World Applied Sciences Journal 24 (1): 96-102, 2013
ISSN 1818-4952

DOI: 10.5829/idosi.wasj.2013.24.01.98

Using Penalty Function Method for Measuring Productivity in the Knowledge Workers Clusters

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Submitted: May 19, 2013; **Accepted:** Jun 29, 2013; **Published:** Aug 07, 2013

Abstract: It is commonly recognized that knowledge is the only source of core competence in the knowledge-based companies, but productivity rate of knowledge worker is always Low. This study seeks to identify factors influence on the productivity. In addition, it presents knowledge workers clusters and measuring productivity of knowledge workers in any clusters. Finally, it describes strategies that influence on knowledge workers productivity in any clusters. It is hoped that this paper will help managers to implement different corresponding measures. A case study is presented where this model measure at the Lead & zinc company (Zanjan, Iran).

Key words: Clusters · Knowledge Workers · Productivity

INTRODUCTION

The world economy has progressed from an industrial economy to a knowledge economy [1]. With knowledge being viewed as a major contributing factor to organisational success, the purveyors of this knowledge in organisations deserve to be focused on. Drucker (1974) first used the term “knowledge worker”; he described these individuals as employees who carry knowledge as a powerful resource which they, rather than the organisation, own. Drucker (1989: 175) states “knowledge workers know that their knowledge gives them freedom to move since everyone’s knowledge has a multitude of applications in the information or knowledge age” [2, 3].

Nowadays, improving the productivity of knowledge workers is one of the major challenges for the business world. Unlike the blue-collar employees who contribute through their muscle power, knowledge workers contribute through thinking. The contribution of the blue-collar employees can be monitored by monitoring his presence at the work spot and also by observing that whether he is operating the machine or not, whereas the contribution of Knowledge Worker cannot be monitored. It is impossible to observe whether the individual is thinking or not. For thinking there is no boundary; the employee may think at work spot, residence, on the way to the office or during the morning walk or evening walk or any other time. So by monitoring the presence of Knowledge Worker his contribution cannot be ensured. Only when the outcome of thinking comes out, the contribution of knowledge worker can be seen [4].

No doubt, productivity process of knowledge workers is an outcome of the interaction and combination of different factors. Productivity of knowledge workers is not just an abstract category and it must necessarily be applicable. The management of the organization will play an important role in providing the suitable ground for institutionalizing and promoting of it and participation of knowledge workers is also of high importance from this viewpoint [5, 6].

Knowledge workers are obviously non-manual workers and are usually employed by organizational managers to carry out innovative activities. A Knowledge Worker is anyone who works for a living at the tasks of developing or using knowledge [5, 7]. Managers that aim to continually improvement in the organization, they should be considering factors of knowledge workers as a part of the management process [8, 9]. Therefore, A scientific method is needed to classify of knowledge workers in organizations. In addition, it is needed to measuring productivity of knowledge workers in any clusters. Finally, it describes strategies that influence on knowledge workers productivity in any clusters.

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Table 1: knowledge management process

Process	*Factors*
Knowledge identification	KWP_{id}
Knowledge creation	KWP_{cr}
Knowledge capturing	KWP_{ca}
Knowledge application	KWP_{ap}
Knowledge sharing	KWP_{sh}
Knowledge saving and storage	KWP_{ss}

Knowledge Workers: Knowledge is a combination of experience, values and new information [9, 10]. Knowledge worker creates knowledge, knows how to tap and share it across an organisation [12].

Knowledge workers make a living by dealing purely with ideas and information. Anyone who makes a living out of creating, handling or spreading knowledge is a knowledge worker. This covers a wide range. Teachers, trainers, university professors and other academics are clearly included. Writers, authors, editors and public relations or communications people are all knowledge workers. Lawyers, scientists and management consultants can be described as knowledge workers. One key difference between knowledge workers and other white-collar workers is the level of education and training. As a rule, Knowledge workers have at least a university undergraduate degree, but that is not always the case [13].

