2021-1177 IJOI
https://www.ijoi-online.org/

International Journal of Organizational Innovation

# WORKLOAD ASSESSMENT IN A LOCAL HOSPITAL

Chao-Chin Chao
Department of Gastroenterology, Kaohsiung Municipal Gangshan Hospital, Kaohsiung City 820, Taiwan, R.O.C.
Tel: +886-7-6222131 ext 51184
E-mail: Chawpp@mail2000.com.tw

## Abstract

Workload assessment is one of the most serious concerns to a manager, since a long-term heavy workload may affect employees' physical and mental health, performance and productivity, as well as turnover. Because rear-service personnel are the supporters for the first contract points for patients in a hospital, their performance generates the service quality of the hospital. This study applies the linear program to discriminate relative workload level of the hospital rear-service personnel in which subjective subscales are utilized. For workload assessment, it is important to effectively alleviate the workloads of heavy workload employees. The advantage of this study is that it can be more aware of the work situations of employees for managers, and thus they can effectively improve workload levels of rear-service personnel to ensure them operating their tasks safely, as well as reduce staff turnover.

Keywords: Workload, Hospital, Rear-service personnel, NASA-TLX

## Introduction

Assessing workload is an important issue in organization performance and employees' health. Hospital studies have shown that added responsibilities and job stress associated with higher workloads affect nursing staff turnover (e.g. Lee et al., 2003). A long-term heavy workload can affect an employee's physical or mental health, performance, or productivity. Furthermore, heavy workloads have been shown to have a negative impact on turnover (Iverson and Pullman, 2000), certainly contribute to a state of stress, and give rise to strain, accidents or illness. High employee turnover carries with it the problems of both a high labor cost and quality issues that hurt the performance and growth of an organization (Davidson et al., 2006). Firth et al. (2004) thus suggested that managers should actively monitor the workloads of employees to reduce turnover.

The hospital industry has been characterized as having excessive employee turnover, which leads to higher costs due to the need to replace staff, as well as having detrimental effects on service quality. Indeed, rear-service personnel are one of the major resources of the hospital, since they are the supporters for medical service jobs. In other words, the service quality of a hospital depends heavily on the effectiveness of rear-service personnel with which medical personnel deal with inpatients and outpatients. Therefore, this study applies a linear program (LP) model to access relative workload level of the rear-service personnel in a local hospital in Taiwan, in which subjective subscales are utilized. To identify the factor (referred to as the critical factor) for the relatively heavy workload of rear-service personnel to enable managers to effectively alleviate the workloads of them, this study applies the dual analysis for the workload assessment model.

## Workload Assessment

Wickens (1992) defined workload as the relationship between resource supply and task demand, and mental workload is commonly defined as the ratio between task demand and the capacity of an employee (Kantowitz, 1988). The major subjective ratings techniques can be divided into two categories: physiological measures and subjective ratings. The physiological measures attempt to derive workload impact from factors such as heart-rate, respiration rate and blood pressure, though they may be influenced by other factors (Veltman and Gaillard, 1996). In subjective techniques, individuals are asked to assess their workloads by a rating scales procedure, and it is accepted by those asked to complete them, since rating scales are easy to fill in and thus subjective measures are widely applied to workload assessment (e.g. Miyake, 2009).

Subjective measures have been

applied to evaluate two types of workloads. The first type focuses on assessing workload for a specified task after the task has been completed (e.g. Matthews et al., 2003; Pickup et al., 2005; Stedmon et al., 2007). The other type of workload assessment is to discriminate relative workloads within a group of employees in the same environment (Chang and Chen, 2006). This study focuses on the second type of workload measurement for the purpose of workload assessment and improvement of the relatively heavy workload rear-service personnel.

## Methodology

### *Linear Program Model*

For subjective workload assessment, individuals are asked to rate the scales. In rating the workload factors, individuals consider their own perceived loading, and then rate each question. This implies that the rating result contains the capacity of the individual (Chang and Chen, 2006). Therefore, Chang and Chen treat all factors as outputs in the LP model and then it is shown as the following form.

$$\text{Max } \theta_l = \sum_{i=1}^{n} u_i y_{il}$$

Subject to

$$\sum_{i=1}^{n} u_i y_{ik} \le 1, \forall k = 1,2,\ldots,L, \quad (1)$$

$$u_i > 0, \forall i = 1,2,\ldots,n.$$

Where $n$ is the number of subscales, $y_{ik}$ is the value of the $i$th subscale of the $k$th sample, $L$ is the number of samples, and $u_i$ gives the weights associated with the $i$th subscale of sample $l$. After running Model (1) for each sample, the set of weights associated with the values of subscales gives the maximum workload level of each sample. If the workload score is equal to one then the employee is classified as having a heavy workload, elsewhere, the employee is classified as having a non-heavy workload.

