PROCEEDINGS

2015 3rd International Conference on Adaptive and Intelligent Agroindustry (ICAIA)

ICAIA 2015

August 3rd - 4th, 2015
IPB International Convention Center
Bogor, Indonesia

ISBN : 978-1-4673-7404-0
IEEE Catalog Number : CFP15C67-CDR

IEEE
INDONESIA SECTION

Proceedings of

2015 3rd International Conference on

Adaptive and Intelligent Agroindustry (ICAIA)

IPB International Convention Center, Bogor, Indonesia

August 3rd – 4th, 2015

Published by :

Department of Agroindustrial Technology

Bogor Agricultural University

Bogor, Indonesia

Welcome Message from The General Chairs of ICAIA 2015

On behalf of the organizing committee, it is our pleasure to welcome you to International Conference on Adaptive and Intelligent Agroindustry, Bogor, Indonesia. This is the 3rd conference on the topic that is held by the Department of Agroindustrial Technology, Bogor Agricultural University, Indonesia.

The conference is expected to provide excellent opportunity to meet experts, to exchange information, and to strengthen the collaboration among researchers, engineers, and scholars from academia, government, and industry. In addition, the conference committee invited five renowned keynote speakers, i.e. Prof Irawadi from Bogor Agricultural University; Prof Kenneth De Jong from George Mason University, USA; Dr Yandra Arkeman from Bogor Agricultural University; and Dr Guillermo Baigorria from University of Nebraska-Lincoln, USA.

The conference committee also invited Prof Noel Lindsay from University of Adelaide, Australia; Kiyotada Hayashi from National Agricultural Research Center-Tsukuba, Japan; Prof Margareth Gfrerer from Islamic State University of Jakarta, Indonesia; Dr Barry Elsey from University of Adelaide, Australia; Dr Gajendran Kandasamy from Melbourne University, Autralia; and Imperial College London-British, Prof Allan O'Connor from University of Adelaide, Australia; Dr Wisnu Ananta Kusuma from Bogor Agricultural University ,Indonesia; and Dr Frank Neumann from University of Adelaide, Australia, as invited speakers.

This conference was organized by Department of Agroindustrial Technology, Bogor Agricultural University and Asosiasi Agroindustri Indonesia, and technically sponsored by IEEE Indonesia Section. Furthermore, it was supported by Departement of Computer Science, Bogor Agricultural University; Surfactant amd Bionegergy Research Center; PT Bogor Life Science and Technology; Indonesian Ministry of Industry; PT Pachira Distrinusa; and PT Kelola Mina Laut.

I would like to take this opportunity to express my deep appreciation to the conference's committee members for their hard work and contribution throughout this conference. I would like to thank authors, reviewers, speakers, and session chairs for their support to participate in the Conference. Lastly, I would like to welcome you to join ICAIA 2015 and wish you all an enjoyable stay in Bogor.

Sincerely,
Dr Yandra Arkeman
General Chairs, ICAIA 2015

WELCOMING ADDRESS

Prof. Dr. Ir. Nastiti Siswi Indrasti
Head of Agroindustrial Technology Department
Faculty of Agricultural Engineering and Technology
Bogor Agricultural University

on

3rd International Conference on Adaptive and Intelligence Agroindustry (3rd ICAIA)

Bogor, August, 3 – 4, 2015

Assalamu'alaikum Warohmatullahi Wabarokatuh
In the name of Allah, the beneficent and the merciful,

Distinguish Guest, Ladies and Gentlemen
Let me first thank you all for accepting the invitation to participate in this 3rd International Conference on Adaptive and Intelligence Agroindustry (ICAIA). In particular I would like to thank Rector of IPB (Institut Pertanian Bogor/Bogor Agricultural University) Prof. Herry Suhardiyanto for supporting this event as part of the series academic event in celebrating the 52nd Anniversary of Bogor Agricultural University.

We are certainly proud to have been able to assemble this event in IPB, Bogor. The range of participants and audience at this conference is precisely something I would like to stress. Participants who followed the event more than 150 people, coming from various countries including the USA, Australia, Japan, Vietnam, Philippine, Germany and Indonesia. The main goal of the conference is to provide an effective forum for distinguished speakers, academicians, professional and practitioners coming from universities, research institutions, government agencies and industries to share or exchange their ideas, experience and recent progress in Adaptive and Intelligent Agroindustry.

The 2015 3rd International Conference on Adaptive and Intelligent Agro-industry (ICAIA) is the third forum for the presentation of new advances and research results on various topics in all aspects of innovative agro-industry that highlights the development and improvement for today and tomorrow's global need for food, energy, water and medicine. The aim of the conference is to stimulate interaction and cohesiveness among researchers in the vast areas of innovative agro-industry. Innovative Agro-industry has the ability to adapt intelligently to future global challenges, i.e. food, energy, water, and medical. Global challenges needs a new breed of Agroindustry which could produce innovative products to fulfill the needs through advanced processing technology, production systems and business strategy supported by cutting-edge information and communication technology.

The topic for this event is "Empowering Innovative Agroindustry for Natural Resources, Bioenergy and Food Sovereignty". The topics clustered into four main parts:
Track 1 : Innovative Agroindustrial and Business System Engineering

Track 2 : Frontier Approaches in Process and Bioprocess Engineering
Track 3 : Frontier Approaches in Industrial Environmental Engineering
Track 4 : Intelligent Information and Communication Technology for Adaptive Agroindustry of the Future

This event also hosts four (4) workshops: (1) Strategies for Agroindustry Development (2) LCA for Agroindustry (3) Innovation and Technopreneurship for Agroindustry and (4) Agroindustry Informatics.

Distinguish Guest, Ladies and Gentlement,
Agroindustry transforms agricultural commodities into high value-added products. Agroindustry is industry that process agricultural products to increase their value added significantly by using technology and by considering environmental aspect and sustainability. However, with changing global demand and technology advancement, innovative agroindustry is needed in order to be competitive as well as sustainable. The challenge of future agroindustry is not merely efficiency and productivity anymore, but also the challenge to appropriately apply frontier technology as well as meeting future global demands.

Agroindustry needs to deal with the application of advance technologies and cope future global issues. Current global issues which arise and expected to exist in the future are food sovereignty, renewable energy, sustainable water management and pharmacy. The ability of agro-industry to respond the future global issues and the undoubtedly substantial increase in demand in future decades will be highly dependent on the increased application of existing technologies as well as the exploitation of new and innovative technologies.

The emergence of high technology could be applied in the agro-industry are: nanotechnology, biotechnology, bioinformatics, food processing, food packaging-waste, state-of-the-art computation and many others. The aforementioned high-technology along with computation technology could greatly advance agro-industry from a traditional system into a smart-intelligent and innovative technology. Therefore, in the new millennia, adaptive-intelligent and innovative agro-industry will contribute to solutions to global problems and brings agriculture into perfection.

Hope this conference will also discuss this issue in more detail as it is an important matter for all of us. We should no more think just how to produce high value product but it is also necessarily important how to keep our live in good quality by understanding following old saying… “You do not live at once. You only die once and live every day”.

I do not to take up any more of your time with these opening remarks. Let me simply thank you once again for sharing your thoughts with us. Here’s wishing every success for the conference. May Allah bless all of us.