Knowledge workers are well paid compared to other groups of workers. Some knowledge workers join unions, but they are not usually organized in that sense. They can take their expertise elsewhere at the drop of a hat. We can distil a list of knowledge work characteristics [14-16]:

- Knowledge workers like autonomy; they do not like being told what to do.
- Specifying detailed steps to follow is less valuable than in other types of work.
- Knowledge workers find it difficult to describe what they do in detail.
- Commitment matters and makes a huge difference in productivity.

Knowledge Worker Productivity factors present in Table 1 [17].

Factors of knowledge worker are defined in Figure 1 [18, 19].

Research Methodology: It was decided to adopt a case study approach for this paper as there is little existing research on measurement and identification factors of knowledge workers. It has been based on the descriptive

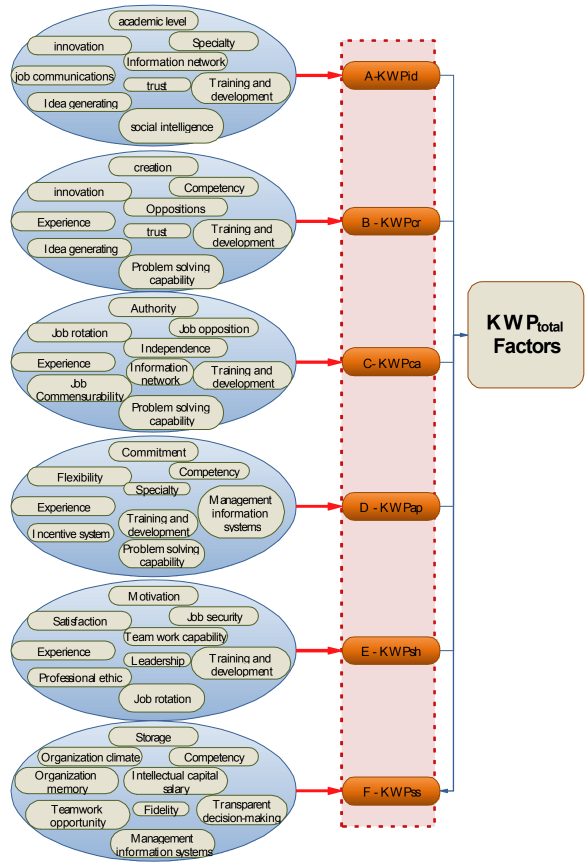

Fig. 1: Knowledge worker factors

Research. This descriptive type research has been carried out using the questionnaire as the research tool for gathering the required data. Data's gathering involved both reference material and a questionnaire survey. Sampling was simple random sampling and the data-gathering instrument was the questionnaire. The author had already undertaken research in this field, which had stimulated the measurement tools and the theoretical framework used to analyze this case study. In November 2011 a request for interviews and questionnaires sent to a number of managers (80 persons, 65% over 15 year's experience) and staff (110 persons, 65% over 20 year's experience) in any company. Prior to the interview and fill the questionnaire, the author explained the purpose of the research and made it clear that this information would be in the public domain, so any confidentiality concerns could be noted. The interview and questionnaire, from December 2011 to April 2012, lasted five hours per week. The interview and questionnaire were semi-structured in nature, starting off with general questions on the company background and knowledge workers to put the respondent at ease.

