

ICT Ontology as Tool to Measure Profession and Career

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ABSTRACT: *In the rapidly changing skill of ICT career, professionals in ICT career must be continually developed and trained. Professional in ICT career development should have planned to define career path. Gathering career information, finding, collecting, analyzing will more useful. Moreover, using semantic relation analysis will make use of an information and meet individual needs in order to career path, career development, career trend and career properties. The purpose of this paper was to ICT career path analysis from weight metric skill of ICT career by using cosine similarity measure. The results demonstrate the similar skills of ICT career that are career path appropriate and easy to develop. We use professional level on the standard of ISCO-08 to compare with ICT career path result show that percent accuracy. Therefore, ICT career path are able to use a guide for career development and achieve career goals quickly to many interested people, professional of ICT career, ICT student and job seekers.*

Keywords: ICT Career, ICT Career path, Cosine Similarity, ISCO-08

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1. Introduction

The Job Markets are source of employment services which provide and match the knowledge and skill needed for government and companies which provide jobs to people who wish to find a job. ICT careers are popular careers in job markets both national and international job market. The job markets services will provide services via Job Portal websites, well-known as Online Careers Center Service (OCCS) which places for announcing the job qualifications from many job careers with many companies. The example of job portal websites such as CareerBuilder, HotJobs, Monster, JobsDB. A large number of careers in OCCS and various sources and organizations cause a problem which is an inconsistency of competent description among organizations. Some competence or skills are required by project activities [1]. Growth factors of job market are 1) The rapid growth of the organization 2) The development of information technology including hardware infrastructure and software. Both factors are influence to students, educational institutions, job seekers or applicants who looking career. They should know the state of career information and requirement of qualification about ICT knowledge and skills. Then jobs data analysis and presentation by using Semantic Relation analysis and Semantic Relation demonstration will make useful of an information and meet individual needs in order to Career Path, Career Development, Career Trend and Career Properties.

In previous research [2], we have proposed and demonstrated ICT analysis by using Semantic Relations and ontology which can be described the relationship of ICT career to users as needs and to become more effective searching than common searching that we found the key element which help to combine in various opinions. ICT Career path are important in determining the appropriateness of applicants and the same as important for applicants in selecting jobs or improving themselves to get opportunities in their careers. Moreover, for students and educational institution ICT skills information will be specified their qualifications and what should be given to graduates to leave the workforce. The similar skills found in a various job postings can be indicator of labour market trend to people who use the data.

Therefore, in this paper propose weighted cosine similarity in order to calculate the information of ICT Skill from all careers and each career group. To demonstrate ICT career path information in term of visualization in order to highlight the most skills found in careers by using weight of the semantic relationship. The order of the contents are describing the ontology of ICT career then describing how to gather data and calculate weight and frequency. And last propose the results of career path in term of visualization.

We organize this paper as follows; Section 2 shows information on competence of ICT career in ISCO-08 for classified and classified knowledge in ICT career, term frequency weighted measure and cosine similarity. Section 3 illustrates propose method to ICT Career Path analysis by using ICT Career ontology. Section 4 illustrates implement and result of ICT Career path analysis and an example on ICT career path Section 6 gives the conclusion and future work.

2. Related Work

In this section, we explain a background ICT career and weighted measure by frequency ICT Career each group in database is very important and has been studied cosine similarity.

2.1 Competence of ICT Career

The competence is set of components knowledge, skills, and attitudes (KSA). The human resource management focuses on skills and behaviors that an individual needs to be effective in a particular work area. Many organizations adopt Competence Management systems (CMS) which is system supportive of knowledge intensive organizations that are embracing a core competence. CMS has been used the principle of balanced competence descriptions to define the balance formal and informal indicators of competence in competence descriptions. While formal descriptions of competence refer to documented knowledge and skills acquired such as earning a degree, attending training course, informal descriptions of competence refer to on-the-job experiences, interests, personal characteristics, and behaviors [3-4].