Thank you for your kind attention,
Wassalamu’alaikum Warohmatullahi Wabarokatuh

COMMITTEE

Condescendent
Prof. Dr. Ir. Herry Suhardiyanto, M.Sc (IPB's Rector)

Steering Committee
Chairman
Prof. Dr. Ir. Nastiti Siswi Indrasti

Vice
Dr. Ir. Yandra Arkeman, M.Eng

Board member
Prof. Dr. Ir. Aziz Darwis
Prof. Dr. Ir. Irawadi Djamaran
Prof. Dr. Ir. Eriyatno, MSAE
Prof. Dr. Ir. Anas M. Fauzi
Prof. Dr. Ir. Syamsul Maarif, M.Eng
Prof. Dr. Ir. Machfud, MS
Prof. Dr. Ir. Djumali Mangunwidjaja

Organizing Committee
Chairman
Dr. Ir. Yandra Arkeman, M.Eng
Co-chairs :
Prof. Dr. Ir. Suprihatin
Prof. Dr. Ono Suparno, S.TP, MT

Treasury
Dr. Indah Yuliasih, S.TP, M.Si
Dr. Elisa Anggraeni, S.TP, MSc

Programs
Dr. Hartrisari Hardjomidjojo, DEA
Dr. Endang Warsiki
Ir. Lien Herlina, MSc
Dr. Ika Amalia Kartika

Funding
Dr. Meika Syahbana Rusli
Dr. Dwi Setyaningsih
Prof. Erliza Hambali
Dr. Mulyorini Rahayuningsih

Secretariat
Dr. Titi Candra Sunarti
Dr. Prayoga Suryadharma
Dr. Sugiarto, MS
Dr. Faqih Uddin
Niken Ayu Permatasari, STP, MSi
Angga Yuhistira, STP, MSi
Luthfa Jamilah, STP
Yulianti
Elvin Septiana

Paper & Proceedings
Prof. M. Romli
Prof. Marimin
Prof. Ani Suryani
Prof. Erliza Noor
Dr. Liesbetini Hartoto
Dr. Moch Yani

Accomodation dan Logistics
Dr. Andes Ismayana
Dr. Ade Iskandar
Dr. Muslich
Dr. Sapta Raharja

Design, Web and Publication
Dr. Taufik Djatna
Dr. Aji Hermawan
M. Arif Darmawan, MT
Teguh Adi Setia, AMd

AGENDA

Time	Activities
Monday, August 3rd 2015	
08.00 - 09.00	Registration
09.00 - 10.00	Opening Ceremony • Welcoming Address: Prof. Nastiti Siswi Indrasti (Head of DAT, Fateta, IPB) • Welcoming Speech Head of Bogor Regency • Conference Opening: Prof. Herry Suhardiyanto (Rector of IPB) • Opening Speech and Conference Opening : Minister of Industry Indonesia * • Launching Expose International program DAT
10.00 – 10.05	*Photo Session*
10.05 - 10.15	*Coffee break*
10.15 - 10.45 10. 45 - 11.30 11.30 – 12.00 12.00 – 12.30	Keynote Speech : 1. Prof Irawadi (Bogor Agricultural University, Indonesia) 2. Prof. Kenneth De Jong (George Mason University, USA) 3. Dr. Yandra Arkeman (Bogor Agricultural University, Indonesia) 4. Dr. Guillermo Baigorria (University of Nebraska, Lincoln, USA)
12.30 – 13.30	Lunch break
13.30 – 13.50 13.50 – 14.10 14.10 – 14.30 14.30 – 14.50 14.50 – 15.10 15.10 – 15.45	Plenary Session 1 : Prof. Noel Lindsay (University of Adelaide, Australia) Dr. Kiyotada Hayashi (National Agricultural Research Center, Tsukuba, Japan) Prof. Margareth Gfrerer (Islamic State University of Jakarta, Indonesia) Dr. Barry Elsey (University of Adelaide, Australia) Ir. M. Novi Saputra (Marketing Director KML Food Group) *Discussion*
15.30 – 15.45	*Coffee break*
15.45 – 18.00	Parallel session A, B and C
18.00 – 21.00	Welcome Dinner

Time	Activities
Tuesday, August 4rd 2015	
08.30 – 09.00	Registration
09.00 – 09.20 09.20 – 09.40 09.40 – 10.00 10.00 – 10.20 10.20 – 10.45	Plenary Session 2 : Dr. Gajendran Kandasamy (PhD in Physic, Melbourne University ; PhD in Innovation Imperial Collage, London) Prof. Allan O'Connor (University of Adelaide, Australia) Dr. Eng. Wisnu Ananta Kusuma, ST, MT (Bogor Agricultural University, Indonesia) Dr. Frank Neumann (University of Adelaide, Australia) *Discussion*
10.45 – 13.00	Parallel Session A, B and C
13.00 – 14.00	Lunch break
14.00 – 15.30	Parallel Workshop • Strategies for Agroindustry Development • LCA for Agroindustry • Innovation and Technopreneurship for Agroindustry • Agroindustrial Informatics
15.30 – 15.45	Coffee Break
15.45 – 16.15	Closing remark

TABLE OF CONTENTS

The Application of Fuzzy-Neuro Approach for ERP System Selection: Case Study on an Agro-industrial Enterprise

Joko Ratono, Kudang Boro Seminar, Yandra Arkeman and Arif Imam Suroso
Bogor Agricultural University
E-mail: *joko.ratono@gmail.com, seminarkudangboro@gmail.com, yandra_ipb@yahoo.com,arifimamsuroso@yahoo.com*

***Abstract*— Enterprise Resource Planning (ERP) adoption emphasizes business transformation that leads to change business processes in an effort to maximize profits and competitive advantage of the enterprise. Many companies were unsuccessful in implementing ERP system. Selection failure affected implementation failure. ERP system selection that misfit and ineffectively caused a major failure of ERP system adoption which is a critical investment, risky and expensive. ERP selection is a complex decision-making process and must be conducted carefully because of the important impacts. Many researchers have studied related to the approach used, but still little was associated with complex and standardized criteria. Most studies were to simplify the complex criteria, which often will eliminate the meaning of the standardized criteria. This study discusses the hybrid approach of Fuzzy - Neural Network (Fuzzy-Neuro) for the ERP selection with numerous and complex criteria. The criterions used were the characteristics and sub-characteristics that compatible with ISO25010, vendors and consultants, fit strategy, change management and cost. A case study was simulated in the agro industrial company that has some special characteristics. The results confirm the Fuzzy-Neuro approach can be used optimally even for ERP selection with many, complex and tiered standardized criteria.**

Key words : Agro-industry, ERP Selection, Fuzzy-Neuro, ISO25010

Manuscript received May 8, 2015.

Joko Ratono was doctoral student from Management and Business School, Bogor Agricultural University; (e-mail : joko.ratono@gmail.com). This paper is part of his dissertation supervised by lecturers.

Kudang Boro Seminar is lecturer at Bogor Agricultural University; (e-mail : seminarkudangboro@gmail.com)

Yandra Arkeman is lecturer at Bogor Agricultural University; (e-mail : yandra_ipb@yahoo.com)

Arif Imam Suroso is lecturer at Bogor Agricultural University; (e-mail : arifimamsuroso@yahoo.com)

I. INTRODUCTION

A. Background

ERP is an information system (IS) and integrated business applications or computer packages of application system that serves to integrate the enterprises business processes, starting from budget planning, marketing, sales, production planning, purchasing, production execution and monitoring of production, raw material and product that store in warehouses, scheduling and delivery, payment processing to the vendor, customer billing, accounting and controlling functions, human resources functions, as well as other functions within a company. ERP is a software package of best practice, centralization of data, real time transactions [41] and E-business enabled [9].

