Guidance for Higher Education to provide the necessary soft skills to meet the needs of Industrial era 4.0 using AHP and Fuzzy AHP

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Abstract

Industry 4.0 is characterized by the digitalization of systems and processes in both service and manufacturing industries and has changed the way people live. Education plays a significant role in preparing the future workforce with the necessary technological skills and competencies required by industries and institutions. Studies have shown that soft-skills improve a student's ability to learn, increase the potential for success in their life and typically provide for an increase in future economic benefits. This study aims to determine the dominant soft-skills that the University students in Manado should possess. By comparing the perceptions of twenty-four lecturers of the of four criteria and twelve sub-criteria using both the Analytical Hierarchy Process (AHP) and Fuzzy Analytical Hierarchy Process (Fuzzy-AHP) methods, the researchers found that teamwork was dominant skill. The global analysis uncovered that integrity was the dominant factor overall. The findings were provided to University leaders with recommendations to incorporate the elements of teamwork and integrity into their teaching materials, teaching methods, and curriculum of the schools. Students should be taught to understand that these elements are essential to their future. This research proved that both AHP and Fuzzy-AHP methods were effective tools in analyzing and determining the dominant factors of soft-skills in the era of Industry 4.0. The researchers recommended other scholars conduct future studies using entrepreneurs or business practitioners as respondents.

Keywords: *AHP, Fuzzy-AHP. Decision-making, Soft-skills, Industry 4.0, LaSalle, digital*

1. Introduction

Industry 4.0's fast paced advancement of technology significantly changed the environment in which we live by improving the connectivity between and among human beings, machines, and other objects (Dombrowski, Wullbrandt, & Fochler, 2019a). Data is now available in real-time, globally, and to everyone that is online, many times in excessive quantities and will require significant changes to the entire industrial system. These changes will require that the educational sector, particularly higher education institutions, rethink what skills and competencies are required of future employees and entrepreneurs.

It is through education that students will prepare to take advantage of the opportunities as well as challenges of Industry 4.0. It is predicted that industries and companies will need people having a high degree of technological-based expertise. To meet these needs, higher education will need to redefine itself, develop its systems, improve its internal management, and enhance its networking.
Industry 4.0 companies will still require people who have hard skills, but increasingly there will be need for a workforce with soft-skills, or non-technical skills, such as teamwork, critical thinking, communication skills, system thinking, and emotional intelligence to truly take advantage of these process improvements. (Fitsilis, Tsoutsa, & Gerogiannis, 2018).

This study focuses on the analysis and determination of the dominant soft-skills that graduates of higher education will require to thrive in Industry 4.0. The primary research question can be stated as: Using AHP and Fuzzy-AHP, what are the dominant soft-skills and cognitive skills that will enable students to become lifelong learners? Secondarily, the researches seek to determine if there is a significant difference between using AHP and Fuzzy-AHP for the data analysis. The goal will be to determine what skills graduates of higher education should possess to thrive in Industry 4.0.

The study uses Analytical Hierarchy Process (AHP) and Fuzzy-AHP methods to evaluate the perceptions of the lecturers collected through a questionnaire. Both methods have been effectively used in decision making studies where complex and multiple variables were involved. Using the hierarchical structure, AHP is able to simplify the analysis of the problem which makes it easier to understand. Fuzzy-AHP allows the researchers to deal with vague and uncertain perceptions, commonly referred to a the "gray area". Since there is minimal previous statistical data available for analysis, both methods are being used to evaluate the experts' opinions.

The respondents of this study are University lecturers with more than twenty years of experience each and doctoral degrees. The respondents understand the context of the educational system of the Universities in Manado and are involved in student activities, comprehend the current situation of the University and meet the essential criteria to be considered as respondents to the questionnaire (Raco & Tanod, 2014).

The researchers acknowledge that there are a number of articles, studies, discourses and commentaries regarding Industry 4.0. However, the existing literature focuses on descriptive, assumptive and qualitative analyses, are theoretical in nature, and do not consider adequately the necessary worker skill-sets for employability (Azmi, Kamin, Noordin, & Nasir, 2018).

The experts of this study identified four criteria and twelve sub-criteria for the research analysis that had been used in previous studies. The criteria and sub-criteria come from previous studies. The criteria include communication skills, teamwork, critical thinking, and entrepreneurial skills. The research findings will be used to enhance the management of higher education in Manado. For the Universitas Katolik De La

Salle (De La Salle Catholic University) of Manado-Indonesia, the results of the study will be considered as key inputs in the review the curriculum, reformulation of the teaching-learning systems, and processes of the school. The findings will improve the school facilities, cooperation and networking with other schools or industries.

There were limitations of the study. Not all respondents were familiar with AHP and Fuzzy-AHP analytical methods. As a result, the researchers had to explain the method and make sure the respondents answered the questions correctly. It was determined that further interviews would be required to clarify the reasons for their choices.

The structure of the study is as follows. First, background of the study, problem formulation, objectives and limitations were developed. Second a literature review was conducted to identify findings and theories of previous studies on Industry 4.0 and its impact on higher education. Third, the methodologies were reviewed, , the reasons for using each methodology identified, and the benefits and drawbacks of each methodology explored. Fourth, the research questionnaire was developed. Fifth, the data was evaluated. Sixth, the meaning and significance of the results as well as the limitations were discussed. Lastly, conclusions and recommendations were prepared.

2. Literature Review

Industry 4.0 is often associated with the intelligent, digital integration of people-machine-objects, advanced computing power, augmented reality, big data analysis, horizontal and vertical system integration, autonomous robots, Internet of Things, cloud computing, and cyber-physical systems for management of business process and value creating networks (Dombrowski, Wullbrandt, & Fochler, 2019b). It serves to integrate intelligent machines, human actors, physical objects, manufacturing lines and processes into every organizational level to create systematic technical data in near real-time.

New technologies are developing at an exponential pace and, as Hussin mentioned, there was not a beginning to the revolution (Hussin, 2018), rather it was an evolutionary growth. Industry 1.0 was characterized by the use of mechanical production assets based on water and steam power, then expanded to Industry 2.0, which was identified by the introduction of mass production techniques centered on the division of labor and the use of electrical energy. Industry 3.0 focused on the introduction of information technology and highly automated production. Industry 4.0 is identified by self-optimizing and real time connected systems. (Aulbur, Arvind, & Bigghe, 2016).

Technology will continue to develop and result in new products and services that cause disruption to the workplace and the workforce. Workforce disruption requires new skills and competencies (Aulbur et al., 2016). The emergence of organizational supply chains changing from a linear and sequential model to an interconnected, open system, known as a digital supply network, has resulted in the need for new organizational structure and employees with new skills to manage them.

A positive impact of this digitalization is the integration of vertical and horizontal value-added steps in the supply chain which allows optimization of customer integration and data access resulting in increased productivity. A smart factory using hundreds or thousands of smart devices is able to self-optimize production increasing productivity (Fitsilis et al., 2018). Digitalization reduces waste and promotes a circular economy and more sustainable patterns of production and consumption (Paravizo, Chaim, Braatz, Muschard, & Rozenveld, 2018). Additionally, customization increases the creation of flexible markets that are customer-oriented and satisfy consumers' needs faster since the gap between the manufacturer and the customer is significantly reduced. Communication will take place seamlessly and require no intermediaries resulting in faster delivery of products. Industry 4.0 will create new markets such as industrial robotics design, build and installation, cyber security, internet of things, and 3D printing. In 2016 these markets were valued at $66.67 billion US. By 2022 it is expected to reach $152.31 billion US.

Industry 4.0 has several negative impacts. It eliminates the need for many old professions and skills as indicated by Fitsilis in the BCG report (Fitsilis et al., 2018). Additionally, security risks have risen exponentially with online integration. Data leaks or loss of data, in addition to data security costs, has resulted in significant financial costs. Many organizations are reluctant to implement new digital technologies because of these risk and cost factors.

Workers are not being taught the new skills and competencies required in the future; such as digital communication, digital content creation, and digital problem solving (Durisova, Kucharcikova, & Tokarcikova, 2015). The development of technology has grown faster than schools are able to recognize and implement necessary training and education.

Certain skills will be imperative to functioning in the Industry 4.0 environment. Generally, there are two kinds of skills or competencies: soft-skill or non-technical skills and hard skills. Examples of hard skill jobs are big data analyst, software engineers, domain experts, network engineers, Information Technology architects, cyber security analyst, location tracking technology experts. Soft-skills include: communication skills, ability to collaborate with others, complex problem solving, emotional intelligence, creativity, system thinking, people management, judgement and decision making, cognitive flexibility especially cognitive skills, and team work. Heckman and Kautz identified that soft-skills are crucial for learning and success in the labor market. Cognitive skills are also shown to increase when facing more complex tasks (Heckman & Kautz, 2012).

