Research on the Crisis Early-warning System of Construction Enterprises

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ABSTRACT: Through establishing the crisis early-warning system in construction enterprise, decision maker can know the condition of the whole enterprise or a single-item index visually in good time and find out the weak links. Then some improving means are proposed according to the assessing results in order to deal with the crisis in time, crush the source of trouble in the egg and reduce or avoid the loss that result in.

1 TALKING FROM THE FROG PHENOMENON

An experiment, operated by some professors in the 19th century, showed that when a frog was put into very hot water, it would immediately sense the danger and jumped out at once; but when it was put into slowly heated cold water, initially, it would feel soothing. But as the water temperature kept on going up, the frog became weaker and weaker. By the time that the frog realized the danger, it was too late for it to escape because it became so weak.

This experiment tells us that the sudden outbreak of events usually could alarm us easily and keep us alert; but what threatens us most is that when we feel good, we usually can not notice the changing situations, not mention to react to the changes in time. As a result, it is too late for us to notice the crisis approaching.

The movement is absolute, but the static is relative. The circumstances that the construction enterprises face are changing as the time’s going, just like everything is changing all the time. So changes will go on forever. Changes themselves aren’t so frightening. What is really frightening is that we can’t sense them, especially those which will have negative effects on the construction enterprise’s development and survival. For the sudden crisis, the majority of the enterprises can take good care of them. But for the potential, slowly developing and even fatal changes, most of the enterprises can’t notice them easily at the beginning. Finally, as the seriousness of the problems expose, it is too late to take any measures to deal with them. Therefore, it is essential for the enterprises to make greater efforts to observe and measure changes both in the social environment and within the enterprises, and thus establish scientific and standardized Enterprise Crisis Early-warning System. In this system, crisis management is closely integrated with warning analysis to research such theoretical issues as the methods and strategies which are used to prevent the crisis, cope with the crisis and design Enterprise Crisis Early Warning Indicator System. The calculation of the indicators can help to identify the situation faced by the enterprise, to have a clear understanding of their own situation so as to enhance the enterprise’ immunity, resilience and competitiveness to ensure that the enterprise can keep calm in front of changes and take preventive measures in advance.

2 THE PHASES OF CONSTRUCTION ENTERPRISE CRISIS’S FORMATION AND DEVELOPMENT

The enterprise crisis’s formation and development can be generally divided into six phases: being latent, generation, peak, outbreak, transformation and fading. Crisis is often latent in the good times. During the period of the generation, the level of the crisis is still low. Before the coming of the outbreak, if effective measures can be taken in time to avoid its breaking out, then the crisis will directly transform and fade away. Otherwise, the crisis is sure to break out and make the enterprise substantial loss. So, even if the enterprise is in good times, it should also make greater efforts to monitor and forecast the crisis. That’s to say, it’s still essential and necessary to establish Enterprise Crisis Early-warning System.
3 ESTABLISH ENTERPRISE CRISIS EARLY-WARNING SYSTEM

3.1 Create enterprise crisis early-warning indicator system

The choice of the indicators and the creation of the indicator system play a very important role in assessing and analyzing the enterprise crisis situation because they are directly related to whether the conclusion of the assessment is scientific, objective and reliable, and whether quantified and operable basis can be provided for the decision-makers. Therefore, when choosing and creating the evaluation index system, the following principles should be followed:

1) Being comprehensive

The enterprise crisis situation is a multi-level organizational system which is constituted by a number of factors, and affected and restricted by many factors from both internal and external of the system. Because the indicator system is so wide-ranged and so informative, it is necessary to comprehensively select various levels and types of the indicators as possible so as not to omit some important information.

2) Being brief and simple

When selecting indicators, the typicalness and representation of the indicators should also be taken into consideration, so try not to select the indicators of the same or similar implications, try to select the least and the most informative indicators, and integrate comprehensiveness with simplicity organically so as to avoid multi-collinearity or serial correlation resulted from repetition.

3) Being systemic

Enterprise Crisis Early Warning Indicator System is an organic whole made of factors with certain structures and functions. The Indicator System is relative and developing, not static or absolute. So in order to ensure that the Indicator System can adjust itself to adapt to the changing needs of the dynamic development, the Indicator System should be holistic, dynamic and systemic.

4) Being scientific

Every indicator should have definite, scientific and profound meaning. The creation of the Indicator System should be based on the scientific theory and principle, should select those indicators with appropriate and profound meanings and easy to understand, calculate and analyze, can reflect the nature and law of the Enterprise Crisis objectively, fairly and scientifically.

3.2 Fuzzily process the indicators

Multi-objective decision-making problems are related to many of the indicators. Since the dimension of each indicator is different, it’s difficult to compare them directly. In order to enable comparability between the various indicators, it is necessary to standardize various indicators. So before making the comprehensive evaluation, the property values of the index should be transformed into a uniform range $[0, 1]$.

