151858
C_4	0.247445	0.27652	0.187131	0.012372	0.291676	0.016393	0.33003	1.361568
C_5	0.05351	0.265694	0.075471	0.247445	0.022889	0.008042	0.059696	0.732748
C_6	0.062789	0.285799	0.075471	0.247445	0.080729	0.016084	0.3124	1.080718
C_7	0	0	0	0	0	0	0	0
	0.532147	1.30816	0.356074	0.568134	0.806876	0.29205	1.567334	J
R + J	1.401762	1.542429	1.507932	1.929702	1.539623	0.732748	1.567334	X
R-J	0.337469	-1.07389	0.795784	0.793433	-0.07413	0.788667	-1.56733	Y

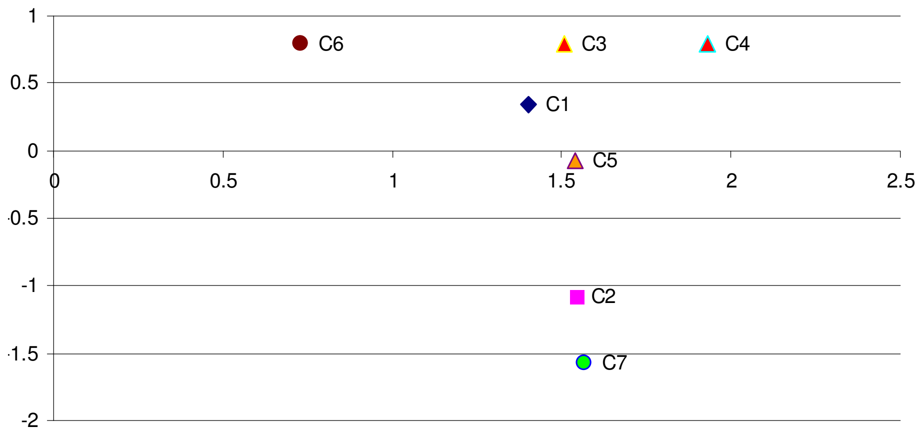
Table 7. Matrix of direct and indirect relative impacts for indicators on each other in external events.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	0.014159	0.067394	0.018375	0.060302	0.019197	0.004316	0.085765
C_2	0.001622	0.008051	0.002287	0.007498	0.000694	0.000244	0.001809
C_3	0.013059	0.096913	0.017752	0.058337	0.032696	0.026001	0.088473
C_4	0.042246	0.151569	0.019619	0.064681	0.083958	0.05205	0.177795
C_5	0.013328	0.060702	0.01602	0.052533	0.018073	0.003611	0.072075
C_6	0.064867	0.074143	0.045641	0.003989	0.084601	0.008178	0.133257
C_7	0	0	0	0	0	0	0

in the second position. Using severity of occurrence, it is possible to define critical conditions. Regarding the external events, the power plant structure, especially reactor containment, has enough resident against earth quake, but considering power plant closeness to the Persian Gulf, different kinds of external events such as tsunami, hurricanes and severe weather changes in terms of occupancy in high level may cause global crisis. In other words, those could potentially cause the occurrence of serious accidents especially in the operations phase and operating plants. Also, regarding internal events in a power plant, there are different processes and each process has its special risks; nevertheless, based on the core of each process, releasing pollutions and destroying power will be different. In Tables 8 and 13, reoccurrence has the maximum value of affectedness than other indicators. Each of the events has different concurrency potential on each other. At the time of an event occurrence, its reoccurrence could have effects and each event is affected by other indicators. These occurrences, especially external ones, may happen at the time of response when the processes of response have problems. The rate or speed of destruction is the second indicator that has the maximum affectedness from other indicators. This indicator is affected more than others such as the earlier warning time or rate of destruction. For external events, earlier warning is the third affected indicator, but for internal events, the third affected indicator is the power of destruction. Based on Table 8, occurrence severity, extension of effects, destructibility

Table 8. Hierarchy of indicators based on different kinds of impacts on each other for external events.

Criteria hierarchy over maximum row summation (R)	Criteria hierarchy over maximum column summation (J)	Criteria hierarchy over maximum (R + J)	Criteria hierarchy over maximum (R-J)
C_4	C_7	C_4	C_3
C_3	C_2	C_7	C_4
C_6	C_5	C_2	C_6
C_1	C_4	C_5	C_1
C_5	C_1	C_3	C_5
C_2	C_6	C_1	C_2
C_7	C_3	C_6	C_7



Criteria	Predictability	Rate of destruction	Occurrence severity	Extension of effects	Earlier warning time	Destructibility	Reoccurrence
Variables	C_1	C_2	C_3	C_4	C_5	C_6	C_7

Figure 3. Hierarchy view of indicators on coordinates page for external events.

Table 9. Matrix of direct impacts for indicators on each other in internal events.

	C 1	C 2	C 3	C 4	C 5	C 5	C 6	C 7
C 1	0	6	0	0	2	2	3	4
C 2	0	0	0	0	0	0	0	5
C 3	3	4	0	0	4	4	1	4
C 4	5	6	6	0	6	6	0	6
C 5	0	1	4	0	0	0	7	5
C 6	0	7	1	8	0	0	0	6
C 7	0	0	0	0	0	0	7	0

and predictability are found to be effectiveness indicators, whereas internal events are potentially able to release radioactive pollutions in higher volume. Other effectiveness indicators are destructibility, earlier warning time, predictability and occurrence severity and they have more affectedness, respectively. In Figure 3, for external events occurrence severity, extension of effects and destructibility are positioned in the upper coordinate page. This state shows that the mentioned indicators have more effectiveness characteristics. In this figure, occurrence and more rate of destruction are affectedness indicators. In Figure 4, which shows the graphical state of indicators related to internal events, extension of effects and destructibility have more effectiveness than other indicators, while the re-event and speed of destruction have more affectedness than others.

