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Key Problems of Implement Diagnosis Index Establishment in Ultra High voltage Projects

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Abstract: In this paper, some key problems for the implementation status index setup in ultra-high voltage projects, including the approach to define the criterions for the indexes, the weight factor values assign method, and the value unify means, are comprehensively studied. The quality management and the quality analysis indexes are firstly taken as an example, with the detailed index setup standards illustrated in the form of specific tables. Then the basic process to define the weight factors is proposed, dividing all of the indexes into three layers. Finally, the method to unify the weight factor values is presented, and three kinds of indexes, namely the small extreme factors, the large extreme factors, and the middle extreme factors, are all transferred into decimal forms within [0, 1]. Specifically, all of the indexes in three levels are given in an aggregate table. The work proposed in this paper can be employed as a potential reference and standard for the practical ultra-high voltage project assessment.

Keywords: Ultra-high voltage projects, implementation status, index system, key problems.

1. Introduction

The diagnosis index is the key factor for the implement assessment in ultra-high voltage projects. Actually, after obtaining the indexes there are still problems that need to be solved. For instance, it needs to decide which indexes are more important, and also the exact relationships among these indexes.

The standard to define the index is a basic problem [1]. To make full use of the indexes, it requires a scientific criterion to assess the index itself so that proper values can be assigned to these indexes. Currently, there is no exact standard to define the indexes. In different disciplines, varied methods are employed. For instance, in medical field, the health condition indexes are set up based on the sufficient case statistics analysis [2], while in mechanical equipment condition monitoring field the indexed are established based on the large amount of experiments and parameter property comparisons [3].

In general, there are 6 approaches to set up the indexes.

(1) Engineering experience based method

This method is to define the standard based on the practical engineering experience [4]. Commonly, in this method large amount of materials need to be collected and analyzed to find out the inherent laws for the index establishment. Since this method accords to the practical results, it is reliable and believable. However, some of the data is hard to obtain and therefore needs supplement means such as the reference taking from citations.

(2) Actual experiment method

This kind of method has the advantages in getting data and therefore is quite satisfied for the common study objects which need data collections [5]. However, during the implement status diagnosis, sometimes it still needs the exact values which have no references or standards to define. In this case, it will be quite a long time to obtain such data.

(3) Computation based method

This method is generally based on the theoretical analysis by employing different mathematical models [6]. During the analysis one of the key problems is to properly set the hypothesis and the restrains to ensure result correctness. Particularly, some parameters are not easy to get a universal value and usually adopt the average values from the practical statistics.

(4) Reference based method

This is a quite popular method in practice. Such method is pretty fit for the study objects on which the government and the industry have already issued relative standards and policies [7]. The problem for this method is that in some fast developing fields the standards cannot catch the change rate of the exact practical conditions.

(5) Questionnaire based method

This kind of method is fit for the objects that have lots of non-determinacy factors. Usually, these non-determinacy factors are hard to be well defined by just one or several people. Alternatively, questionnaires are employed to collect useful information for the index establishment [8]. However, since people may have different, or even opposite choices and opinions, some information may conflict with each other.

(6) Analogy based method

This method is to take the full reference of other disciplines and achievements that have the similar characteristics with the study objects. To make the reference more properly fit, some modifications need to be carried out [9]. This is quite an easy and effective method.

Based on the aforementioned description, for different study objects the most proper method is to employ the specific approach that best suits the objects. For ultra-high voltage projects, the most proper indexes should be the ones that have the exact values so that the implement status can be numerically assessed. However, during the practice, some indexes are not so easy to assign exact values since they need some other extra information that is hard to obtain due to many complex causes. Consequently, it is not sensible to completely employ the current existed indexes for the implementation status diagnosis. Alternatively, modifications such as adding proper indicators based on the current primary index system will be more significant.

Particularly, in this paper, some key problems for the index setup in ultra-high voltage projects, including the approach to define standards for the newly added indexes, the weight factor values assign method, the value unify means, etc., will be comprehensively studied. The remainder of this paper is constructed as follows. The method to define the indexes is described in Section 2, while the weight factor assignment is studied in Section 3. To set up a qualified index system, the detailed approaches to define the unified index values are investigated in Section 4. Finally, the main conclusions drawn from the study are summed up in Section 5.