Soft-skills contribute to an employee's economic return (Hanushek & Woessmann, 2008). Human beings become more mature as they develop their cognitive skills. It is required from the early stages of ones work life (Hanushek, Schwerdt, Wiederhold, & Woessmann, 2015). That was why the World Bank states that tertiary education is a good opportunity for people to acquire higher orders of cognitive skills. Soft skills influence a person's ability to learn (Ra, Shrestha, Khatiwada, & Yoon, 2019). This has two effects on learning. First, neuroscience studies show that triggering one's general curiosity enables the brain to enhance learning (Gruber, Gelman & Ranganath, 2014). It was also found that children who are motivated and curious tend to learn more and score higher on standardized tests (Heckmann & Kautz, 2012). Second, soft skills intensify the progress of one's cognitive abilities that further improved learning (Cunha & Heckman, 2007). These studies link closely with the four qualities identified as key requisites in a LaSallian graduate: 1) a critical and creative thinker, 2) an effective communicator, 3) a reflective lifelong learner and 4) a service driven citizen (Paredes, Bautista, & Jeong, 2018) (Oreta & Roxas, 2012).

Soft-skills can predict success as strongly as cognitive abilities. A report detailing the economic returns caused by soft-skills in Mexico and Sweden found that soft-skills can be cultivated throughout one's lifetime (Fitsilis et al., 2018).
Education is very important for young people and is the key to preparing present and future generations to succeed in highly competitive world (Rauch, Linder, & Dallasega, 2019).

Industry 4.0 is forcing the education system to change. There needs be a transformation in the education system from one that was based on facts and procedures to one that actively applies knowledge to collaborative problem solving in the real world. Just as the world in constantly changing, innovation and change in education is inevitable. The aim is to improve the quality and inclusiveness of the education system (Umeda et al., 2019) and these changes need to happen in pedagogy and teaching methodology. Digital technology should be incorporated in both the content and process of teaching and learning activities. Educational management needs to change from deliverable focused project management to outcome-focused product management. The educational culture has to focus on the recognition of culture's central role in digital product delivery effectiveness.

An important feature of digitalization is the concept of the digital triplet consisting of the physical world, cyber world and intelligent human (Umeda et al., 2019). Previously, we studied the digital twins consisting of the physical world and cyber world. Education 4.0 will need to focus on outcome focused management rather than delivery focused education (Fitsilis et al., 2018).

Hussin stated that the Education 4.0 requires several things. First, it includes problem-solving- such as introducing non-routine and practical problems, challenging students to solve problem collaboratively. Second, focus on critical reflection to reconstruct the meaning of experiences, promote responsive guidance through mentoring, knowing and learning to value experiences whether good or bad. Third, learn from errors, learning something new about their own and other's practices where peers are very significant to their learning. Fourth, students need to learn together and from each other while teachers need to assume the role of facilitators (Hussin, 2018).

Learning practices need to change from being classroom based to any place and anytime. Students will determine how, when and what they want to learn. They need to be exposed to all potential employment fields, industries or manufacturers. Internship and collaborative projects will become more relevant for learning. Assessment methods will need to change. Conventional assessment will become both irrelevant or insufficient. Assessment will need to be performed during the learning process, while the application of the knowledge will need to be tested when they are working on their projects in the fields. Industries will become a more important place of learning (Nyemba, Carter, Mbohwa, & Chinguwa, 2019).

There are some problems in implementing Education 4.0. First, there is a lack of digital culture and training. Second, there is a lack of a clear digital operational vision and support from top management. Third, economic benefits of digital investment are unclear and the implementation of digitalization in some institutions, particularly educational institutions is costly. Fourth, technologies are constantly changing (Glas & Kleemann, 2016). Qin et al mentioned that in 2012 the number of industrial robots was about 273 per 1,000 workers in Germany (Qin, Liu, & Grosvenor, 2016), however they were considered expensive to use, requiring both high cost employees and additional resources to control and maintenance.

3. Methodology

3.1. AHP Method

Analysis of decision-making of multifaceted and complex problems is continuously improving. Researchers, decision makers and managers are now recognizing the benefit of the methods (Javanbarg, Scawthorn, Kiyono, & Shahbodaghkhan, 2012). One method that is well known is the Analytical Hierarchy Process (AHP) that was introduced by Saaty in 1970s.

Advantages of AHP include the ability to quantitatively measure subjective topics and to reconstruct complex problems into a hierarchical structure to make it easy to solve (Ohoitimur, Krejci, Raco, Raton, & Taroreh, 2019). Questionnaires were designed in pairwise comparison which makes it easier for the respondents to determine their preferences. This method is a good combination of quantitative and qualitative approach (Javanbarg et al., 2012). This method has proven useful for decision makers to formulate the management policies of their businesses. It is used by many researchers for scientific studies.

AHP has limitations. It uses crisp numbers and cannot adequately address uncertainties. Anticipating this drawback, the researchers also applied Fuzzy-AHP which can calculate and address vagueness. One of the objectives of the study was to compare the finding provided by both methods.

The researchers started by explaining the steps of the AHP. AHP begins with determining the research goal, then follows by setting up the criteria and sub-criteria, including alternatives. It structures them in the form of a hierarchy. The next step is formulating the pair-wise questionnaire using the comparative scale of Saaty as shown in Table 1 below.

Table 1
Saaty's comparative scale

Intensity of Importance on an Absolute Scale	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment strongly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Very strong importance	An activity is strongly favored and its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is needed

The questionnaires filled out by the experts were aggregated applying the Formula 1 below.

$$GM = \sqrt[n]{(x_1)(x_2)\ldots(x_n)} \qquad (1)$$

The aggregated results were then arranged in the matrix of pair-wise utilizing Formula 2 below.

$$A = [a_{ij}],\ a_{ij} = w_i/w_j,\ a_{ji} = 1/a_{ij},\ a_{ii} = 1 \qquad (2)$$

Normalize the matrix of pair-wise by making use of Formula 3 below.

$$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \qquad (3)$$

The priority weight was established using the Formula 4 below.

$$w_i = \frac{\sum_{j=1}^{n} b_{ij}}{n} \tag{4}$$

The researchers set up the consistency index as follows.

- Calculating the Maximum (Principal) Eigenvalue using Formula 5.

$$\lambda_{max} = \sum_{i=1}^{n} \frac{(Aw)_i}{nw_i} \tag{5}$$

- Calculating the consistency index applying Formula 6.

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{6}$$

- Then counting the consistency of ratio utilizing Formula 7.

$$CR = \frac{CI}{RI} \tag{7}$$

The Ratio Index for each n object appears in Table 2 below.

Table 2
Ratio index

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

3.2. Fuzzy-AHP

It was determined that when the preferences were uncertain and could not easily determined using exact numerical values, AHP was insufficient (Javanbarg et al., 2012). Human understanding of certain complex issues was imprecise (Wang & Chen, n.d.). The real world is highly ambiguous to be understood quantitatively (Javanbarg et al., 2012).

To settle these problems Zadeh introduced fuzzy method in 1965 to rationalize uncertainties in relation to vagueness and thus make them applicable to human thought. Fuzzy method continues to develop. Today, there are many fuzzy methods and one of them is Fuzzy-AHP. The study applies the Fuzzy-AHP method based on Chang's extent analysis.

In Fuzzy-AHP, the pairwise comparison matrices are formed in Triangular Fuzzy numbers (TFN) (Lavic, Vucijak, Pasic, & Dukic, 2018). Fuzzy numbers are triangular obtained by appropriate fuzzification of Saaty's scale (Lavic et al., 2018). Fuzzy-AHP is considered more accurate than AHP (Eskandari & Miesel, 2017).

Chang's extent analysis was used in this study because it was viewed as one of the easier Fuzzy-AHP methods (Celik, Er, & Ozok, 2009). Literature on Fuzzy-AHP using Chang's extent analysis (Celik et al., 2009) allows for incompleteness of the pairwise judgements made (Tang & Lin, 2011). This method uses linguistic variables to express the comparative judgements made by different experts (Chen, Hsieh, & Hung, 2015). It requires simpler computation than the other methods when implementing and can clearly express fuzzy perception. (It is utilized to defuzzify the fuzzy numbers) (Chen et al., 2015).

The steps of Chang's extent analysis are as follows. Set up the Fuzzy Evaluation Matrix in the form of pair-wise matrix using Triangular Fuzzy Number (TFN). The twenty-four respondents' perceptions were collected through questionnaires. Their perceptions were transferred to Fuzzy-AHP as shown in Table 3. (Hsu, Lee, & Kreng, 2010); (Kamvysi, Gotzamani, Andronikidis, & Georgiou, 2014).

Table 3
Scale AHP and Fuzzy-AHP

Linguistic variables	AHP Scale	Fuzzy AHP Scale	
		TFNs	Reciprocal TFNs
Equal Importance	1	(1, 1, 1) diagonal	(1, 1, 1)
Intermediate	2	(1, 2, 3)	(1/3, 1/2, 1)
Moderately more important	3	(2, 3, 4)	(1/4, 1/3, 1/2)
Intermediate	4	(3, 4, 5)	(1/5, 1/4, 1/3)
Strongly more important	5	(4, 5, 6)	(1/6, 1/5, 1/4)
Intermediate	6	(5, 6, 7)	(1/7, 1/6, 1/5)
Very strongly more important	7	(6, 7, 8)	(1/8, 1/7, 1/6)
Intermediate	8	(7, 8, 9)	(1/9, 1/8, 1/7)
Extremely more important	9	(8, 9 ,9)	(1/9, 1/9,1/8)

The method of extent analysis according to Chang (1996) states that if $X = \{x_1, x_2, \ldots, x_n\}$ is a set of objects and $U = \{u_1, u_2, \ldots u_n\}$ is the set of goals, extent analysis is carried out by taking each object and then analyzing for each goal, g_i. Therefore, the value of m extent analysis of each object iss obtained using the Formula 8 below.

$$M_{gi}^1, M_{gi}^2, \ldots, M_{gi}^m, \quad i = 1, 2, \ldots, n. \tag{8}$$

Chang (Chang, 1996) introduced the step of extent analysis as written by Kahraman, Cebeci dan Ruan (Kahraman, Cebeci, & Ruan, 2004) as follows.

