RANKING MULTIPLE INTELLIGENCE OF PEOPLE WITH EPILEPSY

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UNIVERSITI TEKNOLOGI MALAYSIA

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A thesis submitted in fulfilment of the
requirements for the award of the degree of
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To my beloved parents, brothers and my husband.

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ABSTRACT

A person's intelligence can be enhanced through focus and regular practice. Identifying the order of improving the intelligence parameters of People with Epilepsy (PWE) can help them to have a better understanding of their intelligence, which in turn can improve their chances of being employed. Because of their varying backgrounds, PWE differ in terms of which of their intelligence parameters need to be improved. The purpose of this study is to rank the intelligence parameters of PWE which need to be improved based on the patients' demographics and illness background in order to help PWE to reduce the present gap between them and other people. The Analytic Hierarchy Process (AHP) is used to evaluate the impact of demographics and to determine the weights of qualitative factors that affect the intelligence parameters of PWE. The integrated AHP and Data Envelopment Analysis (DEA) method is used to rank the intelligence parameters of PWE to determine the prioritized intelligence parameters to be improved. To rank the PWE's intelligence parameters, enhanced Russell measure (ERM) and ERM super-efficiency models in DEA are first used where the desirable weights for each input and output of each Decision Making Unit (DMU) is determined individually. Then, a new model for ranking DMUs by calculating the interval efficiency with a common set of weights (CSW) in DEA is proposed that determines the lower and upper-bounds of the interval efficiency over a CSW. The eight intelligences or skills are musical, bodily/kinaesthetic, logical/mathematical, spatial, linguistic, interpersonal, intrapersonal and naturalist. The considered patients' demographics are seizure type, age, onset age, marital status, ethnicity, educational level, employment status, and gender. This study was administered on a data base of 158 epilepsy patients collected at Neurology Department, Kuala Lumpur Hospital from May 2007 to March 2009. The Expert Choice is employed to perform the sensitivity analysis with respect to explaining how the demographic features influence the intelligence parameters as alternatives, in addition to supporting and verifying the outcomes of the AHP model. The General Algebraic Modelling System (GAMS) is then employed to carry out the ranking, which is a sophisticated modelling system for mathematical optimization. The effect of demographics on intelligence parameters of PWE are identified. The study reveals that demographic information of PWE is essential for the exploration of the potential abilities of PWE. Sensitivity analysis demonstrates the robustness of the AHP assessment process and the effects of demographics on the intelligence parameters of PWE. The proposed new interval efficiency ranking method with CSW evaluates the PWE's intelligence parameters from the same point of view and gives an interval for the efficiency score that allows decision makers to make subsequent decisions more carefully considering uncertainty. Integration of AHP and new model for ranking DMUs in DEA determines the priority of eight intelligence parameter skills. The new approach of ranking intelligence can be used to enhance the employability of PWE as the intelligence to be improved can be prioritized.