Conclusion

In this research, regarding the proper use of methods to solve problems discussed in coral crisis management system, the DMATEL method was used. Using this method, an interaction between indicators easily investigated the change to the visual structure. Complex problems are easily analyzable; moreover, the DMATEL method was used to determine the relationship among indicators for external and internal events in Bushehr

Table 10. Matrix of relative impacts for indicators on each other in internal events.

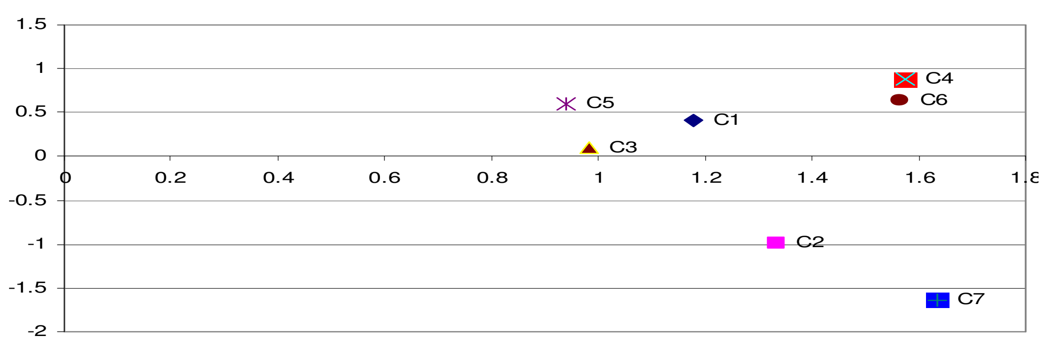
	C 1	**C 2**	**C 3**	**C 4**	**C 5**	**C 6**	**C 7**
C 1	0.005586	0.03862681	0.014868	0.027863	0.004681	0.01661	0.090158
C 2	0	0	0	0	0	0	0
C 3	0.003986	0.03613893	0.003289	0.010021	0.009313	0.012734	0.060926
C 4	0.027401	0.101231163	0.029905	0.016302	0.013381	0.071897	0.171186
C 5	0.024032	0.087219397	0.011687	0.05025	0.011772	0.00941	0.10708
C 6	0.047415	0.072442835	0.055725	0.004106	0.009776	0.016424	0.130368
C 7	0	0	0	0	0	0	0

Table 11. Matrix of direct and indirect relative impacts for indicators on each other in external events.

	C 1	**C 2**	**C 3**	**C 4**	**C 5**	**C 6**	**C 7**	**R**
C 1	0.025561	0.267322372	0.01609	0.026885	0.077396	0.122205	0.256018	0.791478
C 2	0	0	0	0	0	0	0.173123	0.173123
C 3	0.103568	0.175057964	0.003462	0.009776	0.009165	0.042772	0.199804	0.543606
C 4	0.197564	0.301845146	0.232189	0.017109	0.040735	0.068435	0.370076	1.227952
C 5	0.011711	0.103873836	0.132388	0.048882	-0.008045	0.21284	0.265387	0.767037
C 6	0.04766	0.313556412	0.05601	0.244409	0.052446	0.017109	0.369567	1.100757
C 7	0	0	0	0	0	0	0	0
	0.386064	1.16165573	0.44014	0.347061	0.171697	0.463359	1.633976	J
R + J	1.177542	1.334779	0.983746	1.575012	0.938734	1.564116	1.633976	X
R-J	0.405413	-0.98853	0.103466	0.880891	0.59534	0.637398	-1.63398	Y

Table 12. Matrix of indirect relative impacts on each other in internal events.

	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
C1	0.14	0.1	0.07	0	0	0.2	0
C2	0.17	0	0	0	0	0	0
C3	0.14	0.03	0	0	0	0.14	0.1
C4	0.2	0	0.2	0	0.2	0.2	0.17
C5	0.17	0.2	0	0	0.14	0.03	0
C6	0.24	0	0	0.24	0	0.24	0
C7	0	0	0	0	0	0	0



Criteria	**Predictability**	**Rate of destruction**	**Occurrence** severity	**Extension of effects**	**Earlier warning time**	**Destructibility**	**Reoccurrence**
Variables	***C 1***	***C 2***	***C 3***	***C 4***	***C 5***	***C 6***	***C 7***

Figure 4. Hierarchy view of indicators on coordinate page for internal events.

Table 13. Hierarchy of indicators sorted based on its impacts in internal events.

Criteria hierarchy over maximum row summation (R)	Criteria hierarchy over maximum column summation (J)	Criteria hierarchy over maximum (R+J)	Criteria hierarchy over maximum (R-J)
C4	C7	C7	C4
C6	C2	C4	C6
C1	C6	C6	C5

nuclear power plant. Consequently, it is possible to state the following results:

1. Although internal and external events have same indicators, the relationships and effects of weights for each indicator are different according to internal and external events.
2. It is recommended that more researches should be done to identify internal and external dangerous potential factors in Bushehr nuclear power plant. In this subject, data trustworthiness is the most important factor.
3. Based on the documents of the International Atomic Energy Agency, the response planning in emergency conditions and crisis management and the plans related to international communications are the most important foundations for each plant and each country close to the Persian Gulf.

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