Step 1. Determine the Value of Fuzzy Synthetic Extent

Value of Fuzzy Synthetic Extent object i^{th} was defined as in Formula 9.

$$S_i = \sum_{j=1}^{m} M_{gi}^j \otimes \left[\sum_{i=1}^{n} . \sum_{j=1}^{m} M_{gi}^j \right]^{-1} \tag{9}$$

with:

$$\sum_{j=1}^{m} M_{gi}^j = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j \right) \tag{10}$$

and

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i\right) \tag{11}$$

and

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = \left[\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right] \tag{12}$$

Step 2. The degree of possibility

The degree of possibility of $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$ was defined as follows:

$$V(M_2 \geq M_1) = \sup_{y \geq x} \lfloor \min\left(\mu_{M1}(x), \mu_{M2}(y)\right) \rfloor \tag{13}$$

And equivalent to

$$V(M_2 \geq M_1) = hgt\ (M_1 \cap M_2 = \mu_{M_2}(d)$$
$$= \begin{cases} 1. & if\ m_2 \geq m_1, \\ 0, & if\ l_1 \geq u_2, \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & otherwise \end{cases} \tag{14}$$

Where d is the ordinate of the highest intersection point D between μ_{M_1} dan μ_{M_2} (figure 1)

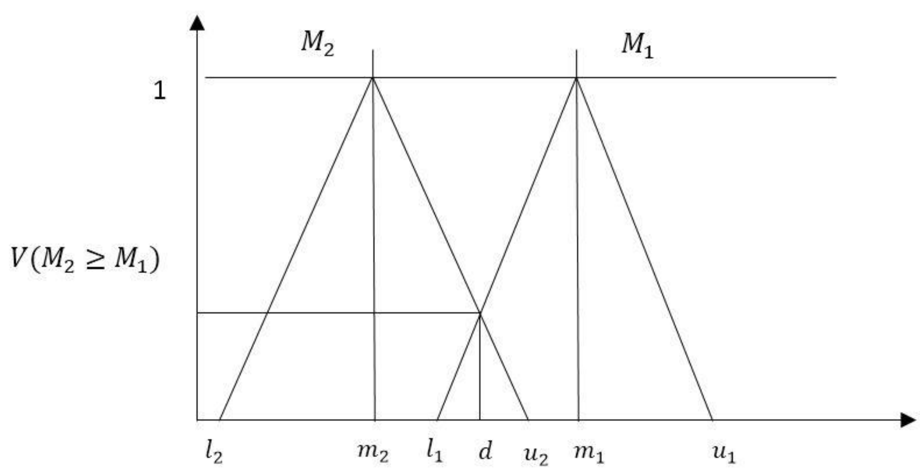

Fig.1. Intersection between M1 dan M2

It was required the two values of $V(M_1 \geq M_2)$ dan $V(M_2 \geq M_1)$ to compare between M_1 and M_2

Step 3. Level of probability Convex Fuzzy Number was greater compare to k convex fuzzy numbers

Definition:

$$V(M \geq M_1, M_2, \ldots M_k) = V[(M \geq M_1)\ and\ (M \geq M_2)\ and \ldots and\ (M \geq M_k)] \tag{15}$$
$$= \min V(M \geq M_i), \qquad i = 1, 2, 3, \ldots, k.$$

And

$$M_i (i = 1, 2, \dots, k) \text{ where } k \text{ was the convex fuzzy numbers}$$

Assume that:

$d'(A_i) = \min V(S_i \geq S_k)$. (16)

For $k = 1, 2, \dots., n; k \neq i$.

Then the weight vector was defined as:

$W' = (d'(A_1), d'(A_2'), d'(A_n))^T$ (17)

with

$A_i (i = 1, 2, \dots, n)$ *are n elements*

Step 4. The normalized weight vectors are

$$W = (d(A_1), d(A_2), \dots, d(A_n))^T \quad (18)$$

Where W was the nonfuzzy number

4. The Results

The goal of this research was to determine the dominant soft-skills graduates should possess in the Industrial era 4.0 using the AHP and Fuzzy-AHP method. Another objective of this study was to compare the result analysis using both methods. The respondents were the lecturers in Manado who have more than twenty years' experience in teaching at University and hold doctoral degrees. They were considered the experts for this study. Based on previous studies, four criteria and twelve sub-criteria were included in the study. Fifty questionnaires were distributed but only twenty-four were completed. Those criteria were communication skills, team-work, critical thinking, and entrepreneurship skills. Each criterion had three sub-criteria so the total number of sub-criteria was twelve. The goal, criteria and sub-criteria was structured in hierarchy form at Figure 2 below.

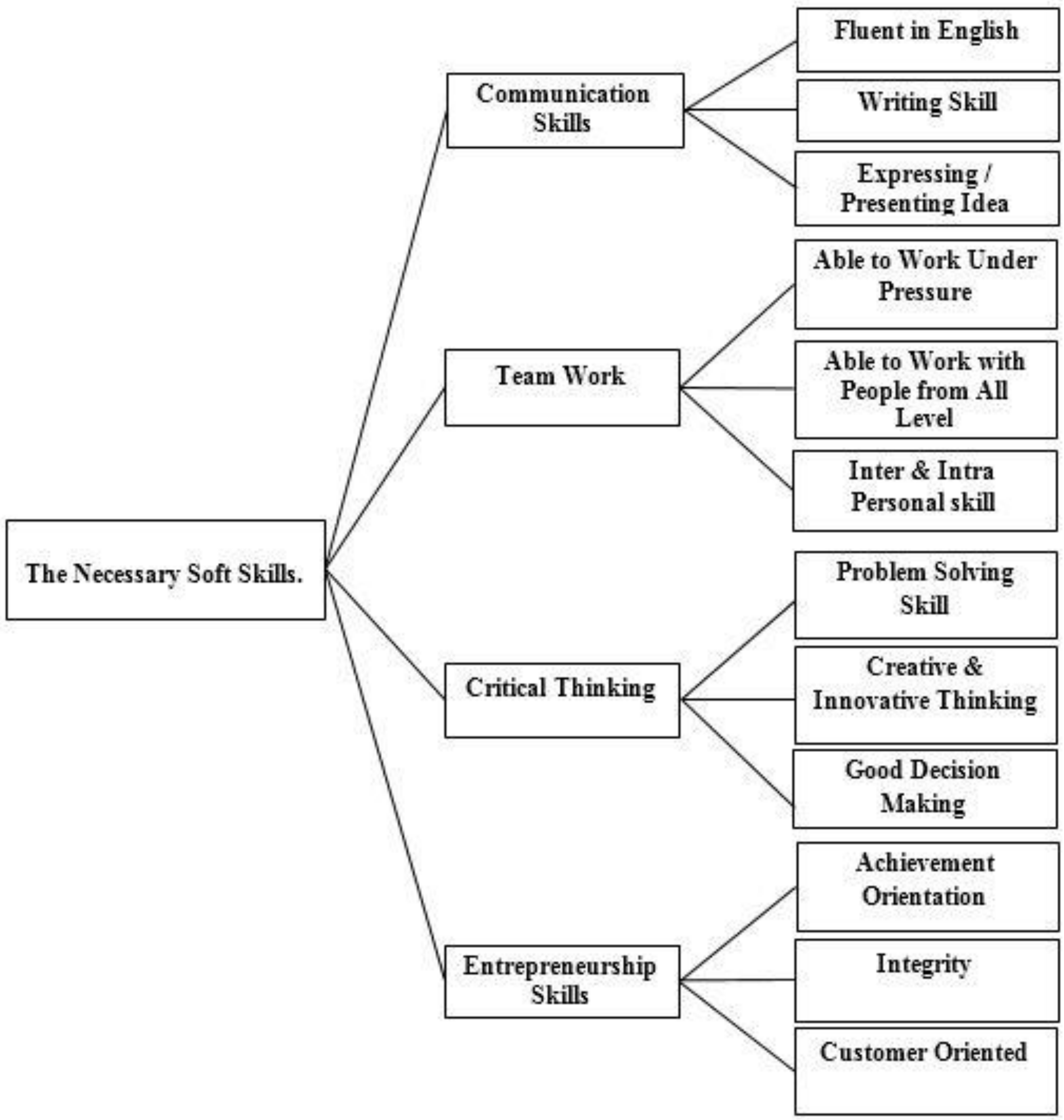

Fig.2. Hierarchy structure

4.1. The weighting of criteria and sub-criteria using AHP method

The weighting of criteria and sub-criteria in AHP method was using Formula 1 – 7. After going through the consistency test, the pair-wise matrix of comparison and the weight of criteria and sub-criteria were presented on the tables as follows.

