Analyzing and Developing Competency-Based Assessment of Persons with Disabilities in Thailand

Julaluk Watthananon[1] and **Pollawat Chintanaporn**[2]

ABSTRACT

The objectives of this research were to analyze and develop a competency-based assessment application for use with persons with disabilities in Thailand. A competency-based system is strategy of human resource development in the organization helping disabled people to improve their competency this will cause a paradigm shift of the labor market in Thailand. The target group for the study consisted of individuals with physical, visual, hearing, mental health, intellectual and learning impairments at the Universal Foundation for Persons with Disabilities (Thailand). Subjects were selected by purposive sampling. The experimental tools were: (i) a competency-based system for use by persons with disabilities; and (ii) a questionnaire administered to psychologists and social workers. The results were that: (i) the sample group reacted positively to the program and rated each aspect at a statistically significant 'good' level; and (ii) after development, the program was able to identify people with disabilities who were ready for work within an organization.

Keywords: Competency-Based System, Persons with Disabilities, Architecture Management

1. INTRODUCTION

The Convention on the Rights of Persons with Disabilities (CRPD) [1], a United Nations international human rights convention, affirms the rights and dignity of persons with disabilities, which should be guaranteed without discrimination. In light of this, society should be aware of the importance of protecting and promoting the rights of those with disabilities and of eradicating the social disadvantages which affect people with a variety of impairments. Action in this direction takes two forms: (i) social development through the development of a service-oriented framework to help persons affected by disabilities achieve the same benefits as the able-bodied; and (ii) protection of the human rights and fundamental freedoms of those with disabilities, which includes ensuring non-discrimination and equality. Currently, around the world, economic reforms focus on the performance of individuals who are almost always assumed to be able-bodied. Indeed, research shows that in Thailand [2] persons with disabilities at working age (15-60 years old) represent 1.4% of the total working age population, but only 0.4% of those in employment. The same research also investigates the occupations of the disabled: 37.67% were 'general employed', 36.23% were farmers, 11.47% were engaged in private business, 6.66% were employed in a private company, 1.44% worked for the government, and the remaining 7.53% worked in other occupations, such as collecting refuse for sale, etc.

However, persons with disabilities are a potential human resource; they have the skills and competences required by organizations, yet they are often underemployed and in fact, it is found that in some work activities, persons with disabilities have equaled or excelled the performance of the able-bodied [3], [4]. These features will motivate employees to achieve higher levels of performance in their work. Their capacity for this is being referred to here as 'competency'. It is important therefore to consider how organizations can tap this potentially valuable human resource, that is, persons affected by disabilities.

This then is the motivation for this study, which reports on the design and development of a competency-based system delivered via the Internet for use with persons with disabilities. The objectives are thus:

- To design and develop an Internet-based competency-based system for use as a tool for identifying the skills and capabilities of people with disabilities.
- To evaluate the feasibility of the next phase of the project, which involves the practical implementation of this system.

The remainder of this paper is structured as follows. Section two presents some related research. The methodology of the approach and the different stages of development are described in section three. Experiments and results analysis, which are

Manuscript received on August 20, 2017 ; revised on October 21, 2017.

Final manuscript received on April 24, 2018.

[1]The authors are with Department of Computer Science, Faculty of Science and Technology, Rajamangala University of Technology Thanyaburi, Thailand., Email: julaluk.w@rmutt.ac.th and watthananon@hotmail.com

[2]The authors are with Portalpolis Co. Ltd., 281/112 Vibhavadi-Rangsit Road, Donmuang, Bangkok, Thailand., Email: pollawat@portalpolis.co.th and pollawat_c@hotmail.com

compared using Pearson's correlation, and mean and standard deviation together with t-test with separated variance, are provided in section four. The conclusion and possible areas for future research are given in section five.

2. RELATED WORK

A. Persons with disabilities

Persons with disabilities include those who have long-term physical, metal, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others. Much research which is focused on disability awareness training is important and the impact of this research should be evaluated. Mukerherjee et al. [12], as cited by Lodge et al. [13], point out that teachers need to have a full understanding of the implications of impairments for teaching and learning if they are to educate other students or support students with impairments. The Task Force on Autism (2001) made similar observations with respect to the education of students with autistic syndrome disorder. At the same time, The Task Force on Dyslexia (2001) observed that teachers often failed either to identify or to fully recognize learners' disabilities and that they may have inadequate understandings of these issues [13]. This and negative public and social attitudes are major obstacles to establishing the basic conditions required for disabled people to achieve their full human potential because these attitudes develop, reinforce and solidify socio-environmental barriers to participation in work and other mainstream activities [14], [15].

