Assessment of District wise Primary Education using Evidential Reasoning

Mohammad Salah Uddin Chowdury, Smita Sarker

Abstract— Education sector, one of the important social sectors in the developing countries plays a gigantic role in promoting the social as well as the economic growth and development of the concerned countries. More specifically, not the only education but the quality primary education will contribute a lot for its smooth acceleration. In primary education, if the quality will maintain then automatically all the problems in primary education i.e. enrollment, completion, drop-out and so on will be robotic and gradually solved. The assessment of district wise primary education (ADPE) depends on both multiple qualitative and quantitative factors. This paper presents evidential reasoning(ER) approach for ADPE in which most significant factors are aggregated. A case study of Dhaka, Chittagong, Rajshahi and Khulna districts in Bangladesh is provided to illustrate the implementation process of the ER approach for ADPE. In this paper we find out the best performing district while the weakness and strength of specific factors of particular district are determined. In this paper we show the relation of lowest performing districts to its specific factors.

Index Terms— Assessment, evidential reasoning, district-wise primary education, key performance indicator (KPI), multiple attribute decision analysis (MADA), uncertainty, utility interval.

1 INTRODUCTION

Primary education in Bangladesh that is the largest unitary authorities in the world plays an important role in education system. In order to improve primary education Bangladesh government has undertaken a lot of necessary steps. The Primary and Mass Education Division (PMED) prepared in 1997 a comprehensive Primary Education Development Program (PEDP) which aimed at enhancement of education planning and management capacity, increasing equitable access to primary schooling and improvement of the quality of primary education through its several projects [10]. In the World Education Forum held at Dakar, Senegal in April 2000, the government of Bangladesh has committed to achieve of Education for All goals and every citizen by the year 2015[12]. Now 75% of total schools are controlled by the government and around 83% of the total children enrolled in the primary level educational institution go to these schools [10], [12]. The performance of primary education depends upon multiple factors including educational, planning, national curriculum, management, teacher's training and classroom teaching and learning conditions. The quality of primary education is evaluated in terms of the classroom climate, teaching style, classroom management, and understanding the subject matters during the lesson in the class [13]. PEDP-II defines 14 key monitoring indicators, the Key Performance Indicators (KPI) and the Primary School Quality Level (PSQL) indicators which act as the basis for the sector programme performance report, setting expectations that will instill purpose to ongoing monitoring and evaluation activities for the benefit of the planning process [1], [2], [10].

A number of survey reports were published to reflect the performance of primary education of Bangladesh based on some statistical measurement. According to case study of two district of Tamil Nadu it is observed that they assess the primary education with taking few major factors such as completion, repetition, and dropout rates. After analyzing these factors they identify the weaken areas which contribute to the lack of acceptable quality schools and focus the learning environment, school governance and management issues [11].But this assessment procedure do not follow systematic computational methods. For this reason the result is reflected by unwanted uncertainties. At that case, Evidential Reasoning approach is very effective which enable both qualitative and quantitative measurement under the multiple attributes decision analysis [3], [4], [5], 6].

In this paper we select four focus districts as our problem areas where two significant factors of KPI such as enrollment and outcomes are selected for performance measuring factors. The main objective of this paper is to select best performing district of primary education using ER approach by aggregating basic attributes of these two factors. Finally we show the ranking of district wise primary education.

We organize the research activities as follows. In section 2, we explain the ER approach for ADPE outlined and illustrated by subsequent sub-sections 2.1, and 2.2. The experimental result is outline by section 3.Finaly we concluding our remarks at section 4 in which we show the outcomes of evaluation with the discussion of suggestion of future work.

2 The Evidential Reasoning Approach for Assessment of District wise Primary Education

2.1 Identification of Assessment Factors and Evaluation Grades

We apply the evidential reasoning approach to analyze the performance of four main districts wise primary education including *Dhaka, Chittagong, Rajshahi,* and *Khulna*. Here only qualitative performance attributes are considered for demonstrating purpose. The major performance attributes are considered as *enrollmen*t and *outcomes*. For facilitating the assessment these attributes are further classified basic attributes

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such as *gross enrollment, net enrollment, survivable rate* and *coefficient of efficiency*.