### *Identification Of The Critical Factors*

In Model (1), the objective is to maximize the value of $\sum_{i=1}^{s} u_i y_{ij}$. Therefore, the larger value of $u_i$ the more the contribution of workload score offered by factor $i$. For a heavy workload employee $j$, if $u_p$ is the largest weight among all factors, i.e. $u_p = \max_i \{u_i\}$, then factor $p$ is referred to as the critical factor of sample *j*. To effectively reduce the workload score of sample *j*, the improvement effort should focus on factor *p*.

## A Case Study

Rear-service personnel are the supporters for the first contract points for patients in a hospital, their workload generates the service quality of the hospital, and the service quality of a hospital depends heavily on the effectiveness with which medical personnel deal with inpatients and outpatients. Therefore, this study focuses on the rear-service personnel in a local local hospital in Kaohsiung City, Taiwan, namely Kaohsiung Municipal Gangshan Hospital.

### *Assessment Factors*

To investigate the workload and performance levels of the rear- service personnel in Kaohsiung Municipal Gangshan Hospital, the NASA Task Load Index (NASA-TLX), a widely used technique for subjective workload assessment, is utilized. NASA-TLX is a multidimensional approach to measure workload by a weighted workload score and the subscales of NASA-TLX are always applied to evaluate workload after a task has been completed. In this study, we use the factors of the NASA-TLX as the workload assessment factors in Model (1), and individuals subjectively rate their workload on five factors, using a rating scale from 0 to 100. The five factors are mental demands, Y1, physical demands, Y2, temporal demands, Y3, effort, Y4, frustration level, Y5 and performance level, Y6.

In rating the workload subscales, each rear-service personnel considered their own perceived workload, and then rated each question. This implies that the rating result contains the capacity of the individual. In this study, the rating scale is from 0 to 100 for each factor. In other words, we assume the capacity of each individual is 100, although the maximum tolerance of each employee is different. The perceived workload is an index of an individual on a specific subscale.

### *The Data and Results*

In this analysis, the six assessment subscales are treated as outputs in Model (1). In other words, a large value of an output is considered to be better than a smaller value. However, Mayes et al. (2001) stated that the performance subscale is logically reversed to the other subscales, so we use the 5 subscales of NASA-TLX except for the performance subscale in our workload computation. The data from the thirty-four rear-service personnel on the six subscales and the workload scores are presented in Table 1. The weight set of subscales of individual employee are shown in Table 2.

Based on the workload scores, the last column in Table 1, employee 2, 3, 13, 14, 15, 18, 28, 31, 32 and 33 have relatively heavy workloads, since their workload scores are all of one. The sets of weights in Table 2 are the best weights for each employee, and the largest weight corresponding to each relatively heavy workload employee is highlighted. As can be seen, the critical factor (Chen et al., 2009) for employees 2, 14 and 15 is temporal demands, employee 13 is effort, employee 18 is mental demands, and employees 18 and 32 are frustration level. Moreover, the critical factors of employees 31 are effort and frustration level, and employees 33 are physical demands and frustration level. To effectively reduce the workload score of relatively heavy workload employee, the improvement effort should focus on critical factor(s).

The associated weight set in Table 2 are the most favorable weights for individual employee. The effort subscale is the most significant factor in this workload assessment for Kaohsiung Municipal Gangshan Hospital, because it achieves the largest sum value compare to the other subscales shown in the last row in Table 2. The mental demands subscale may not contribute much in this workload analysis since the sum weights of the mental demands subscale is 0.0448, which is smaller than the other subscales.

After obtaining the relative workload scores of employees, the decision maker may have an interest in understanding the relation between the relative workload and the performance of each employee. This study draws the coordinate of the overall workload score and performance in Figure 1, where the value of the X-axis is the workload score and the value of the Y-axis is the performance of each employee. The data of workload scores and performances are drawn from Table 1.