Table 4
Matrix of pair wise comparison and priority weight of the criteria

	C1	**C2**	**C3**	**C4**	**Priority Weight**
C1	1.000	1.056	1.105	0.727	0.238
C2	0.947	1.000	1.352	0.957	0.260
C3	0.905	0.739	1.000	1.607	0.257
C4	1.375	1.045	0.622	1.000	0.246

$\lambda_{max} = 4.104, CI = 0.035, CR = 0.039$

Criteria Symbol
C1: Communication Skill
C2: Team Work
C3: Critical Thinking
C4: Entrepreneurship Skill

The priority weight of the criteria then was shown in graphic form in Figure 3 below.

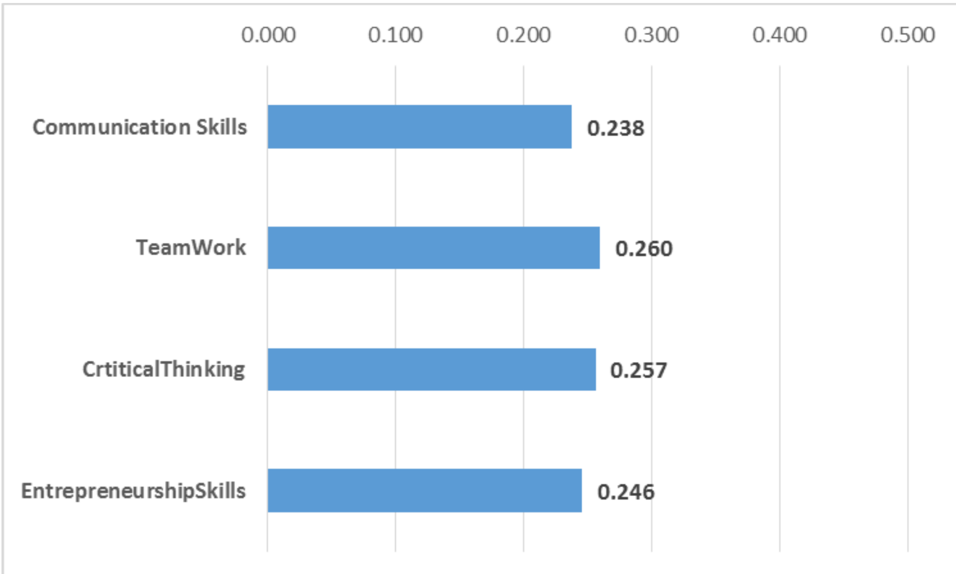

Fig.3. Priority weight of the criteria

From the AHP calculation of the criteria, the results were as follows. First the consistency index $(CI = 0.035)$ *and consistency ratio* $(CR) = 0.039 < 0.1$, the results were consistent. The results, as appeared Table 4 and figure 3, showing us that the criteria of team-work (0.260) got the highest number, followed by the criteria of critical thinking (0.257), then the criteria of entrepreneurship skills (0.246), and the last was communication skills (0.238).

The pair-wise matrix of comparison and priority weight of sub-criteria of communication skills were displayed on Table 5 below.

Table 5
Matrix of pair wise comparison and priority weight of the communication skill sub criteria

	SC1.1	**SC1.2**	**SC1.3**	**Priority Weight**
SC1.1	1.000	1.997	0.851	0.386
SC1.2	0.501	1.000	0.714	0.231
SC1.3	1.175	1.401	1.000	0.383
$\lambda_{max} = 3.030, CI = 0.015, CR = 0.026$				

Sub Criteria Communication Skill symbol
SC1.1. English Fluent
SC1.2. Writing Skill
SC1.3. Expressing / Presenting Idea

The pair-wise matrix of comparison and priority weight of the sub-criteria of team-wok were shown on Table 6 below.

Table 6
Matrix of pair wise comparison and priority weight of the team work sub criteria

	SC2.1	**SC2.2**	**SC2.3**	**Priority Weight**
SC2.1	1.000	0.891	0.486	0.250
SC2.2	1.122	1.000	1.420	0.381
SC2.3	2.058	0.704	1.000	0.369
$\lambda_{max} = 3.103, CI = 0.051, CR = 0.089$				

Sub Criteria team work symbol
SC2.1. Able to Work Under Pressure
SC2.2. Able to Work with People from All Levels
SC2.3. Inter & Intra Personal Skill

The pair-wise matrix of comparison and priority weight of the sub-criteria of critical thinking was on Table 7 below.

Table 7
Matrix of pair wise comparison and priority weight of the critical thinking sub criteria

	SC3.1	**SC3.2**	**SC3.3**	**PriorityWeight**
SC3.1	1.000	0.918	1.016	0.322
SC3.2	1.089	1.000	1.596	0.396
SC3.3	0.984	0.627	1.000	0.281
$\lambda_{max} = 3.015, CI = 0.007, CR = 0.013$				

Sub Criteria critical thinking symbol
SC3.1. Problem solving skill
SC3.2. Creative & Innovative Thinking
SC3.3. Good Decision Making

The pair-wise matrix of comparison and priority weight of the sub-criteria of entrepreneurship skills was found on Table 8 below.

Table 8
Matrix of pair wise comparison and priority weight of the entrepreneurship skills sub criteria

	SC4.1	**SC4.2**	**SC4.3**	**PriorityWeight**
SC4.1	1.000	0.788	1.034	0.305
SC4.2	1.269	1.000	1.772	0.428
SC4.3	0.967	0.564	1.000	0.267
$\lambda_{max} = 3.010, CI = 0.005, CR = 0.009$				

Sub Criteria critical thinking symbol
SC4.1. Achievement Orientation
SC4.2. Integrity
SC4.3. Customer Oriented

Based on the calculation analysis using AHP method for each of the sub-criteria showed that the experts' assessments were consistent because the Consistency Ratio (CR) of each of the sub-criteria were < 0.1 as appeared on Table 5 to 8.

4.2. The weighting of criteria and sub-criteria using Fuzzy-AHP method

The weighting of criteria and sub-criteria in Fuzzy-AHP method was measured using the Formula 8 to 18. The results of twenty-four experts was transferred in form of pair-wise matrix of comparison as on Table 9. The assessment of twenty-four experts then were aggregated using the arithmetic-mean and the results showed in fuzzy matrix of pair-wise comparison as on Table 9 below.

Table 9
Fuzzy matrix of pair-wise comparison for criteria

Crite-Ria		**C1**			**C2**			**C3**			**C4**	
	l	**m**	**u**	**l**	**m**	**u**	**l**	**m**	**u**	**l**	**m**	**U**
C1	1.000	1.000	1.000	1.736	2.091	2.472	2.082	2.564	3.074	1.516	1.875	2.259
C2	1.519	1.867	2.226	1.000	1.000	1.000	2.314	2.872	3.445	1.895	2.343	2.825
C3	1.832	2.271	2.690	1.483	1.852	2.272	1.000	1.000	1.000	2.386	2.946	3.536
C4	2.310	2.866	3.433	1.825	2.346	2.888	1.185	1.463	1.770	1.000	1.000	1.000

Value of Fuzzy Synthetic Extent based on Formula 9 produced the follow results:
$SC_1 = (6.334, 7.530, 8.805) \otimes (0.027, 0.032, 0.038) = (0.172, 0.240, 0.338).$
$SC_2 = (6.728, 8.082, 9.496) \otimes (0.027, 0.032, 0.038) = (0.182, 0.258, 0.364).$
$SC_3 = (6.702, 8.069, 9.499) \otimes (0.027, 0.032, 0.038) = (0.182, 0.257, 0.364)$
$SC_4 = (6.320, 7.675, 9.091) \otimes (0.027, 0.032, 0.038) = (0.171, 0.245, 0.349)$

Degree of possibility $M_2 \geq M_1$ using the Formula 13 and 14, produced the follow results:

$$V(SC_1 \geq SC_2) = \frac{0.182 - 0.338}{(0.240 - 0.338) - (0.258 - 0.182)} = 0.898$$

$$V(SC_1 \geq SC_3) = \frac{0.182 - 0.338}{(0.240 - 0.338) - (0.257 - 0.182)} = 0.901$$

$$V(SC_1 \geq SC_4) = \frac{0.171 - 0.338}{(0.240 - 0.338) - (0.245 - 0.171)} = 0.973$$

$V(SC_2 \geq SC_1) = 1, V(SC_2 \geq SC_3) = 1, V(SC_2 \geq SC_4) = 1$
$V(SC_3 \geq SC_1) = 1$

$$V(SC_3 \geq SC_2) = \frac{0.182 - 0.364}{(0.257 - 0.364) - (0.258 - 0.182)} = 0.998$$

$V(SC_3 \geq SC_4) = 1.$
$(SC_4 \geq SC_1) = 1$

$$V(SC_4 \geq SC_2) = \frac{0.182 - 0.349}{(0.245 - 0.349) - (0.258 - 0.182)} = 0.927$$

$$V(SC_4 \geq SC_3) = \frac{0.182 - 0.349}{(0.245 - 0.349) - (0.257 - 0.182)} = 0.930$$