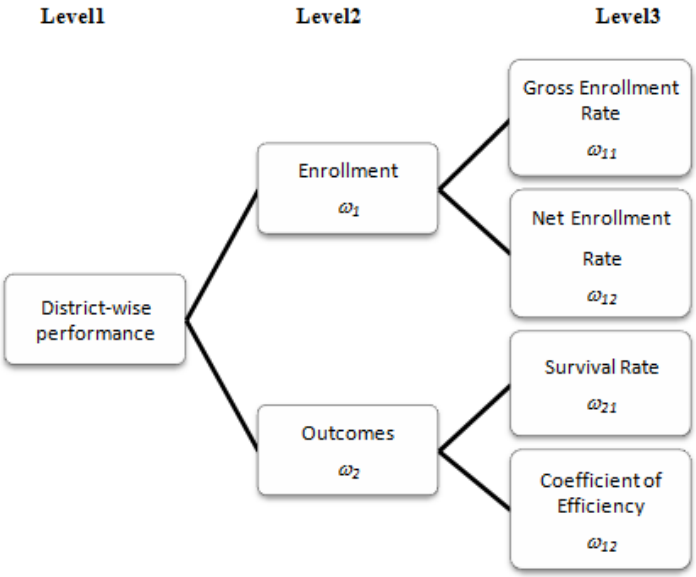


Fig. 1. Evaluation hierarchy of the district-wise primary level education

According to School Survey Report 2007 we draw the scenario of primary education of four districts as the following table [1].

TABLE 1
District wise Comparison of Enrollment and Outcomes (2005-2007)

General attributes	Basic attributes	District level Primary Education (2005,2006,2007)			
		Dhaka	Chittagong	Rajshahi	Khulna
Enrollment	Gross Enrollment Rate(GER)	87.9%,91.4%,91.2%	85.7%,95%,95.3%	91.2%,92.2%,93.4%	100.4%,97.3%98.1%
	Net Enrollment Rate(NER)	82.7%,87.5%,86.0%	84.3%,88.8%,89.6%	90.1%,86.5%,88.5%	92.9%,91.3%,92.4%,
Outcomes	Survival Rate	69.5%,61.6%,47.2%	58.1%,63.6%,62.6%	53.3%,57.7%,59.9%	64.4%,60.3%,63.2%
	Coefficient of efficiency	75.2%,67.7%,58.0%	61.5%,66.6%,64.8%	59%,65.8%,66.7%	66.8%,66.1%,65.8%

Considering the data of three years of the following table 1 we define the evaluation scale as follows:

Gross Enrollment Rate and Net Enrollment Rate

Indifferent (I):80-85% Average (A): 85-90%, Good (G): 90-95, Excellent (E): 95-100%

Survival Rate

Indifferent (I):45-55%, Average (A):55-60%, Good (G):60-65%, Excellent (E): 65-70%

Coefficient of efficiency

Indifferent (I):45-55%, Average (A):55-65%, Good (G):65-75, Excellent (E): -75-85%

In the following table 2 we summarize the whole assessment problem where I, A, G, and E indicate the evaluation grades Indifferent, Average, Good and Excellent respectively, and the number in a bracket denotes the degree of a belief to which an attribute is assessed to a grade. Now we consider the primary education of Dhaka district where we use the grades as defined before and represent the following distribution as follows[3] , [4], [5],[6],[7],[8]:

S(Gross Enrollment Rate)={ (average, 0.2) , (good, 0.8) } (1a)
S(Net Enrollment Rate)={ (indifferent, 0.2) , (average, 0.8) } (1b)
S(Survival Rate)={ (average, 09) } (1c)
S(coefficient of efficiency)={ (average, 0.2) , (good, 0.6) } (1d)

Due to uncertainty some incomplete assessment are shown in the table 2.For example:

The gross *enrollment rate* of Dhaka is complete because the sum of belief is 1 but the *coefficient of efficiency* is incomplete because .8<1.

TABLE 2
Decision matrix for district wise primary level education assessment

General attribute	Basic attributes	Districts types			
		Dhaka (a_1)	Chittagong (a_2)	Rajshahi (a_3)	Khulna (a_4)
Enrollment (e_1)	gross enrollment rate(e_{11})	A(.2) G(.8)	A(.1) G(.9)	G(1)	E(1)
	net enrollment rate(e_{12})	I(.2) A(.8)	I(.1) A(.9)	A(.2) G(.8)	G(1)
Outcomes (e_2)	survival Rate(e_{21})	A(.9)	G(.8) A(.2)	I(.1) A(.9)	G(1)
	coefficient of efficiency (e_{22})	A(.2) G(.6)	A(.9) G(.1)	A(.4) G(.6)	G(.8)