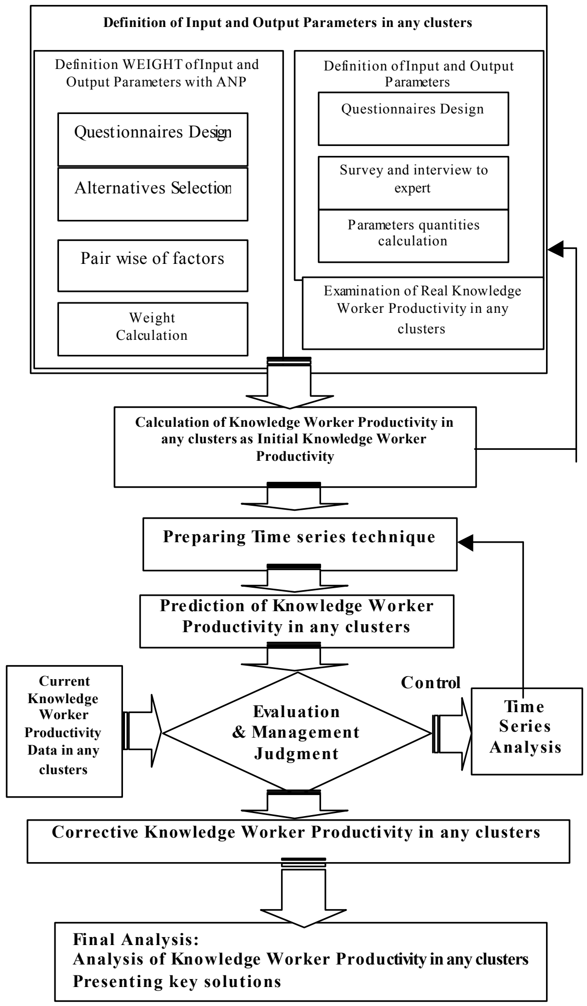

Fig. 2: Knowledge Worker Productivity in any clusters

Detailed questions based on factors knowledge workers and related frameworks were then used to gather information, with other questions included so as not to limit the information collected. Care was taken not to produce expected answers and flexibility was allowed in the process which enabled an effective two-way dialogue to emerge. To ensure internal validity, the interview and questionnaire sent to staff in the Lead & zinc company (Zanjan, Iran) for confirmation of accuracy and to check that no commercially sensitive information had been included.

Generalizability of the research has been based on Partial generalizations. It is possible to similar populations. The knowledge generated by qualitative research is significant in its own right. Problems related to sampling and generalizations may have little relevance to the goals of the study and the reality of the situation. In this situation, a small sample size has been more useful in examining a situation in Company from various perspectives. The goal of a study has been being to focus on a selected contemporary phenomenon such as factors of knowledge workers or measurement addiction were in-depth descriptions would be an essential component of the process.

Productivity in Knowledge Workers Clusters: In this section, it has been tried to combine two measurement and prediction methods for knowledge workers' productivity and a combined method can be presented which can cover the research objectives. The knowledge worker productivity in any clusters is developed to help managers keep track of productivity status in the life cycle of a knowledge worker development as well as incorporating the updated model. Knowledge worker Productivity in any clusters provides for managers to discern the true status of productivity quickly. It gives a manager a quick current view of knowledge workers productivity in any clusters which will be used to predict optimum and used to gap analysis between current and future view.

It is shown in Figure 2. According to Figure 2, at first, knowledge workers' productivity has been measured in any clusters, then it has been predicted in any clusters and at last, based on the final data, the knowledge workers' productivity has been obtained through the approaches proposed to the organizational managers.

For clustering of knowledge workers are used the BMF method. Many publications discussed about BMF and its application on biclustering. Many biclustering algorithms have been proposed recently to explore the correlations between genes and samples and to identify the local gene-sample structures in microarray data [20-22]. The idea of biclustering is to characterize each sample by a subset of genes and to define each gene in a similarway.As a consequence, biclustering algorithms can select the groups of genes that show similar expression behaviors in a subset of samples that belong to some specific classes such as some tumor types, thus identify the local structures of the microarray matrix data [23-25]. Several biclustering methods have been presented in the literature including BiMax, ISA (Iterative Signature Algorithm), SAMBA and OPSM (Order Preserving Submatrix) [26, 27]. A systematic comparison and evaluation of these methods has been studied in Prelic *et al*. (2006) [28]. Recently, Non-negative Matrix Factorization (NMF), as a useful tool for analysing datasets with non-negativity constraints, has been receiving a lot of attention [29, 30]. Nonnegative matrix factorization (NMF) factorizes an input nonnegative matrix into two nonnegative matrices of lower rank. In particular, NMF with the sum of squared error cost function is equivalent to a relaxed K-means clustering, the most widely used unsupervised learning algorithm [29-31]. In addition, NMF with the I-divergence cost function is equivalent to probabilistic latent semantic indexing; another unsupervised learning method popularly used in text analysis [30-32]. However, NMF cannot produce the biclustering structures explicitly. In this paper, we extend standard NMF to Binary Matrix Factorization (BMF) for solving the biclustering problem: the input binary gene-sample matrix X is decomposed into two binary matrices W and H. The binary matrices W and H preserve the most important integer property of the input matrix and also explicitly designate the cluster memberships for genes and samples [31]. As a result, BMF leads to a new biclustering model.