Adoption of ERP systems within the enterprise can provide both business and technical benefits. Strategic business, best practice and unique business process built in ERP system will become the foundation of the company competitiveness and operation excellence, as evidenced by the many previous studies.

Rayner and Woods [42] defines ERP systems as a strategy of enterprise: "*Technology strategy that integrates a set of business functions, such as finance, HR and purchasing, with operational aspects, such as manufacturing or distribution, through tight linkages from operational business transactions to financial records".* Aberdeen [1] considers ERP as part of the most important aset on enterprise: *"ERP software could be considered the brain of on organization, it tracks necessary information used to make decisions and should be the epicenter that guides and enables business processes, it is a vital component of a successful organization and needs to be treated as such"*.

ERP has life cycle consists of several stages: pre-implementation, implementation and post-implementation. ERP selection is the initial step on ERP adoption life cycle and as the one of the critical processes in the pre-implementation stage.

Based on the KPMG survey in 1997, ERP project failure reached 61%, and in 2008 decreased to 51% [28], [19]. Panorama [39] in 2013 reported that 40% of ERP projects still unsuccessful. One of the causes of failure was improper package selection [19], the failure of the selection affected the implementation failure [20], [40]. Initial scope of the project implementation and budget accounted for 32.4% was over delay and 16.7% was over budget [38].

ERP selection is a complex decision-making process [31] about the ERP system itself, vendors and consultants, adoption of best practices, customization of company's unique practices, fitting with corporate strategy and should involve employees from the beginning [2]. Selection systems that did not fit [49] and ineffective [27] could be the main cause of failure of ERP system that is a critical investment, risky, expensive [7], [15] and affect enterprise performance and profit [32] and a competitive advantage in the future [6]. ERP selection is the activity associated with the processes, methods and tools that are used to decide the ERP implementation vendors and consultants, that chosen from a wide range of available solutions. ERP selection should be carried with carefully because the significant impact on the medium and long term and related in helping companies to build competitive advantage [48]. ERP selection is the first and an important step [4], [6], [33], towards the successful implementation [37] to understand the critical factors [13]. However, many companies take this important decision did not based on the proven selection method, whereas the selected ERP system contributed significantly to the success or failure of the ERP implementation [8], [52], the selection criteria are also very important in the success of ERP adoption [23], [47].

B. Previous Research

Quantitative approaches are widely used in the ERP selection methods, including traditional investment analysis approach such as NPV, ROI, payback, and other [18], real options [46], as well as approaches that use basic programming theory and MCDM. Approach and the use of modern tools in computing-based intelligent system increases its use along with the development tools themselves as well the development of computational science, statistics and science system in conjunction with the development of computer and information technology. Processes with complex iteration can now be executed by a computer in a short time. The study of literature shows that AHP and Fuzzy most popular and widely used, including the hybrid of both results. Fisher *et al*. [17] used DEA approach to determine the scoring of factors or selection criteria. Wei *et al*. [51] applied AHP to determine the influence of criteria and the final score of the ERP vendor selection. Shyur [44] and Ayag [5] used the ANP to cover the weaknesses of AHP, making structures of criteria more flexible and getting feedback. Wei and Wang [50] applied fuzzy logic, Asgari *et al*. [3] used the triangular fuzzy. Lien and Chan [29], Onut and Efendigil [34] applied the hybrid of fuzzy-AHP, Ayağ and Özdemir [5] used fuzzy-ANP, Cebeci [10] applied the BSC-DSS criteria, Karsak and Ozogul [24] and Yazgan *et al*. [53] used a combination of ANP and ANN, where the ANP was used to determine the weight of each criterion and ANN was used to optimally process by following the principles of neural networks to transform inputs into the final score. Ozalp *et al*. [36] used three approaches at the same time to select ERP consultants i.e. AHP, FAHP and ANP, which confirmed the same result rankings. Fuzzy-Goal Programming was also used in the selection for the process optimization [14]. PCA was applied to simplify the criteria [35] and DEMATEL was used to search for causal relationships between criteria [16], [22]. While Tazyen [45], used system dinamics in ERP selection. Approach to decision analysis can be used for complex problems, multiple criteria and full of uncertainty [30].

This study used a hybrid approach between triangular fuzzy and neural network that is Fuzzy-Neuro for the many and complex ERP selection criteria. Simplification of the criteria is not suggested to preserve the characteristics and sub-characteristics of ISO25010 international quality software standards [21] and other criteria that have been developed based on the literature review, experience and competence in the world of ERP and the criteria have been validated by experts in the ERP system [41]. This approach is proposed as an alternative solution based on computing and intelligent systems without simplifying the existing standard criteria to avoid loss of meaning of the selection criteria, as if we use PCA, and to overcome many and tiered criteria, that will be very complicated if using pairwise comparation method on AHP/ANN group technique.

II. FUZZY-NEURO APPROACH

A. Fuzzy Theory

The usefulness of fuzzy set theory is to quantify the vagueness concept in human thought. The formation process of fuzzy membership function there are a number of ways such as through intuition, inference, ratings, neural networks, genetic algorithms and induction [43].

One form of fuzzy functions most widely used is triangular fuzzy. Triangular fuzzy widely used because it is easy in the calculation and can assist

 ISBN : 978-1-4673-7404-0

decision-making [3]. Triangular fuzzy membership function follows the function in Figure 1.

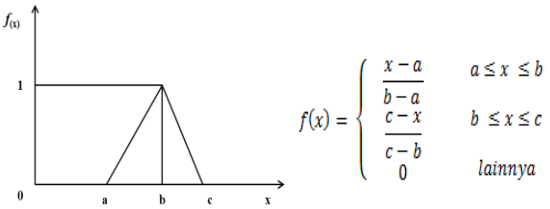

Figure 1. Membership function of triangular fuzzy.

Cochran and Chen [12] have used the generic membership functions that are useful for weighting and values. Asgari *et al*. [3] utilized the membership function with different weights and values, that has been widely used in various fields of research and are very popular among users [25]. Linguistic terms were used in this study include the weight and value (score) with symbols and membership function as shown in Figure 2. [3], [12], [25].

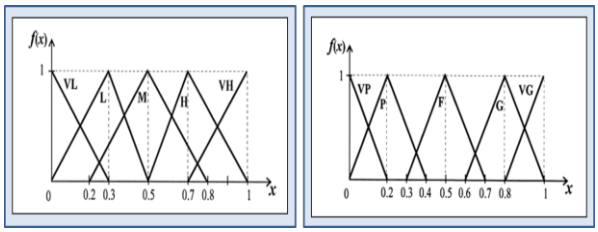

Figure 2. Fuzzy number for weight and score

B. Fuzzy - Neuro

The basic idea of fuzzy-neuro hybrid is to use the results of fuzzy as weights to optimize the neural network output (Figure 3).

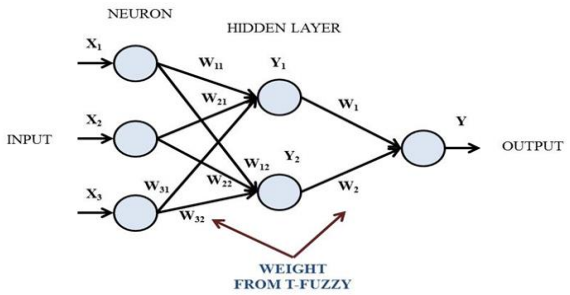

Figure 3. Analytical framework of Fuzzy-Neuro, modified from AHP-NN framework [26].