ABSTRAK

Kecerdikan seseorang boleh ditingkatkan melalui fokus dan latihan tetap. Pengenalpastian susunan penambahbaikan parameter kecerdikan Orang Menghidapi Epilepsi (PWE) dapat membantu PWE untuk lebih memahami kecerdikan mereka dan dengan ini dapat meningkatkan peluang mereka untuk diterima bekerja. Oleh sebab latar belakang pesakit yang pelbagai, PWE berbeza dari segi parameter kecerdikan yang perlu diperbaiki. Tujuan kajian ini adalah untuk mengkadarkan parameter-parameter kecerdikan PWE yang perlu diperbaiki mengikut demografi para pesakit dan latar belakang penyakit bagi membantu PWE mengurangkan jurang semasa antara mereka dengan orang lain. Proses Analisa Hierarki (AHP) digunakan untuk menilai impak demografi dan menentukan pengaruh faktor-faktor kualitatif yang memberikan kesan kepada parameter-parameter kecerdikan PWE. Kaedah integrasi AHP dan Analisa Data Lingkungan (DEA) digunakan untuk pengkadaran parameter-parameter kecerdikan PWE bagi menentukan parameter-parameter keutamaan untuk diperbaiki. Bagi mengkadarkan parameter-parameter kecerdikan PWE, pertamanya model-model pengukuran Russell yang dipertingkatkan (ERM) dan keberkesanan luar biasa ERM dalam DEA digunakan supaya pengaruh yang bersesuaian bagi setiap input dan output sesuatu Unit Pembuat Keputusan (DMU) ditentukan secara individu. Kemudian, satu model baharu untuk pengkadaran DMU dengan mengira keberkesanan jarak waktu dengan satu set umum pengaruh (CSW) dalam DEA dicadangkan yang menentukan had atas dan had bawah keberkesanan jarak waktu ke atas CSW. Lapan kecerdikan atau kemahiran adalah musik, tubuh/kinastetik, logik/matematik, ruang, linguistik, interpersonal, intrapersonal dan ahli alamiah. Demografi para pesakit yang diambil kira ialah jenis serangan sawan, umur, umur permulaan menghidapi sawan, status perkahwinan, bangsa, tahap pendidikan, status pekerjaan dan jantina. Kajian ini dijalankan menggunakan pengkalan data 158 pesakit epilepsi yang diperoleh daripada Jabatan Neurologi, Hospital Kuala Lumpur dari Mei 2007 hingga Mac 2009. Pilihan Pakar digunakan bagi menjalankan analisis sensitiviti berhubung penjelasan bagaimana ciri-ciri demografi mempengaruhi parameter-parameter kecerdikan sebagai alternatif, di samping menyokong dan mengesahkan hasil-hasil model AHP. Sistem Umum Model Algebra (GAMS) digunakan bagi melaksanakan pengkadaran yang merupakan satu sistem model yang sofistikated bagi optimasi matematik. Kesan demografi ke atas parameter-parameter PWE telah dikenal pasti. Kajian menunjukkan bahawa informasi demografi PWE penting bagi eksplorasi potensi kebolehan PWE. Analisis sensitiviti menunjukkan keteguhan proses penilaian AHP dan kesan-kesan demografi ke atas parameter-parameter kecerdikan PWE. Kaedah keberkesanan jarak waktu baharu yang disyorkan dengan CSW menilai parameter-parameter kecerdikan PWE dari sudut yang sama, dan memberikan satu jarak waktu untuk keberkesanan skor yang membenarkan pembuat keputusan membuat keputusan selanjutnya dengan lebih berhati-hati dengan mengambil kira ketidakpastian. Integrasi AHP dan model baharu bagi pengkadaran DMU terhadap DEA menentukan keutamaan lapan kemahiran parameter kecerdikan. Kaedah baharu pengkadaran ini boleh digunakan bagi meningkatkan peluang pekerjaan PWE iaitu dengan mengutamakan kecerdikan yang boleh dipertingkatkan.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADMU	–	Anti-ideal DMU
AHP	–	Analytic Hierarchy Process
ANP	–	Analytic Network Process
AP	–	Anderson and Peterson
ATIE	–	Ability Test in Epilepsy
BCC	–	Banker, Charnes, Cooper
CCR	–	Charnes, Cooper, Rhodes
C.I	–	Consistency Index
C.I_R	–	Consistency Index for a Random square matrix
C.R	–	Consistency Ratio
CRS	–	Constant Return to Scale
CSW	–	Common Set of Weights
CWA	–	Common Weights Analysis
DEA	–	Data Envelopment Analysis
DEAHP	–	Data Envelopment Analytic Hierarchy Process
DM	–	Decision Maker
DMU	–	Decision Making Unit
EM	–	Eigenvector Method
ERM	–	Enhanced Russell Measure
FLD	–	Facility Layout Design
g	–	general intelligence
GAMS	–	General Algebraic Modeling System
IDMU	–	Ideal DMU
IQ	–	Intelligence Quotient
LLSM	–	Logarithmic Least Squares Method
LP	–	Linear Programming
LSM	–	Least Squares Method
MADM	–	Multiple Attribute Decision Making

MCDM	–	Multiple Criteria Decision Making
MI	–	Multiple Intelligence
MODM	–	Multiple Objective Decision Making
OR	–	Operational Research
PPS	–	Production Possibility Set
PWE	–	People With Epilepsy
s	–	task intelligence
VRS	–	Variable Return to Scale
	–	

LIST OF SYMBOLS

ε	–	Non-Archimedean infinitesimal constant
θ	–	CCR efficiency score
Θ_{ERM}	–	ERM efficiency score
ξ_j^*	–	CWA efficiency score
Ω	–	ERM super-efficiency score
	–	

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

In this chapter, several key aspects of the thesis are deliberated. The background of the study including a brief description of epilepsy and seizure, theory of multiple intelligences and epileptics employment are presented. Then, the research problem, research objectives, research framework, and research approach are introduced.