B. Competency Models

Competency models are a resource for both employers and actual or potential employees. A great deal of research is focused on these frameworks for business and industry to help them to clearly articulate their workforce needs [16]. Research has found that these models provide a map for jobseekers of the skills required for successful careers in an industry. They also help to articulate the essential competencies required for occupational licenses and certifications, or the credentials that ensure that a worker has the necessary skills to be successful in a particular field. Kathrin [17] examines relevant studies and approaches, best practices, and key findings in the field of information systems education and in related areas, such as computer science and business. These are examined to develop a systematic framework, while Watthananon and Yoosuka [11] explore methods for recruiting team members based on the matching of individual competency and organizational expectations and find that feature selection with information is more consistent but takes longer. In the context of measuring soft skills, Beard et al. [18] propose using student performance on team projects as a measure of teamwork skills.

C. Data Mining

Data mining [19] is a process performed in order to find patterns and hidden relationships within large sets of data. At present, data mining is being applied in many domains, including in business decision making, in scientific and medical research, as well as in areas involving economics and society.

Heymann et al. [23] published a work in which they devised models to predict keywords at the "social tag prediction" problem for a social benchmarking system del.icio.us based on page text, anchor text, surrounding hosts, and other keywords applied to the URL. They found that tag-based association rules can produce very high-precision predictions as well as of the state being applied for tagging text documents with keywords. Clayton et al. [24] proposed cognitively-inspired Bayesian probabilistic model on ACT-R's (Anderson et al., 2004 [25]). The research found that choosing the tag has the highest log odds of being correct, is mean successful case showing memory retrieval equations scale, and relevant to task domains that large-scale. While, Jian et al. [26] is another work on similar lines which suggests users to expand queries leveraging the keywords associated with the queries. They used SVM along with their application specific tweaks which were not useful for our problem. In this paper, we use data mining principles to assist in the analysis of data on the multidimensional competencies of persons with disabilities.

3. METHODOLOGY

In this research, the theory of structural systems (Shelly, Cashman & Rosenblatt, 2005) [6] was deployed to analyze and design the SDLC process. To build the application, MySQL was used as the database management system, and HTML5 and Macromedia ColdFusion were utilized to develop the frontend and to serve the web application. The system architecture was divided into the three main processes of input, process and output, as shown in Figure 1.

A. Input

The presentation tier is the logical group of components that provide a user interface. These components include a web server and the application, which is designed for use by three groups: 1) persons with disabilities input their own performance data with the test method, 2) teachers or academics (to support the individuals) imports their training plans and development plans for the disabled, and 3) the company imports job information and expected performance into the job, which selects the individual who has potential and is qualified to work. This research thus begins with the collection of information through a computer-based testing system, and by observation and interview.