Output of fuzzy will be calculated to be defuzzy number using Center of Gravity (CoG) technique, due to the popularity and easy to use [12]. Then the weights and scores can be calculated, and used in the neural network to generate vendor-consultants final value. The detail flow can be seen in Figure 4.

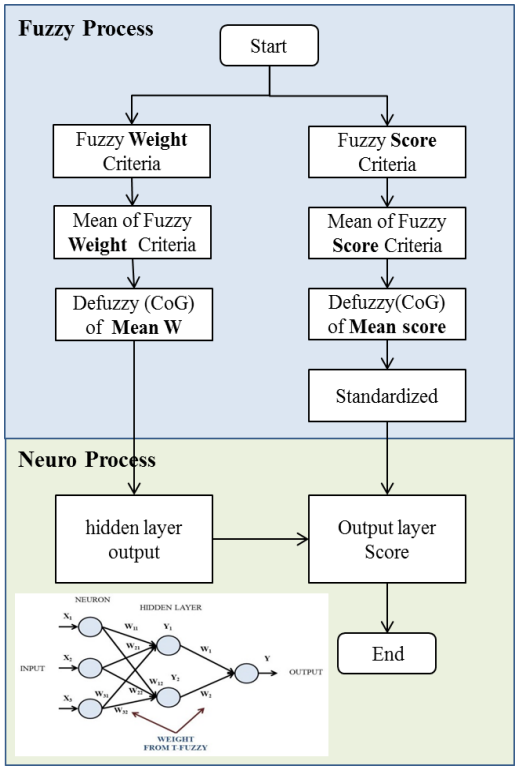

Figure 4. Fuzzy-Neuro process

III. SIMULATION OF FUZZY-NEURO APPROACH

The simulation was performed on one of the national agro-industry in the food bakery. The company has approximately 9 factories spread both in Java and outside Java. The business process of the company has a high complexity both in the manufacturing and distribution and has very unique product characteristics which have a life cycle product of 4 days only. The need for an ERP system is very urgent to be enabling the company to grow rapidly, competing with other world-class companies. Vendor-consultant who entered the contest in the ERP selection, there is 8 vendor-consultants who has been known the competency and experience in the ERP field and food industries.

IV. SCORING PROCESS CALCULATION WITH FUZZY-NEURO

Fuzzy-Neuro architecture in this simulation is shown in Figure 5. A total of 8 Vendor-consultants in this contest will be selected by the 5-tiered selection with 3 level criteria used.

 ISBN : 978-1-4673-7404-0

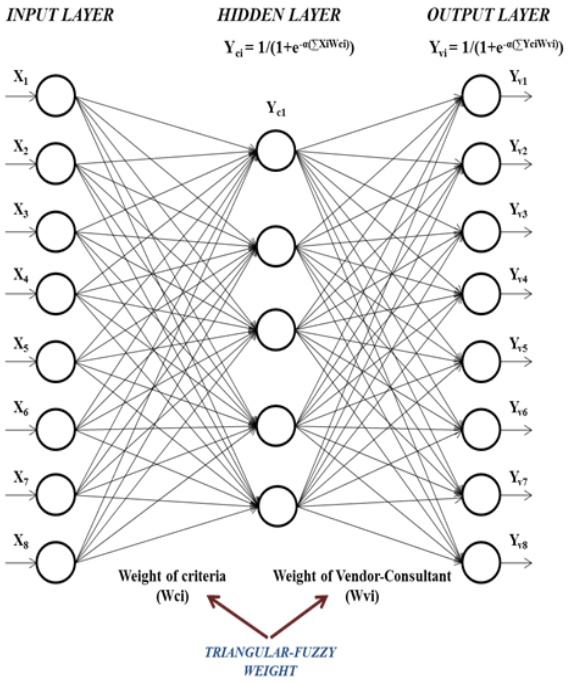

Figure 5. Fuzzy-Neuro architecture in simulation

Notation notes:
X_i : Input value for vendor-consultant i
Y_{ci} : Output of hidden layer for i group criteria
Y_{vi} : Final score (output layer) for vendor-consultant i.

V. Discussion and Results

Top management is the key factor of ERP adoption and available as a resource to provide an assessment to simulate the ERP vendor-consultant selection. The composition of the vendor-consultant is three consulting companies with SAP vendor, one each consulting company Oracle vendor and Microsoft Axapta vendor and the other three consulting companies with other ERP vendor. All vendor-consultants were given the opportunity to conduct scoping together to deepen understanding on existing and to be business processes in the food bakery company, understanding the goals, vision and mission in future and exercising the potential solution for improvement and development related to the ERP adoption. The expected result of this process was vendor-consultant could understand the needs of the future, the scope of the function/department and branches/location, as well as the problems facing companies today and are going to look for solutions. On the other side vendor-consultants also should sell theirself with competency and experienced consultants and solutions, as well as they have proven methodology and accelerated implementation tools that they already developed to facilitate the ERP implementation and how the vendor-consultants also have the concept of change management in ERP adoption. Vendor-consultants were also required to explore the need for the necessary supporting infrastructure such as servers and network specifications required related transaction data volume, distribution and location, approximate data growth in future by using the new ERP system. Vendor-consulting firms were also expected to have an industrial solution / special programs in the food industry, manufacturing and distribution area that were developed on the vendor platform and become the basis of the bakery food development. Results of scoping would be the basis of vendor-consultant provided solutions and presented in outline to the ERP adoption team and top management. Related team then could provide assessments according to the given guidance. Results can be seen in Table 1. Percentage of weight was resulted from preliminary research.

Table 1. Data of assesment result for Fuzzy-Neuro

ERP Vendor and Consultant Selection Criteria	Weight	VK1	VK2	VK3	VK4	VK5	VK6	VK7	VK8
Product Quality Software (ISO25010)									
Functional suitability	13,18%								
Appropriateness	33,54%	G	F	P	P	F	F	P	P
Completeness	32,28%	VG	G	F	F	F	P	P	P
Correctness	34,18%	G	G	G	F	G	P	F	P
Performance Efficiency	12,38%	VG	G	G	F	G	F	F	F
Compatibility	11,38%	VG	G	F	G	G	P	F	P
Usability	12,61%	G	G	F	F	G	F	F	P
Reliability	13,09%	G	F	G	F	G	P	P	P
Security	13,42%	G	G	G	F	G	P	P	P
Portability	11,90%	G	G	F	G	F	F	F	P
Maintainability	12,04%	VG	G	G	G	F	P	P	F
Vendor & Consultant									
Competency	20,65%	VG	G	F	F	F	F	P	P
Methodology	21,41%	VG	F	F	F	G	F	F	P
Profile	18,60%	G	G	F	F	G	F	F	F
Accelarated tools	19,21%	VG	G	F	G	G	P	P	P
Project Management	20,12%	G	G	G	G	G	F	P	F
Fit Strategy									
Best Product	35,25%								
Low Cost	49,66%	VG	VG	F	G	G	F	F	F
Differentiation	50,34%	VG	G	G	G	VG	F	F	F
Total Customer Solution	33,94%								
Customer Integration	34,19%	VG	G	G	F	G	G	F	F
Redefine customer relationship	33,43%	VG	F	F	F	G	F	P	F
Horizontal breadth	32,38%	G	G	F	G	F	F	F	F
System Lock in	30,81%								
Restricted Access	36,42%	G	G	F	F	G	P	F	P
Dominant Exchange	31,38%	G	G	F	F	F	F	P	F
Proprietary standard	32,20%	G	G	F	F	G	P	P	P
Change Management									
Communication strategy & planning	19,66%	VG	F	F	F	G	G	F	F
Impact mapping & transition plan	20,46%	G	F	F	G	G	F	P	P
Perform transition plan	20,22%	G	F	F	F	F	F	F	P
User Acceptance	20,62%	G	G	G	F	G	P	F	F
User Training & Budget	19,02%	G	G	G	G	F	F	F	F
Cost or Economic Value	15,38%								
Total Cost	55,22%	G	F	P	G	VP	F	G	G
Financing	44,78%	G	G	P	G	P	G	G	VG

Notes: *VK1-VK8*:Vendor-consultant 1-8, *VG*:Very Good, *G*:Good, *F*:Fair, *P*:Poor, *VP*:Very Poor.