Vector weight was obtained using the Formula 16 and 17, produced the follow results:
$d'(SC_1) = V(SC_1 \geq SC_2, SC_3, SC_4) = \min(0.898, 0.901, 0.973) = 0.898$
$d'(SC_2) = V(SC_2 \geq SC_1, SC_3, SC_4) = \min(1.000, 1.000, 1.000) = 1.000$
$d'(SC_3) = V(SC_3 \geq SC_1, SC_2, SC_4) = \min(1.000, 0.998, 1.000) = 0.998$
$d'(SC_4) = V(SC_4 \geq SC_1, SC_2, SC_3) = \min(1.000, 0.927, 0.930) = 0.927$

Vector weight :
$W' = (d'(SC_1), d'(SC_2), d'(SC_3), d'(SC_4))^T = (0.898, 1.000, 0.998, 0.927)^T$

The result of vector weight normalization:
$$d'(SC_1) = \frac{0.898}{(0.898 + 1.000 + 0.998 + 0.927} = 0.235$$
$$d'(SC_2) = \frac{1.000}{(0.898 + 1.000 + 0.998 + 0.927} = 0.262$$
$$d'(SC_3) = \frac{0.998}{(0.898 + 1.000 + 0.998 + 0.927} = 0.261$$
$$d'(SC_4) = \frac{0.927}{(0.898 + 1.000 + 0.998 + 0.927)} = 0.243$$

So, the normalized vector weight for criteria:
$W = (0.235, 0.262, 0.261, 0.243)^T$

The calculating results of Fuzzy-AHP for the criteria as shown on Table 10 below:

Table 10
Result of Fuzzy AHP for criteria

Criteria		Weight
Communication Skills	C1	0.235
TeamWork	C2	0.262
CrititicalThinking	C3	0.261
EntrepreneurshipSkills	C4	0.243

The result of calculating analysis of the Fuzzy-AHP for criteria showed us that the criteria of team-work got the highest number (0.262), followed by the criteria of critical thinking (0.261), then entrepreneurship skills (0.243), and the last was communication skill (0.235).

The matrix of pair-wise comparison for Fuzzy-AHP, the aggregating result of the 24 experts' assessments appeared on Table 11 below.

Table 11
The matrix of pair-wise comparison for Fuzzy-AHP of sub-criteria of communication skills

Sub Criteria	**SC1.1**			**SC1.2**			**SC1.3**		
	l	**m**	**u**	**l**	**m**	**u**	**l**	**m**	**u**
SC1.1	1.000	1.000	1.000	2.156	2.792	3.438	1.279	1.569	1.910
SC1.2	0.635	0.802	1.019	1.000	1.000	1.000	1.169	1.419	1.722
SC1.3	1.382	1.853	2.335	1.622	2.174	2.734	1.000	1.000	1.000

Value of Fuzzy Synthetic Extent for sub-criteria Communication Skill based on the Formula 9 produced the follow results:

$S_{SC1.1} = (4.435, 5.360, 6.347) \otimes (0.062, 0.073, 0.089) = (0.275, 0.394, 0.565)$
$S_{SC1.2} = (2.804, 3.221, 3.741) \otimes (0.062, 0.073, 0.089) = (0.174, 0.237, 0.333)$
$S_{SC1.3} = (4.004, 5.027, 6.069) \otimes (0.062, 0.073, 0.089) = (0.248, 0.369, 0.540)$

Degree of possibility $M_2 \geq M_1$ for sub-criteria of communication skill using the Formula 13 and 14, produced the follow results:

$V(S_{SC1.1} \geq S_{SC1.2}) = 1$
$V(S_{SC1.1} \geq S_{SC1.3}) = 1$

$$(S_{SC1.2} \geq S_{SC1.1}) = \frac{0.275 - 0.333}{(0.237 - 0.333) - (0.394 - 0.275)} = 0.270$$

$$(S_{SC1.2} \geq S_{SC1.3}) = \frac{0.248 - 0.333}{(0.237 - 0.333) - (0.369 - 0.248)} = 0.390$$

$$(S_{SC1.3} \geq S_{SC1.1}) = \frac{0.275 - 0.540}{(0.369 - 0.540) - (0.394 - 0.275)} = 0.915$$

$(S_{SC1.3} \geq S_{SC1.2}) = 1$

Vector weight for sub criteria of communication skill was obtained using the Formula 16 and 17, produced the follow results:

$d'(S_{SC1.1}) = V(S_{SC1.1} \geq S_{SC1.2}, S_{SC1.3}) = \min(1.000, 1.000) = 1.000$
$d'(S_{SC1.2}) = V(S_{SC1.2} \geq S_{SC1.1}, S_{SC1.3}) = \min(0.270, 0.390) = 0.270$
$d'(S_{SC1.3}) = V(S_{SC1.3} \geq S_{SC1.1}, S_{SC1.2}) = \min(0.915, 1.000) = 0.915$

Vector weight for sub criteria of communication skill :
$W' = (d'(S_{SC1.1}), d'(S_{SC1.2}), d'(S_{SC1.3}))^T = (1.000, 0.270, 0.915)^T$

The normalized Vector weight for sub criteria communication skill produced the follow results:

$$d'(S_{SC1.1}) = \frac{1.000}{(1.000 + 0.270 + 0.915)} = 0.458$$

$$d'(S_{SC1.2}) = \frac{0.270}{(1.000 + 0.270 + 0.915)} = 0.124$$

$$d'(S_{SC1.3}) = \frac{0.915}{(1.000 + 0.270 + 0.915)} = 0.419$$

The normalized vector weight for sub-criteria of communication skills:
$W = (0.458, 0.124, 0.419)^T$

The pair-wise matrix of comparison for Fuzzy-AHP, the aggregating results of the 24 experts' assessment for sub-criteria of team-work was shown in Table 12 below.

Table 12
The pair-wise matrix comparison of Fuzzy-AHP for sub-criteria of teamwork

Sub Criteria	SC2.1			SC2.2			SC2.3		
	l	m	u	l	m	u	l	m	u
SC2.1	1.000	1.000	1.000	1.936	2.300	2.705	0.882	1.085	1.326
SC2.2	1.884	2.394	2.910	1.000	1.000	1.000	2.440	2.879	3.310
SC2.3	2.534	3.211	3.904	1.230	1.534	1.845	1.000	1.000	1.000

Value of Fuzzy Synthetic Extent for sub-criteria of team-work using the Formula 9. We got:

$$S_{SC2.1} = (3.818, 4.386, 5.031) \otimes (0.053, 0.061, 0.072) = (0.201, 0.267, 0.362)$$
$$S_{SC2.2} = (5.324, 6.273, 7.221) \otimes (0.053, 0.061, 0.072) = (0.280, 0.382, 0.519)$$
$$S_{SC2.3} = (4.764, 5.745, 6.749) \otimes (0.053, 0.061, 0.072) = (0.251, 0.350, 0.485)$$

Degree of possibility $M_2 \geq M_1$ for the sub-criteria of team-work applying the Formula 13 and 14, we got:

$$V(S_{SC2.1} \geq S_{SC2.2}) = \frac{0.280 - 0.362}{(0.267 - 0.362) - (0.382 - 0.280)} = 0.415$$
$$V(S_{SC2.1} \geq S_{SC2.3}) = \frac{0.251 - 0.362}{(0.267 - 0.362) - (0.350 - 0.251)} = 0.573$$
$$V(S_{SC2.2} \geq S_{SC2.1}) = 1, V(S_{SC2.2} \geq S_{SC2.3}) = 1$$
$$V(S_{SC2.3} \geq S_{SC2.1}) = 1$$
$$V(S_{SC2.3} \geq S_{SC2.2}) = \frac{0.280 - 0.485}{(0.350 - 0.485) - (0.382 - 0.280)} = 0.864$$

Vector weight for sub-criteria of team-work using the Formula 16 and 17 we got:

$$d'(S_{SC2.1}) = V(S_{SC2.1} \geq S_{SC2.2}, S_{SC2.3}) = \min(0.415, 0.573) = 0.415$$
$$d'(S_{SC2.2}) = V(S_{SC2.2} \geq S_{SC2.1}, S_{SC2.3}) = \min(1.000, 1.000) = 1.000$$
$$d'(S_{SC2.3}) = V(S_{SC2.3} \geq S_{SC2.1}, S_{SC2.2}) = \min(1.000, 0.864) = 0.864$$

Vector weight for sub-criteria of team-work :

$$W' = (d'(S_{SC2.1}), d'(S_{SC2.2}), d'(S_{SC2.3}))^T = (0.415, 1.000, 0.864)^T$$

The normalized vector weight for sub-criteria of team-work we got:

$$d'(S_{SC2.1}) = \frac{0.415}{(0.415 + 1.000 + 0.864)} = 0.182$$
$$d'(S_{SC2.2}) = \frac{1.000}{(0.415 + 1.000 + 0.864)} = 0.439$$
$$d'(S_{SC2.3}) = \frac{0.8644}{(0.415 + 1.000 + 0.864)} = 0.379$$

The normalized vector weight for sub-criteria of team work:

$$W = (0.182, 0.439, 0.379)^T$$

The matrix of pair-wise comparison of Fuzzy-AHP, the aggregating results of the 24 experts' assessment for sub-criteria of critical thinking was shown in Table 13 below.