Table 1. The data of six subscales and the workload scores

| Employee | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Workload score |
|---|---|---|---|---|---|---|---|
| 1 | 90 | 82 | 60 | 60 | 75 | 90 | 0.959 |
| 2 | 90 | 60 | 95 | 60 | 60 | 60 | 1.000 |
| 3 | 96 | 80 | 80 | 90 | 75 | 75 | 1.000 |
| 4 | 85 | 80 | 90 | 60 | 60 | 90 | 0.969 |
| 5 | 90 | 70 | 80 | 60 | 75 | 70 | 0.958 |
| 6 | 60 | 90 | 50 | 60 | 75 | 75 | 0.984 |
| 7 | 90 | 30 | 80 | 50 | 75 | 80 | 0.953 |
| 8 | 60 | 70 | 80 | 90 | 75 | 80 | 0.994 |
| 9 | 70 | 80 | 83 | 60 | 75 | 80 | 0.920 |
| 10 | 70 | 80 | 80 | 90 | 55 | 80 | 0.994 |
| 11 | 90 | 50 | 80 | 90 | 74 | 80 | 0.995 |
| 12 | 95 | 90 | 80 | 90 | 74 | 75 | 0.999 |
| 13 | 80 | 90 | 80 | 90 | 74 | 75 | 0.998 |
| 14 | 90 | 50 | 95 | 63 | 50 | 40 | 1.000 |
| 15 | 80 | 82 | 95 | 52 | 50 | 52 | 1.000 |
| 16 | 90 | 95 | 89 | 50 | 55 | 60 | 1.000 |
| 17 | 70 | 85 | 80 | 85 | 45 | 75 | 0.939 |
| 18 | 95 | 90 | 90 | 90 | 74 | 80 | 1.000 |
| 19 | 95 | 50 | 80 | 90 | 75 | 60 | 0.997 |
| 20 | 70 | 70 | 60 | 50 | 45 | 80 | 0.755 |
| 21 | 80 | 70 | 90 | 50 | 75 | 60 | 0.980 |
| 22 | 90 | 60 | 90 | 60 | 75 | 70 | 0.991 |
| 23 | 70 | 80 | 90 | 90 | 75 | 70 | 0.997 |
| 24 | 90 | 90 | 80 | 70 | 55 | 95 | 0.994 |
| 25 | 60 | 90 | 78 | 70 | 73 | 78 | 0.984 |
| 26 | 60 | 80 | 75 | 78 | 70 | 65 | 0.894 |
| 27 | 60 | 80 | 90 | 90 | 73 | 80 | 0.995 |
| 28 | 90 | 80 | 80 | 60 | 85 | 75 | 1.000 |
| 29 | 70 | 40 | 80 | 80 | 65 | 80 | 0.883 |
| 30 | 80 | 90 | 60 | 70 | 75 | 80 | 0.989 |
| 31 | 70 | 80 | 90 | 90 | 80 | 80 | 1.000 |
| 32 | 75 | 85 | 90 | 85 | 85 | 80 | 1.000 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 33 | 75 | 90 | 80 | 85 | 80 | 80 | 1.000 |
| 34 | 70 | 80 | 90 | 60 | 70 | 70 | 0.976 |

Table 2. The weight set of subscales

| Employee | Weight | | | | |
|---|---|---|---|---|---|
| | Y1 | Y2 | Y3 | Y4 | Y5 |
| 1 | 0.0063 | 0.0001 | 0.0001 | 0.0001 | 0.0041 |
| 2 | 0.0001 | 0.0001 | 0.0102 | 0.0001 | 0.0001 |
| 3 | 0.0030 | 0.0001 | 0.0001 | 0.0018 | 0.0071 |
| 4 | 0.0001 | 0.0001 | 0.0088 | 0.0001 | 0.0012 |
| 5 | 0.0001 | 0.0001 | 0.0001 | 0.0102 | 0.0008 |
| 6 | 0.0001 | 0.0092 | 0.0001 | 0.0001 | 0.0018 |
| 7 | 0.0063 | 0.0001 | 0.0009 | 0.0001 | 0.0041 |
| 8 | 0.0001 | 0.0001 | 0.0001 | 0.0103 | 0.0006 |
| 9 | 0.0001 | 0.0066 | 0.0017 | 0.0001 | 0.0032 |
| 10 | 0.0001 | 0.0001 | 0.0001 | 0.0107 | 0.0001 |
| 11 | 0.0001 | 0.0001 | 0.0001 | 0.0107 | 0.0001 |
| 12 | 0.0094 | 0.0009 | 0.0001 | 0.0001 | 0.0001 |
| 13 | 0.0001 | 0.0001 | 0.0001 | 0.0107 | 0.0001 |
| 14 | 0.0001 | 0.0001 | 0.0099 | 0.0007 | 0.0001 |
| 15 | 0.0001 | 0.0001 | 0.0102 | 0.0001 | 0.0001 |
| 16 | 0.0001 | 0.0102 | 0.0001 | 0.0001 | 0.0001 |
| 17 | 0.0001 | 0.0097 | 0.0001 | 0.0011 | 0.0001 |
| 18 | 0.0094 | 0.0009 | 0.0001 | 0.0001 | 0.0001 |
| 19 | 0.0004 | 0.0001 | 0.0001 | 0.0092 | 0.0016 |
| 20 | 0.0047 | 0.0059 | 0.0001 | 0.0001 | 0.0001 |
| 21 | 0.0011 | 0.0001 | 0.0081 | 0.0001 | 0.0021 |
| 22 | 0.0011 | 0.0001 | 0.0081 | 0.0001 | 0.0021 |
| 23 | 0.0001 | 0.0001 | 0.0093 | 0.0012 | 0.0006 |
| 24 | 0.0001 | 0.0097 | 0.0001 | 0.0011 | 0.0001 |
| 25 | 0.0001 | 0.0092 | 0.0001 | 0.0001 | 0.0018 |
| 26 | 0.0001 | 0.0039 | 0.0001 | 0.0039 | 0.0037 |
| 27 | 0.0001 | 0.0001 | 0.0001 | 0.0107 | 0.0001 |
| 28 | 0.0003 | 0.0001 | 0.0001 | 0.0001 | 0.0112 |