Although NMF has shown its power in many applications, it cannot discover the biclustering structures explicitly. In this paper, we extend the standard NMF to Binary Matrix Factorization (BMF), that is, elements of X are either 1 or 0 and we want to factorize X into two binary matrices W and H (thus conserving the most important integer property of the objective matrix X) satisfying X ˜ WH. We will study both the theoretical and the practical aspects of BMF. In this paper, we use Penalty function algorithm of BMF for biclustering.

Penalty Function Method: In terms of nonlinear programming, the problem can be represented as:

$$
\begin{aligned}
\min \quad & J(W,H) = \sum_{i,j} (X_{ij} - (WH)_{ij})^2 \\
\text{s.t} \quad & H_{ij}^2 - H_{ij} = 0 \\
& H_{ij}^2 - H_{ij} = 0
\end{aligned}
$$

This can be solved by a penalty function algorithm and is programmed as follows:

Algorithm 1: Penalty function method of BMF

Step 1 Initialize λ, W, H and ϵ. Normalize W, H

Step 2 For W and H, alternately solve:

$$\min J^* = \sum_{i,j} (X_{ij} - (WH)_{ij})^2 + \tfrac{1}{2}\lambda[(H_{ij}^2 - H_{ij})^2 + (W_{ij}^2 - W_{ij})^2]$$

Step 3 if

$(H_{ij}^2 - H_{ij})^2 + (W_{ij}^2 - W_{ij})^2 < \epsilon$

$W = \theta(W - 0.5)$; $H = \theta(H - 0.5)$, **break**

else $\lambda =: 10\lambda$, return to 2.

Where the Heaviside step function is defined as

$$\theta(x) = \begin{cases} 1 & x \geq 0 \\ 1 & x < 0 \end{cases}$$

and $\theta(\bullet)$ is element-wise operation: $\theta(\bullet)$ is a matrix whose (i, j)th element is $[\theta(\bullet)]ij = \theta(\bullet ij)$.

Case Study: Lead & zinc Company was selected for conducting the research.

Clustering of Knowledge Workers

Select the Best Threshold: In this section, we implement two algorithms (penalty and threshold methods) in Matlab software with various preprocessors. Results are shown in Table 2.

With implementing of above algorithm in various thresholds and in finally for matrix discretization, then we select final upper threshold and lower threshold (1.05 and 0.07), because of, ACC and NMI have best answers for this range.

Results of Penalty Method: Result of Penalty method in matlab2010 has shown Figure 3.

Penalty algorithms for high-density matrices are better results. Thus, based on the relatively high dispersion of the studied matrices, the results of Penalty algorithm are best performance. Based on penalty function method, we have two clusters of knowledge workers (H, W).