This assessment technique looks better and simpler when compared to pairwise comparison method in a tiered structure criteria. Results of the assessment were then processed into triangular fuzzy numbers. In this context it would seem more complicated calculations, due to incorporate fuzzyness, but it can be simplified by providing templates and formulas in Microsoft Excel. Most detailed calculation can be seen in Table 2 for calculation of the vendor-consultants 1 to 3, and Table 3 for vendor-consultants 4 to 6 and Table 4 for vendor-consultants 7-8. The data processing is starting from level 3 hierarchies. Each value multiplied by the weights, then summed into level 2. For example, the values of criteria:

 ISBN : 978-1-4673-7404-0

appropriateness, completeness, correctness (level 3) multiplied by their respective weights and summed so that become a value of functional suitability criteria (level 2). Furthermore, the criteria in level 2, each criterion multiplied by each weight and summed to level 1 criterion for the fifth group of criteria i.e. criteria for product quality ERP software (*KSPE*), vendors-consultants (*VEKO*), fit-strategy (*FITS*), change management (*MAPE*) and Cost (*COST*). This value is then calculated into a krispy value, as a result of defuzzy number process based on center of gravity (CoG) method.

Table 2. Data calculation for *VK1-VK3*

ERP Vendor & Consultant Selection Criteria	Weight	VK1		Fuzzy		VK2		Fuzzy		VK3		Fuzzy	
			a	b	c		a	b	c		a	b	c
Quality Software (ISO25010)-KPSE	17,80%	0,8534	0,6801	0,8801	1,0000	0,7475	0,5475	0,7475	0,9475	0,6530	0,4530	0,6530	0,8530
Functional suitability	13,18%		0,6646	0,8646	1,0000		0,4994	0,6994	0,8994		0,3019	0,5019	0,7019
Appropriateness	33,54%	G	0,6	0,8	1	F	0,3	0,5	0,7	P	0	0,2	0,4
Completeness	32,28%	VG	0,8	1	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Correctness	34,18%	G	0,6	0,8	1	G	0,6	0,8	1	G	0,6	0,8	1
Performance Efficiency	12,38%	VG	0,8	1	1	G	0,6	0,8	1	G	0,6	0,8	1
Compatibility	11,38%	VG	0,8	1	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Usability	12,61%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Reliability	13,09%	G	0,6	0,8	1	F	0,3	0,5	0,7	G	0,6	0,8	1
Security	13,42%	G	0,6	0,8	1	G	0,6	0,8	1	G	0,6	0,8	1
Portability	11,90%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Maintainability	12,04%	VG	0,8	1	1	G	0,6	0,8	1	G	0,6	0,8	1
Vendor & Consultant-VEKO	17,18%	0,8816	0,7225	0,9225	0,9999	0,7357	0,5357	0,7357	0,9357	0,5603	0,3603	0,5603	0,7603
Competency	20,65%	VG	0,8	1	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Methodology	21,41%	VG	0,8	1	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Profile	18,60%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Accelarated tools	19,21%	VG	0,8	1	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Project Management	20,12%	G	0,6	0,8	1	G	0,6	0,8	1	G	0,6	0,8	1
Fit Strategy-FITS	17,06%	0,8776	0,7164	0,9164	1,0000	0,7893	0,6010	0,8010	0,9660	0,5880	0,3880	0,5880	0,7880
Best Product	35,25%		0,8000	1,0000	1,0000		0,6993	0,8993	1,0000		0,4510	0,6510	0,8510
Low Cost	49,66%	VG	0,8	1	1	VG	0,8	1	1	F	0,3	0,5	0,7
Differentiation	50,34%	VG	0,8	1	1	G	0,6	0,8	1	G	0,6	0,8	1
Total Customer Solution	33,94%		0,7352	0,9352	1		0,4997	0,6997	0,8997		0,4026	0,6026	0,8026
Customer Integration	34,19%	VG	0,8	1	1	G	0,6	0,8	1	G	0,6	0,8	1
Redefine customer relationship	33,43%	VG	0,8	1	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Horizontal breadth	32,38%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
System Lock in	30,81%		0,6	0,8	1		0,6	0,8	1		0,3	0,5	0,7
Restricted Access	36,42%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Dominant Exchange	31,38%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Proprietary standard	32,20%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Change Management-MAPE	16,75%	0,8261	0,6392	0,8392	0,9998	0,6188	0,4189	0,6188	0,8188	0,6188	0,4189	0,6188	0,8188
Communication strategy & planning	19,66%	VG	0,8	1	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Impact mapping & transition plan	20,46%	G	0,6	0,8	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Perform transition plan	20,22%	G	0,6	0,8	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
User Acceptance	20,62%	G	0,6	0,8	1	G	0,6	0,8	1	G	0,6	0,8	1
User Training & Budget	19,02%	G	0,6	0,8	1	G	0,6	0,8	1	G	0,6	0,8	1
Cost	15,38%	0,8000	0,6	0,8	1	0,6343	0,4343	0,6343	0,8343	0,2000	0	0,2	0,4
Total Cost	55,22%	G	0,6	0,8	1	F	0,3	0,5	0,7	P	0	0,2	0,4
Financing	44,78%	G	0,6	0,8	1	G	0,6	0,8	1	P	0	0,2	0,4