1.1 Background of the Research

Intelligence is defined as a distinct collective ability which can act and react in response to the surrounding environment. A person's intelligence can be enhanced through focus and regular practice (Gardner, 1983).

There are two different ideas about intelligence. The first idea is based on a single intelligence, and the second idea is based on multiple intelligences (Paik, 1998). In 1904, Charles Spearman introduced the 'two-factor' theory of intelligence, the theory of 'g' (general intelligence) and 's' (task intelligence), which expressed that almost all people who were excellent in a particular mental ability test performed well on other tasks. However, other people who were not excellent in this test tended to perform poorly in other tasks (Kaplan and Saccuzzo, 2005; Paik, 1998). Louis Leon Thurstone was the first psychologist who introduced the Multiple-Intelligence (MI) theory, which emphasized several primary mental abilities (Paik,

1998). Howard Gardner, who is a contemporary psychologist, also believes in the multiple intelligences theory. Based on Gardner any person has a combination of several intelligences with different strength. Gardner presented his first Theory of MI in a book, 'Frames of Mind: The Theory of Multiple Intelligence' (Gardner, 1983). Gardner expressed intelligence as "ability to solve problems or to create products that are valued within one or more cultural settings" (Gardner, 2004a,b). He introduced musical, kinesthetic, verbal, math/logic, spatial, interpersonal, intrapersonal, and naturalist as eight elements of intelligence. A person can improve his intelligences once he focuses and practices regularly (Gardner, 1983).

Epilepsy, one of the oldest diseases in history, has affected numerous people for several centuries (Samir *et al.*, 2000; Yu *et al.*, 2009). It can attack anyone in any social position having nothing to do with one's level of intelligence. The People With Epilepsy (PWE) lose their self-confidence, sense a large gap between themselves and other people, and do not follow normal activities in society. Employment is one of the most challenging issues for PWE. PWE encounter high unemployment rates, are often underpaid, and cannot keep their jobs because of the stigma, severity of seizure and other psychological deficiencies. Consequently, various studies have been done related to the effects, types of epilepsy, and the quality of life of PWE (Awang *et al.*, 2009a,b; Giordani *et al.*, 1985).

Awang (2012) focused on identifying intelligence profiles of PWE in order to improve the probability of employment. Awang *et al.* (2009a) also explored attitudes and perception of human resource personnel toward epilepsy and the unemployment of PWE. They classified PWE's intelligence patterns and characteristics based on an intelligence scale, Ability Test in Epilepsy $(ATIE^{©})$. Awang proposed only several intelligence parameters that need to be improved for better employability without giving any priority to the intelligence parameters considering the patient's demographics and illness background (Awang, 2012). Some of these demographics are qualitative, and some others are quantitative. Hence, it is necessary to rank intelligence parameters which is a multiple criteria decision making problem based on the patient's demographics and illness background as a qualitative and quantitative criteria.

1.2 Statement of the Problem

Intelligence is defined as a distinct collective ability that can act and react in response to the surrounding environment. Based on Gardner's multiple intelligences theory, each person possesses a combination of several intelligences of different strengths. The intelligence parameters can be enhanced through regular practice. Gardner has suggested that human intelligence is changeable, and it can be improved throughout one's life. He also believed that multiple intelligences are used at the same time and balance among the intelligences to help a person to overcome difficulties (Gardner, 1983, 1989, 1991, 2004a,b). Based on Gardner, prioritized skills can be improved by specific activities (Awang, 2012).