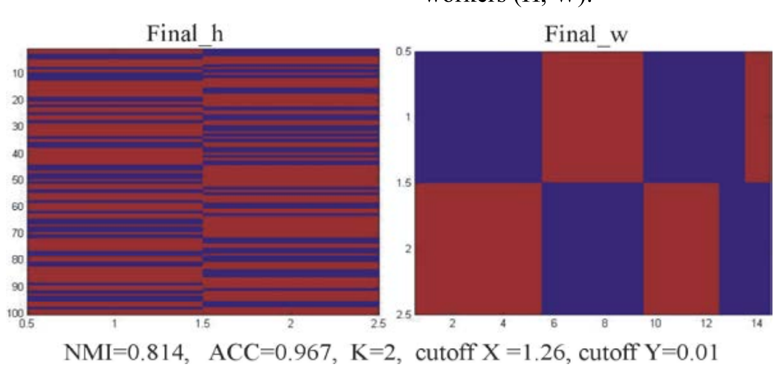

Fig. 3: Result of Penalty method

Table 2: Results of penalty method

		1.05, 0.07	1.05 , 0.05	1.05 , 0.04	1.06 , 0.07	1.07 , 0.07	1.08 , 0.07
ACC	Penalty	95.83	95.83	95.83	87.50	87.50	91.67
NMI		73.34	73.34	73.34	51.47	48.92	58.09

Table 3: Knowledge worker Productivity in any clusters

	Measured knowledge worker productivity		Real knowledge worker productivity		Residual	
t	Cluster 1	Cluster 2	Cluster 1	Cluster 2	Cluster 1	Cluster 2
1	64.35%	56.06%	65.96%	58.30%	1.61%	2.24%
2	66.63%	57.87%	68.30%	60.18%	1.67%	2.31%
3	67.45%	57.94%	69.14%	60.26%	1.69%	2.32%
4	67.78%	58.03%	69.47%	60.35%	1.69%	2.32%
5	68.65%	58.36%	70.37%	60.69%	1.72%	2.33%
6	69.01%	58.84%	70.74%	61.19%	1.73%	2.35%

It is worth noting that the calculation error should be less than 0.05. In this section, an initial analysis can be conducted, according to which knowledge workers' productivity values are high in early months and this result persists until the six periods.

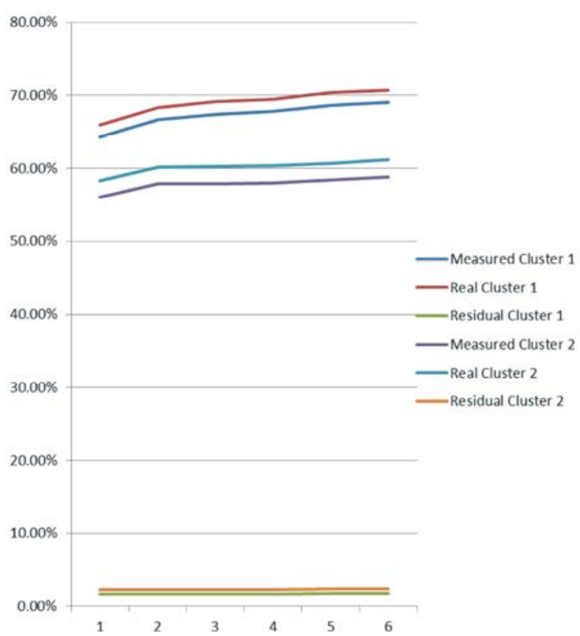

Fig. 4: Productivity in knowledge workers clusters

Productivity of Knowledge Workers in Any Clusters: Productivity was measured for one year or 6 periods which is presented in Table 3.

According to Figure 4, Parallel with the measured and predicted data, we will have:

- Knowledge workers' average productivity in cluster 1 is better than to cluster 2, (productivity of cluster1 is 67.31% and cluster2 is 57.85%).
- Error squares' average reached its minimum (0.03) using the mentioned function.
- R_2 equals to 96.49 which shows the model's validity.
- Reliability and validity: This method was tested using Cronbach's alpha (its value was more than 79.36); it has been validated and confirmed by 81% of the experts, 79% of the managers and by company directors.
- Important solutions using the predicted method are as follows:
- Creating financial and spiritual incentives based on the output work level
- Suitable organizational atmosphere based on the responsibility awarding to knowledge workers and omitting the unnecessary rules.

