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Applying fuzzy integral for evaluating intensity of knowledge work in jobs

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A B S T R A C T

In this article, a framework is proposed to define and identify knowledge work intensity in jobs, quantitatively. For determining the Knowledge Work Intensity Score (KWIS) of a job, it is supposed that the job comprises some tasks and KWIS of the job is determined based on knowledge intensity of these tasks. Functional Job Analysis (FJA) method is applied to determine tasks of jobs and then Task's Knowledge Intensity Score (TKIS) is computed by using Fuzzy integral method. Besides, importance weight and time weight of tasks are determined by utilizing appropriate methods. Finally, KWIS is calculated by a formula composed of tasks' TKISs and the weights. For evaluating applicability of the framework, it is applied to calculate KWISs of two jobs (Deputy of Finance and service, Laboratory technician).

1. Introduction

In today's world, work in organizations has become complex and knowledge-intensive, considerably (Eppler et al., 1999). The growing trend towards knowledge workers in the labor market is, indeed, one of the primary features of the economy and society (Drucker, 1995; Lavoie et al, 2003; Overbeek, 2007). Measuring and increasing the productivity of knowledge workers are the biggest management challenges during the 21st century (Drucker, 1991, 1999). In order to improve the performance of knowledge workers in a systematic manner, it is necessary to have a clear understanding of knowledge work and knowledge workers in the first place (Ramirez, 2008). Up to now, there is still no effective way to define knowledge work, which is the primary requirement of knowledge work productivity (Shi-You, 2008). Ramirez (2006) states "Some researchers (Helton, 1998; Drucker, 1999; Agarwalet al., 2011) argue that knowledge workers account for roughly 75% of the workforce. Although a lack of a clear definition of what constitutes a knowledge worker creates doubts on the reliability of that figure, we can assume that the number is high enough that, even if it is overestimated, it is significantly high."

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Most of the researches in knowledge work area have been very general and vague in definition of the knowledge work or knowledge workers (Akhavan 2010; Heidary et al., 2011). Since there have been few researches, which present a quantifiable definition of knowledge work, it can be claimed that there is currently no clear definition that is generally accepted in literature or in practice (Ramirez, 2004, 2006). With respect to particular attributes of this group of workers, this paradox results serious problems in defining of human resource management's systems (recruitment, compensation, productivity measurement, etc.).

In this article, a characteristic based definition of knowledge work is adopted and an appropriate framework is proposed to quantify knowledge work intensity of jobs. The rest of this paper is organized as follows: section 2 provides literature review in the field of knowledge work definitions and knowledge work quantification frameworks. Section 3 presents characteristics of knowledge work used in the developed framework. In Section 4, the framework is introduced and its steps are explained. In section 5, KWIS is calculated for two sample jobs to illustrate applicability of the framework. Finally section 6 draws conclusions and future researches.

2. Literature review

Despite the growing trend in knowledge workers' population and the increasing number of researches in this field, there is still not a unique definition for knowledge work and knowledge workers and the definition of knowledge work remains elusive (Guns & Valikangas, 1998; Pyoria, 2005; Shi-you, 2008). Most of these definitions are descriptive and hard-to-use in the practice of management (Shi-you, 2008). Heidary et al. (2011) identified two paradigms and four streams for definition of knowledge work summarized in Table 1 as follows,

Table 1

Definition Streams for Knowledge Work or knowledge worker (Heidary et al., 2011)

Paradigm	Stream	Description & Features
Job-Oriented Definitions	*Characteristics based*[1]	- Some dimensions and characteristics associated with the nature of the job are considered in order to define KW. - Several attributes are identified (e.g. tacit, none routine, unstructured, complex, and variant). - KW is a job that has several (or all) of the aforementioned attributes. - KW is a continuum and each job can have its own score.
	Occupation based[2]	- A list of occupations is prepared and each entry is regarded as a KW (e.g. researcher, engineer, teacher, and accountant) - KWrs have specific professions and other workers cannot be grouped in the same category.
	Activity based[3]	- A specific group of activities and tasks are considered to be the essential part of the KW. - Two categories are considered by researchers: - Mental and high cognitive activities (like reasoning and refining). - "Working with Knowledge" and associated activities (such as knowledge and information creation, discovery, development, and use).
Worker-Oriented Definitions	*worker characteristics based*[4]	- Intellectual ability, innovating, analyzing, planning, and education are some of the KWr's characteristics mentioned in the literature.

1- Liker & Hancock (1984), Thomas & Barone (1994), Kriengkrai (1998), Lewis (2004), Ramirez & Steudel (2008)
2- Bell (1987), Wuthnow & Shrum (1983), Quinn (1992), Ruhleder (1994), Reed (1996), Francalanci & Galal (1998), Tam et al. (2002), Lavoie et al. (2002), Thompson & Heron (2005)
3- Pan et al. (2008), Horwitz at al. (2006), Amadi, (2007), Jinkun et al. (2008), Machlup (1962), Drucker, (1991;1993), Davenport & Prusak (2000), Schultze, (2000), Smith&Rup (2004), Hammer et al (2004), Davenport (2005), Dragunov et al. (2005), Turner & D'Art (2008), Weidong (2008)
4- Kelley (1990), Sulek & Marucheck (1994), Fojt (1995), McDermott (1995), Janz et al. (1997), Dove (1998), Davis (2002)

Job-oriented definitions normally concentrate on knowledge work activities and different tasks performed to accomplish the assigned job. In this paradigm, researchers define knowledge work in the first place and then introduce knowledge workers as individuals who perform such activities. This paradigm can be divided into three major streams; Job characteristics based definition, Occupation based definition and Activity based definitions. In worker-oriented definitions, traits and talents, which are necessary to perform a particular job are in the spot light. In this paradigm, a broad range of human behavior involved in knowledge work activities is examined (Heidary et al., 2011).

Although the majority of thinkers believe two styles describe one entity and even some researchers simultaneously use two styles in their definition of knowledge work; but it seems that each style refers to various groups of jobs (Heidary et al., 2011). We can see this difference in survey of some knowledge work classifications. These differences must be considered in knowledge work quantification. Few studies have discussed knowledge work quantification. Jackson (1989) determined the parameters, which influence expected task completion time developed a method to calculate target time of knowledge work. This study can be categorized as the first paradigm of knowledge work definition (Heidary et al., 2011).

Shi-You (2008) presented a framework for analyzing content of knowledge work in a certain position. As a result, he divided the analysis model of position knowledge structure into two modules: “Core Content” and “Ability Application”. The “Ability application” comprises ability of knowledge application, ability of skill application and ability of self-determination in working and three types of indexes are applied in “Core Content” module, including information collection and disposal, information and knowledge application, planning, reasoning and decision-making. Then by application of Position Analysis Questionnaire (PAQ) and empirical testing data, he selected 10 important subdivided indexes to six indexes of knowledge characteristic and calculated knowledge characteristic value (KCV) of position based on them (Shi-You, 2008). In this study both paradigm of knowledge work definition was applied (Heidary et al., 2011). Sen-Wang (2008) used Rough Set Theory for evaluation of Knowledge worker value. He attempted to evaluate work efficiency by determining 13 attributes knowledge work, which are important for its accomplishment (Sen-Wang, 2008). This study can be categorized as job-oriented and characteristic based. Ramirez (2006) defined knowledge workers on the basis of four knowledge work principles (Ramirez, 2006, 2008):

- Knowledge work can be stated as a continuum, which varies from 0% to 100% knowledge work.
- Knowledge work is defined based on job characteristics (what the worker does) with no regarding of “who is knowledge worker”.
- Work or job that a worker does is defined by tasks that compose the job.
- Knowledge work characteristics can be used for measuring the knowledge work level in a task.