1) Fuzzy processing of the quantitative indicators

Generally speaking, the quantitative indicators mainly include the following types.

- Benefit type: the greater the property value of the index is, the better it is.
- Cost type: the smaller the property value of the index is, the better it is.
- Valuation type: when the property value of the index is a fixed value, it is the best.
- Interval type: when the property value of the index is in a fixed interval, it is better.

Set the domain of the Ui-based indicators as $d_i = [m_i, M_i]$, Where $m_i$ and $M_i$ respectively stand for the minimum and maximum values of $u_i$, the mid-point is $M$ ($d_i$). And define the policy makers’ satisfaction degree to the property values $X_{pi}$ of the evaluation indexes $U_i$ as $r_{pi} = \mu_{d_i}(x_{pi})$, i = 1, 2, ..., n, in which $r_{pi} \in [0,1]$. $\mu_{d_i}(\cdot)$ is the dimensionless membership function of the property value of the indicators $u_i$ defined in the domain $d_i$.

2) Fuzzy processing of the qualitative indicators

For those indicators which only fit qualitative determination, it’s better to apply the method of selecting the membership degree of the Evaluation levels to determine them so as to transform the qualitative description into quantitative determination. In this way, any one evaluation index property value $x_{pi} = (x_{pi1}, x_{pi2}, ..., x_{pin})$ standardized by the above methods can form the evaluation vector (membership degree vector) $r_{p} = (r_{p1}, r_{p2}, ..., r_{pn})$. In this paper, the indicators are determined by the method of applying the membership degree of the evaluation levels (excellent, good, medium, poor, poorer), its methods are:

Set the membership degree vector of the Ui-based evaluation index relative to the indicators evaluation level $A$ = (excellent, good, medium, poor, poorer) as $r_i = (r_{i1}, r_{i2}, ..., r_{i3})$, set $B = (B_1, B_2, ..., B_5)$ $T$, $B_j$ stands for the scale corresponding to the j-level evaluation. Through scale set, the membership degree vector of the fuzzy variables can be integrated into a scalar. In fact, $V = r_iB$ is the quantified value of the qualitative assessment indicators under the given scale B.

3.3 Determine the index weight

There are many ways to determine the index weight. In comparison with common methods, AHP has more positive advantages. AHP method is a practical multi-objective decision making method. The method gives quantitative approaches to the problem difficult to quantify, with its profound mathematical background, rigorous analytical methods and characteristics of simple and practical, through the combination of qualitative analysis and quantitative
calculation. The method not only takes the weight of the various indicators into account, but also avoids the subjectivity of determining the weight, so it is more scientific and reasonable. Therefore, this article uses AHP method to determine the weight of each index. The steps are:
  1) Draw Hierarchy Model.
  2) Delphi method to construct and determine matrix D.
  3) Single-level sorting
  Calculate and determine the characteristic roots and characteristic vectors of matrix D, that is, to meet the $DW = \lambda_{\text{max}}W$ feature vector W (selecting regular feature vector), whose component $D_i$ is the weight to sort the corresponding elements.
  4) Levels of total sorting. Similar to steps 3 and test consistency.
  After calculation, the component of the corresponding eigenvector to the matrix with a satisfying consistency is the weight of each index layer to the upper layer. Note: the weight of $U_{ij}$ to $U_i$ is $\alpha_{ij}$, and $A_i = (\alpha_{i1}, \alpha_{i2}, ..., \alpha_{ij})$; the weight of $U_i$ to $U$ is $\alpha_i$, and $A = (\alpha_1, \alpha_2, ..., \alpha_i)$. In which i, j respectively stand for the numbers of indicators lying in the warning source layer, the warning situation indicator layer.

3.4 Calculate the evaluation value of the crisis

There are two steps to calculate the evaluation value of the crisis:
  1) Calculate the crisis evaluation value of each index. In the equation $U_i = \sum U_{ij} \times a_{ij}$, $U_i$ stands for the comprehensive evaluation value of the indicators in category i, and $U_{ij}$ stands for the evaluation value of the indicators in class j category i, $\sum a_{ij} = 1$.
  2) Calculate the crisis comprehensive evaluation value of the whole enterprise. In the equation $U = \sum U_i \times a_i$, U stands for the comprehensive evaluation value of the whole indicators, and $U_i$ stands for the comprehensive evaluation value of the indicators in category i, $\sum a_i = 1$.

3.5 Determine the standard of warning degree and release early warning signal

Determine the Crisis warning degree and establish crisis early-warning system according to the reference standard for the construction enterprise crisis warning degree Evaluation.

Enterprise crisis early-warning system can set five lights: red light, yellow light, blue light, light blue light and green light, whose meanings are shown in Table 1.