Table 3. Data calculation for *VK4-VK6*

ERP Vendor & Consultant Selection Criteria	Weight	VK4		Fuzzy		VK5		Fuzzy		VK6		Fuzzy	
			a	b	c		a	b	c		a	b	c
Quality Software (ISO25010)-KPSE	17,80%	0,5927	0,3927	0,5927	0,7927	0,7022	0,5022	0,7022	0,9022	0,3239	0,1239	0,3239	0,5239
Functional suitability	13,18%		0,1994	0,3994	0,5994		0,4025	0,6025	0,8025		0,1006	0,3006	0,5006
Appropriateness	33,54%	P	0	0,2	0,4	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Completeness	32,28%	F	0,3	0,5	0,7	F	0,3	0,5	0,7	P	0	0,2	0,4
Correctness	34,18%	F	0,3	0,5	0,7	G	0,6	0,8	1	P	0	0,2	0,4
Performance Efficiency	12,38%	F	0,3	0,5	0,7	G	0,6	0,8	1	F	0,3	0,5	0,7
Compatibility	11,38%	G	0,6	0,8	1	G	0,6	0,8	1	P	0	0,2	0,4
Usability	12,61%	F	0,3	0,5	0,7	G	0,6	0,8	1	F	0,3	0,5	0,7
Reliability	13,09%	F	0,3	0,5	0,7	G	0,6	0,8	1	P	0	0,2	0,4
Security	13,42%	F	0,3	0,5	0,7	G	0,6	0,8	1	P	0	0,2	0,4
Portability	11,90%	G	0,6	0,8	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Maintainability	12,04%	G	0,6	0,8	1	F	0,3	0,5	0,7	P	0	0,2	0,4
Vendor & Consultant-VEKO	17,18%	0,6179	0,4180	0,6179	0,8179	0,7380	0,5380	0,7380	0,9380	0,4423	0,2423	0,4423	0,6423
Competency	20,65%	F	0,3	0,5	0,7	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Methodology	21,41%	F	0,3	0,5	0,7	G	0,6	0,8	1	F	0,3	0,5	0,7
Profile	18,60%	F	0,3	0,5	0,7	G	0,6	0,8	1	F	0,3	0,5	0,7
Accelarated tools	19,21%	G	0,6	0,8	1	G	0,6	0,8	1	P	0	0,2	0,4
Project Management	20,12%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Fit Strategy-FITS	17,06%	0,6387	0,4387	0,6387	0,8387	0,7617	0,5735	0,7735	0,9380	0,4714	0,2714	0,4714	0,6714
Best Product	35,25%		0,6000	0,8000	1,0000		0,7007	0,9007	1,0000		0,3000	0,5000	0,7000
Low Cost	49,66%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Differentiation	50,34%	G	0,6	0,8	1	VG	0,8	1	1	F	0,3	0,5	0,7
Total Customer Solution	33,94%		0,3971	0,5971	0,7971		0,5029	0,7029	0,9029		0,4026	0,6026	0,8026
Customer Integration	34,19%	F	0,3	0,5	0,7	G	0,6	0,8	1	G	0,6	0,8	1
Redefine customer relationship	33,43%	F	0,3	0,5	0,7	G	0,6	0,8	1	F	0,3	0,5	0,7
Horizontal breadth	32,38%	G	0,6	0,8	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
System Lock in	30,81%		0,3	0,5	0,7		0,5059	0,7059	0,9059		0,0941	0,2941	0,4941
Restricted Access	36,42%	F	0,3	0,5	0,7	G	0,6	0,8	1	P	0	0,2	0,4
Dominant Exchange	31,38%	F	0,3	0,5	0,7	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Proprietary standard	32,20%	F	0,3	0,5	0,7	G	0,6	0,8	1	P	0	0,2	0,4
Change Management-MAPE	16,75%	0,6183	0,4184	0,6183	0,8183	0,6821	0,4822	0,6821	0,8821	0,4970	0,2971	0,4970	0,6970
Communication strategy & planning	19,66%	F	0,3	0,5	0,7	G	0,6	0,8	1	G	0,6	0,8	1
Impact mapping & transition plan	20,46%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Perform transition plan	20,22%	F	0,3	0,5	0,7	F	0,3	0,5	0,7	F	0,3	0,5	0,7
User Acceptance	20,62%	F	0,3	0,5	0,7	G	0,6	0,8	1	P	0	0,2	0,4
User Training & Budget	19,02%	G	0,6	0,8	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Cost	15,38%	0,8000	0,6	0,8	1	0,1264	0	0,0896	0,2896	0,6343	0,4343	0,6343	0,8343
Total Cost	55,22%	G	0,6	0,8	1	VP	0	0	0,2	F	0,3	0,5	0,7
Financing	44,78%	G	0,6	0,8	1	P	0	0,2	0,4	G	0,6	0,8	1

Table 4. Data Calculation for *VK7-VK8*

ERP Vendor & Consultant Selection Criteria	Weight	VK7		Fuzzy		VK8		Fuzzy	
			a	b	c		a	b	c
Quality Software (ISO25010)-KPSE	17,80%	0,3583	0,1583	0,3583	0,5583	0,2733	0,0733	0,2733	0,4733
Functional suitability	13,18%		0,1025	0,3025	0,5025		0,0000	0,2000	0,4000
Appropriateness	33,54%	P	0	0,2	0,4	P	0	0,2	0,4
Completeness	32,28%	P	0	0,2	0,4	P	0	0,2	0,4
Correctness	34,18%	F	0,3	0,5	0,7	P	0	0,2	0,4
Performance Efficiency	12,38%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Compatibility	11,38%	F	0,3	0,5	0,7	P	0	0,2	0,4
Usability	12,61%	F	0,3	0,5	0,7	P	0	0,2	0,4
Reliability	13,09%	P	0	0,2	0,4	P	0	0,2	0,4
Security	13,42%	P	0	0,2	0,4	P	0	0,2	0,4
Portability	11,90%	F	0,3	0,5	0,7	P	0	0,2	0,4
Maintainability	12,04%	P	0	0,2	0,4	F	0,3	0,5	0,7
Vendor & Consultant-VEKO	17,18%	0,3200	0,1200	0,3200	0,5200	0,3161	0,1162	0,3161	0,5161
Competency	20,65%	P	0	0,2	0,4	P	0	0,2	0,4
Methodology	21,41%	F	0,3	0,5	0,7	P	0	0,2	0,4
Profile	18,60%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Accelarated tools	19,21%	P	0	0,2	0,4	P	0	0,2	0,4
Project Management	20,12%	P	0	0,2	0,4	F	0,3	0,5	0,7
Fit Strategy-FITS	17,06%	0,4072	0,2072	0,4072	0,6072	0,4366	0,2366	0,4366	0,6366
Best Product	35,25%		0,3000	0,5000	0,7000		0,3000	0,5000	0,7000
Low Cost	49,66%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Differentiation	50,34%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Total Customer Solution	33,94%		0,1997	0,3997	0,5997		0,3	0,5	0,7
Customer Integration	34,19%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Redefine customer relationship	33,43%	P	0	0,2	0,4	F	0,3	0,5	0,7
Horizontal breadth	32,38%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
System Lock in	30,81%		0,1093	0,3093	0,5093		0,0941	0,2941	0,4941
Restricted Access	36,42%	F	0,3	0,5	0,7	P	0	0,2	0,4
Dominant Exchange	31,38%	P	0	0,2	0,4	F	0,3	0,5	0,7
Proprietary standard	32,20%	P	0	0,2	0,4	P	0	0,2	0,4
Change Management-MAPE	16,75%	0,4385	0,2386	0,4385	0,6385	0,3779	0,1779	0,3779	0,5778
Communication strategy & planning	19,66%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Impact mapping & transition plan	20,46%	P	0	0,2	0,4	P	0	0,2	0,4
Perform transition plan	20,22%	F	0,3	0,5	0,7	P	0	0,2	0,4
User Acceptance	20,62%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
User Training & Budget	19,02%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Cost	15,38%	0,8000	0,6	0,8	1	0,8597	0,6896	0,8896	1
Total Cost	55,22%	G	0,6	0,8	1	G	0,6	0,8	1
Financing	44,78%	G	0,6	0,8	1	VG	0,8	1	1

The weight of the hidden layer using standard industry experts for consumer product goods (CPG) from previous preliminary study. *KPSE* = 17.8%; *VEKO* = 17.18% then *FITS* = 17.06%, *MAPE* = 16.75% and *COST* = 15.38 %. The input *Xi* is calculated by $1 / n = 1/8 = 0.125$, n is the number of vendor-consultants, can be seen in Table 5. It will use two weights; they are weight of selection criteria and weight of score for each vendor-consultant that will determine the value of the final outcome of the process in both the neural network for input layer and the output layer. The process of neural network is actually a transformation process value by weighting the results of the fuzzy process using a sigmoid function. The techniques used in this neural network is a type of unsupervised learning. This method is easier when compared to the ranking techniques developed by Chen [11], as a further step the rating results from fuzzy calculation.