He used literature review methodology and shapes a systematic review for 591 publications. He used frequency analysis to evaluate the characteristics and finally selected 8 characteristics for defining knowledge work. In addition, he proposed a mathematical model to quantify knowledge work (Ramirez, 2008).This study can be categorized as job-oriented and characteristic based. Heidary et al. (2011) proposed a structure to identify different kinds of activities that comprise a worker’s job, and provide a framework for quantitative definition and segmentation of knowledge work. They postulated that every knowledge work has two main parts: working with knowledge and establishing communication. Thus, in order to provide an exact definition for the knowledge work it is necessary to calculate the knowledge intensity score of a job (JKIS) and communication intensity score of a job (JCIS). For determining these two parameters precisely, jobs were broken hierarchically to tasks and then activities. To identify these activities, an initial list of activities mentioned in the literature was created and then completed with generalized work activities of O*NET. A six-step framework for calculating of JKIS and JCIS was proposed and finally, different groups of knowledge workers with respect to JKIS and JCIS were identified by using a clustering method (Heidary et al., 2011).

Three research gaps identified in the previous characteristic based knowledge work quantification frameworks are as follows:

- former researchers did not use specific methodology for identifying tasks that compose the job;
- weights of tasks is determined by only the ratio of time spent on the tasks, while other factors like importance of task must be considered, as well.
- For calculating knowledge work intensity of tasks, former researchers use only simple average method. While it's obvious that criteria used for calculation do not have equal weight and there are interactions among them. Therefore, applying the simple average method is not appropriate.

In this article, a characteristic based framework for evaluating intensity of knowledge work in jobs that covers identified gaps is proposed. For covering these gaps, four principles presented by Ramirez (2006) are accepted and a mathematical model is presented for determining knowledge work intensity.

3. Knowledge work characteristics

Eight characteristics that were presented by Ramirez are: high level of autonomy, knowledge, creativity and innovation and complexity and low level of structure, tangibility, routine and repetitiveness and physical effort (Ramirez, 2006).

Fig. 1. Knowledge work continuum (Ramirez, 2008)

Since Ramirez (2006) used a clear and acceptable approach for defining these characteristics, in the first step, we use his approach (literature review methodology) for identifying knowledge work characteristics. Ramirez (2006) reviewed studies published before 2007, thus we analyze other articles that he did not cover in his dissertation (especially cases that published after 2006). We gather 84 new articles in this field and analyze lists, categories, factors or characteristics, which can be implemented to differentiate knowledge work from manual work and then adjust them with characteristics introduced by Ramirez. Results revealed that these eight characteristics will cover all new characteristics, and then we accept Ramirez' eight characteristics in this article as criteria used for evaluating in the framework

4. Framework

In this section, the developed framework is introduced. As depicted in Fig. 2 the framework consists of five major steps. Explanation of each step is as follows:

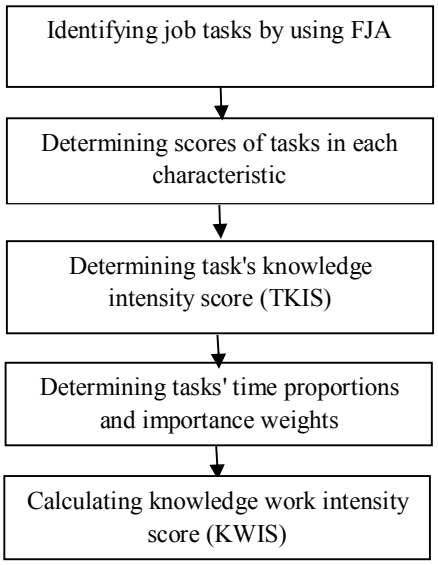

Fig. 2. Methodology steps

4.1. Identifying job tasks by using FJA

One of the gaps discovered in the literature is the absence of a methodology for task identification. Job analysis is a process for task identification, job specification distinction, etc. Table 2 presents some job analysis methods and their functions.

Table 2
Job analysis methods and their attributes (Madani, 2007)

Job analysis method	Focus level	Input/output classification	Personnel specification	Job structural needs	Mental processes
PAQ	Position	✓	✓	✓	✓
AET	Task	-	-	✓	✓
TAPA	Task	-	✓	-	-
OAI	Position	✓	✓	✓	✓
CTA	Task	-	✓	-	✓
CIT	Task	-	-	-	-
FJA	Task	✓	✓	-	✓
JEM	Element	✓	✓	-	-
TI	Task	-	✓	-	-

Whereas these methods are developed for all types of works, we must select one method to first focus on the task level and then be appropriate for knowledge works. Among the techniques mentioned in Table 2, FJA is a method, which focuses on job tasks. In addition, this method presents tasks associated with the job, and, based on working with people, working with things, and working with data, scales the functions of workers. Furthermore this method is based on Subject Matter Experts (SMEs) like knowledge workers themselves and this is close to their autonomy discussed in the literature (Madani, 2007). FJA defines the exact tasks of a specific job or occupation. FJA is based on the premise that every job needs a worker to function in relation to things, data and people in different degrees. Task actions may be Physical (for example, operating an electrical typewriter), Mental (for example, analyzing data) or Interpersonal (for example, consulting another person). In FJA method, tasks consist of basic elements of job and they are defined in pursuit of organizational goals. Thus in first step of this method, analyst must define expected outputs of job and then describe tasks that provide these outputs (Fine, 1999; Levin et al., 1983).

4.2. Determining scores of tasks in each characteristic

After identifying job tasks, each task must be measured based on eight characteristics of knowledge work. Whereas these eight characteristics can't be measured quantitatively and have fuzzy attitude, then fuzzy variables are used for measurement. Table 3 lists the semantics (Herrera et al., 2000; Chang et al., 2006).

Table 3
Linguistic interval scale

Linguistic term set	None (N)			Very Low(VL)			Low(L)			Medium(M)			High(H)			Very High (VH)			Perfect(P)		
Fuzzy number	0	0	1/6	0	1/6	1/3	0.16	1/3	1/2	1/3	1/2	2/3	1/2	2/3	5/6	2/3	5/6	1	5/6	1	1
Membership degree	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0

For determining TKIS, each SME notes a linguistic value that indicates the intensity or frequency in a particular characteristic for a particular task based on Table 3. Then we must derive fuzzy numbers that are comparable with linguistic terms (Fig. 3). For example, the linguistic term "Medium" is converted into a linguistic rating of 0.5 (Chang et al., 2006).