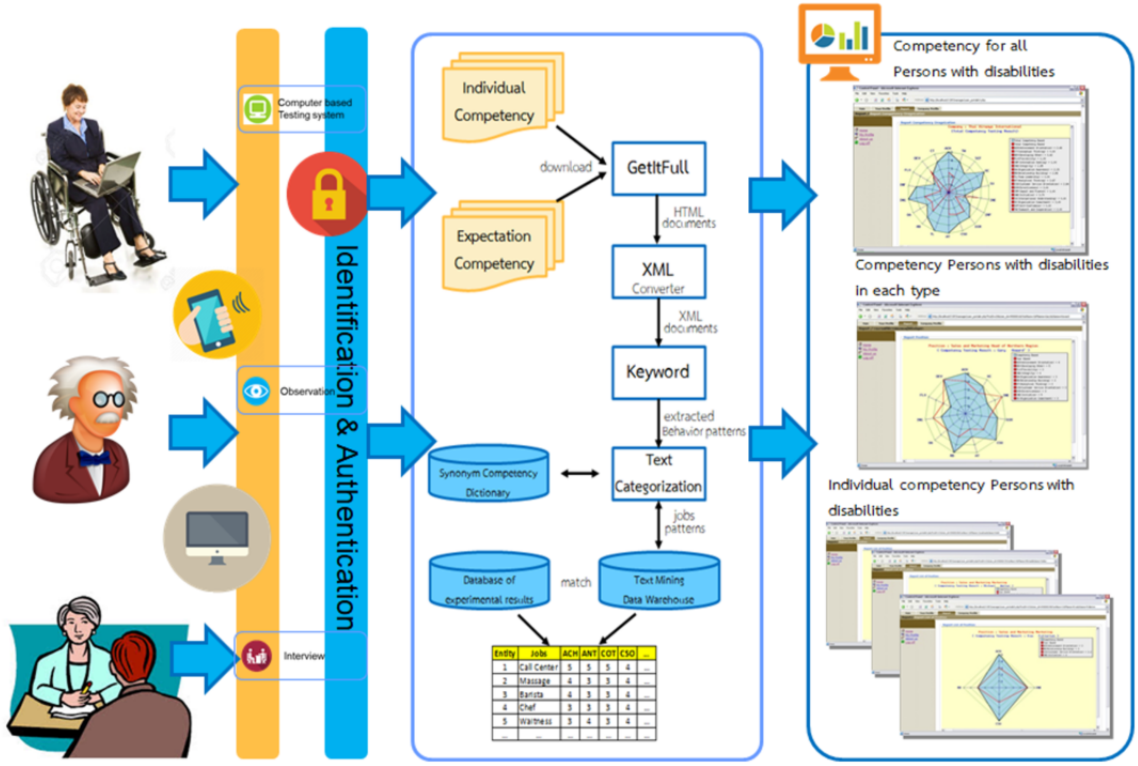

Fig.1: *Architecture of our competency-based system for assessing persons with disabilities.*

B. Process

The 'process' is the database tier, which forms the base of a web database application. These services are provided by an RDBMS system, with the data being stored in this relational database. In this research, MySQL RDBMS is used to manage data, which is stored in several different databases (e.g. disabled DB, performance DB, Job matching DB and Item Banking System, etc.).

The Disabled DB is used to store semantic words for use in the process of analysis of usage behavior of the system from the disabled.

The Performance DB will store a similar group of words, and store the weight of the words in the text ranking from both of individual and expected competency.

The Job matching DB is responsible for collecting the association rules from the relationship between the questions and answers, to apply the performance of each job. It will calculate the weight of the performance so that the group which has the most weight is ranked first in the Text categorization phase and uses the words of competency to find the relationship, and then saves the results to the database.

The Item Banking System is a collection of questions and answers that are grouped by the performance and evaluation of this behavior. It will be used in the testing module. The answer is shown in the section on individual competency and we compare it with the expectation of competency on the job by using Pearson's coefficient.

The competency-based system must allow training managers to quickly identify tests, and to assess individual competencies. The system is also required to make relevant data as accessible as possible in order to allow teachers or companies to view competencies. This is detailed below:

• Step 1: Download all data from the input process. This includes the competency of the individual tested and the expectation of competency derived from observation and interviews by teachers and company staff. This data is stored as HTML documents.

• Step 2: Convert HTML files to XML documents in order to insert metadata and custom properties in the original documents. By doing this, the data will be in a more flexible form for processing. Although the new content is stored in an XML format, it will remain compatible with the original data.

• Step 3: Keyword extraction is carried out. For this research, we divide the automatic keyword extraction into two categories: (i) text-based extraction [20, 21, 22]; and (ii) database-based extraction.

Text-based extraction is performed by exploiting the TF*IDF weight of the term and is calculated according to Equation 1:

$$TF{*}IDF(term) = TF(term) * \log\left(1 + \frac{N}{DF(term)}\right) \quad (1)$$

where $TF(term)$ is the frequency of a term in the

given competency, N is the total number of competencies in the collection, and $DF(term)$ is the number of competencies that contain the term.

For database-based extraction, we use the database specific values from job, competency, and position. Its attribute value tends to contain on average two words. All stop words are removed from the text, a suffix array [9] of candidate competency keywords (which are a set of words separated by stop words) is created, the frequency of the words is found (stemming is used), the degree of each word is calculated (degree of a word is the number of times a competency word is used by other candidate keywords) and for every candidate keyword the total frequency and degree is found by summing all word scores. Finally, the degree or frequency gives the keyword score. An example is shown in Figure 2.