2.2 Information and Communications Technology Career

ICT careers information are also used in a wide range of research topic such as matching job seekers with job vacancies[2], educational planning, and so on. The rapid changes that have taken place in information and communications technologies, and the influence of these changes on the occupation structure of the labour market. Therefore, International Standard Classification of Occupations 2008 (ISCO-08) was adopted by International Labour Organization (ILO)¹ which is to promote rights at work, encourage decent employment opportunities, enhance social protection and strengthen dialogue on work-related issues [5].

The ISCO-08 is a four-level hierarchically structured classification that allows all jobs in the world to be classified into 436 unit groups, based on their similarity in terms of the skill level. Career skill level involve the performance include of Level 1 a simple and manual tasks, Level 2 an operating machinery and electronic equipment, Level 3 a complex technical and practical tasks, and Level 4 a require complex problem-solving and decision-making base on a factual knowledge in a specialized field [5]. Figure 1. shows ICT careers major groups contains 3 levels the following information.

A level Information and Communications Technology Services Mangers (ICTSM) plan direct and coordinate the acquisition, development, maintenance and use of computer, such as Data Processing Manager, Application Development Manager, Information Technology Manager.

¹ <http://www.ilo.org/public/english/bureau/stat/isco/isco08/>

B level Information and Communications Technology Professionals (ICTP) plan, design, write, test, provide and improve information technology systems, develop, maintain and support database, include of sub-major group are Software and Applications Developers and Analysts (SADA), such as System Analysts, Software Developers, Web and Multimedia Developer and Application Programmers, and Database and Network Professionals (DNP), such as Database Designer and Administrators, System Administrators and Computer Network Professionals.

C level Information and Communications Technicians (ICT) are classified into the Information and Communication Technology Operations and User Support Technicians (ICTOUST) which provide support for the day-to-day running of communications systems computer systems and networks such as ICT Operations Technicians (ICTOT), ICT User Support Technicians (ICTUST), Computer Network and System Technicians (CNST) and Web Technicians (WT).

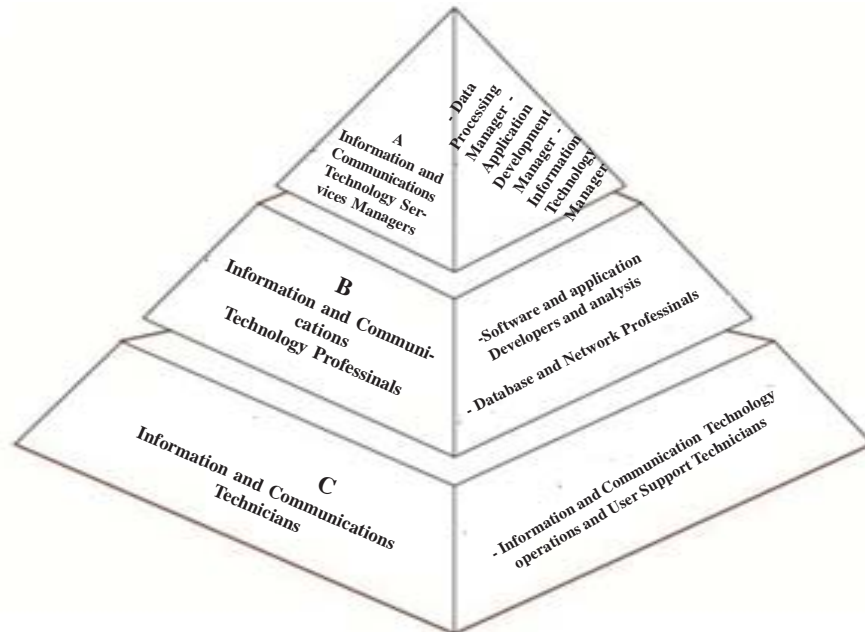


Figure 1. ICT Career Level of ISCO-08

2.3 Term Frequency Weighted

The weight of specification determine their representative for ICT careers. This paper adapt weights calculate of document term matrix algorithm [12], which we consider the number of occurrence of a specification in the ICT career. The equation (1) is:

$$W_{i,j} = \frac{freq_{i,j}}{itemfreq_{i,j}} \quad (1)$$

$W_{i,j}$ is weight of specification “i” in the ICT Career “j”

$freq_{i,j}$ is number of item specification “i” in ICT Career “j”