2. Method to Define Indexes

In this paper, the standards for the index selection is set up based on the summary concluded by large amount of professional experts specialized in ultra-high voltage project management. Generally, the standard is to follow the already issued industry standards by the government and the professional institutes, taking full reference of the engineering data and performing the adjustment based on the empirical experience. Then all of the indexes need to be assigned with an exact value which is unified.

According to the management requirements in the project quality, there are mainly two kinds of diagnosis indexes, namely the quality management and the quality analysis, as indicated in Tab.1.

Tab.1 Criterion for Implementation Rate of Quality Targets in Ultra-high Voltage Projects

index	implementation rate of quality targets		
purpose	to obtain the pass rate and good rate of the quality targets		
items	contents	un-implemented	implemented
		0	1

1	quality target implementation of whole unit		
2	quality target implementation of department		
3	quality target implementation of sub-items		
scores	rate of total score to highest score	total score:	

Tab.2 Implementation Rate Indexes of Quality Assurance in Ultra-high Voltage Projects

Index	implementation rate of quality measures						
purpose	to check whether the quality measures are implemented						
items	contents	worst ←（criterion）→ best					
		0	1	2	3	4	5
1	measures for common quality control issues						
2	measures for key quality control issues						
3	detection method for engineering materials						
4	measures for special techniques						
5	measures for equipment installations						
scores	rate of total score to highest score	total score:					

Tab.3 Criterion for Arrival Rate of Quality Monitoring Measures

Index	Arrival Rate of quality monitoring measures						
purpose	to check whether the process monitoring is well taken						
items	contents	worst ←（criterion）→ best					
		0	1	2	3	4	5
1	whether the technical disclosure is finished						
2	whether the daily inspection is performed						
3	whether the construction method is correct						
4	whether the operating procedure is correct						
5	whether the material quality is checked						
6	whether the property experiment is taken						
7	whether the covert items inspected						

8	whether the quality assessment is performed						
9	whether the discovered problems are solved						
10	whether the later maintenance is qualified						
scores	rate of total score to highest score	total score:					

The quality implementation rate is to diagnose the exact ongoing status of the quality target control in the project. Commonly, it refers to the measures such as the special technique protection, the specific utility installation, the process monitoring, etc. Correspondingly, the detailed indexes for the quality control are illustrated in Tab.2 and Tab.3.

Commonly, each material and equipment should have their own assessment standards. The assessment results based on the inspection and technical checking should be compared with the requested standards, so that the scientific diagnosis conclusion can be obtained. The specific criterions for each item are shown in Tabs. 4-8.

Tab.4 Criterion for Qualified Rate of Main Body Quality

Index	qualified rate of main body quality			
purpose	to check whether the casual inspection meets the requirement			
items	content	total items	qualified items	fine items
1	department projects			
2	sub-item projects			
scores	percentage of fine items to total items	in total:		in total:

Tab.5 Standard of Qualified Rate for Equipment Installation

Index	Qualified Rate for Equipment Installation			
purpose	to check whether the installation accuracy meets the requirement			
items	contents	total items	qualified items	fine items
1	water supply and drainage			
2	heating, ventilation and air conditioner			
3	electrical equipment			
4	electric driven appliances			
5	close circuit TV			

6	communication network			
7	others			
score	percentage of fine items to total items	in total:	in total:	

Tab.6 Standard for Qualified Rate of Functional Facilities

Index	standard for qualified rate of functional facilities			
purpose	to check whether airtightness and vibration-heat insulation meet the requirement			
items	contents	total items	qualified items	fine items
1	airtightness			
2	vibration insulation			
3	heat insulation			
scores	percentage of fine items to total items	in total:	in total:	

Tab.7 Standard of Qualified Rate of Engineering Components

Index	qualified rate of engineering components			
purpose	to check whether the mechanics load test meets the requirement			
items	contents	total items	qualified items	fine items
1				
2				
3				
4				
scores	percentage of fine items to total items	in total:	in total:	

Tab.8 Standard for Qualified Rate of Material Test

Index	Qualified Rate of Material Test			
purpose	to check whether the material test meets the requirement			
items	content	total items	qualified items	fine items
1				
2				
3				

4				
scores	percentage of fine items to total items	in total:	in total:	

3. Method to assign weight factor values

Obviously, different indexes should have varied weight factors. For the eight primary objects, namely the project quality, the process, the cost, the security, the risk, the environmental protection, and the resource guarantee, properly varied weight factor values are pretty significant for the implementation status diagnosis of the whole project. One of the key issues to assign the appropriate values for these weight factors is to sort out the relative importance among all of the factors. In this paper, we classified all of the factors into three layers, of which the first layer is the eight primary factors, while the management items of these eight primary factors are defined as the second layer factors, and the detailed diagnosis indexes of the second-layer factors are treated as the third layer factors.