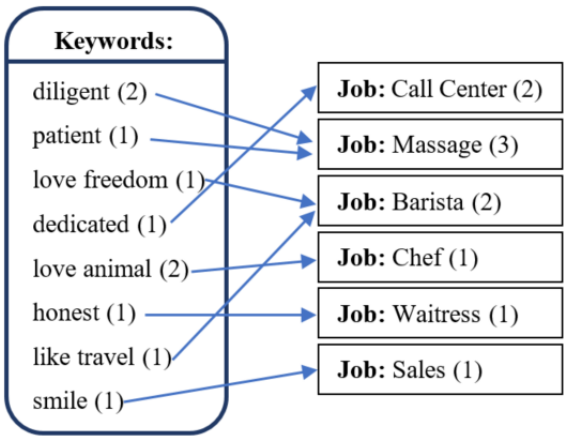

Fig.2: *Example of mapping terms to concepts involving keywords and job competency.*

For simplicity's sake, suppose there is a text consisting of only ten phrases: diligent (2), patient (1), love freedom (1), dedicated (1), love animal (2), honest (1), like travel (1) and smile (1), where the number in brackets is the number of occurrences. The score is calculated according to Equation 2:

$$TF*IDF(term, freq) = 1*\log(1+\frac{DF(freq)}{DF(term, freq)}) \quad (2)$$

where $DF(freq)$ is the frequency of entities containing the given attribute databases (job, competency, and position) and $DF(term, freq)$ is the frequency of entities where the given term appears in the given attribute database.

- Step 4: The text-categorization algorithm [10] maps the competency synonym dictionary and the stored jobs pattern into the text-mining data warehouse. From here, the system will match the text-mining data with the database of experimental results to compute a weight ranking and to evaluate likely performance in customer service. This will provide a best fit with the competency model for which the organization has a need.

C. Output

After this process is completed, the information received is evaluated against individual results and performance indicators for persons with disabilities. Teachers or agencies can then use this information to create an individual development plan (IDP) for that person for use in the future.

4. EXPERIMENTS AND RESULTS

This research is experimental and applies data mining techniques to text categorization in the area of human resource management of persons with disabilities, on the basis that every individual has the capacity to develop. Thus, the research focuses principally on the design and development of a competency-based system for persons with disabilities.

A. Data

The samples: The samples for this research were obtained by purposive sampling of individuals from the six groups of disabled people having physical, visual, hearing, mental health, intellectual and learning impairments. Individuals were made available by the Universal Foundation for Persons with Disabilities (Thailand).

The target group: The target of this phase were individuals of working age (15-60 years old) affected by impairments but who were ready for work.

Data preparation: Datasets on core and functional competency in customer service positions were prepared by using focus groups involving the business owner, the disability development agency and occupational representatives. It will be seen that customer service competency consists of five core areas. These are: ACH (achievement orientation), ANT (analytical thinking), CSO (customer service orientation), IMP (impact and influence) and SCF (self-confidence). As shown in figures 3 and 4, all the jobs shared the same competencies.

Entity	Jobs	Competency									
		ACH	ANT	COT	CSO	DEV	IMP	INF	TEL	TWC	SCF
1	Call Center	✓	✓	✓	✓	×	✓	✓	×	×	✓
2	Massage	✓	✓	×	✓	×	✓	×	×	×	✓
3	Barista	✓	✓	✓	✓	×	✓	✓	×	×	✓
4	Chef	✓	✓	✓	✓	×	✓	✓	✓	✓	✓
5	Waitness	✓	✓	✓	✓	×	✓	×	×	✓	✓
6	Sales	✓	✓	✓	✓	×	✓	✓	✓	✓	✓

Core competency in customer service

Fig.3: *Five core competencies in customer service positions.*

The functional competencies for each job were then mapped onto their corresponding concepts in cus-

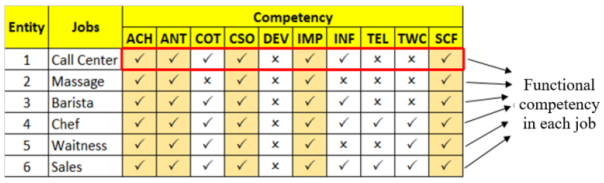

Fig.4: *Functional competencies in each job based on a customer service position.*

tomer service. In this example, call center work has seven functional competencies: ACH (achievement orientation), ANT (analytical thinking), COT (conceptual thinking), CSO (customer service orientation), IMP (impact and influence), INF (information seeking) and SCF (self-confidence) in contrast, work as a masseur has, for example, the five functional competencies of ACH (achievement orientation), ANT (analytical thinking), CSO (customer service orientation), IMP (impact and influence) and SCF (self-confidence).