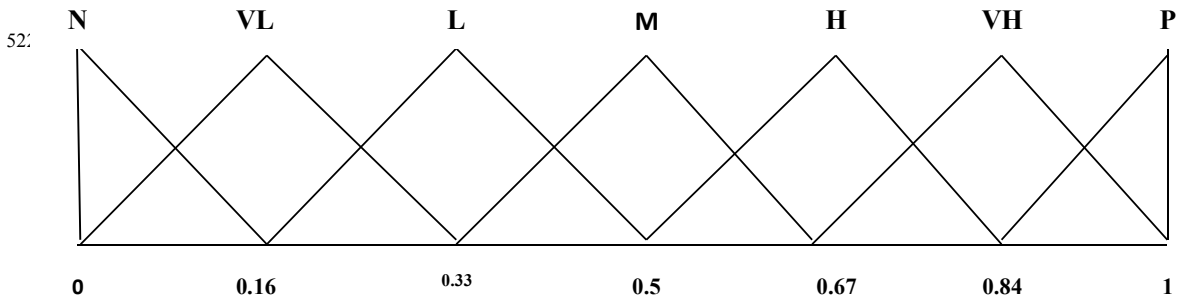

Fig. 3. Linguistic rating on membership function corresponding to fuzzy numbers

For determining the score for a particular task (j) in a characteristic ($x_{(i)}$) which is defined by $f_j(x_{(i)})$, it is necessary to classify these characteristics as regular or irregular (Ramirez; 2006). Autonomy, knowledge, creativity and innovation and complexity are regular characteristics and then $f_j(x_{(i)})$ for this characteristics are equal to linguistic values. Structure, tangibility, routine and repetitiveness and physical effort are irregular and then $f_j(x_{(i)})$ for these characteristics calculate based on Eq. 1.

$$f_j(x_{(i)}) = 1 - Linguistic rating \quad (1)$$

4.3. Determining task's knowledge intensity score (TKIS)

As mentioned earlier, one of the deficiencies in the previous works was application of the simple average method in calculating knowledge intensity (regarding that these criteria don't have equal weight and there is interaction between them). Furthermore, scores of characteristics are fuzzy and then an appropriate approach must be selected. Five most often used aggregation operators are as below (Detyniecki, 2001; Grabisch, 1996),

- Basic Operator
- Quasi-arithmetic means
- Symmetric Sum
- Ordered Weighted Averaging Operators
- Choquet & Sugeno discrete Fuzzy Integrals

Each of these operators has mathematical and behavioral properties that can help researchers in selection of an appropriate operator (Detyniecki, 2001; Grabisch, 1996). The characteristics in our problem have following properties (Ramirez, 2006):

- The dependency and interaction among characteristics must be considered.
- Each characteristic has a weight (relative importance) in compared with other characteristics.
- There are Substitutive/ Complementary relation between characteristics.

As Grabisch (1996) states, the fuzzy integrals are useful operators to model these conditions.

According to literature, the fuzzy integrals used in many situations like prediction of wood strength (Ishii & Sugeno, 1985), evaluation of strategies (Narukawa & Torra, 2007), evaluation of the capability of supplier (Kong et al., 2007), evaluation the students' performance (Shieh et al., 2009), warehouse location selection (Demiral et al., 2010), evaluating customer service perceptions on fast food stores (Hu.C, 2010), etc. There are two types of commonly used fuzzy integrals; Choquet and Sugeno integrals. In this article we use Choquet integral because this type is proposed for qualitative setting (Wagholikar & Deer, 2007).

Definition 1: Let μ be a fuzzy measure on X. the *choquet integral* of a function $f: X \to [0,1]$ is defined by

$$C_\mu(f(x_1),...,f(x_n)) := \sum_{i=1}^{n} (f(x_{(i)}) - f(x_{(i-1)}))\mu(A_{(i)}), \tag{2}$$

where $_{(i)}$ indicates that the indices have been permuted so that $0 \le f(x_{(1)}) \le ... \le f(x_{(n)}) \le 1$, $A_{(i)} = \{x_{(i)},...,x_{(n)}\}$ and $f(x_{(0)}) = 0$ (Detyniecki, 2001; Demiral et al., 2010). More complete definitions can be found in (Detyniecki, 2001; Grabisch, 1996). Let X be the set of the characteristics that participate in TKIS and $f(x_{(i)})$ is the characteristic $x_{(i)}$'s score. Then it's enough to define fuzzy measures match to the set of the characteristic.

4.3.1 Introducing an appropriate method for calculating Fuzzy measures

Definition 2: A fuzzy measure μ defined on the set X is a set function $\mu: P(X) \to [0,1]$ satisfying the following axioms (Wang & Shen, 2006):

(3) μ(ø)=0 , μ(X)=1
(4) $A \subseteq B \subseteq X \Rightarrow$ μ (A) ≤ μ (B)

For any A, B ⊆ X and A ∩ B = ∅, fuzzy measure values do not always satisfy the additive relation (μ (A) + μ(B) = μ (A ∪ B)) and according to Tan and Chen (2010) and Wang and Shen (2006) it can be stated as follows,

Complementary μ (A) + μ (B) < μ (A ∪ B),
Substitutive μ (A) + μ (B) > μ (A ∪ B).

The most difficult part in using fuzzy integrals is determination of fuzzy measures. Some methods can be found for this purpose in literature (Wagholikar & Deer, 2007). In this article, we use fuzzy measure identification method by diamond pair wise comparisons and φ_s transformation. Fig. 4 outlines the fuzzy measure identification in this method (Takahagi, 2008).

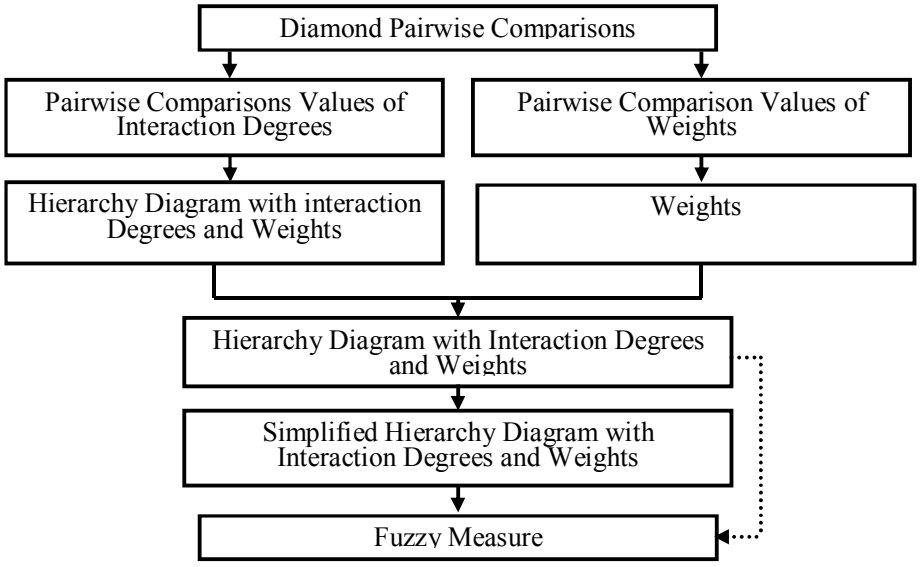

Fig. 4. Outline of identification (Takahagi, 2008)

According to Fig. 4, first we use questionnaire for pairwise comparison among characteristics with respect to determining relative importance and Substitutive/Complementary ability between each pair. Pairwise comparisons between two characteristics are described in Fig. 5 at 2 axes. The horizontal axis (additive line) means the pairwise comparison with respect to relative importance (weights). In middle point of this axis, two characteristics have equal weights and to left increase weight characteristic A and wise versa (Takahagi, 2008). The vertical line is associated with interaction degrees. In the bottommost point of this axis, either A or B is important (Both are not needed) and it means that the two evaluation items are substitutive. Against, in upmost point of this axis, both A and B is important (Takahagi, 2008).