### Table 1. Indicator lights of enterprise crisis early-warning system.

<table>
<thead>
<tr>
<th>Indicator lights</th>
<th>Meaning</th>
<th>Evaluation value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red light</td>
<td>Giant crisis warning, indicating the crisis at the stage of the outbreak</td>
<td>0.0~0.2</td>
</tr>
<tr>
<td>Yellow light</td>
<td>Heavy crisis warning, indicating the crisis at the stage of peak</td>
<td>0.21~0.40</td>
</tr>
<tr>
<td>Blue light</td>
<td>Less Heavy crisis warning, indicating the crisis at the stage of generation</td>
<td>0.41~0.60</td>
</tr>
<tr>
<td>Light Blue light</td>
<td>Light Crisis warning, indicating the crisis at the stage of latent</td>
<td>0.61~0.80</td>
</tr>
<tr>
<td>Green light</td>
<td>Security, indicating the crisis at the stage of transformation and fade</td>
<td>0.81~1.0</td>
</tr>
</tbody>
</table>

4 CASE APPLICATION

Using the above method, the crisis warning degree of a construction enterprise has been evaluated. The results are shown in Table 2.

### Table 2. The results of the evaluation of the enterprise’s crisis situation.

<table>
<thead>
<tr>
<th>Warning source</th>
<th>Crisis situation indicators</th>
<th>Evaluation value</th>
<th>Indicator lights</th>
<th>Warning degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise Image</td>
<td>Public’s trust</td>
<td>0.5</td>
<td>Blue light</td>
<td>Less Heavy crisis warning</td>
</tr>
<tr>
<td>Enterprise management</td>
<td>Employee motivation</td>
<td>0.64</td>
<td>Light blue light</td>
<td>Light crisis warning</td>
</tr>
<tr>
<td>Other indicators of the individual</td>
<td></td>
<td>0.81~1.0</td>
<td>Green light</td>
<td>Security</td>
</tr>
<tr>
<td>The whole enterprise</td>
<td></td>
<td>0.75</td>
<td>Light blue light</td>
<td>Light crisis warning</td>
</tr>
</tbody>
</table>

The following conclusions can be drawn from the data in Table 2:
  1) As to the enterprise as a whole or to the individual indicators, both qualitative conclusions and quantitative results are given;
  2) From a macro perspective, the comprehensive evaluation value of the enterprise crisis is 0.75, which is the light crisis warning;
  3) From the micro perspective, the scores of each individual crisis situation indicator are given. With
the scores, the enterprise can accurately sort the
warning degree for each crisis situation indicator, so
as to identify the weaknesses and to guide the job of
the next step;

4) As far as each individual crisis situation
indicator is concerned, first of all, the public trust
lies in the lowest scores (0.50 points) which is a less
heavy crisis warning. The possible causes are: the
enterprise’s products caused the occurrence of an
accident due to quality reasons. Solutions: First, put
the public interest in the first place, not just to weigh
their own economic interests. Substandard products
must be withdrawn immediately. The enterprise
must inspect their products, and stop selling
defective products, moreover, find out the causes
and make improvements. Second, properly and
kindly treat the victims. To the victims, the
enterprise’s leaders should sincerely apologize to
them, attentively listen to the victims’ views, and
take appropriate remedial measures; Third, strive for
the media’s understanding and cooperation. The
news report can directly impact on the enterprise’s
image, therefore, the enterprise should cooperate
with the press as sincerely as possible to avoid the
reports’ negative influence on the enterprise’s image.
In addition, Employees motivation lies in the second
lowest scores (0.64 points) which is a light crisis
warning. The possible causes are: The enterprise’s
evaluation mechanism to employees’ performance is
not perfect, resulting in staff’s personal values and
work effort cannot be reflected reasonably, that’s to
say, the evaluation to employees’ performance keeps
the same, no matter how much work they do or how
good they do. Solutions: Establish a fair, just and
scientific performance evaluation system, strengthen
the incentive and restraint mechanisms to stimulate
all staff’s enthusiasm and sense of responsibility to
the work

5 CONCLUSION

Through the establishment of enterprise crisis early
warning systems, decision-makers can intuitively
know the operating conditions of the whole
enterprise or a single indicator in time so as to
identify the weakness, take timely measures to deal
with the crisis and take preventive measures to
reduce or avoid losses caused by the outbreak of the
crisis.

REFERENCES

and consequences of the 2008 crisis: Early warning, Japan
and the World Economy. Volume 24, Issue 1, January
2012, Pages 1–16.
Support: Contemporary Approaches and Thoughts on
[3] How to Evaluate an Early-Warning System: Toward a
Unified Statistical Framework for Assessing Financial
Crises Forecasting Methods. Bertrand Candelon*, Elena-
Ivona Dumitrescu* and Christophe Hurlin. IMF Economic