The scope of the study entails the evaluation of performance with regard to work in customer service and ensuring the best fit with that competency model which reflects organizational needs. To fill the position within the organization requires effective recruitment and this should take place under the given conditions and with reference to each of the organizational expectations, as shown in Table 1.

Table 1: *10 core competencies reflecting organizational needs for particular jobs.*

#	Abb.	Competency Names	Jobs expectation of the organization needs					
			Call Center	Massage	Barista	Chef	Waitness	Sales
1	ACH	Achievement Orientation	2	4	4	3	3	5
2	ANT	Analytical Thinking	4	3	3	3	4	5
3	COT	Conceptual Thinking	3	3	3	3	3	5
4	CSO	Customer Service Orientation	5	4	4	4	4	4
5	DEV	Developing Others	4	3	3	3	3	5
6	IMP	Impact and Influence	2	3	3	3	4	4
7	INF	Information Seeking	4	4	5	3	3	3
8	TEL	Team Leadership	3	2	2	3	3	5
9	TWC	Teamwork and Cooperation	4	4	4	4	4	4
10	SCF	Self-Confidence	4	2	2	3	3	4

The performance data was regarded as optimized and relevant to a career as determined by three user groups: (i) representatives of the persons with disabilities who work in the profession; (ii) teachers or academics who are supporting the individual with an impairment; and (iii) the employer, who selects the individual who is qualified to work. In the example of a call center position, the applicant must have competency levels of: 2 in ACH 2, 4 in ANT, 3 in COT, 5 in CSO, 4 in DEV, 2 in IMP, 4 in INF, 3 in TEL, 4 in TWC, and 4 in SCF.

B. Evaluation

This assessment is divided into two sections: the first uses Pearson's correlation coefficient to assess the similarity between the devised competency and the competency of the individuals with disabilities. The value of the correlation indicates how suitable the individual is for the position. This is calculated using Equation 3.

$$r_{xy} = \frac{n\sum xy - \sum x \sum y}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad (3)$$

r_{xy} is Pearson's coefficient, which represents the correlation between variables x and y.
$\sum x$ is the sum of variable x.
$\sum y$ is the sum of variable y.
$\sum xy$ is the sum of the product of x and y.
$\sum x^2$ is the sum of the squares of x.
$\sum y^2$ is the sum of the squares of y.
n is the sample size.

In the second half of the evaluation, data from questionnaires administered to (i) professional psychologists and (ii) social workers were analyzed. Mean, standard deviation and t-test with separated variance were computed using equations 4 and 5.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \quad (4)$$

$$df = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}} \quad (5)$$

$\bar{x}_1$ and $\bar{x}_2$ are the means of the responses by psychologists and social workers.
S_1^2 and S_2^2 are the standard deviations of the responses by psychologists and social workers.
n_1 and n_2 are the sizes of the sample of psychologists and social workers.
df is the degrees of freedom.

C. Results

Pearson's correlation coefficient was used to evaluate the degree of similarity between the desired competency and the actual competencies of individuals. Five dimensions were analyzed, as described below.

• *The first dimension* is the individual competency results for the person with an impairment who has been tested. This is a random test designed by psychologists, social workers and other experts and is shown in Figure 5.

Figure 5 shows the result of assessing an individual's competency. The blue area represents the expectation of competencies, while the red line represents the actual competencies of the person who has been assessed. It can be seen then that there is a gap in competencies in two areas and thus, this per-

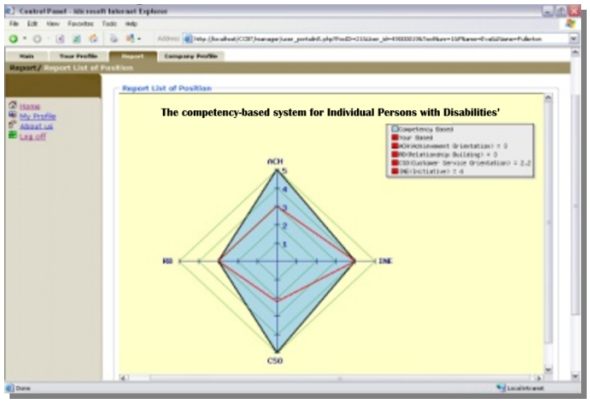

Fig.5: *Assessment by competency-based system of an individual with a disability.*

son should go through a development process based on his or her IDP (Individual Development Plan) as drafted by the responsible agency or teacher.