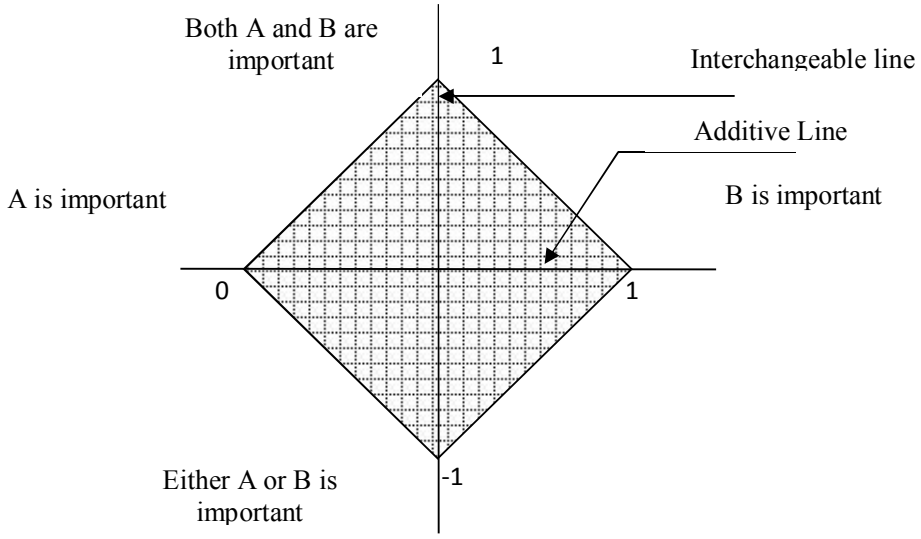

Fig. 5. Diamond pair wise comparison's properties (Takahagi, 2008)

In this method Grabisch's graphical interpretation have been used. When n=2, Grabisch's graphical values are defined as Eq. (5) to Eq. (7).

$$I_{ij} = \mu(\{i,j\}) - \mu(\{i\}) - \mu(\{j\}), \tag{5}$$

$$sv_i = \frac{\mu(\{i\}) + \mu(\{i,j\}) - \mu(\{j\})}{2}, \tag{6}$$

$$sv_j = \frac{\mu(\{j\}) + \mu(\{i,j\}) - \mu(\{i\})}{2}. \tag{7}$$

sv_i and sv_j ($sv_i + sv_j = 1$) are Shapley value of the μ and I_{ij} is the Murofush and Soneda's interaction index (Murofushi & Soneda 1993). With respect to these equations, fuzzy measure values for the diamond are estimated as Eq. (8).

$$\mu(\{i\}) = sv_i - (1/2)I_{ij} \quad \text{and} \quad \mu(\{j\}) = sv_j - (1/2)I_{ij} \tag{8}$$

In this method interaction degree indexes (ξ_{ij}) has been used instead of I_{ij}. This interaction degree indexes compute based on equation $\mu(\{i\}) = \varphi_s(sv_i, \xi_{ij})$ and function φ_s is defined as Eq. (9)

$$\varphi_s(\xi,u)=\begin{cases}1 & if \quad \xi=1 \quad and \quad u>0\\ 0 & if \quad \xi=1 \quad and \quad u=0\\ 1 & if \quad \xi=0 \quad and \quad u=1\\ 0 & if \quad \xi=0 \quad and \quad u<1\\ \dfrac{s^u-1}{s-1} & other \quad cases\end{cases} \tag{9}$$

where $s=\dfrac{(1-\xi_{ij})^2}{\xi_{ij}^{\ 2}}$.

Fore computing the weights of characteristics, we use AHP's eigenvalue method that weight ratio matrix's elements define as Eq. (10).

$$c_{ij}=\frac{sv_i}{sv_j} \tag{10}$$

After calculating interaction degree indexes (ξ_{ij}) and characteristics weigh, we define dissimilarity measure among the characteristics as average distance to other characteristics. More with Applying ordinal agglomerative hierarchical clustering method pairs of clusters that have smallest dissimilarity are merged (Takahagi, 2008). Then, we simplify the diagram by procedure that presented by Takahagi (Takahagi, 2008). Finally fuzzy measures identified by φ_s transformation based on hierarchical clusters that obtained.

4.3.2. Calculating Fuzzy measures of knowledge work characteristics

For extracting sv_i and I_{ij} of the eight characteristics, a questionnaire is prepared. Then this questionnaire is sent to 60 experts in the field of human resource management and knowledge management. 52 experts responded and returned their filled questionnaires. Table 4 presents average of their proposed values for sv_i and I_{ij} (up sv_i and bottom I_{ij}). In this table, Index i indicates columns and index j indicates rows. Then weights and interaction degree are calculated based on the method explained in above. Agglomerative hierarchical clustering method is applied in 6 repetitions; results are shown in Fig. 6.

Table 4
sv_i and I_{ij} values that presented by SMEs

	Independence 1						
2. Structure	0.65	Structure 2					
	-0.8						
3. Explicit	0.57	0.6	Explicit 3				
	0.8	0.3					
4.Knowledge	0.13	0.1	0.16	Knowledge 4			
	0.9	0.73	0.1				
5. Creativity& Innovation	0.3	0.16	0.26	0.56	Creativity& Innovation 5		
	-0.7	-0.1	0.73	-0.7			
6. Complexity	0.5	0.3	0.5	0.78	0.73	Complexity 6	
	0.8	0.73	0.83	0.2	-0.1		
7. Routine	0.4	0.5	0.5	0.83	0.76	0.7	Routine 7
	0.7	-0.9	0.7	0.8	0.75	0.5	
8. Physical Activity	0.58	0.5	0.5	0.8	0.73	0.53	0.36
	0.85	0.9	-0.9	-0.8	-0.8	0.6	0.4

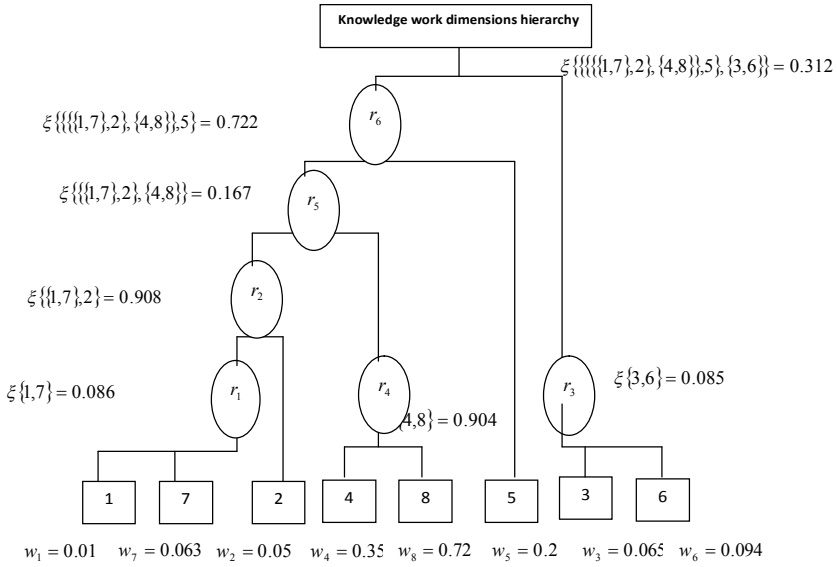

Fig. 6. Identified hierarchy diagram

The simplified hierarchy diagram of this example is depicted in Fig. 7 (threshold value is 0.5). Fuzzy measures based on this figure are presented in appendix 1.