$itemfreq_{i,j}$ is frequency of item specification in ICT Career

2.4 Cosine Similarity

We apply cosine similarity to measure of similarity between two ICT careers in vectors form of space that measures the cosine of angle between them, similarity between ICT careers items a and b, denoted by $sim(a, b)$ is given by equation (2):

$$sim(a, b) = \cos \theta = \frac{\vec{a} \cdot \vec{b}}{\|\vec{a}\| \cdot \|\vec{b}\|} = \frac{\sum_{i=1}^n a_i \times b_i}{\sqrt{\sum_{i=1}^n (a_i)^2} \times \sqrt{\sum_{i=1}^n (b_i)^2}} \quad (2)$$

where \vec{a} and \vec{b} are weight vector between two ICT career, are the norm of a both vector, $\|\vec{a}\| \|\vec{b}\|$ the resulting similarity ranges from 0 to 1, to 1 meaning exactly the same, with 0 indicating independence or dissimilarity.

3. Proposed Method

Based on the literature reviewed in the previous section, we present the process of ICT career path analysis is following:

3.1 Input ICT Career Specification

The first step is input specification of the ICT career. We collected career specification from ICT job portal websites consist of 550 careers which is a requirement of the various employers. Specifications of the ICT Careers are technical skill and soft skill. For example, Software Developer employer requires a technical skill set in the following MS SQL, MySql, ASP.Net, OOAD, Windows and Linux; and soft skill in the following Good Analytical, Interpersonal Skill, Under Pressure and Self-Motivation.

3.2 ICT Career Ontology

ICT Career Ontology was adopted this research, which defined term reference by the International Standard Classification of Occupation 2008 (ISCO-08). ISCO-08 provides a system for classifying and aggregating occupational information. ICT Career set of 11 career group 3 levels shown in Figure 1. The hierarchical structure model of ICT Career Ontology was defined relation among terms on the relations, is-a, part-of and attribute-of relation. Is-a and part-of relation are the relation which connecting between classes, attribute-of relation is defined by the primitive data type, such as string, integer, boolean and so on. For example technical skill and soft (personal) skill are part-of ICT careers. “Java Programmer” is name of Application Programmer for ICT Career which have Good Analytical, Interpersonal Skill and Good Team Working for Soft Skill, shown in Figure 2.