Table 13
The pair-wise matrix of comparison of Fuzzy-AHP for sub-criteria of critical thinking

Sub criteria	SC3.1			SC3.2			SC3.3		
	l	m	u	l	m	u	l	m	u
SC3.1	1.000	1.000	1.000	1.921	2.198	2.464	1.656	1.973	2.327
SC3.2	1.699	2.121	2.544	1.000	1.000	1.000	2.207	2.759	3.319
SC3.3	1.510	1.856	2.211	1.109	1.349	1.625	1.000	1.000	1.000

Value of Fuzzy Synthetic Extent for sub-criteria of critical thinking using Formula 9 we got:

$$S_{SC3.1} = (\,4.578, 5.172, 5.791) \otimes (0.057, 0.066, 0.076) = (0.262, 0.339, 0.442)$$
$$S_{SC3.2} = (\,4.906, 5.879, 6.864) \otimes (0.057, 0.066, 0.076) = (0.280, 0.385, 0.524)$$
$$S_{SC3.3} = (\,3.619, 4.205, 4.836) \otimes (0.057, 0.066, 0.076) = (0.207, 0.276, 0.369)$$

Degree of possibility $M_2 \geq M_1$ for sub-criteria of critical thinking using the Formula 13 and 14, we got:

$$V(S_{SC3.1} \geq S_{SC3.2}) = \frac{0.280 - 0.442}{(0.339 - 0.442) - (0.385 - 0.280)} = 0.777$$
$$V(S_{SC3.1} \geq S_{SC3.3}) = 1$$
$$V(S_{SC3.2} \geq S_{SC3.1}) = 1$$
$$V(S_{SC3.2} \geq S_{SC3.3}) = 1$$
$$V(S_{SC3.3} \geq S_{SC3.1}) = \frac{0.262 - 0.369}{(0.276 - 0.369) - (0.339 - 0.262)} = 0.629$$
$$V(S_{SC3.3} \geq S_{SC3.2}) = \frac{0.280 - 0.369}{(0.276 - 0.369) - (0.385 - 0.280)} = 0.447$$

Vector weight for sub-criteria of critical thinking was obtained using the Formula 16 and 17 and produced the follow results:

$$d'(S_{SC3.1}) = V(S_{SC3.1} \geq S_{SC3.2}, S_{SC3.3}) = \min(0.777, 1.000) = 0.777$$
$$d'(S_{SC3.2}) = V(S_{SC3.2} \geq S_{SC3.1}, S_{SC3.3}) = \min(1.000, 1.000) = 1.000$$
$$d'(S_{SC3.3}) = V(S_{SC3.3} \geq S_{SC3.1}, S_{SC3.2}) = \min(0.629, 0.447) = 0.447$$

Vector weight for sub-criteria of critical thinking :

$$W' = (d'(S_{SC3.1}), d'(S_{SC3.2}), d'(S_{SC3.3}))^T = (0.777, 1.000, 0.447)^T$$

The normalized vector weight for sub-criteria of critical thinking we got:

$$d'(S_{SC3.1}) = \frac{0.777}{(0.777 + 1.000 + 0.447)} = 0.349$$
$$d'(S_{SC3.1}) = \frac{1.000}{(0.777 + 1.000 + 0.447)} = 0.450$$
$$d'(S_{SC3.1}) = \frac{0.447}{(0.777 + 1.000 + 0.447)} = 0.201$$

The normalized vector weight for sub-criteria of critical thinking:

$$W = (0.349, 0.450, 0.201)^T$$

The matrix of pair-wise comparison of Fuzzy-AHP, the aggregating results of the 24 experts' assessment for sub-criteria of entrepreneurship skills as shown on Table 14 below.

Table 14
The matrix of pair-wise comparison of Fuzzy-AHP for sub-criteria entrepreneurship skills.

Sub criteria	SC4.1			SC4.2			SC4.3		
	l	m	u	l	m	u	l	m	u
SC4.1	1.000	1.000	1.000	1.620	1.972	2.345	1.737	2.174	2.635
SC4.2	2.312	2.788	3.285	1.000	1.000	1.000	2.799	3.397	4.014
SC4.3	1.790	2.188	2.611	1.226	1.502	1.804	1.000	1.000	1.000

Value of Fuzzy Synthetic Extent for sub-criteria of entrepreneurship skills using the Formula 9 we got:
$S_{SC4.1} = (4.357, 5.146, 5.980) \otimes (0.051, 0.059, 0.069) = (0.221, 0.302, 0.413)$
$S_{SC4.2} = (6.111, 7.185, 8.299) \otimes (0.051, 0.059, 0.069) = (0.310, 0.422, 0.573)$
$S_{SC4.3} = (4.016, 4.690, 5.415) \otimes (0.051, 0.059, 0.069) = (0.204, 0.276, 0.374)$

Degree of possibility $M_2 \geq M_1$ for sub-criteria of entrepreneurship skills using the Formula 13 and 14, we got:

$$V(S_{SC4.1} \geq S_{SC4.2}) = \frac{0.310 - 0.413}{(0.302 - 0.413) - (0.422 - 0.310)} = 0.461$$

$V(S_{SC4.1} \geq S_{SC4.3}) = 1$
$V(S_{SC4.2} \geq S_{SC4.1}) = 1, V(S_{SC4.2} \geq S_{SC4.3}) = 1$

$$V(S_{SC4.3} \geq S_{SC4.1}) = \frac{0.221 - 0.374}{(0.276 - 0.374) - (0.302 - 0.221)} = 0.850$$

$$V(S_{SC4.3} \geq S_{SC4.2}) = \frac{0.310 - 0.374}{(0.276 - 0.374) - (0.422 - 0.310)} = 0.303$$

Vector weight for sub-criteria of entrepreneurship skills using the Formula 16 and 17, produced the follow results:
$d'(S_{SC4.1}) = V(S_{SC4.1} \geq S_{SC4.2}, S_{SC4.3}) = \min(0.461, 1.000) = 0.461$
$d'(S_{SC4.2}) = V(S_{SC4.2} \geq S_{SC4.1}, S_{SC4.3}) = \min(1.000, 1.000) = 1.000$
$d'(S_{SC4.3}) = V(S_{SC4.3} \geq S_{SC4.1}, S_{SC4.2}) = \min(0.850, 0.303) = 0.303$

Vector weight for sub-criteria of entrepreneurship skills:
$W' = (d'(S_{SC4.1}), d'(S_{SC4.2}), d'(S_{SC4.3}))^T = (0.4614, 1.000, 0.3025)^T$

The Normalized vector weight for sub-criteria of entrepreneurship skills produced the follow results:

$$d'(S_{SC4.1}) = \frac{0.461}{(0.461 + 1.000 + 0.303)} = 0.262$$

$$d'(S_{SC4.2}) = \frac{1.000}{(0.461 + 1.000 + 0.303)} = 0.567$$

$$d'(S_{SC4.3}) = \frac{0.303}{(0.461 + 1.000 + 0.303)} = 0.172$$

The normalized vector weight for sub-criteria of entrepreneurship skills:
$W = (0.262, 0.567, 0.172)^T$

4.3. The comparison analysis of the calculating results of AHP and Fuzzy-AHP methods

The comparison of calculating results of the AHP and Fuzzy-AHP for criteria appeared on Table 15 and Figure 4 below:

Table 15
The comparison analysis results of the AHP and fuzzy AHP for criteria

Criteria		Weight (AHP)	Weight (F-AHP)
Communication Skills	C1	0.238	0.235
Team Work	C2	0.260	0.262
Critical Thinking	C3	0.257	0.261
Entrepreneurship Skills	C4	0.246	0.243

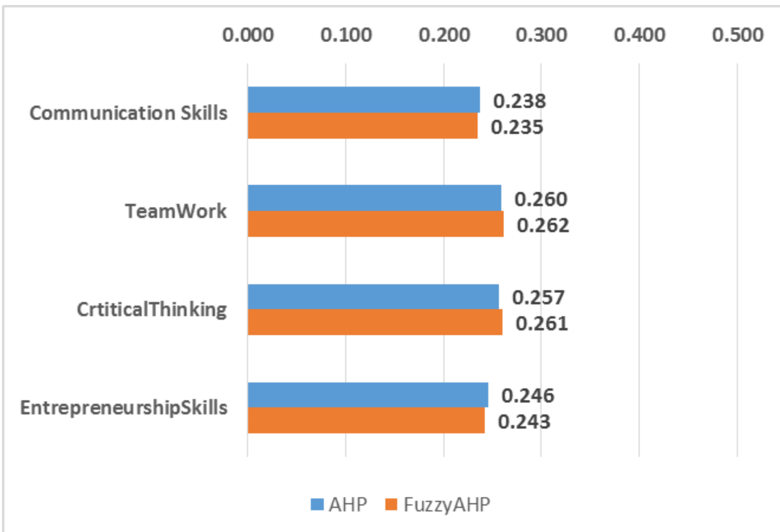

Fig.4. The comparison analysis results of the AHP and the Fuzzy-AHP for Criteria

From the results in Table 15 and Figure 4, we conclude that there were no differences of results between the two methods. The criteria of teamwork were the number one and got the highest number, followed by the critical thinking, then entrepreneurship skills and the last was communication skills. The differences of the results of both the AHP and Fuzzy-AHP were quite small. For example, the difference result of criteria of teamwork between AHP and Fuzzy-AHP was only 0.0439; for the critical thinking was 0.0075. It was also true for the comparison between the criteria. For example, the differences between the criteria of teamwork (Fuzzy-AHP 0.2456) and the criteria of critical thinking (Fuzzy-AHP 0.2224), the difference was only 0.0232.