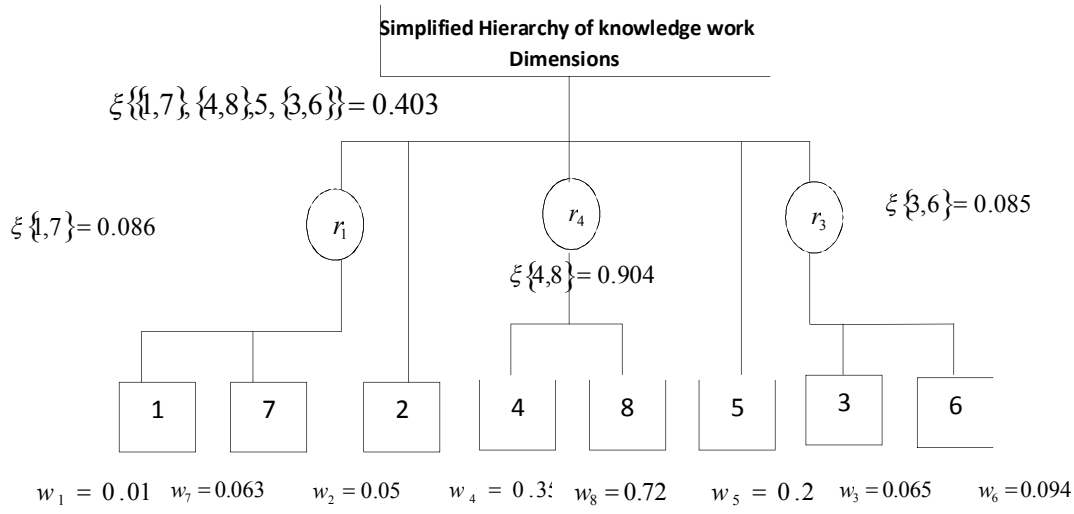

Fig. 7. Simplified identified hierarchy diagram

4.3.3. Calculating TKIS

In this step, TKISs are calculated based on Choquet integral, fuzzy measures (appendix 1) and task scores for each one based on eight characteristics. For example while supposed $\{f_j(x_{(1)}), \ldots, f_j(x_{(8)})\}$ score set for task j in 8 characteristics as $0 \le f_j(x_{(1)}), \ldots, f_j(x_{(8)}) \le 1$ then TKIS for task j (c_μ^j) is calculated by Eq. 11 (with respect to Choquet integral definition). In this relationship $A_{(i)}=\{X_{(1)},\ldots,X_{(8)}\}$, $f(x_0)=0$, $\mu(A_{(i)})$ is fuzzy measure for $A_{(i)}$ set such that their values are presented in Appendix 1.

$$c_\mu^j := \sum_{i=1}^{8} (f_j(x_{(i)}) - f_j(x_{(i-1)}))\mu(A_{(i)}) \tag{11}$$

4.4. Determining tasks' time proportions and importance weights

Workers need a different proportion of the total time to accomplish each task. However, a task comprising less proportion of the total time may play an essential role in accomplishing a job. Such tasks usually form some parts of a job mission. For example, ‘‘writing reports’’ is the most important task of a laboratory technician; but, it comprises less proportion of the total time compared to his/her other tasks (Heidary et al., 2011). Based on the required proportion of the total time and the importance, two types of weights are assigned to each task.

4.4.1. Determining the time proportion weights

Determination of time proportions of tasks needs to apply time study. Selection of the appropriate method for the time study depends mostly on the nature of the job. Jackson (1989) and Groover (2007) chose different approaches in order to select a method for the time study. Results obtained via these two approaches are very similar. The first approach is more accurate, but requires more computational time. In this article, approach proposed by Groover (2007) is followed. Fig. 8 presents job structure hierarchy (Groover, 2007). As this figure indicates, researcher must select appropriate time study method based on job level and time that he/she wants to spend. Based on Table 5 and with respect to this reality that our study focuses on the task level (level 2), Direct Observation Methods like Stop-Watch and work sampling are appropriate methods. As direct observation methods focus on task level, then, major use of methods in this family is on level 2 of job structure hierarchy (Marashi, 1997).

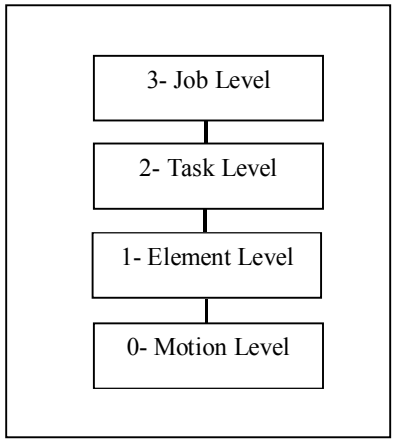

Fig. 8. Definitions of orders of work units

Table 5
Appropriate time study methods based on orders of work units

Useful Techniques	Work Levels
- MTM Techniques (include MTM-1, MTM-2, MTM-3, MTM-C, etc.)	0-Motion Level
- MOST Techniques (include Basic MOST, MOST-C, Mini MOST, etc.)	1- Element Level
Direct Observation Methods (include Stop-watch, work sampling, etc.)	2- Task Level

Note: MTM (Methods Time Measurement) and MOST (Maynard Operation Sequence Technique)

Another factor that must be considered in selecting time study approach is nature of the job. As knowledge workers must be involved in their performance evaluation process (Roger G. Schroeder, 1985; Mary R. Lind, 2000; Josu Takala; 2006; Ramirez, 2008) then in this article *self reporting technique* is selected for time study. In this technique, workers that their job is studied are requested to report their situation and tasks that they are doing, in distinct times. It means that only difference between this technique and work sampling method that presented first time (Trippett, 1935) is that

workers involved in time study procedure (Ampt, et al., 2007, Bell, 1999, Agustinus, 2007). The ratio of needed time to accomplish each task to the total time required to accomplish the job is defined as time proportion weight (W_1^j).

4.4.2. Determining the importance weights

There are various methods for determining importance of tasks in a job. For example, some job analysis methods can be used for this reason. However these methods are to some extent complicated and time consuming. Heidary et al. (2011) proposed an effective and simple method for determining importance of tasks which is utilized in this article. To determine the importance of the tasks, job incumbent and other SMEs are asked to assign a number from the set $\{1,2,...,7\}$ to each task (Heidary et al.,2011). The importance weight of tasks (W_2^j) is calculated by Eq. (12).

W_2^j: *Importance weight of task j*

s^j: *Number assigned to task j by SME*

n: *Number of the job's tasks*

$$W_2^j = \frac{s^j}{\sum_{i=1}^{n} s^i} \tag{12}$$

4.5. Calculating knowledge work intensity score (KWIS)

The following information can be obtained from pervious steps of the framework:

- Tasks of the job,
- Tasks' knowledge intensity scores (C_μ^j),
- Time proportion weight (W_1^j) of the tasks,
- Importance weight (W_2^j) of the tasks.

Knowledge work intensity score (KWIS) of a job which has n tasks is calculated by Eq. (13) as follows,

$$\mathrm{KWIS} = \sum_{j=1}^{n} \left(\frac{W_1^j + W_2^j}{2}\right) \times C_\mu^j \tag{13}$$

5. Application of the framework

In this part, knowledge work scores are calculated for two jobs to illustrate the applicability of framework. We consider one managerial job (Deputy of Finance and support) and one technician job (Laboratory technician) in a power plant for this reason. The jobs had job description, which could be used for identifying tasks of these jobs. SMEs in each field and HRM's experts were interviewed to extracting scores of the tasks in each knowledge work characteristic ($f_j(x_{(i)})$), of the tasks and Importance weight (W_2^j) of the tasks. Also, time proportion weights (W_1^j) is obtained by interviewing incumbents of the jobs and applying the self-reporting method.