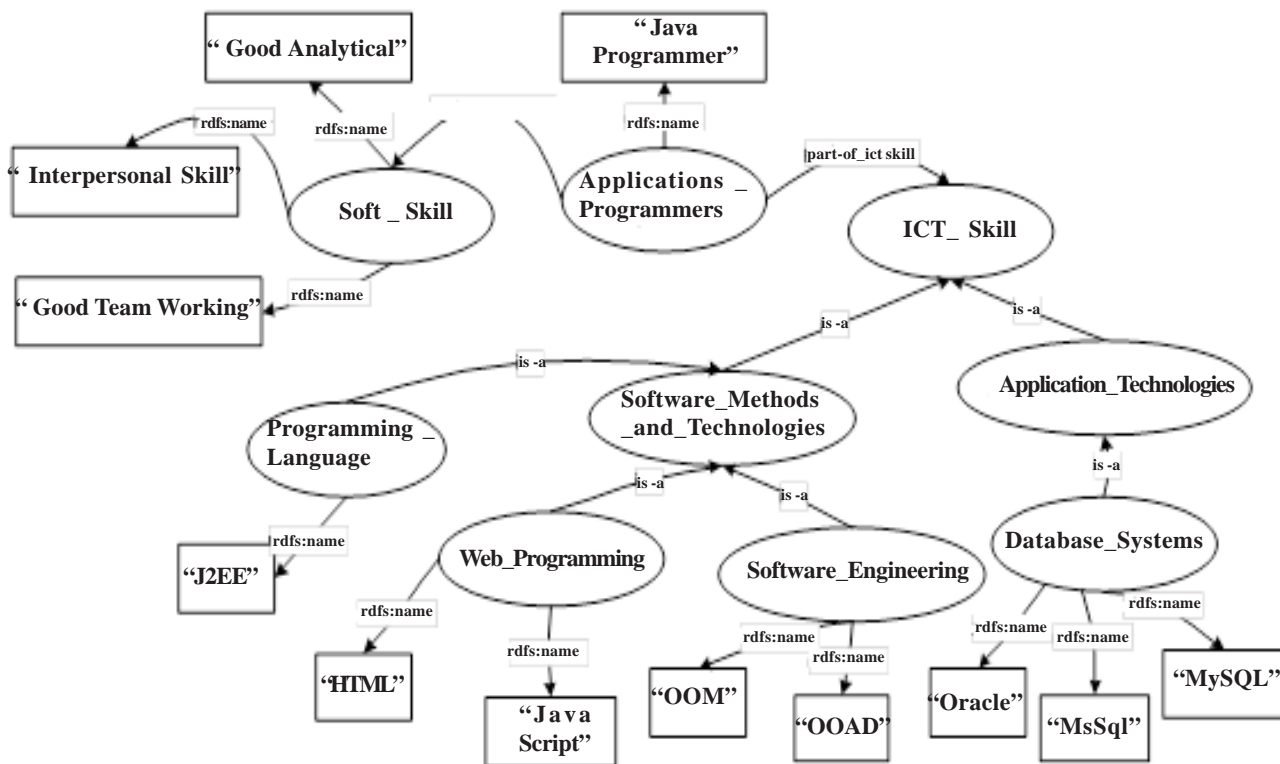


Figure 2. Application Programmer ICT Career Ontology

3.3 Classify Career and Weight Measurement

The third step is represented by obtain a weight standard relationships of ICT Career Ontology with a weight parameter each item in a data description [2]. This paper uses ICT Career ontology to compute weight, between concepts in adjacent term. Table 1 shows the levels of relevance between ontology members which define three relevance levels consist of direct, strong and normal which these have value 1.0, 0.9 and 0.6 respectively, shown in Table 1.

Relevance Level	Concept/Individual	Relevance Quantification
Direct	Synonyms	1
Strong	Hyponyms, Hypernyms (is-a)	0.9
Normal	Meronyms, holonym (part-of)	0.6

Table 1. Relevance between ontology levels

Specifications of ICT Career from first step are calculated weighting skills (terms) equation (1). We propose a specifications weighting based on combine between skills (terms) frequency weighting and relevance ontology levels weight. The equation is (3).

$$W_i = \frac{w_i + R_i}{2} \quad (3)$$

w_i is term frequency weighted of skill (terms) “ i ”

R_i is relevance ontology levels weight of skill (terms) “ i ”

W_i is weighted of skill (terms) “ i ”

3.4 ICT Career Similarity Measurement

This step is measure ICT Career similarity consist of 11 careers which have a weighted value from previous step. ICT career similarity measurement was measured by Cosine Similarity for Vector Space Model (VSM) (2) that is used in relevancy ranking of each ICT career. ICT Career used the assumptions of document similarities theory where ICT Career vector is compared the angle between each ICT career. We describe the result of ICT Career similarity, shown in Table 2.

3.5 Career Path Measurement

The last step is construction ICT career relationship which used by cosine similarity. The purpose of this paper is path analyze in relational between ICT career. Our Career Path measures in this paper are following:

- ICT Careers specifications vectors are a weight of skill frequency which is calculated by equation (3). For example, the skills specification weighted of Information Technology Manager is showed in Table 1 for 15th first value of highest skills weighted.
- ICT Careers consist of 11 careers and 3 levels is calculated similarity among ICT Careers vectors by equation (2). We show result as a comparison among ICT Careers in Table 2.
- Career Paths calculation have following step;
 - o Set an ICT Career target that find an ICT Career similar to the target and a similar descending sequence.
 - o Set an ICT Career start that find an ICT Career similar to the start and a similar descending sequence.
 - o Calculate Career Path of ICT Career start to target with the minimum value of the total similar sequence.