• *The second dimension* is the competency of the individual in each area, as shown in Figure 6.

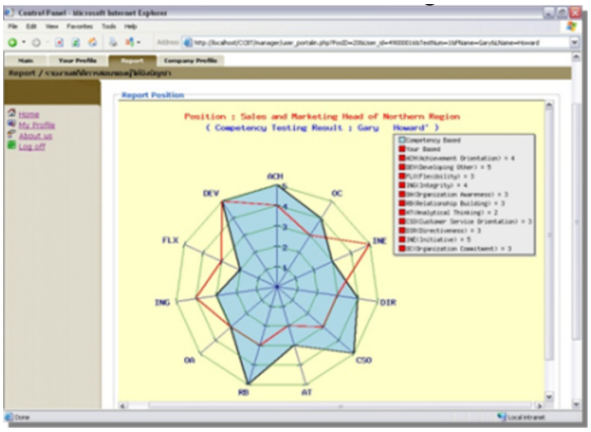

Fig.6: *Assessment by competency-based system of a persons with a disability in each area.*

Figure 6 shows that the results for each person tested will result in a different development plan. In the example, the person with a physical disability has a competency gap which will have an impact on the overall performance level which the organization has specified. These results should therefore be used when planning for development to address the types of disabilities which affect individuals. This might include assigning budgets for developing the individual or drawing up a road map for education or career development. In the past, many organizations designed methods for this kind of development by themselves but these would often fail to meet the needs of those affected by disabilities. By contrast, the results from this system will provide better and clearer insight into these needs, and in addition do so conveniently.

• *The third dimension* is the combined competency of all results from the testing of people with disabilities, as shown in Figure 7.

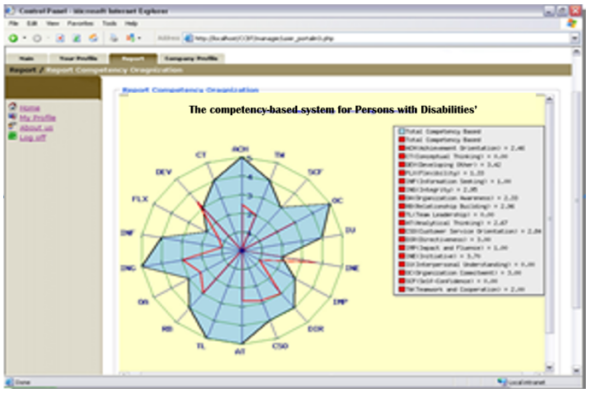

Fig.7: *Assessment by competency-based system for all persons with disabilities.*

These results show the aggregate competencies of all people tested with all types of disabilities. This may be useful for agencies responsible for planning and assigning budgets for development, as the data is easy to understand and indicates clearly the needs which exist.

• *The fourth dimension* is the comparison of competencies with those needed for a sales or customer service career (Figure 8).

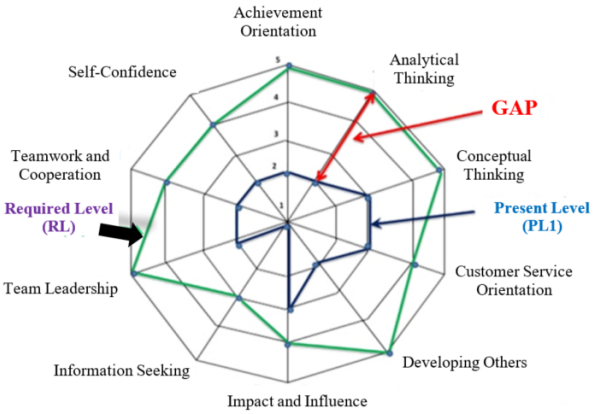

Fig.8: *Assessment by competency-based system of suitability for sales position.*

Figure 8 shows the results of comparing actual and expected competency in a sales position. 'Gap' refers to the distance between the required level (RL) and the present level (PL1), with these competencies being measured on a scale of 0 to 5. In this case, the individual has several large gaps in his/her competencies (i.e. the individual's competency is lower than the expectation) and so is unlikely to be able to do this job well. This individual should therefore undertake some kind of skills development, with a teacher, government agency, or human resources department creating an IDP. When this individual's assessment fits the expected competencies, he or she may then

be recruited for that position or moved to a more appropriate one.