Furthermore, by taking the input value to bias neuron = 1 and a weight of bias neuron = 0.2 then $\Sigma XiWci$ can be calculated. The results are presented in Table 5. By taking the value of $\alpha = 1$, the output value of the hidden layer $Yci = 1 / (1 + e^{-\alpha(\sum XiWci)})$ can be calculated. *Yci* will be inputted in the process along with the output layer and the weights of *Wv*.

Table 5. Weight for input dan the hidden layer output

Criteria	Persentage	Weight	Input (Xi)	∑XiWci	Yci
KPSE	17,80%	0,2115	0,125	0,4115	0,6014
VEKO	17,18%	0,2041	0,125	0,4041	0,5997
FITS	17,06%	0,2027	0,125	0,4027	0,5993
MAPE	16,75%	0,1990	0,125	0,3990	0,5984
COST	15,38%	0,1827	0,125	0,3827	0,5945

Results of calculation for the eight vendors and consultants in each of the criteria can be seen in Table 6. These values will be the weight (*Wv*) as the input to the output layer. It needs to be normalized so that the amount of weight to eight vendors and consultants alike with one. *Wv* value is used to calculate the weight of the output layer which is actually the score of every vendor-consultant on selection criteria.

Table 6. Score (*DfzCoG*) and Weight (*Wv*) for vendor-consultants

DFzCoG	KPSE	VEKO	FITS	MAPE	COST	Wv	KPSE	VEKO	FITS	MAPE	COST
VK1	0,8534	0,8816	0,8776	0,8261	0,6000	VK1	0,1895	0,1912	0,1766	0,1766	0,1510
VK2	0,7475	0,7357	0,7893	0,6188	0,4343	VK2	0,1659	0,1595	0,1588	0,1323	0,1093
VK3	0,6530	0,5603	0,5880	0,6188	0,2000	VK3	0,1450	0,1215	0,1183	0,1323	0,0503
VK4	0,5927	0,6179	0,6387	0,6183	0,8000	VK4	0,1316	0,1340	0,1285	0,1322	0,2014
VK5	0,7022	0,7380	0,7617	0,6821	0,1264	VK5	0,1559	0,1600	0,1532	0,1458	0,0318
VK6	0,3239	0,4423	0,4714	0,4970	0,6343	VK6	0,0719	0,0959	0,0948	0,1063	0,1597
VK7	0,3583	0,3200	0,4072	0,4385	0,8000	VK7	0,0796	0,0694	0,0819	0,0937	0,2014
VK8	0,2733	0,3161	0,4366	0,3779	0,3779	VK8	0,0607	0,0685	0,0878	0,0808	0,0951

Yvi is a final score of vendor-consultants calculated as $Yvi = 1 / (1 + e^{-\alpha(\sum YciWv)})$. The final results (*Yvi*) of the output layer are presented in Table 7.

Table 7. Final score of vendor-konsultan from output layer and rank

VK	KPSE Yc1 = 0,6014	VEKO Yc2 = 0,5997	FITS Yc3 = 0,5993	MAPE Yc4 = 0,5984	COST Yc5 = 0,5945	∑YciWv	Yvi	Rank
VK1	0,1895	0,1912	0,1766	0,1766	0,1510	0,7299	**0,6748**	**1**
VK2	0,1659	0,1595	0,1588	0,1323	0,1093	0,6348	**0,6536**	**3**
VK3	0,1450	0,1215	0,1183	0,1323	0,0503	0,5401	**0,6318**	**5**
VK4	0,1316	0,1340	0,1285	0,1322	0,2014	0,6353	**0,6537**	**2**
VK5	0,1559	0,1600	0,1532	0,1458	0,0318	0,5877	**0,6428**	**4**
VK6	0,0719	0,0959	0,0948	0,1063	0,1597	0,5161	0,6262	**6**
VK7	0,0796	0,0694	0,0819	0,0937	0,2014	0,5144	0,6258	**7**
VK8	0,0607	0,0685	0,0878	0,0808	0,0951	0,4351	0,6071	**8**

Table 7, it can be seen that the final score vendor-consultant consecutive top five of highest to lowest *VK1* = 0.6748; *VK4* = 0.6537; *VK2* = 0.6536; *VK5* = 0.6428; and *VK3* = 0.6318. The final results of the assessment process and calculation by using the tools of fuzzy-neuro show that *VK1* gets the highest score. The assessment process of fuzzy-neuro approach by related expert person in team is very easy to do although the criteria used are many and tiered. The complexity of the case in the calculation process can be assisted by a program or formula with computer applications such as microsoft excel to produce score of vendor-consultants easily. Finally, fuzzy-neuro approach can be used to choose the right implementor.

VI. CONCLUSION

Fuzzy-neuro approach can be used optimally and easily in the ERP selection as one approach to address the complexity and the large number of standard selection criteria used. Standard and valid criteria have been only referenced to avoid the simplification of the criteria in advance which would eliminate the significance meaning of original standard criteria.

REFERENCES

[1] Aberdeen G. 2012. *Extending ERP's Lifecycle with Third-party Maintenance*. Boston (US): Analyst Insight.

[2] Allen GF. 2005. The impact of enterprise resource planning on business processes in allied aerospace corporation [dissertation]. Minnesota (US): Walden University.

[3] Asgari M, Allahverdiloo M, Samkhani S. 2011. A comprehensive framework for selecting the ERP system in Iran Khodro company. *European Journal of Economics, Finance and Administrative Sciences*. 38(2011):7-19.

[4] Avram CD, Zofa RD, Ciovica L. 2012. Developing an ERP strategy based on the IT solution life cycle. *Economy Informatics*. 12(1):26-41.

[5] Ayağ Z, Özdemir RG. 2007. An intelligent approach to ERP software selection through fuzzy ANP. *International Journal of Production Research*. 45(10): 2169-2194.

[6] Bakas O, Romsdal A and Alfnes E. 2007. Holistic ERP selection methodology. *The 14th International EurOMA Conference*; 2007 Jun 17-20; Ankara, Turkey. Ankara (TR): EurOMA.

[7] Brown RW. 2006. *Implementation of enterprise information systems: a comparatives study of enterprise application integration (EAI) vs enterprise resource planning (ERP)* [dissertation]. Arlington (US): The University of Texas.

[8] BSM Consulting. 2010. *Enterprise Resource Planning (ERP) Survey 2010 - Benefits Realisation*. Galway (IE): BSM.

[9] Chan JO. 2010. E-business enabled ERP II architecture. *Journal of the International Information Management Association*. 10(1):44-54.

[10] Cebeci U. 2009. Fuzzy AHP-based decision support system for selecting ERP systems in textile industry by using balanced scorecard. *Journal Expert System Applications.* 36(5):8900-8909.

[11] Chen SH. 1985. Ranking fuzzy numbers with maximizing set and minimizing set. *Fuzzy Set and Systems*. 17(1985):113-129.