Currently there are many methods to define the weight factors, such as the subjective assignment method, the objective assignment method, the composite analysis method, the empirical method, the analytic hierarchy process method [10-14], etc. Among these methods, the diversity factor comparison based method [15] has a relatively better effect since it considers both the actual condition and the mathematical analysis. The basic process of this method to define the weight factors is as follows.

1) establish the explore scheme and assess the scheme by professional experts,

2) carry out the performance of the statistical findings,

3) operate the diversity comparison based on the statistics data,

4) assign the weight factor value wi according to the diversity calculation results rij.

(2) Weight factor values in ultra-high voltage projects

To properly assign the weight factor values of different layers, the importance of the factors are divided into five levels, namely extremely important, important, relatively important, normal, and dis-important. The factors of these five levels are assigned with the scores of 5, 4, 3, 2, and 1, respectively. Specifically, the weight factors of the first and the second layers are listed in Tab.9.

Tab.9 Weight Factors of the First and the Second Level Indexes

1st level	factor importance					2nd level	factor importance				
	5	4	3	2	1		5	4	3	2	1
project quality	31	26	5	1	1	quality management	18	21	18	5	1
						quality analysis	61	3	1	2	0

project process	25	32	4	2	1	process management	20	18	20	2	1
						process analysis	56	7	1	1	2
project cost	32	31	4	1	0	cost management	17	19	20	5	0
						cost analysis	52	11	1	1	2
construction safety	25	26	5	9	1	safety management	4	11	36	11	4
						safety inspection	41	8	11	8	2
environmental protection	8	6	12	18	20	environmental management	3	7	6	20	23
						environmental content	6	26	25	5	1
project risk	23	21	11	8	2	risk detection	13	30	11	14	0
						risk monitoring	14	29	16	4	1
resource guarantee	35	31	5	2	1	resource management	4	16	21	11	8
						labor deploy	10	28	18	5	2
						material goods	20	21	9	4	1
						energy status	20	19	22	5	0
						equipment	7	16	33	5	2
						fund payment	38	21	3	1	1
						technical support	11	22	17	14	1
						project information	16	18	25	2	0
other work	9	8	13	22	17	coordinate manage	21	20	12	5	2
						behavior manage	5	12	3	20	20

4. Method to unify weight factor values

Based on the basic data in Tab.9, these weight factor values are further normalized and then computed by taking the reference of their own weight factor percentage. Since different indexes have varied value forms, for instance, some are integrals while some are decimals, the data forms of these indexes need to be further unified to the same form. In this paper, all of the factor values are unified into the decimal forms within [0, 1]. Specific standards for the data transformation are as follows.

1) For the qualitative indexes, all weight factors are set in the decimal forms in the range of [0, 1], and the larger the value is, the more important the factor will be.

Detailed transform model is as follows:

$\forall V(x) \in \{B1, B2, B3, B4, B5, B6, B7, B8\}$

$\forall V(x) \in X,\ X \in [0,1]$

$f: x \to rule(x)$, f is the standard transform function

$If\ Max[rule(x)] \to 1, \quad rule(x) \Rightarrow S(x)$

$If\ Max[rule(x)] \to 0, \quad rule(x) \Rightarrow 1 - rule(x)$

$|1 - rule(x)| \Rightarrow S(x)$

$putout: S(x)$

Tab.10 Weight Factor Values of Diagnostic Indicators

1st layer index weight		2nd layer index weight		3rd layer index weight	
project quality	0.15	quality management	0.43	decomposed rate of quality targets	0.31
				implemented rate of quality guarantee	0.35
				implemented rate of measure oversight	0.34
		quality analysis	0.57	qualified rate of main body quality	0.21
				qualified rate of equipment installation	0.20
				qualified rate of facility functions	0.20
				qualified rate of component properties	0.20
				qualified rate of material test	0.19
project process	0.15	process management	0.44	decomposed rate of process plan	0.49
				implemented rate of guarantee measures	0.51
		process analysis	0.56	deviation rate of partial process	0.49
				deviation rate of total process	0.51
project cost	0.15	cost management	0.44	decomposed rate of cost plan	0.45
				implemented rate of guarantee measures	0.55
		cost analysis	0.56	deviation rate of direct cost	0.36