2.2 Computational steps of aggregating assessment

Firstly we show the total calculation for assessment of enrollment of Dhaka primary education .The enrollment (e_1) is assessed by two basic attributes: gross enrollment rate (e_{11}) and net enrollment rate(e_{12}).
From (1a) and (1b), we have

$\beta_{1,1} = 0,$ $\beta_{1,2} = 0.2,$ $\beta_{1,3} = 0.8,$ $\beta_{1,4} = 0$

$\beta_{2,1} = 0.2,$ $\beta_{2,2} = 0.8,$ $\beta_{2,3} = 0,$ $\beta_{2,4} = 0$

On the basis of importance on the performance of primary education suppose the hypothetical weights for two attributes are: ω_{11}=0.55 and ω_{12}=0.45.
We get the basic and combined probability masses $(m_{n,i})$ by using following recursive equations [4], [5], [6], [7], [8]:

$m_{n,i} = \omega_{n,i}\beta_{n,i}$ for i=1, 2…N

$m_{1,1} = 0;$ $m_{2,1} = 0.11;$ $m_{3,1} = 0.44;$ $m_{4,1} = 0;$

$\overline{m}_{H,1} = 0.45 \quad \tilde{m}_{H,1} = 0$

$m_{1,2} = 0.09;$ $m_{2,2} = 0.36;$ $m_{3,2} = 0;$ $m_{4,2} = 0;$

$\overline{m}_{H,2} = 0.55 \ ; \tilde{m}_{H,2} = 0$

$$K_{I(2)} = \left[1 - \sum_{t=1}^{4}\sum_{\substack{j=1 \\ j\neq t}}^{4} m_{t,I(1)} m_{j,2}\right]^{-1}$$

$$= \left[1 - (0 + .. + 0 + .0099 + 0.0396 + 0.1584 + 0 + .. + 0)\right]^{-1}$$

$$= \left[1 - .2079\right]^{-1} = 1.2625$$

And $m_{H,i} = \overline{m}_{H,i)} + \tilde{m}_{H,i}$ (i=1,2) now we have

$m_{1,I(2)} = K_{I(2)}(m_{1,1}m_{1,2} + m_{1,1}m_{H,2} + m_{1,2}\, m_{H,1}) = 1.2625(0+0+0.09*0.45) = 0.0511$

$m_{2,I(2)} = K_{I(2)}(m_{2,1}m_{2,2} + m_{2,1}m_{H,2} + m_{2,2}\, m_{H,1})$
$= 1.2625(0.11*0.36+00.11*0.55+0.36*0.45) = 0.3309$

$m_{3,I(2)} = K_{I(2)}(m_{3,1}m_{3,2} + m_{3,1}m_{H,2} + m_{3,2}\, m_{H,1})$
$= 1.2625(0+0+0.44*0.45) = 0.3055$

$m_{4,I(2)} = K_{I(2)}(m_{4,1}m_{4,2} + m_{4,1}m_{H,2} + m_{4,2}\, m_{H,1}) = 0$

$$\overline{m}_{H,I(2)} = K_{I(2)}\left[\overline{m}_{H,I(1)}\overline{m}_{H,2}\right] = 0.3124$$

$$\tilde{m}_{H,I(2)} = K_{I(2)}\left[\tilde{m}_{H,I(1)}\tilde{m}_{H,2} + \overline{m}_{H,I(1)}\tilde{m}_{H,2} + \tilde{m}_{H,I(1)}\overline{m}_{H,2}\right] = 0$$

Now the combined degrees of belief are calculated by using equation as follows [4], [5], [6], [7], [8]:

$$\beta_1 = \frac{m_{1,I(2)}}{1-\overline{m}_{H,I(2)}} = \frac{0.0511}{1-0.3124} = 0.0743$$

$$\beta_2 = \frac{m_{2,I(2)}}{1-\overline{m}_{H,I(2)}} = \frac{0.3309}{1-0.3124} = 0.4812$$

$$\beta_3 = \frac{m_{3,I(2)}}{1-\overline{m}_{H,I(2)}} = \frac{0.3055}{1-0.3124} = 0.4443$$

$$\beta_4 = \frac{m_{4,I(2)}}{1-\overline{m}_{H,I(2)}} = 0$$

$$\beta_H = \frac{\tilde{m}_{H,I(2)}}{1-\overline{m}_{H,I(2)}} = 0$$

Then the enrollment rate of primary education of Dhaka district is assessed by

S (enrollment rate) = {(indifferent, 0.0743*), (average, 0.4812), (good, 0.4443)}* (2a)