[12] Cochran JK, Chen H. 2005. Fuzzy multicriteria selection of object-oriented simulation software for production system analysis. *Computers and Operations Research*. 32(1):153-168.

[13] Chung BY. 2007. *An analysis of success and failure factors for ERP systems in engineering and contruction firms* [dissertation]. Maryland (US): University of Maryland.

[14] Erol I, Barut M. 2003. Developing knowledge based decision support tool for enterprise resources planning (ERP) software selection. *Ankara Üniversitesi Siyasal Bilgiler Fakültesi Dergisi*. 58(1):72-96.

[15] Etezady N. 2008. *The impact of ERP investments on organizational performance* [dissertation]. Florida (US): Nova Southeastern University.

[16] Feili HR, Mood MM, Youshanlouei HR, Sarabi N. 2012. A multi-stage approach to enterprise resource planning system selection. *African Journal of Business Management*. 6(31):9105-9117.

[17] Fisher DM, Fisher SA, Kiang MY. 2004. Evaluating mid-level ERP software. *Journal of Computer Information Systems*. 45(1):38-46.

[18] Gall M, Grechenig T, Bjerre M. 2011. Assessing the feasibility of development a federated ERP system.

International Journal of Managing Information Technology. 3(3):16-26

[19] Ghosh R. 2012. A comprehensive study on ERP failures stressing on reluctance to change as a cause of failure. *Journal of Marketing and Management.* 3(1):123-134.

[20] Gupta PC, Kumar A. 2012. Evaluation of ERP life cycle on the scale of ERP implementation failure. *International Journal of Research in IT, Management and Engineering*. 2(8):61-68.

[21] ISO/IEC 25010. 2011. *Systems and Software Engineering - Systems and software Quality Requirements and Evaluation (SQuaRE) - Quality Model*. Geneva (SZ): International Organization for Standardization.

[22] Jahanshahi H, Farhadzareh B, Fotuhi H, Golpour A, Mokhtari MB. 2013. A new algorithm for ERP system selection based on fuzzy DEMATEL approach. *Advances in Environmental Biology*. 7(9):2509-2521

[23] Jayawickrama U, Yapa S. 2013. Factors affecting ERP implementations: client and consultant perspectives. *Journal of Enterprise Resource Planning Studies*. 2013(2013):1-13.

[24] Karsak EE, Özogul CO. 2009. An integrated decision making approach for ERP system selection. *Journal Expert System Applications.* 36(1):660-667.

[25] Karsak EE, Tolga E. 2001. Fuzzy multi-criteria decision-making procedure for evaluating advanced manufacturing system investments. *International Journal Production Economics*. 69(2001):49-64.

[26] Kumar J, Roy N. 2010. A hybrid method for vendor selection using neural network. *International Journal of Computer Applications*. 11(12):34-40.

[27] Lall V, Teyarachakul S. 2006. Enteprise resource planning (ERP) system selection: a data envelopment analysis (DEA) approach. *The Journal of Computer Information Systems*. 47(1):123-127.

[28] Leung C.2008. ERP implementation failure rate. IT Strategy Tips [Internet]. [Accessed on 2014 Jan 15]. Available at: http://www.wizebiz.ca/erp-implementation-failure-rate/

[29] Lien CT, Chan HS. 2007. A selection model for ERP system by applying fuzzy AHP approach. *International Journal of The Computer, the Internet and Management.* 15(3):58-72.

[30] Marques MRF. 2012. *Risk assessment in technology acquisitions: the case of ERP systems* [thesis]. Lisboa (PT): Instituto Superior Técnico.

[31] Munkelt T, Volker S. 2013. ERP systems: aspects of selection, implementation and sustainable operations. *International Journal of Information Systems and Project Management*. 1(2):25-39.

[32] Molnar B, Szabo G, Benczus A. 2013. Selection process of ERP systems. *Business Systems Research*. 4(1):36-48.

[33] Nah FFH, Delgado S. 2006. Critical success factors for enterprise resource planning implementation and upgrade. *The Journal of Computer Information Systems*. 46(5):99-113.

[34] Onut S & Efendigil T. 2010. A theorical model design for ERP software selection process under the constraints of cost and quality: a fuzzy approach. *Journal of Intelligent & Fuzzy Systems*. 21(6):365-378.

[35] Olson DL, Wu DD. 2011. Multiple criteria analysis for evaluation of information system risk. *Asia-Pacific Journal of Operational Research*. l28(1):1-25.

[36] Ozalp V, Yigit O, Maria MC. 2012. ERP consultant selection problem using AHP, fuzzy AHP and ANP: a case study in Turkey. *E3 Journal of Business Management and Economics*. 3(3):106-117.

[37] Panorama CG. 2011. *The 2011 Guide to ERP Systems and Vendors*. Denver (US): Panorama Consulting Group LLC.

[38] Panorama CG. 2012. *The 2012 ERP Report*. Denver (US): Panorama Consulting Group LLC.

[39] Panorama CG. 2013. *The 2013 ERP Report*. Denver (US): Panorama Consulting Group LLC.

[40] Phusavat K, Anussornnitisarn P, Helo P, Dwight R. 2009. Performance measurement: roles and challenges. *Industrial Management & Data Systems Journal*. 109(5): 646-61.

[41] Ratono J, Seminar KB, Arkeman Y, Suroso AI. 2014. The Development of Enterprise Resource Planning (ERP) Using Delta Model. *International Journal of Information Technology and Business Management*. 31(1):1-12.

[42] Rayner N, Woods J. 2011. ERP strategy: why do you need one and key considerations for defining one. *Gartner RAS Core Research*. 2(4):1-9.

[43] Ross TJ. 2010. *Fuzzy Logic with Engineering Applications*. 3rd ed. New York (US): John Wiley & Sons Ltd.

[44] Shyur HJ. 2003. A semi-structured process for ERP systems evaluation: applying analytic network process. *Journal of e-Business*. 5(1):105-122.

[45] Tazyen F. 2012. *Modelling goverment ERP acquisition methods using system dynamics* [thesis]. Massachusetts (US): Massachusetts Institute of Technology.

[46] Tolga AC. 2011. Fuzzy multi-criteria method for revaluation of ERP system choices using real options. *Proceedings of the World Congress on Engineering 2011*; 2011 Jul 6-8; London, United Kingdom. London (UK): IAENG.

[47] Tsai W, Lee P, Shen Y, Lin H. 2012. A comprehensive study of the relationship between enterprise resource planning selection criteria and enterprise resource planning system success. *Information & Management.* 49(1):36-46.

[48] Uta A, Intorsureanu I, Mihalca R. 2007. Criteria for the selection of ERP software. *Informatica Economica*. 2(42):63-66.

[49] Verville J, Halingten A. 2003. A six-stage model of the buying process for ERP software. *Industrial Marketing Management.* 32(7):585-594.

[50] Wei CC, Wang MJJ. 2004. A comprehensive framework for selecting an ERP system. *International Journal of Project Management*. 22(2):161-169.

[51] Wei CC, Chien CF, and Wang MJJ. 2005. An AHP-based approach to ERP system selection. *International Journal of Production Economics*. 96(1):47-62.

[52] Yang Y. 2010. *Research of ERP application prospects and its implementation at Chinese SMEs* [thesis]. Kuopio (FI): Savonia University.

[53] Yazgan HR, Boran S, Goztepe K. 2009. An ERP software selection process with using artificial neural network based on analytic network process approach. *Journal Expert System Applications*. 36(5):9214-9222.