				deviation rate of indirect cost	0.34
				incremental rate of unpredicted cost	0.30
construction safety	0.13	safety management	0.41	improving rate of rules	0.25
				implemented rate of safety measures	0.27
				safeguard allocation rate	0.24
				implemented rate of safety fund	0.24
		safety inspection	0.59	incidence of violating regulations	0.26
				serviceable rate of equipment	0.23
				available rate of protective facilities	0.26
				qualified rate of working environment	0.25
environmental status	0.07	environmental management	0.35	clarified rate of environmental protection plan	0.31
				implemented rate of protection measures	0.34
				invest rate of environmental protection	0.35
		environmental content	0.65	control rate of dust emission	0.14
				control rate of drainage	0.16
				control rate of waste gas emission	0.13
				construction waste clear rate	0.17
				eliminating rate of construction noise	0.15
				effective rate of vibration control	0.13
				protection rate of trees	0.12
project risk	0.13	risk detection	0.49	recognition rate of internal risk	0.47
				recognition rate of external risk	0.53

		risk monitoring	0.51	effective rate of risk analysis	0.47
				implemented rate of risk measures	0.53
resource guarantee	0.15	resource management	0.10	full-equipped rate of rules and regulations	0.50
				implemented rate of planned measures	0.50
		labor deploy	0.12	labor allocation rate	0.48
				labor use rate	0.52
		material management	0.14	material supply coverage rate	0.60
				multipurpose use rate of materials	0.40
		energy management	0.13	energy supply coverage rate	0.66
				energy composite use rate	0.34
		equipment	0.11	serviceable rate of equipment	0.51
				equipment use rate	0.49
		fund payment	0.15	fund coverage rate	1.00
		technical support	0.12	technical support rate	1.00
		project information	0.13	qualified rate of information feedback	0.48
				use rate of project information	0.52
other work	0.07	coordinate manage	0.61	teamwork rate of departments	1.00
		behavior mange	0.39	rule violation rate of employee	0.34
				ratio of work to efficiency of participants	0.66

2) For the quantitative indexes, all weight factors are transformed into the decimal forms by calculating the ratios of the exact factor value to the sum of all factor values. In this means, all of the weight factors will be transformed into the decimal forms within [0, 1].

3) For the indexes which are of different extreme value properties, e.g., for some factors the smaller, the better, while for others the larger, the better, factors values are transformed via

$$\begin{cases} x_t = \dfrac{M - x_o}{M - m} \cdots\cdots\cdots\cdots\cdots\cdots (\text{small extrem factors}) \\ x_t = \dfrac{x_o - m}{M - m} \cdots\cdots\cdots\cdots\cdots\cdots (\text{large extrem factors}) \\ x_t = 1 - \dfrac{\left| x_o - 0.5(M - m) \right|}{0.5(M - m)} \cdots (\text{middle extrem factors}) \end{cases} \quad (1)$$

where M is the max value of the index, m is the minimum value, x_o is the original index value, and x_i is the final unified value.

Finally, the detailed results of the final weight factors are listed in Tab.10.

5. Conclusion

In this paper we propose a comprehensive study on the index definition method for the implementation status diagnosis of ultra-high voltage projects. The three key problems to establish the index system, namely the method to define the indexes, the method to assign the weight factor values, and the method to unify the weight factor values, are studied in detail, respectively.

It is found that there are large amount of factors that affect the assessment on the implementation status diagnosis in ultra-high voltage projects. The method to define the proper indexes and to assign the unified weight factor values is pretty significant for the scientific project management. The proposed method in this paper can be employed as a good reference for application and is highly potential to be used as a basis for the further improvement.

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