After repeating above procedures we assess the outcomes attribute as follows:
S (outcomes) = {(average, 0.7094), (good, 0.1751)} (2b)

Finally the performance of Dhaka district primary education is assessed by enrollment (e_1) and outcomes (e_2) as shown in table 3 in appendices where we let the weight of these two attributes are equal i.e. $\omega_{1=}$ $\omega_{2=}$.0.5.By using above similar actions we find the assessment degree of for Dhaka district as follows:

S(Dhaka) = { (indifferent, 0.0328*), (average, 0.6272) , (good, 0.2954) }* (3a)

Similarly we can generate the overall assessment of primary education of other three districts such as Chittagong, Rajshahi and Khulna:

S(Chittagong) = { (indifferent, 0.0153*), (average, 0.4381) , (good, 0.5467) }* (3b)

S(Rajshahi) = { (indifferent, 0.0271), (average, 0.4034) , (good, 0.5695) } (3c)
S(Khulna) = { ((good, 0.7281), (excellent, 0.2613) } (3d)

The performance of primary education is shown in the following figure 2

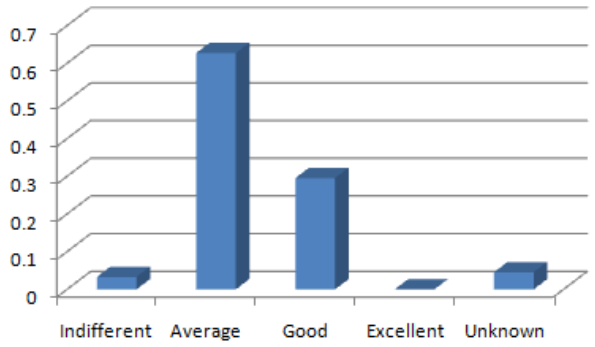


Fig. 2. Performance of Dhaka District Primary Education.

According to the statements 3a-3d we show the distributed district-wise performance of our given four districts in the following figure 3.

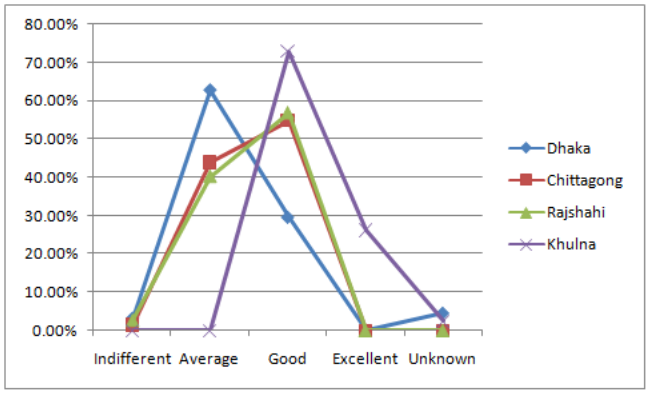


Fig. 3. Distributed Assessment of District-wise performance

3 Experimental Results and Analysis

To precisely rank the four districts, their utilities need to be estimated. To do so, the utilities of the four individual evaluation grades need to be estimated first. The above partial rankings of alternatives could be used to formulate regression models for estimating the utilities of grades [4],[5].[6],[7],[8]. The maximum, minimum, and the average expected utility on y are given by:

$$u_{\max}(y) = \sum_{n=1}^{N-1} \beta_n u(H_n) + (\beta_N + \beta_H) u(H_N) \quad (4a)$$

$$u_{\min}(y) = (\beta_1 + \beta_H) u(H_1) + \sum_{n=2}^{N} \beta_n u(H_n) \quad (4b)$$

$$u_{avg}(y) = \frac{u_{\max}(y) - u_{\min}(y)}{2}. \quad (4c)$$

If all original assessments on y are complete, meaning $\beta_H = 0$, then $u(y) = u_{\max}(y) = u_{\min}(y) = u_{avg}(y)$. The ranking of two alternatives a_l and a_k is based on their utility intervals. It is said that a_l is preferred over a_k if and only if $u_{\min}(y(a_l)) > u_{\max}(y(a_k))$. The alternatives are indifferent if and only if $u_{\min}(y(a_l)) = u_{\min}(y(a_k))$ and $u_{\max}(y(a_l)) = u_{\max}(y(a_k))$. In any other case ranking is inconclusive and not reliable. To generate reliable ranking, the quality of the original assessment needs to be improved by reducing associated incompleteness concerning a_l and a_k.