5.1. Example 1: Deputy of Finance and support

Job description: Planning, supervision and coordinating finance activities, public services, commerce (Procurement & Contracts), foreign subscribers and legal rights based on regulations in order to meeting organizational goals and programs.

Tasks and their scores in each knowledge work characteristic (as Linguistic variables) have been listed in appendix 2. TKISs and time and importance weights for the tasks of this job are presented in Table 6. As this table shows, KWIS for first job (deputy Finance and support) is equal to 0.6121.

Table 6
KWIS calculation for Deputy of Finance and support

Task's code	TKIS(C_μ^j)	Time proportion weight (W_1^j)	Importance weight (W_2^j)	$(\frac{W_1^j + W_2^j}{2}) \times C_\mu^j$
1	0.39660024	0.06	0.0953	0.030791
2	0.47100652	0.03	0.0805	0.026017
3	0.5242257	0.08	0.0898	0.044516
4	0.46456573	0.05	0.0903	0.032591
5	0.73256835	0.14	0.0935	0.085516
6	0.53553869	0.08	0.0934	0.046432
7	0.70358488	0.14	0.079	0.07705
8	0.76861379	0.16	0.0942	0.097674
9	0.41887126	0.02	0.0939	0.023852
10	0.7619401	0.15	0.1009	0.095578
11	0.5812845	0.09	0.0893	0.052111
$\text{KWIS} = \sum_{j=1}^{n} (\frac{W_1^j + W_2^j}{2}) \times C_\mu^j$				0.6121

5.2. Example 2: Laboratory technician

Job description: Responsibility for installation, testing and maintenance measurement accessories with the aim of correct utilization and providing better services to subscribers;
Tasks and their scores in each knowledge work characteristic (as Linguistic variables) for this job have been listed in Appendix 3. Table 7 presents calculation of KWIS for this job which is equal to 0.5225.

Table 7
KWIS calculation for Laboratory technician

Task's code	TKIS(C_μ^j)	Time proportion weight (W_1^j)	Importance weight (W_2^j)	$(\frac{W_1^j + W_2^j}{2}) \times C_\mu^j$
1	0.63608196	0.174377793	0.2	0.11906748
2	0.36900344	0.16810931	0.17	0.062381749
3	0.41666889	0.169533965	0.14	0.064486587
4	0.38708311	0.161460919	0.11	0.052538968
5	0.45953271	0.173937445	0.16	0.076727589
6	0.79118078	0.152580569	0.22	0.147389292
$\text{KWIS} = \sum_{j=1}^{n} (\frac{W_1^j + W_2^j}{2}) \times C_\mu^j$				0.522591666

6. Summary and Conclusions

Presenting a knowledge work quantifiable definition is very important for Development of human resources management tools, especially in the field of knowledge workers' productivity management. In this article a framework is presented for quantitative definition of knowledge work. The framework covers identified gap in literature review by using appropriate job analysis method (FJA) time study method (Self reporting), fuzzy variables, and fuzzy integral and fuzzy measures.
Results of using this methodology for quantifying knowledge intensity of two jobs (deputy Finance and support and Laboratory technician) indicate applicability of the framework. Based on these examples, job of deputy Finance and support is more knowledge intensive as a laboratory technician and experts agree with this result. This study provides many starting points for Future researches. Some studies in this field can be used for Statistical analysis of the results of this methodology and validate it

by the Statistical test (at business level), mapping KWISs with previous knowledge work classifications (like Davenport, 2005) and provide clearer definitions of each class of knowledge workers.

References

Akhavan, P., Adalati, M., Sharifi, S., & Atashgah, R. (2010). The Challenges of Knowledge Management Portals Application and Implementation: The Iranian Organizations Case Study. *International Journal of Industrial Engineering Computations*, *1*, 79-93.

Agustinus, R., & Siringoringo, H. (2007). Work sampling comparative among conventional self assessment and continuous monitoring methods to measure proportion of non productive activities.

Agarwal, P., Sahai, M., Mishra, V., Bag, M., & Singh, V. (2011). A review of multi-criteria decision making techniques for supplier evaluation and selection. *International Journal of Industrial Engineering Computations*, *2*(4), 801-810.

Ampt, A., Westbrook, J., Creswick, N., & Mallock, N. (2007). A comparison of self-reported and observational work sampling techniques for measuring time in nursing tasks. *Journal of Health Services Research & Policy*, *12*(1), 18-24.

Bell, H. M., McElnay, J. C., & Hughes, C. M. (1999). A self-reported work sampling study in community pharmacy practice. *Pharmacy World and Science*, *21*(5), 210-216.

Brannick, M. T., Levine, E. L., & Morgeson, F. P. (2007). *Job and work analysis: Methods, research, and applications for human resource management*. SAGE Publications, Incorporated.

Burkhart, J. (1995). Identifying Critical Job Tasks. Colorado State Dept. of Education, Denver. State Library and Adult Education Office.

Chang, S. L., Wang, R. C., & Wang, S. Y. (2006). Applying fuzzy linguistic quantifier to select supply chain partners at different phases of product life cycle. *International Journal of Production Economics*, *100*(2), 348-359.

Dahooie, J. H., Afrazeh, A., & Hosseini, S. M. M. (2011). An activity-based framework for quantification of knowledge work. *Journal of Knowledge Management*, *15*(3), 422-444.

Davenport, T. H., & Prusak, L. (2000). *Working knowledge: How organizations manage what they know*. Harvard Business Press.

Davenport, T. (2002). Can you boost Knowledge worker's impact on the bottom line?. *Management Update*, 7(11), 3-5.

Davenport, T. H. (2005). *Thinking for a living: how to get better performances and results from knowledge workers*. Harvard Business Press.

Demirel, T., Demirel, N. Ç., & Kahraman, C. (2010). Multi-criteria warehouse location selection using Choquet integral. *Expert Systems with Applications*, *37*(5), 3943-3952.

Detyniecki, M., Bouchon-meunier, D. B., Yager, D. R., & Prade, R. H. (2000). Mathematical aggregation operators and their application to video querying.

Dragunov, A. N., Dietterich, T. G., Johnsrude, K., McLaughlin, M., Li, L., & Herlocker, J. L. (2005, January). TaskTracer: a desktop environment to support multi-tasking knowledge workers. In *Proceedings of the 10th international conference on Intelligent user interfaces* (pp. 75-82). ACM.

Drucker, P. F. (1959). *The landmark of tomorrow*. New York: Harper Business.

Drucker, P. F. (1993). *Post-Capitalist Society*. New York: Harper Business.

Drucker, P. F. (1995). The new productivity challenge. *Quality in Higher Education*, 37.

Drucker, P. F. (1999). Knowledge-worker productivity. *California management review*, *41*(2), 79-94.

Drucker, P. F. (2009). *Managing in a time of great change*. Harvard Business School Press.

Eppler, M. J., Seifried, P., & Röpnack, A. (2008). Improving Knowledge Intensive Processes through an Enterprise Knowledge Medium (1999). In *Kommunikationsmanagement im Wandel* (pp. 371-389). Gabler.

Grabisch, M. (1996). The application of fuzzy integrals in multicriteria decision making. *European journal of operational research*, *89*(3), 445-456.

Groover, M. P. (2007). *Work systems and the methods, measurement, and management of work*. Upper Saddle River, NJ: Pearson Prentice Hall.

Guns, W. D., & Välikangas, L. (1997). Rethinking knowledge work: creating value through idiosyncratic knowledge. *Journal of Knowledge Management*,*1*(4), 287-293.