Employment is one of the most challenging issues for PWE who encounter high unemployment rates. PWE are often underpaid, and they cannot keep their jobs because of the stigma and other psychological deficiencies. Identifying the order of improving the intelligence parameters of PWE can help them to have a better understanding of their intelligence, which in turn can improve their chances of being employed.

Because of their varying backgrounds, PWE differ in terms of which of their intelligence parameters need to be improved. Information such as educational level, age, employability status, onset age, gender, seizure type, ethnicity, and marital status of epileptic patients are essential in order to explore PWE's potential. Considering these features, the ability of PWE to improve their intelligence parameters can be different.

By ranking these intelligence parameters, PWE can focus on the importance of improving them, hence they have more opportunities to get a job or to be successful in their life. The performance evaluation and ranking of perceived intelligence parameters can be used to assist PWE identify their levels of competencies, strengths, and weaknesses. Therefore, a ranking procedure of PWE's intelligence parameters which need to be improved is required.

1.3 Objectives of the Research

The purpose of this study is to rank the intelligence parameters of PWE which need to be improved based on the patients' demographics and illness background such as their seizure type, age, ethnicity, educational level and other specific epileptic patients' capabilities in order to help PWE to reduce the present gap between them and other people. This research focuses on the PWE's intelligence parameters in order to answer research objectives as follows:

1. To determine the weights of qualitative factors which affect the intelligence parameters of PWE using AHP.
2. To determine the proper Data Envelopment Analysis (DEA) model, the Decision Making Units (DMUs), and their quantitative inputs and outputs.
3. To integrate AHP and DEA (AHP-DEA) methods in order to consider the weights of qualitative factors for ranking the intelligence parameters of PWE.
4. To determine the prioritized intelligence parameters to be improved.

Objectives 1 to 4 above will lead to a ranking procedure of PWE's intelligence parameters.

1.4 Scope of the Research

This research was mainly concerned with the intelligence parameters of PWE. The current work is actually based on a psychometric test, Inverse Ability Test in Epilepsy, i-ATIE that has been developed since August 2009. The test is the improvement of a psychometric test, Ability Test in Epilepsy $(ATIE^{©})$. The tests were developed based on eight Howard Gardners Multiple Intelligence (MI) theory, namely the musical, kinaesthetic, math-logic, spatial, verbal, interpersonal, intrapersonal and naturalist skills. In order to develop i-ATIE, the data based on

the subjects comprising 166 outpatients at the Neurology Department, Kuala Lumpur General Hospital, were randomly selected and examined.

In the current work, the data used in $ATIE^{©}$ is considered in order to complete the comparison matrices. The age, onset age, educational level, gender, marital status, seizure type, employment status, and ethnicity are considered as criteria.

1.5 Significance of the Research

This study can lead to a new application of the AHP-DEA method, that is the identification of the order of improving the intelligence parameters of PWE considering the demographics and epileptic patients' illness background. It will help PWE to have a better understanding of their intelligence, which can improve their chances of being employed.

1.6 Research Framework

The research framework is shown in Figure 1.1. Based on the framework, the study will be performed according to these following phases:

Phase 1. In this phase, a comprehensive literature review is performed to support the proposed approach for ranking the intelligence parameters of the PWE. The literature review includes MI theory, PWE, DEA, AHP, and integrated AHP-DEA method (Chapter 2 and Chapter 3).

Phase 2. The study on essential mathematical concepts and theory is done to find an appropriate DEA model that could be used in this research (Chapter 4).

Phase 3. In this phase, based on AHP, the effects of qualitative and quantitative criteria on intelligence parameters, as alternatives, are determined (Chapter 5).

Phase 4. In this phase the integrated AHP-DEA model is applied in order to derive the ranking model for the intelligence parameters. Considering Awang's output and the results from phase 3, the ranking of multiple intelligences, which must be improved will be determined for each patient (Chapter 6 and Chapter 7).

1.7 Significant Contributions

In this section, the contributions of the thesis are described. The first contribution is determining the weights of qualitative and quantitative factors which affect the intelligence parameters of PWE using AHP. Because PWE have various backgrounds, they also require improvement in various intelligence parameters. Therefore, an investigation of the effects of the patients' demographics on these intelligence parameters is essential to explore the potential of PWE. Sensitivity analysis demonstrates the robustness of the AHP assessment process and the effects of demographics on the intelligence parameters of PWE.