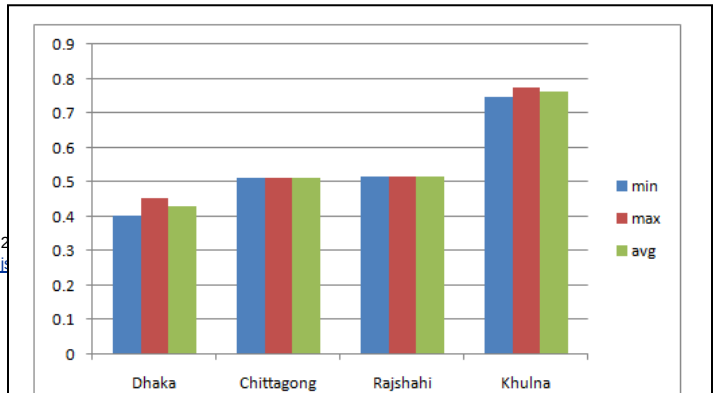
Suppose the utilities of the four evaluation grades are equidistantly distributed in the normalized utility space. Now the utilities are:
u(I) = 0, *u(A)*=.33, *u(G)*=.67, *u(E)*=1

Now using (4a)-(4c) we get the following utilities as the table 4.

TABLE 4
Utilities on district wise performance

	U_{min}	U_{max}	U_{avg}	Rank
Dhaka	0.4049	0.4548	0.4321	4
Chittagong	0.5109	0.5109	0.5109	3
Rajshahi	0.5147	0.5147	0.5147	2
Khulna	0.7491	0.7730	0.7611	1

The utilitity interval on district wise performance is show graphically as the following fihure 4.



Now from above analysis it clear that the the permormance ranking of four district-wise primary education is stated as follows.

Khulna>Rajshahi>Chittagong>Dhaka

Hence we can say that Khulna is the best performing district of primary education based on enrollment and outcomes attributes among four districts.

4 Appendices

Here we show the attribute aggregation procedures in the following resulting tables. The following tables show level 2 attribute aggregation and combined belief of four districs i.e. Dhaka, Chittagong, Rajshahi and Kulna respectively.

TABLE 3
Assigned weights, beliefs and calculated probability masses for level 2 attributes of Dhaka

Attributes	Weight	Belief				Probability Mass						
	ω_i	$\beta_{1,i}$	$\beta_{2,i}$	$\beta_{3,i}$	$\beta_{4,i}$	$m_{1,i}$	$m_{2,i}$	$m_{3,i}$	$m_{4,i}$	$m_{H,i}$	$\bar{m}_{H,i}$	$\tilde{m}_{H,i}$
enrollment (e_1)	.5	.0743	.4821	.4443	0	.0372	.2412	.2222	0	.5	.5	0
Outcomes (e_2)	.5	0	.7094	.1751	0	0	.3547	.0876	0	.5577	.5	0.0577

TABLE 5
Combined belief distribution of Dhaka

	Constants	Probability Mass (aggregation)											
	$K_{I(i+1)}$	$m_{1,I(i+1)}$	$m_{2,I(i+1)}$	$m_{3,I(i+1)}$	$m_{4,I(i+1)}$	$m_{H,I(i+1)}$	$\bar{m}_{H,I(i+1)}$	$\tilde{m}_{H,I(i+1)}$	β_1	β_2	β_3	β_4	β_H
	1.1317	.0235	.4498	.2118	0	.3156	.2829	.0327					
Belief degree For the district wise performance									.0328	.6272	.2954	0	.0454

TABLE 6
Assigned weights, beliefs and calculated probability masses for level 2 attributes of Chittagong

Factors	Weight	Belief				Probability Mass						
	ω_i	$\beta_{1,i}$	$\beta_{2,i}$	$\beta_{3,i}$	$\beta_{4,i}$	$m_{1,i}$	$m_{2,i}$	$m_{3,i}$	$m_{4,i}$	$m_{H,i}$	$\bar{m}_{H,i}$	$\tilde{m}_{H,i}$
Enrollment(e_1)	.5	.038	.4451	.5163	0	.019	.2226	.2582	0	.5	.5	0
Outcomes(e_2)	.5	0	.4452	.5551	0	0	.2226	.2776	0	.5	.5	0