The comparison results of analysis for each of the sub-criteria was shown on tables and figures below.

Table 16
The comparison analysis of sub-criteria of communication skills.

Criteria		Weight (AHP)	Weight (F-AHP)
English Fluent	SC1.1	0.386	0.458
WritingSkills	SC1.2	0.231	0.124
Expressing/PresentingIdea	SC1.3	0.383	0.419

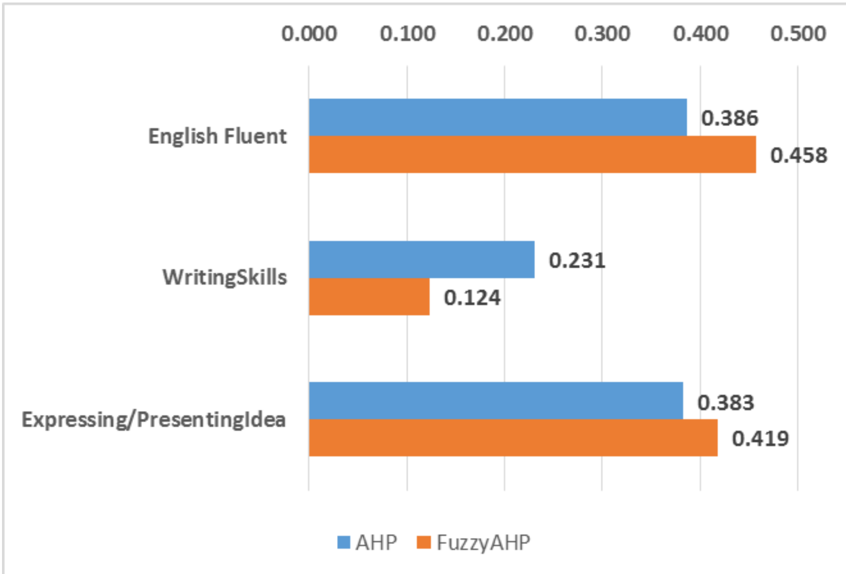

Fig.5. The comparison result analysis of AHP and Fuzzy AHP for sub-criteria Communication Skills

Table 17
The comparison result analysis of the sub-criteria of team-work

Criteria		Weight (AHP)	Weight (F-AHP)
AbleToWorkUnderPressure	SC2.1	0.250	0.182
AbleToWorkWithPepoleFromAllLevel	SC2.2	0.381	0.439
Inter&IntraPersonalSkills	SC2.3	0.369	0.379

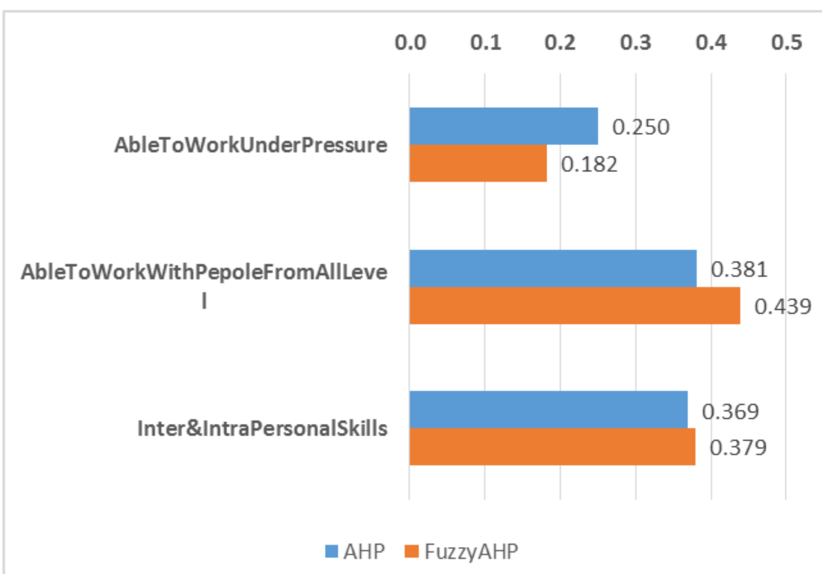

Fig.6. The comparison result analysis of AHP andFuzzy AHP for sub-criteria of team work

Table 18
The comparison result analysis for sub-criteria of critical Thinking

Criteria		Weight (AHP)	Weight (F-AHP)
ProblemSolvingSkill	S32.1	0.322	0.349
Creative&InnovativeThinking	SC3.2	0.396	0.450
GoodDecisionMaking	SC3.3	0.281	0.201

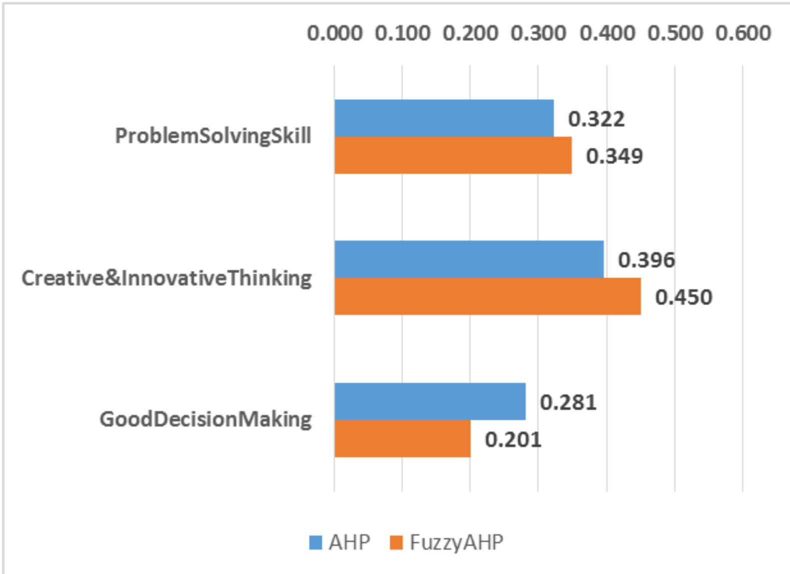

Fig.7. The comparison result analysis of sub criteria of critical thinking

Table 19
The comparison result analysis of sub-criteria of entrepreneurship skills.

Criteria		Weight (AHP)	Weight (F-AHP)
AchievementOrientation	SC4.1	0.305	0.262
Integrity	SC4.2	0.428	0.567
CustomerOriented	SC4.3	0.267	0.172

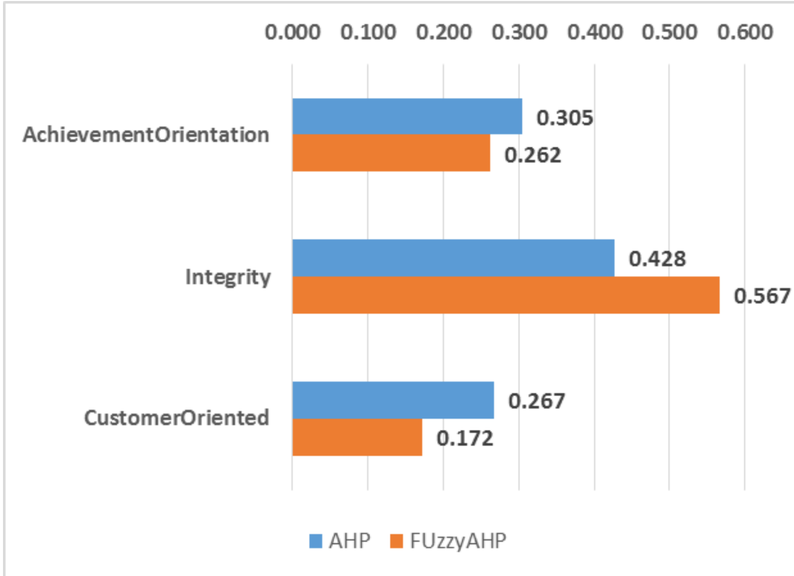

Fig.8. The comparison result analysis of the sub-criteria of Critical Thinking

4.4. The global calculating results

The global result or global weight of the dominant factor of soft-skills, the graduates in Manado should possess based on the assessment of 24 experts, was obtained by multiplication between the criteria and each sub-criterion. Based on the calculation we got the results of the global weight as shown in Table 9 below:

Table 20
Global weight

Criteria/Sub Criteria		Local Weight		Global Weight		LocalPriority		GlobalPriority	
		AHP	F-AHP	AHP	F-AHP	AHP	F-AHP	AHP	F-AHP
Communication Skills	C1	0.238	0.235			4	4		
TeamWork	C2	0.260	0.262			1	1		
CrtiticalThinking	C3	0.257	0.261			2	2		
EntrepreneurshipSkills	C4	0.246	0.243			3	3		
	Sum	1.000	1.000						
Communication Skills Sub Criteria									
Fluent in English	SC1.1	0.386	0.458	0.092	0.107	1	1	5	4
WritingSkills	SC1.2	0.231	0.124	0.055	0.029	3	3	12	12
Expressing/PresentingIdea	SC1.3	0.383	0.419	0.091	0.098	2	2	6	6
	Sum	1.000	1.000	0.238	0.235				
Team Work Sub Criteria									
AbleToWorkUnderPressure	SC2.1	0.250	0.182	0.065	0.048	3	3	11	10
AbleToWorkWithPepoleFromAllLevel	SC2.2	0.381	0.439	0.099	0.115	1	1	3	3
Inter&IntraPersonalSkills	SC2.3	0.369	0.379	0.096	0.099	2	2	4	5
	Sum	1.000	1.000	0.260	0.262				
Critical Thinking Sub Criteria									

ProblemSolvingSkill	SC2.1	0.322	0.349	0.083	0.091	2	2	7	7
Creative&InnovativeThinking	SC3.2	0.396	0.450	0.102	0.117	1	1	2	2
GoodDecisionMaking	SC3.3	0.281	0.201	0.072	0.052	3	3	9	9
	Sum	1.000	1.000	0.257	0.261				
Entrepreneurship Skills Sub Criteria									
AchievementOrientation	SC4.1	0.305	0.262	0.075	0.063	2	2	8	8
Integrity	SC4.2	0.428	0.567	0.105	0.138	1	1	1	1
CustomerOriented	SC4.3	0.267	0.172	0.066	0.042	3	3	10	11
	Sum	1.000	1.000	0.246	0.243				

The global weight revealed that integrity was the soft-skills dominant factor. The result calculation of the integrity was the highest both for the AHP (0.105) and for the Fuzzy-AHP (0.138).

5. Discussion

The AHP and Fuzzy-AHP methods were used to determine the soft-skills dominant factors that the graduates in Manado need to possess to be able to compete in the Industrial 4.0 era.

The research findings will be used to improve the curriculum, teaching-learning systems of the higher institution particularly at Universitas Katolik De La Salle Manado (De La Salle Catholic University of Manado-Indonesia). The criteria and sub-criteria were determined by the experts based on previous studies. The researchers designed questionnaires in the form of a pair-wise comparison matrix. The analysis of consistencies verified that the results were consistent and considered scientifically acceptable.

The results proved, as shown on Table 20, that the criteria of teamwork was the dominant factor, followed by critical thinking, then entrepreneurship skills and the last was communication skills. The research findings both for AHP and Fuzzy-AHP were the same. The differences of the results between the criteria AHP and Fuzzy- AHP were small. For example, the result gap between AHP and Fuzzy-AHP for criteria teamwork was only 0.0439, critical thinking 0.0075. It was also true for the resulting gap between the criteria themselves. For example, the difference gap between the criteria of teamwork (Fuzzy-AHP 0.2456) and criteria of critical thinking (Fuzzy-AHP 0.2224) was only 0.0232. The differences are understandable because the Fuzzy-AHP uses triangular fuzzy numbers unlike the AHP which uses a single value.

The global analysis (Table 20) shows that integrity was the dominant factor. The findings recommend that in the Industrial era of 4.0 the higher institutions in Manado need to provide students with team-work skills. The team-work skills should appear in the curriculum and teaching-learning system. School faculties and teaching methods must focus on providing team-work skills. The sectoral ego will not be effective in the era of Industry 4.0. Everybody needs to work together to be successful. However other skills such as critical thinking, entrepreneurship and communication must also be considered because those criteria also support the future success of the graduates. Combining criteria would produce a large number, so failure to acknowledge them will downgrade of graduates' competencies.

The study advocates that whatever profession and job they have, team-work must be given a priority. The interconnection amongst human being, machines and objects in Industry 4.0 requires team players. Compatibility of products, systems and services are only possible if there is teamwork.

The overall result or global weight shows that integrity has the highest score 0.0892 (AHP) and 0.1220 (Fuzzy-AHP). It means that the superior skill in Industry 4.0 is integrity. Integrity is defined as conformity between words and doing, otherwise it is manipulation. Integrity is a key to success in Industry 4.0 and it must be incorporated into the curriculum, teaching-learning materials, studying system and educational processes. Integrity means to behave in an honest, fair, and ethical manner. Mondal mentioned that integrity is the ability to act with honesty and be consistent in whatever it is one is doing based on the particular moral, value or belief compass he has (Mondal, 2015). Covey defined integrity as "honestly matching words and feelings with thoughts and actions, with no desire other than for the good of others"(Pillay, 2014). The Latin word "integritas" denoted to wholeness or unity. It means that to attain integrity, someone has to be whole and undivided. In the scholarly discourses this position is called "integrated-self view" and it implies that "integrity is a matter of persons integrating various parts of their personality into a harmonious, intact whole (Schottl, 2015).

These findings are in line with the LaSallian's expected qualities known as Elga (expected Lasallian graduate attributes). These attributes are effective communicator, critical and creative thinker, lifelong learner, service driven-citizen, steward of the environment and entrepreneurial spirit.

The AHP and Fuzzy- AHP methods were appropriate for this study. The rankings were produced by AHP and Fuzzy-AHP are the same even though there are numerical differences between them. It is because AHP uses crisp number while Fuzzy-AHP applies triangular fuzzy numbers so it can capture the uncertainties or vagueness of the perceptions. We had to be aware that both AHP and Fuzzy-AHP were not competing with each other. We used AHP if the evaluation or information was definite. However, if the information or evaluation was still blurred and uncertain, then we used Fuzzy-AHP. Many times, these two methods were used just to compare the results and to determine how the size of the differences. The Fuzzy-AHP is appropriate to use in a study intended to comprehend human reasoning like this research.

AHP is a good methodology when there was a lack of statistical data and the researchers have to rely on the experts' choice. For the experts or respondents, the AHP questionnaire, in form of pair-wise comparison matrix is quite helpful since they only had to compare two options. One of the limitations of this study was the unfamiliarity in the part of the respondent toward the AHP method. There was some confusion answering the questionnaire and that required the researchers to drill the respondent to determine their choice. Most of them felt indifferent about the options. They found out that there was little difference between the criteria or sub-criteria.

The limitation of AHP is that it cannot evaluate the vagueness since it uses crisp number while in the real-world problems are not always represented by crisp number. In human lives, the reality all things are not black and white.

Furthermore, the limitation of the Fuzzy-AHP especially Chang's extent analysis was that the decision maker could make a wrong decision if it assigned zero weights to some items such as criteria or sub-criteria and most of the time the researcher excluded them from their decision analysis. However, it was well understood since the Chang's Formula gave the option to get a zero weight if the condition required it to happen. If there was a zero weight we can conclude that the criteria or sub-criteria was not significant when compared to other criteria or sub-criteria. Changs Formula calculated the triangular fuzzy numbers only approximately, therefore there may be serious uncertainties under certain conditions (Radionovs & Uzhga-rebrov, 2017).

However, despite the limitation of Chang's Fuzzy-AHP method, the researchers found out that Chang's extent analysis was the most popular Fuzzy-AHP method being used by experts. Both the AHP and Fuzzy-AHP were appropriate in this study.

6. Conclusion

This study aimed to find out the soft-skills determinate factors that the graduates of higher education should possess to be successful in Industry 4.0 and to compare the results of AHP and Fuzzy-AHP

The results of the study showed that the criteria of team-work were the highest priority followed by critical thinking, entrepreneurial skill and communication skills. Moreover, the global weight calculation proved that the element of integrity was the highest factor, followed by the ability to work with people of all levels, then having intra-extra personal skills, followed by creative and innovative thinking and then the fluency in English (Table 20).

While team-work as the most dominant and integrity were the top global weights, other criteria and elements should not be ignored. It was because the team-work and integrity will be effective and successful in combination with other criteria and elements. Moreover, the numerical differences between the criteria were quite small. It was also true with other elements of global weights. Failing to count other criteria and sub-criteria will jeopardize the findings, because if those criteria with smaller numerical results combined, they will yield a significant number.

The findings might be different with other research based in different situations. The researchers suggest caution when it came to implementation of the results. Factors such as lack of knowledge and undistinguished opinion in the options of the respondents should be seriously taken into consideration.

The calculation of the Fuzzy-AHP method took longer but had higher accuracy than the AHP. It can catch the vagueness of in human thinking style and effectively solve multi criteria decision making problems.

The result of the study has implications for management. First, the dominant criteria should be used as guidelines for management decision for making changes. In this study the greatest attention should be given to team-work and integrity. Second, there were only small numerical differences between the criteria and the global weight result. The research suggests a need to do comparative research with other institutions to find out whether there would be different results. Since the changes are happening fast, the same research needs to be conducted regularly. Third, every researcher has different interpretations, so the narrative of the background and ranking methodologies is necessary.

The researchers recommend future studies using the same or different soft-skills criteria using entrepreneur, owners or business management as respondents.

Acknowledgement

This paper is dedicated to all civitas academica of Universitas Katolik De La Salle Manado-Indonesia on its 20th anniversary.

The authors declare that they have no conflict of interest.

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