The second contribution is the process of ranking the epileptic patients' intelligence parameters with Enhanced Russell Measure (ERM) and ERM super-efficiency models in DEA. Here, the intelligence parameters are ranked based on the effects of demographics on the intelligence parameters of PWE achieved in the first contribution. Previous studies have shown that PWE have high unemployment rates, are underpaid, and cannot keep their jobs because of stigma, seizure severity and other psychological deficiencies (Jacoby *et al.*, 2005); therefore, the results are important to improve the employment opportunities of PWE.

The third contribution is a new proposed model for ranking DMUs by calculating the interval efficiency with a common set of weights (CSW) in DEA. To measure the overall performance of the DMUs, an integration of both the best and worst relative efficiencies is considered in the form of an interval. The advantage of this efficiency interval is that it provides all of the possible efficiency values and an

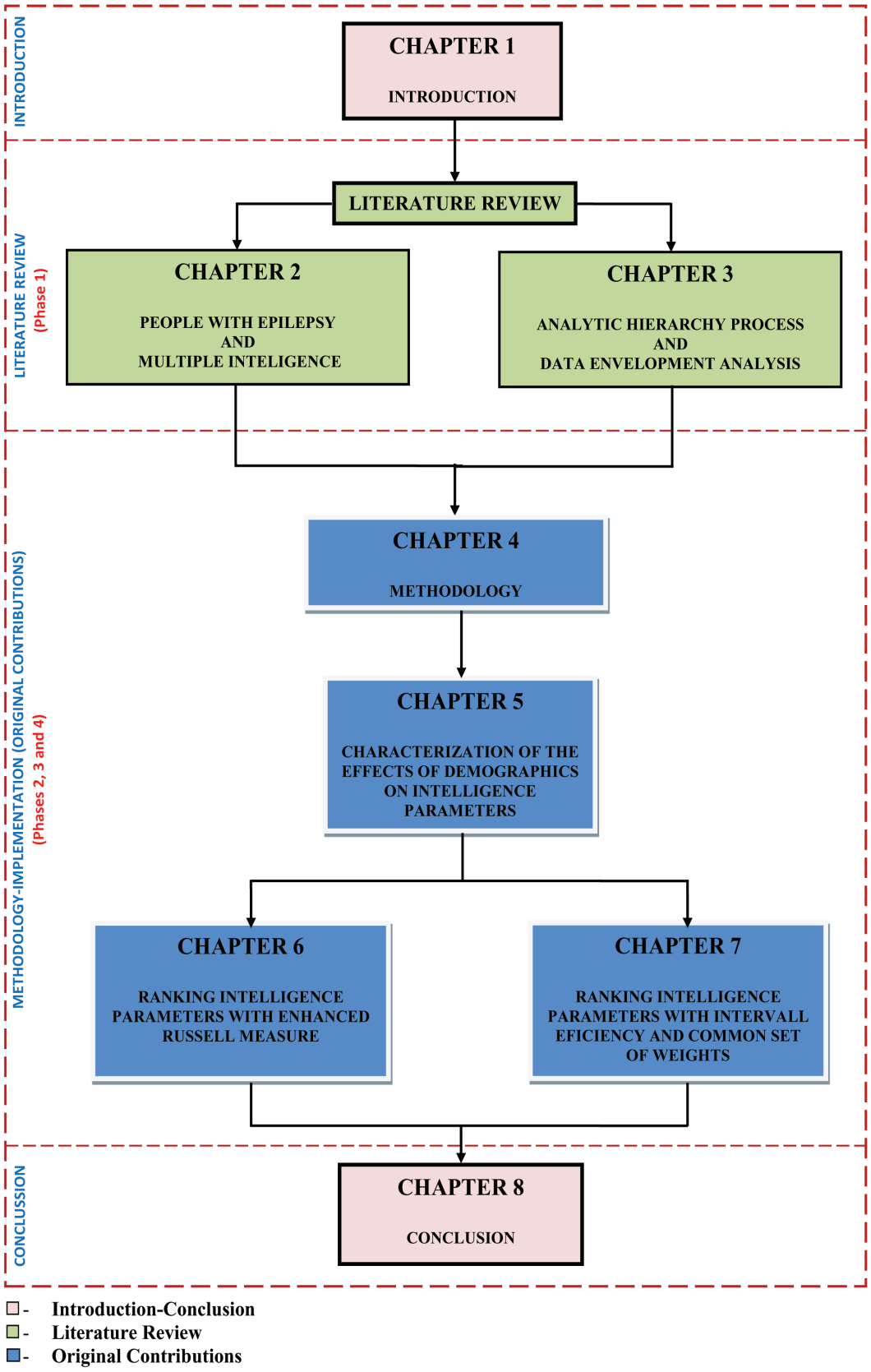

Figure 1.1 Research Framework.

expanded overview to the decision maker. The proposed method determines the lower- and upper-bounds of the interval efficiency over a CSW.

The last contribution is the ranking of epileptic patients' intelligence parameters using the proposed new ranking model which is by calculating the interval efficiency using a CSW in DEA. The previous work on the intelligence parameters of the PWE (Awang, 2012) was not taken into account the demographic factors. Awang just suggested the intelligence parameters need to be improved. Therefore, in the current work, the weights of qualitative factors which affect the intelligence parameters of PWE are considered to determine the prioritized intelligence parameters to be improved. Ranking the epileptic patients' intelligence parameters using this model provides all of the possible efficiency values of the intelligence parameters. Here, the intelligence parameters are also ranked based on the effects of demographics on the intelligence parameters of PWE achieved in the first contribution. From the results, PWE can identify their strengths and weaknesses where they can improve their chances of employability and enhance their potential for suitable employment.

1.8 Thesis Organization

The organization of the thesis is as follows: In Chapter 1, the research background, research problem, research objectives, and scope of the research are described. Chapters 2 and 3 present the literature review and discuss PWE, MI theory, AHP, and DEA, respectively.