TABLE 7
Combined belief distribution of Chittagong

	Constants	Probability Mass (aggregation)											
	$K_{I(i+1)}$	$m_{1,I(i+1)}$	$m_{2,I(i+1)}$	$m_{3,I(i+1)}$	$m_{4,I(i+1)}$	$m_{H,I(i+1)}$	$\bar{m}_{H,I(i+1)}$	$\tilde{m}_{H,I(i+1)}$	β_1	β_2	β_3	β_4	β_H
	1.1478	.0109	.3124	.3898	0	.287	.287	0					
Belief degree									.0153	.4381	.5467	0	0

TABLE 9
Combined belief distribution of Rajshahi

	Constants	Probability Mass (aggregation)											
	$K_{I(i+1)}$	$m_{1,I(i+1)}$	$m_{2,I(i+1)}$	$m_{3,I(i+1)}$	$m_{4,I(i+1)}$	$m_{H,I(i+1)}$	$\bar{m}_{H,I(i+1)}$	$\tilde{m}_{H,I(i+1)}$	β_1	β_2	β_3	β_4	β_H
	1.2522	.0186	.2771	.3912	0	.3131	.3131	0					
Belief degree For the district wise performance									.0271	.4034	.5695	0	0

TABLE 8
Assigned weights, beliefs and calculated probability masses for level 2 attributes of Rajshahi

Factors	Weight	Belief				Probability Mass						
	ω_i	$\beta_{1,i}$	$\beta_{2,i}$	$\beta_{3,i}$	$\beta_{4,i}$	$m_{1,i}$	$m_{2,i}$	$m_{3,i}$	$m_{4,i}$	$m_{H,i}$	$\bar{m}_{H,i}$	$\tilde{m}_{H,i}$
Enrollment(e_1)	.5	0	.0576	.9419	0	0	.0288	.471	0	.5	.5	0
Outcomes(e_2)	.5	.0593	.7824	.1583	0	.0297	.3912	.0792	0	.5	.5	0

TABLE 10
Assigned weights, beliefs and calculated probability masses for level 2 attributes of Khulna

Factors	Weight	Belief				Probability Mass						
	ω_i	$\beta_{1,i}$	$\beta_{2,i}$	$\beta_{3,i}$	$\beta_{4,i}$	$m_{1,i}$	$m_{2,i}$	$m_{3,i}$	$m_{4,i}$	$m_{H,i}$	$\bar{m}_{H,i}$	$\tilde{m}_{H,i}$
Enrollment(e_1)	.5	0	0	.401	.599	0	0	.2005	.2995	.5	.5	0
Outcomes(e_2)	.5	0	0	.9579	0	0	0	.479	0	.529	.5	0.029

TABLE 11
Combined belief distribution of Khulna

	Constants	Probability Mass (aggregation)											
	$K_{I(i+1)}$	$m_{1,I(i+1)}$	$m_{2,I(i+1)}$	$m_{3,I(i+1)}$	$m_{4,I(i+1)}$	$m_{H,I(i+1)}$	$\bar{m}_{H,I(i+1)}$	$\tilde{m}_{H,I(i+1)}$	β_1	β_2	β_3	β_4	β_H
	1.1675	0	0	.5156	.185	.3088	.2919	.0169					
Belief degree For the district wise performance									0	0	.7281	.2613	.0239

5 CONCLUSION

Assessment of District Wise Primary Education problem requires many qualitative and quantitative attributes which need strong methodologies in order to find out their significant impact. In this paper we apply evidential reasoning approach that is appropriate for such attributes assessment under uncertainties. Because of major role in the assessment of primary education we focus our attention on two attributes i.e. enrollment and outcomes which are successfully aggregated by ER approach. The uncertainties among various attribute of particular district are properly handled by our suggested approach. On the above study we summarize that the performance of Khulna district is highest among all other districts. In the case of particular district assessment process the relative importance of each attribute is also measured by identifying the strengths and weakness of it's on each district. In this paper we present the result of an individual district in the form of interval from minimum utility to maximum utility in a systematic and effective way. When a set of necessary steps to increase the performance of such factors of weaken districts then the expected quality of primary education is achieved. More especially, we continue our work to assess the individual primary school with a number of assessment factors.

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