COCLUSIONS AND DISSCUSSIONS

In this paper, we explored the possibility of building a hybrid method. Knowledge worker productivity console (KWPC) or hybrid method provides the measurement and prediction of knowledge worker productivity in clusters. KWPC plays an important role in revaluating the initial knowledge worker productivity. Time series analysis shows its strength through the research experiment.

In this paper, several objectives have been accomplished. First, knowledge workers has been classified and clustered using penalty function method (BMF method), a KWPC measurement and prediction hybrid method has been created, which can be used in a knowledge worker development. Second, we have gathered real data to validate KWPC or hybrid method in Lead & zinc company (Zanjan, Iran). Third, a KWPC has been created to help managers.

This study has been identified and analyzed factors influence on productivity of knowledge workers. In addition, it has been presented strategies that influence on knowledge workers productivity. Strategies were selected using the ANP approach. This approach has been verified and validated in a case study (The Lead & zinc company (Zanjan, Iran)). The results of this research show that the most important strategy is Activity transparency and intellectual property rights.Activity transparency and intellectual property rights is very important for these companies, because of the current global economic crisis is focusing renewed attention on the urgent need to incentivize and protect innovation to both solve the world's most challenging problems and to generate jobs and economic growth. Intellectual Property (IP), which refers to everything from inventions to the creative arts, drives innovation and improves our lives—generating life-saving devices and medicines, discovering new energy and climate-saving technologies, finding novel ways to create and deliver information and generating consumer goods of all types. Indeed, the nation's future economy will be in the companies that rely on innovation and strong IP rights. Below are some specific arguments and facts about the importance of fostering effective protection of IP, in particular patent, trademark and copyright protection and enforcement.

Limitations:

- Before addressing the future Research and references of the review, the study first need to address three important limitations of our study. First, only few empirical and relevant conceptual studies found and the study is therefore, not able to draw strong conclusions on the impact of the various conceptualizations of factors influence on knowledge workers. Furthermore, from the literature review, it appears that several factors may intervene in knowledge workers. Finally, the operationalizations of knowledge worker factors differ across the studies reviewed, reducing the ability to compare the results found in these studies.

REFRENCES

1. Abdel-Hamid, T., 1993. Adapting, Correcting and Perfecting Software Estimates: a Maintenance Metaphor. *Computer*, 26(3): 20-29.
2. Afrazeh, A., 2005. Knowledge Management (Introduction, Models, Measurement and Implementation), Amirkabir University of Technology Pub., (in Farsi).
3. Afrazeh, A., H. Bartsch and H. Hinterhuber, 2003. Human Resources Productivity measurement and Problem Solving Algorithm. Amirkabir Journal of Science & Technology. Vol15, No60-2 Fall&Winter 2004-2005 pp: 157-158.
4. Afrazeh, A., H. Bartsch and H. Hinterhuber, 2003. Effective Factors in Human Activities and Knowledge Sharing, in Zülch G. (Editor), European Series in Industrial Management, Human Aspects in Production Management. Vol. 6, 2003, Shaker Verlag. pp: 160-167.
5. Afrazeh, A., A. Najafi and H. Bartsch, 2003. Decision Support System for Measurement and Promoting of the human resources Productivity. Proceedings of the 3th International Conference on Industrial Engineering. 13-14 July, Tehran, Iran. (in Farsi).
6. Albrecht, A., 1979. Measuring Application Development Productivity. Proceedings in Joint SHARE/GUIDE/IBM Application Development Symposium, pp: 83-92.
7. Antikainen, R. and A. Lönnqvist, 2006. Knowledge Work Productivity. Assessment. Institute of Industrial Management Tampere University of Technology.
8. Bommer, W., J. Johnson, G. Rich, P. Podsakoff and S. MacKenzie, 1995. On the Interchangeability of Objective and Subjective Measures of Employee Performance: Meta-Analysis. Personnel Psychology, 48(3): 587-606.
9. Cohen, W. and D. Levinthal, 1990. Absorptive capacity: a new perspective on learning and innovation. Administrative Science Quarterly, 35(1): 128-52.
10. Coopey, J., 1995. The learning organization, power, politics and ideology. Management Learning, 26(2): 193-213.
11. Darroch, J. and R. Mc Naughton, 2002. Examining the link between knowledge management practices and types of innovation. Journal of Intellectual Capital, 3(3): 210-22.
12. Davenport, T.H. and L. Prusak, 1998. Working Knowledge: How Organizations Manage What They Know. Harvard Business School Press: Cambridge, MA.
13. Drucker, P.F., 1999. Knowledge-Worker Productivity: The Biggest Challenge. California Management Review, 41(2): 79-94.
14. Fatahi, K. and A. Afrazeh, 2005. An Integrated Model for Evaluating Knowledge Value in Organizations, International Journal, WSEAS Transaction on Information Science and Applications, 2(2): 138-143.