4. Implement and Results

ICT careers existing in job web portals are online human resource requirement of ICT industry which is not convenience for ICT careers analyze. This research analyzes the relations between ICT careers 11 career, which used ICT careers received 550 records filtered data and ICT Career ontology structure to description relationship. This paper is the set of skill for all ICT career to a career group. Skills are terms each ICT careers; we calculate term frequency weighted the equation (3). The results were calculated from 550 ICT Careers and 11 ICT Careers group. For example, see Table 2 shown 15th first value of highest skill weighted of Information Technology Manager and skill weighted of 3 ICT Career of 3 levels on ISCO-08 to compare skill weighted consist of ICT Operations Technicians level C and System Administrator, Application Programmer level B. This study, the target ICT Career is Information Technology Manager and start ICT Career is ICT Operations Technicians and Application Programmer.

ICT Career Skill	Information Technology Manager	System Administrator	Application Programmer	ICT Operations Technicians
Network System	0.21	0.07	-	0.28
Network Security	0.04	0.14	-	0.08
Linux	0.04	0.17	-	0.04
Unix	0.04	0.10	-	-
Software Design	0.07	-	0.21	-
RDBMS	0.07	-	0.00	-
ERP	0.07	-	-	-
SAP	0.07	-	-	-
MS SQL	0.04	0.17	0.26	0.08
ASP.Net	0.04	0.10	0.11	0.00
SQL Language	0.04	0.03	0.11	0.04
Good Analytical	0.07	0.10	0.26	0.12
ProblemSoving	0.07	-	-	0.04
Interpersonal skill	0.11	0.10	0.05	0.32
Leadership skill	0.04	-	-	-

Table 2. 15th First value of highest Skill Weighted of Information Technology Manager

ICT Career	Application development Manager	Information Technology Manager	System Analysts	Software Developer	Web Developer	Application Programmer	Database Administrator	System Administrator	Computer Network Professionals	ICT Operations Technicians	ICT User Support Technicians
Application development Manager	0	0.60	0.52	0.55	0.47	0.32	0.44	0.47	0.42	0.40	0.36
Information Technology Manager	0.60	0	0.53	0.49	0.41	0.46	0.50	0.61	0.58	0.44	0.46
System Analysts	0.52	0.53	0	0.79	0.69	0.61	0.76	0.67	0.60	0.58	0.61
Software Developer	0.55	0.49	0.79	0	0.63	0.67	0.62	0.61	0.52	0.52	0.57
Web Developer	0.47	0.41	0.69	0.63	0	0.58	0.54	0.50	0.46	0.44	0.47
Application Programmer	0.32	0.46	0.61	0.67	0.58	0	0.49	0.57	0.51	0.50	0.52
Database Administrator	0.44	0.50	0.76	0.62	0.54	0.49	0	0.69	0.68	0.59	0.63
System Administrator	0.47	0.61	0.67	0.61	0.50	0.57	0.69	0	0.88	0.77	0.77
Computer Network Professionals	0.42	0.58	0.60	0.52	0.46	0.51	0.68	0.88	0	0.74	0.75
ICT Operations Technicians	0.40	0.44	0.58	0.52	0.44	0.50	0.59	0.77	0.74	0	0.79
ICT User Support Technicians	0.36	0.46	0.61	0.57	0.47	0.52	0.63	0.77	0.75	0.79	0

Table 3. ICT Career Cosine Similarity

The resulting similarity of ICT Career ranges from 0.0 – 1.0, to 1 meaning the same, with 0 indicating independence. The cosine similarities of 45 dual ICT Careers were as shown in Table 3.

The ICT Career paths compare with the maximum similarity value which can select ICT career similar to career development. ICT careers relationship was compared by ICT professional level on ISCO-08 explanation which is a close relationship between ICT Career selections. ICT Operations Technicians (ICTOT) and Application Programmer (AP) is ICT Career the start of selections to career development which shown in Table 3 ICT Career Path to Information Technology Manager that select short distance total of ICTOT to ITM is 3 and AP to ITM is 5. Therefore, AP develop to System Administrator and to ITM, ICTOT develop to System Administrator and to ITM, shown in Table 4.