• *The fifth dimension* shows the results of the evaluation of competencies for each group (i.e. of each type of impairment). In this case, there were ten people in each group. The example uses only 10 of the 18 competencies because those are the requirements for employment in information service (as in the example). The results show that the people with physical, visual and hearing impairments can work in information service. In addition, as shown in Figure 9, an analysis of each competency shows that these individuals had high levels of 'information seeking' and 'customer service' skills.

For the second part of the assessment, the researchers analyzed data from questionnaires given to psychologists and social workers by t-test for equality for means, which was calculated at five levels (Best, 1981: 179 - 187) [8], as shown in Table 1.

Table 2: *Comparison of differences between professionals and factors design system.*

Evalulate	Professional	t-test for Equality for Means				
		X	*S.D.*	*t*	*df*	*p*
1. Perceivable	Psychologist	3.7325	0.48647	5.644	398	**0.000***
	Social worker	4.0439	0.57734			
2. High contrast option	Psychologist	3.8978	0.57774	0.771	398	0.422
	Social worker	3.8453	0.72517			
3. Operable	Psychologist	4.2556	0.75955	0.376	398	0.716
	Social worker	4.2293	0.63616			
4. Access Keys	Psychologist	3.0844	0.83251	2.471	398	**0.014***
	Social worker	3.2880	0.79400			
5. Understandable	Psychologist	4.0695	0.64836	1.797	398	0.073
	Social worker	3.9437	0.71349			
6. Robust	Psychologist	4.0353	0.56100	0.628	398	0.530
	Social worker	4.0749	0.65737			
7. Thai Text to Speech	Psychologist	4.2331	0.66732	0.995	398	0.321
	Social worker	4.1624	0.71898			

* statistical significance at 0.05

Table 2 reports the results of testing for differences between psychologists and social workers and their assessment of the system design. With df = 398, α = 0.05, t-test was calculated as 5.644 and a p-value = 0.000. This means that assessment of the 'perceivable' factor was statistically different at a significance of 0.05. For the 'access keys' factor, df = 398, α = 0.05, t-test was calculated as 2.471 and p-value = 0.014, and so the two groups were significantly different at the rate of 0.05, too. The differences between the two groups with regard to 'high contrast option', 'operable', 'understandable', 'robust' and 'Thai text to speech' were not statistically significant.

5. CONCLUSIONS

This research aimed to develop competency-based assessment of persons with disabilities drawn from the six groups of people with physical, visual, hearing, mental health, intellectual and learning impairments at the Universal Foundation for Persons with Disabilities (Thailand). The researchers believe that this work may help society to better accept those who are disabled and to increase the employment chances of those with impairments.

As regards future work, the researcher will extend the work to investigate the competencies required for other positions, and will conduct in-depth analysis in other dimensions and with other relationships.

ACKNOWLEDGEMENT

This data is based upon work supported by the Universal Foundation for Persons with Disabilities (Thailand). Research grants were supported by the Fund to Promote Education for People with Disabilities (Thailand). The infrastructure was partly supported by the Department of Computer Science, Faculty of Science and Technology, Rajamangala University of Technology, Thanyaburi, Thailand. In addition, help was gratefully received from Portal Polis Co. Ltd. The authors would also to thank Viriya Namsiripongpan, Benjha Chonthanon, Kanlaya Aonchun, and the anonymous reviewers for their time and feedback.

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Julaluk Watthananon is a lecturer in department of Computer Science, Faculty of Science and Technology at Rajamangala University of Technology Thanyaburi (RMUTT), Thailand. She received Master of Science in IT from King Mongkuts Institute of Technology North Bangkok (KMUTNB), Thailand in 2003 and Ph.D. in Information Technology from KMUTNB in 2010. Her research interests are in the area of system analysis harvesting for Persons with Disabilities, Software Engineering, Human Computer Interaction and STEM Education.

Pollawat Chintanaporn is an independent researcher and business owner in Portalpolis Co. Ltd. He received Master of Science in Information Technology from King Mongkuts Institute of Technology North Bangkok (KMUTNB), Thailand in 2002. His research interests are in the area of energy harvesting for wireless communication, Internet of Things (IoT), sensor networks and Competency.