Chapter 2 gives an overview of seizures and epilepsy. It explains the history of epilepsy, its background, its definitions, and seizure classification. The unemployment problem of PWE in society is also discussed. This chapter also provides a literature review on theory of MI and previous studies on this subject. The progress of the intelligence theory from the notion of single intelligence to the MI theory introduced by Howard Gardner is explained.

In Chapter 3, the AHP method that can assess the effect of a criterion, which affects decision alternatives and creates a consistent model for evaluating alternatives is explained. This chapter also provides the literature of DEA including the basic models of DEA such as CCR (Charnes, Cooper, and Rhodes), BCC (Banker, Charnes, and Cooper), and Enhanced Russel Measure (ERM). Then, the DEA ranking models, their concepts, definitions, and methods will be explained.

In Chapter 4, the research methodology is described and the procedure used to rank the intelligence parameters of the PWE is explained.

Chapter 5 focuses on the characterization of the effects of demographics on the intelligence parameters of PWE using AHP. To develop the ranking method, investigation of the effects of the demographics and illness background on intelligence parameters is essential.

Chapter 6 explains the procedure to evaluate the performance and to rank the intelligence parameters for PWE by considering the demographics and illness background based on Awang's database using ERM and ERM super-efficiency in DEA. The ranking procedure has determined the priority of eight intelligence parameter skills by considering demographic factors.

In Chapter 7, a new model for ranking DMUs by calculating the interval efficiency with a CSW in DEA is proposed. The proposed method determines the lower- and upper-bounds of the interval efficiency over a CSW. The advantage of this efficiency interval is that it provides all of the possible efficiency values and an expanded overview to the decision maker. Then, the performance of PWE's intelligence will be evaluated and ranked by considering the demography and illness background based on Gardner's theory and Awang's database using new method for ranking DMUs by calculating the interval efficiency with a CSW. In this chapter the interval efficiency of intelligence parameters for epileptic patients is calculated which provides all of the possible efficiency values and gives an expanded overview about

the patient's capabilities. The priority of eight intelligence parameters skills is also determined by considering PWE's demography.

Chapter 8 summarizes the overall thesis, re-states the contributions, and suggests directions for future research.

Finally, Appendices A-D show the results of different parts of the thesis and Appendix E shows the thesis publications list.

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