ICT Career	Application development Manager	Information Technology Manager	System Analysts	Software Developer	Web Developer	Application Programmer	Database Administrator	System Administrator	Computer Network Professionals	ICT Operations Technicians	ICT User Support Technicians
Application development Manager	0	0.60	0.52	0.55	0.47	0.32	0.44	0.47	0.42	0.40	0.36
Information Technology Manager	0.60	0	0.53	0.49	0.41	0.46	0.50	0.61	0.58	0.44	0.46
System Analysts	0.52	0.53	0	0.79	0.69	0.61	0.76	0.67	0.60	0.58	0.61
Software Developer	0.55	0.49	0.79	0	0.63	0.67	0.62	0.61	0.52	0.52	0.57
Web Developer	0.47	0.41	0.69	0.63	0	0.58	0.54	0.50	0.46	0.44	0.47
Application Programmer	0.32	0.46	0.61	0.67	0.58	0	0.49	0.57	0.51	0.50	0.52
Database Administrator	0.44	0.50	0.76	0.62	0.54	0.49	0	0.69	0.68	0.59	0.63
System Administrator	0.47	0.61	0.67	0.61	0.50	0.57	0.69	0	0.88	0.77	0.77
Computer Network Professionals	0.42	0.58	0.60	0.52	0.46	0.51	0.68	0.88	0	0.74	0.75
ICT Operations Technicians	0.40	0.44	0.58	0.52	0.44	0.50	0.59	0.77	0.74	0	0.79
ICT User Support Technicians	0.36	0.46	0.61	0.57	0.47	0.52	0.63	0.77	0.75	0.79	0

Table 4. ICT Career Path to Information Technology Manager

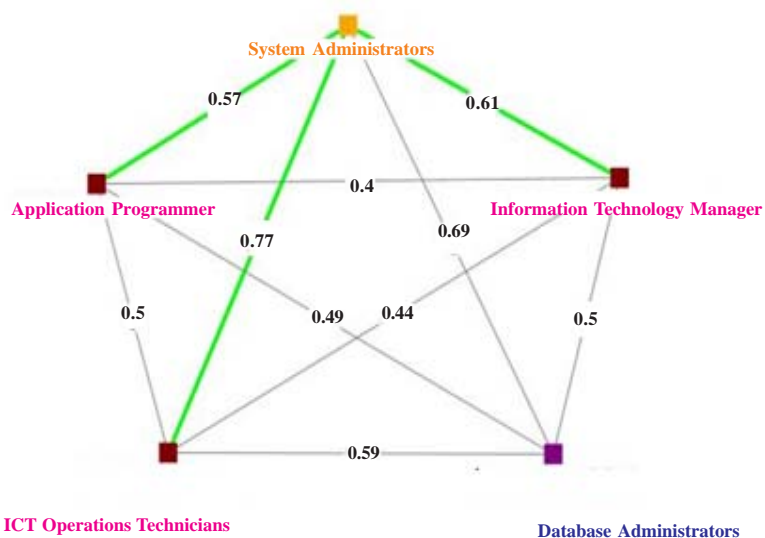


Figure 3. ICT Career Path Sample

² <http://nodexl.codeplex.com/>

See Figure 4 for compares 15th first value of highest skills should have each of ICT Career. To describes 15th first skills of Information Technology Manager indicated four skills is RDBMS, SAP, CRM and Leadership skill not found in other ICT Career. Therefore, professionals of ICT Career should be develop or train these skills. MS-SQL and Good Analytical found in four ICT Career show that these skill is most important skill for career development, but Software Design least important for career development, since Software Design not meet all ICT Career and specified skill of software developer level.

For Network System skill meet very high the same between ICT Operations Technician and Information Technology Manager shown that should be develop for ICT Career.