Hammer, M., Leonard, D., & Davenport, T. (2004). Why don't we know more about knowledge?. *MIT Sloan Management Review*, *45*, 14-18.

Harney, N. D. (2006). Precarious migrant knowledge workers: new entrepreneurial identities in Naples, Italy. *International journal of manpower*,*27*(6), 572-587.

Helton, R. (1988). The 'best work's method of knowledge worker assessment. *Industrial Management*, *30*(5), 19-22.

Herrera, F., Herrera-Viedma, E., & Martí nez, L. (2000). A fusion approach for managing multi-granularity linguistic term sets in decision making. *Fuzzy Sets and Systems*, *114*(1), 43-58.

Hu, Y. C., & Chen, H. C. (2010). Choquet integral-based hierarchical networks for evaluating customer service perceptions on fast food stores. *Expert Systems with Applications*, *37*(12), 7880-7887.

Ishii, K., & Sugeno, M. (1985). A model of human evaluation process using fuzzy measure. *International Journal of Man-Machine Studies*, *22*(1), 19-38.

Jackson, D. F. (1989). *A methodology for the quantification of knowledge work*(Doctoral dissertation, University of Tennessee, Knoxville).

Kong, W., Qu, H., & Zhang, Q. (2007, September). A Fuzzy Choquet Integral Approach to Evaluate the Capability of Supplier. In *Wireless Communications, Networking and Mobile Computing, 2007. WiCom 2007. International Conference on* (pp. 4740-4743). IEEE.

Lavoie, M., Roy, R., & Therrien, P. (2003). A growing trend toward knowledge work in Canada. *Research Policy*, *32*(5), 827-844.

Levine, E. L., Ash, R. A., Hall, H., & Sistrunk, F. (1983). Evaluation of job analysis methods by experienced job analysts. *Academy of Management Journal*, *26*(2), 339-348.

Lewis, K. (2004). Knowledge and performance in knowledge-worker teams: A longitudinal study of transactive memory systems. *Management science*, *50*(11), 1519-1533.

Lind, M. R., & Sulek, J. M. (2000). A methodology for forecasting knowledge work projects. *Computers & Operations Research*, *27*(11), 1153-1169.

Madani, F. (2007). Job Analysis Methods, MehrooMah (in Persian).

Marashi, S. N. (1998). Time Studying Systems, Basir (in Persian).

McKillip, J. (2002). IT Pro Job Task Analysis: Report to Participants.

Murofushi, T., & Soneda, S. (1993). Techniques for reading fuzzy measures (III): interaction index. In *9th Fuzzy System Symposium* (pp. 693-696).

Narukawa, Y., & Torra, V. (2007). Fuzzy measures and integrals in evaluation of strategies. *Information Sciences*, *177*(21), 4686-4695.

Nickols, F. R. E. D. (2000). 'What is' in the world of work and working: some implications of the shift to knowledge work. *The knowledge management yearbook 2000–2001*, 3-11.

Overbeek, S.J. (2007), Improving efficiency and effectiveness of knowledge exchange between knowledge workers, *Journal of Knowledge Management*, 5(1), 24-38.

Pan, W., Liu, J., & Hawryszkiewycz, I. (2008, April). A method for describing knowledge work processes. In *Advanced Information Systems for Enterprises, 2008. IWAISE'08. International Workshop on* (pp. 46-52). IEEE.

Pyöriä, P. (2005). The concept of knowledge work revisited. *Journal of Knowledge Management*, *9*(3), 116-127.

Ramírez, Y. W., & Nembhard, D. A. (2004). Measuring knowledge worker productivity: A taxonomy. *Journal of intellectual capital*, *5*(4), 602-628.

Ramirez, Y. W. (2006). Defining measures for the intensity of knowledge work in tasks and workers. *Department of Industrial Engineering, University of Wisconsin-Madison, Madison, WI*.

Ramirez, Y. W., & Steudel, H. J. (2008). Measuring knowledge work: the knowledge work quantification framework. *Journal of Intellectual Capital*, *9*(4), 564-584.

Schroeder, R. G., Anderson, J. C., & Scudder, G. D. (1985). Measurement of white collar productivity. *International Journal of Operations & Production Management*, *5*(2), 25-34.

Scott, P. B. (2005). Knowledge workers: social, task and semantic network analysis. *Corporate communications: an international journal*, *10*(3), 257-277.

Shi-you, Q. U. (2008, September). Knowledge characerisics of jobs and the empirical testing. In *Management Science and Engineering, 2008. ICMSE 2008. 15th Annual Conference Proceedings., International Conference on* (pp. 1010-1017). IEEE.

Shieh, J. I., Wu, H. H., & Liu, H. C. (2009). Applying a complexity-based Choquet integral to evaluate students' performance. *Expert Systems with Applications*, *36*(3), 5100-5106.

Smith, A. D., & Rupp, W. T. (2004). Knowledge workers' perceptions of performance ratings. *Journal of Workplace Learning*, *16*(3), 146-166.

Takahagi, E. (2008). A fuzzy measure identification method by diamond pairwise comparisons and {\ phi_s} transformation. *Fuzzy Optimization and Decision Making*, *7*(3), 219-232.

Takala, J., Suwansaranyu, U., & Phusavat, K. (2006). A proposed white-collar workforce performance measurement framework. *Industrial Management & Data Systems*, *106*(5), 644-662.

Tan, C., & Chen, X. (2010). Intuitionistic fuzzy Choquet integral operator for multi-criteria decision making. *Expert Systems with Applications*, *37*(1), 149-157.

Tankoonsombut, K. (1998). *Investigation of the effects of feedback and goal-setting on knowledge work performance in the distributed work environment*(Doctoral dissertation, Virginia Polytechnic Institute and State University).

Turner, T., & D'Art, D. (2008). Is there a new knowledge economy in Ireland? An analysis of recent occupational trends. *International Journal of Manpower*,*29*(8), 700-714.

Wagholikar, A., & Deer, P. (2007). Fuzzy Measures Acquisition Methods. *Engineering Letters*, *14*(2), 56-60.

Wang, X. Z., & Shen, J. (2006). Using special structured fuzzy measure to represent interaction among IF-THEN rules. In *Advances in Machine Learning and Cybernetics* (pp. 459-466). Springer Berlin Heidelberg.

Wang, S. (2008, October). Study on the evaluation of knowledge worker value based on rough set theory. In *Wireless Communications, Networking and Mobile Computing, 2008. WiCOM'08. 4th International Conference on* (pp. 1-4). IEEE.