15. Gilbert, M. and M. Cordey-Hayes, 1996. Understanding the process of knowledge transfer to achieve successful technological innovation. Technovation, 16(6): 301-12.
16. Gold, A.H., A. Malhotra and A.H. Segars, 2001. Knowledge management: an organizational capabilities perspective. Journal of Management Information Systems, 18(1): 185-214.
17. Grant, R.M., 1996. Prospering in dynamically-competitive environments: organizational capability as knowledge integration. Organization Science, 7(4): 375-87.
18. Hall, R. and P. Andriani, 2003. Managing knowledge associated with innovation., Journal of Business Research, 56(2): 145-52.
19. Joseph, G. and R. Gary, 1998. Expert Systems: Principles and Programming. Boston: PWS Publishing Company.
20. Kline, P. and B. Saunders, 1993. Ten Steps to a Learning Organization. Great Ocean Publisher, United States.
21. Marquardt, M.J., 1996. Building the Learning Organization: A Systems Approach to Quantum Improvement and Global Success. McGraw-Hill, New York.
22. Meeker, W.Q., 2006. Methods for Nonstationary Time Series Transformations and ARIMA Models. Iowa State University.
23. Nonaka I. and H. Takeuchi, 1995. The Knowledge-Creating Company. B Oxford University Press: New York.
24. Sipilä, J., 1996. The Expert and the Client - How to Handle these Two Roles? 2nd Edition. Porvoo, WSOY. (In Finnish).
25. Scarbrough, H. and J. Swan, 2001. Explaining the diffusion of knowledge management: the role of fashion. British Journal of Management. 12(1).
26. Senge, P.M., C. Roberts, R.B. Ross, B.J. Smith and A. Kleiner, 1994. The Fifth Discipline Fieldbook: Strategies and Tools for Building a Learning Organization. Nicholas Brealey, London.
27. Sterman, J., 1994. Learning in and about complex systems. System Dynamics Review, 10(2-3): 291-330.
28. Yun, S. and D.B. Simmons, 2004. Continuous Productivity Assessment and Effort Prediction Based on Bayesian Analysis. Proceedings of the Twenty-Eighth Annual International Computer Software and Applications Conference, pp: 44-49.
29. Omar, F., F.W. Halim, H. Zainah, R. Nasir and R. Khairudin, 2011. Stress and job satisfaction as antecedents of workplace deviant behaviour. World Applied Sciences Journal (Special Issue of Social and Psychological Sciences for Human Development), 12: 46-51.
30. Anvari, A.R., Y. Ismail and S.M.H. Hojjati, 2011a. A Study on Total Quality Management and Lean Manufacturing: Through Lean Thinking Approach, World Applied Sciences Journal, 12(9): 1585-1596.
31. Wiig, K.M., 2001. What future knowledge management users may expect. Journal of KnowledgeManagement, 3(2): 155-165.
32. Chung, S.H., A.H.L. Lee and W.L. Pearn, 2005. Analytic network process (ANP) approach for product mix planning in semiconductor fabricator. International Journal of Production Economics, 96: 15-36.