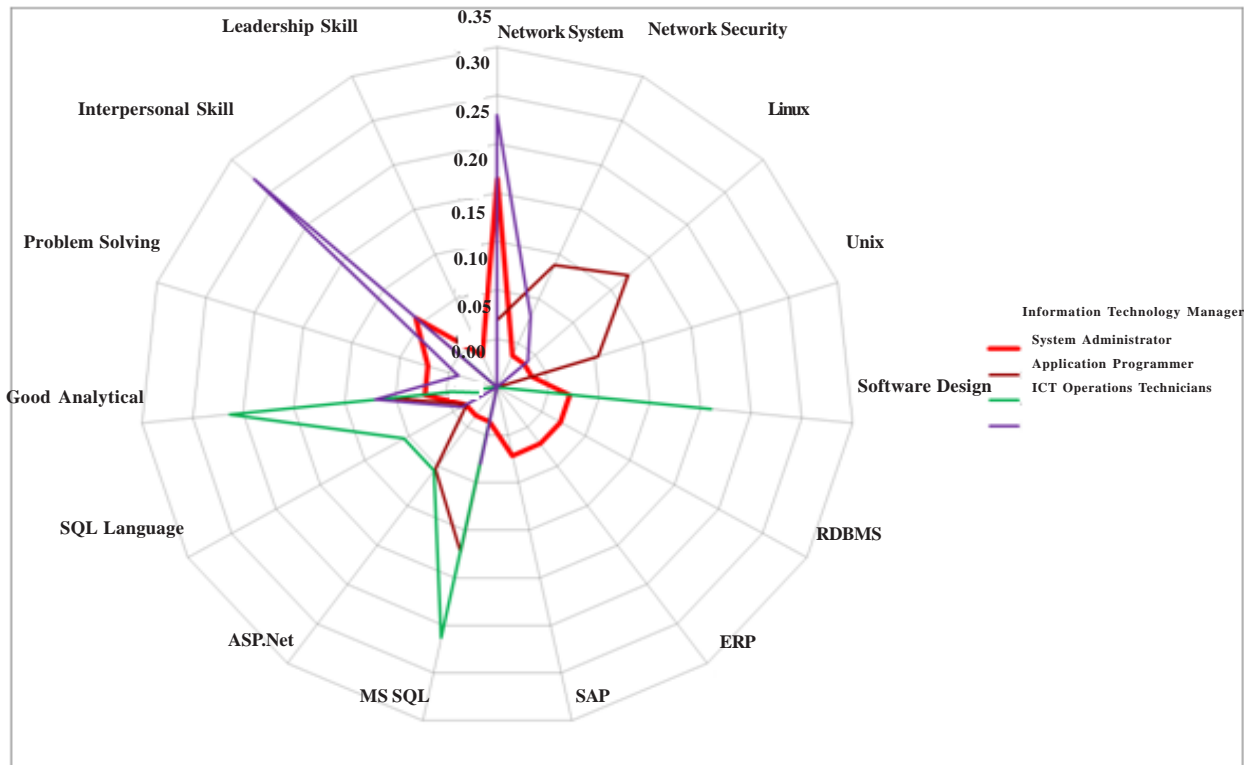


Figure 4. Compares 15th First Value of Highest Skill Weighted of Information Technology Manager

This example is representing the ICT career paths following result as Fig 3. We show the ICT Careers path to Information Technology Manager with the NodeXL¹ which describes the connection between five most similarities of ICT Careers. Application Programmer (AP) similar System Administrator (SA) with 0.57 and System Administrator (SA) similar Information Technology Manager (ITM) with 0.61. Therefore, professionals in ICT Career should be follows to develop or training in request skill each of ICT career.

5. Conclusion

In this paper, we propose weighted term frequency calculation of skills for ICT Career. Data from ICT ontology of ICT career will be calculated as weight calculated by term of frequency and relevance then generated visualization to demonstrate results. When analyzing and demonstrating overall of information of Information Technology Manager that the most soft skill is Leadership skill which not found to System Administrator, Application Programmer and ICT Operation Technician. Analyzing by career path with 2 samples path showed that System Administrator similar to Information Technology Manager more than any other ICT careers. Therefore, professional of ICT career start to Application Programmer or ICT Operation Technician should be developed and trained skills to career development to Information Technology. Application Programmer and ICT Operation Technician should develop skills include of RDBMS, ERP, SAP and Leadership skill. Application Programmer

should develop skills include of Network System, Network Security, RDBMS, ERP, SAP and Leadership skill. ICT Operation Technician should develop skills include of Unix, Software Design, RDBMS, ERP, SAP, ASP.Net and Leadership skill. Results of ICT Career path can be analyzed the importance of qualifications and skills needs to labour market and useful for career development in all ICT career groups. For further research, to study and discover about work experience in ICT careers and to compare among ICT career for career development.

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