Appendix 1:

Fuzzy measures for eight characteristics in calculating KWIS

A	μ	A	μ	A	μ	A	μ	A	μ	A	μ
1	0.04381	145	0.596979	1236	0.204357	2468	0.464724	13567	0.422648	134578	0.783034
2	0.036295	146	0.449365	1237	0.180247	2478	0.442507	13568	0.500088	134678	0.644062
3	0.035678	147	0.443614	1238	0.242786	2567	0.323494	13578	0.469132	135678	0.582512
4	0.30926	148	0.394162	1245	0.659157	2568	0.410626	13678	0.357085	145678	0.819996
5	0.158023	156	0.279645	1246	0.505143	2578	0.389332	14567	0.786476	234567	0.851684
6	0.05559	157	0.274653	1247	0.499143	2678	0.263091	14568	0.723785	234568	0.807281
7	0.040355	158	0.342996	1248	0.447546	3456	0.707067	14578	0.716807	234578	0.748889
8	0.106231	167	0.160215	1256	0.328064	3457	0.652234	14678	0.55686	234678	0.612846
12	0.082005	168	0.221524	1257	0.322856	3458	0.613074	15678	0.498933	235678	0.552593
13	0.081355	178	0.216792	1258	0.394162	3467	0.524482	23456	0.774018	245678	0.785072
14	0.369255	234	0.40994	1267	0.203457	3468	0.488681	23457	0.716807	345678	0.814924
15	0.210103	235	0.245421	1268	0.267424	3478	0.441603	23458	0.67595	1234567	0.962839
16	0.10231	236	0.152563	1278	0.262486	3567	0.344852	23467	0.583516	1345678	0.923659
17	0.09811	237	0.117419	1345	0.658098	3568	0.433587	23468	0.546164	1245678	0.891843
18	0.155601	238	0.189081	1346	0.529843	3578	0.388465	23478	0.497044	1235678	0.644062
23	0.07352	245	0.584745	1347	0.498198	3678	0.283338	23567	0.396099	1234678	0.708281
24	0.358964	246	0.43839	1348	0.446638	4567	0.686212	23568	0.488681	1234578	0.853278
25	0.20117	247	0.416623	1356	0.349506	4568	0.646159	23578	0.441603	1234568	0.893338
26	0.094296	248	0.383658	1357	0.322036	4578	0.620846	23678	0.331917	2345678	0.886551
27	0.0784	256	0.270118	1358	0.393291	4678	0.470775	24567	0.752259	12345678	1
28	0.147133	257	0.251222	1367	0.222606	5678	0.416426	24568	0.710469		
34	0.358118	258	0.332928	1368	0.28775	12345	0.722926	24578	0.684059		
35	0.200435	267	0.139196	1378	0.261708	12346	0.58911	24678	0.527482		
36	0.111436	268	0.212493	1456	0.69221	12347	0.556093	25678	0.470776		
37	0.077753	278	0.19458	1457	0.685374	12348	0.502297	34567	0.781506		
38	0.146437	345	0.58374	1458	0.626587	12356	0.400955	34568	0.738948		
45	0.52566	346	0.461863	1467	0.528662	12357	0.372293	34578	0.682983		
46	0.385386	347	0.415736	1468	0.475926	12358	0.446638	34678	0.552593		
47	0.364523	348	0.382795	1478	0.470056	12367	0.268553	35678	0.494844		
48	0.332928	356	0.290494	1567	0.348481	12368	0.33652	45678	0.717662		
56	0.224106	357	0.250452	1568	0.421362	12378	0.30935	123456	0.858334		
56	0.224106	358	0.332101	1578	0.415736	12456	0.758517	123457	0.819084		
58	0.284307	367	0.157163	1678	0.286777	12457	0.751384	123458	0.755134		
67	0.098625	368	0.231808	2345	0.645343	12458	0.690048	123467	0.677021		
68	0.168876	378	0.193851	2346	0.518182	12467	0.587878	123468	0.618556		
78	0.151707	456	0.616155	2347	0.470056	12468	0.532855	123478	0.584857		
123	0.121178	457	0.591354	2348	0.435686	12478	0.526731	123567	0.477268		
124	0.42156	458	0.553795	2356	0.339384	12567	0.399885	123568	0.558065		
125	0.255508	467	0.444319	2357	0.297606	12568	0.475926	123578	0.525767		
126	0.143041	468	0.410626	2358	0.382795	12578	0.470056	123678	0.408862		
127	0.138659	478	0.389332	2367	0.200272	12678	0.335506	124567	0.856869		
128	0.198643	567	0.275265	2368	0.278154	13456	0.78788	124568	0.79146		
134	0.42067	568	0.358776	2378	0.238551	13457	0.750261	124578	0.78418		
135	0.254735	578	0.338367	2456	0.679164	13458	0.688968	124678	0.617298		
136	0.161078	678	0.217372	2457	0.653288	13467	0.614101	125678	0.55686		
137	0.137969	1234	0.475203	2458	0.614101	13468	0.558065	134567	0.888042		
138	0.19791	1235	0.302075	2467	0.499878	13478	0.525767	134568	0.821429		

Appendix 2

Information associated with tasks of Deputy Finance and support

Code	Tasks Descriptions
1	Control on performance of under supervision units such as financial affairs, procurement , general services, and juridical affairs based on related rules, instructions and received reports from authorities
2	Control on instructions procurements in rule framework based on regulations(budget rule, labor law)
3	Control on operational programs of under supervision units such as financial affairs, procurement, general services, and juridical affairs based on aims and performance of firm in order for financial resource management and goals attainment.
4	Coordinating the extra-organizational institutes based on negotiations in order for aims advancement
5	Control on reporting and financial information based on accounting standards and statistical analysis in order for presenting information to authorities for future decision-making
6	Coordinating among under supervision units through meetings, committees and negotiations in order for creating fluent and quick flow of work
7	Economic analysis about material procurement from domestic and international market based on specialized instructions and software (for economic and qualified goods purchase)
8	Attending in different administrative and financial commissions and committees based on of related authorities to present useful strategies for proper decision making.
9	Control on approving the needed budget in units under supervision based on related instructions for obtaining costs of them in deputy of financial affairs.
10	Control on implementation of managerial systems in deputy of financial affairs based on related standards in order for proper IMS
11	Cooperation in presenting suggestions for potential contradictions with laws in action based on rules

Calculating TKIS

	knowledge work characteristics								
	Physical	Routine and repetitiveness	complexity	Creativity and innovation	knowledge	Tangibility	Work structure	Autonomy	
TKIS	Irregular	Irregular	Regular	Regular	Regular	Irregular	Irregular	Regular	
0.39660024	N	H	M	L	M	M	H	VH	1
0.47100652	N	M	H	L	M	M	H	VH	2
0.5242257	N	VL	H	M	H	M	H	H	3
0.46456573	N	M	H	H	VL	M	H	M	4
0.73256835	N	M	H	H	VH	VL	M	VH	5
0.53553869	N	M	H	H	L	M	M	M	6
0.70358488	N	M	H	VH	VH	H	H	H	7
0.76861379	N	L	H	VH	H	VL	N	H	8
0.41887126	N	M	VL	VL	M	H	M	VH	9
0.7619401	N	VL	H	VH	VH	M	M	H	10
0.5812845	N	M	M	M	M	VL	VL	M	11

Job Tasks

Appendix 3

Information related to tasks of Laboratory technician

Code	Tasks Descriptions
1	Presenting and arranging job frameworks concerning to information of service unit for procuring measurement instruments
2	Teaching launching new counters
3	Receiving files from related actors based on instructions
4	Following late files for revision
5	Confirming the performance based on instructions
6	Preparing instructions for proper performance

Calculating TKIS

	knowledge work characteristics								
	Physical	Routine and repetitiveness	complexity	Creativity and innovation	knowledge	Tangibility	Work structure	Autonomy	
TKIS	Irregular	Irregular	Regular	Regular	Regular	Irregular	Irregular	Regular	
0.63608196	M	L	VH	VH	M	H	VL	N	1
0.36900344	H	H	VH	M	L	L	VH	M	2
0.41666889	M	VH	H	M	L	M	VH	VL	3
0.38708311	M	L	M	L	L	L	VH	VL	4
0.45953271	L	VH	VL	H	VL	M	H	N	5
0.79118078	H	VL	VL	VH	H	VH	VL	N	6

Job Tasks