| | | | | | |
|---|---|---|---|---|---|
| 29 | 0.0001 | 0.0001 | 0.0001 | 0.0107 | 0.0001 |
| 30 | 0.0005 | 0.0088 | 0.0001 | 0.0001 | 0.0020 |
| 31 | 0.0001 | 0.0001 | 0.0001 | 0.0058 | 0.0056 |
| 32 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0114 |
| 33 | 0.0001 | 0.0058 | 0.0001 | 0.0001 | 0.0056 |
| 34 | 0.0001 | 0.0006 | 0.0092 | 0.0001 | 0.0012 |
| Sum | 0.0448 | 0.0835 | 0.0788 | 0.1007 | 0.0732 |

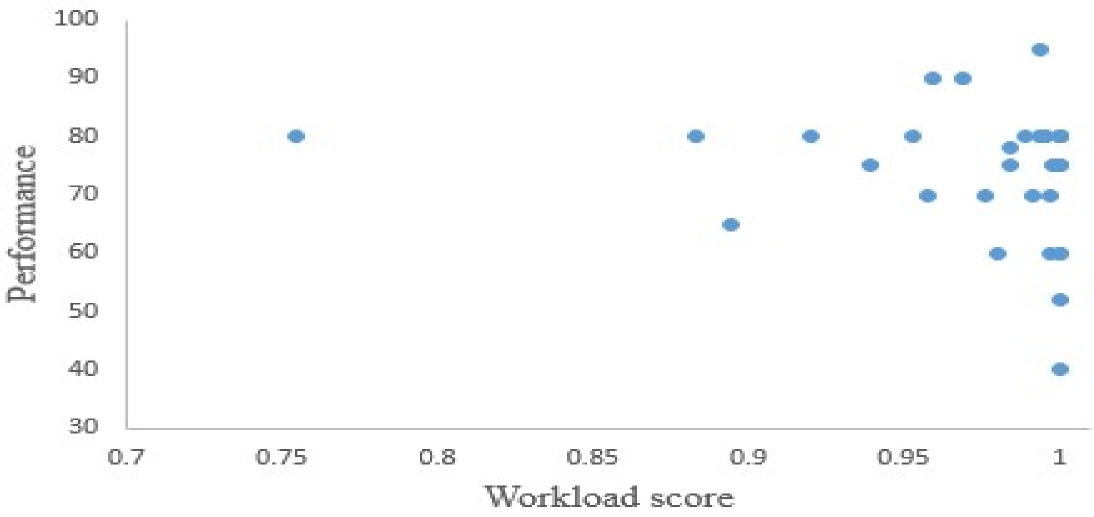


Figure 1. The situation of employees

According to Figure 1, employee 20 is located at the most left side and both employees 14 and 16 are located at the lowest situation, compared to the clusters. For employee 20, her/his performance is not high although her/his relative workload is the lowest one. It may indicate that the employee 20 has more capacity remaining for more tasks; the decision maker can assign additional tasks to her/him and use incentive activities to improve job involvement. For employees 14 and 15, their relative workloads are heavy but these come with the lowest values of the performance subscale. From the diagram and Table 1, it can be seen that they have heavy workloads and poor performance in doing their job. The interpretation is that these two employees may not have the ability to do their tasks or that their tasks are not suited to their capabilities. The decision maker can strengthen their in-service education programs, assign seniors as their instructor, or change them to a suitable department.

## Conclusion

Workload is an important and integrative concept that determines the ability of an employee in order to accomplish mission requirements. This study extends the LP model for measuring relative workload within a group of employees, based on multiple subscales. The set of weights calculated by the LP model is more considerate and less confrontational to each employee than the other methods in that the weights are determined by the individual's judgment. After obtaining the relative workload of each employee, the decision maker can further view the situation of each employee in workload and performance, and implement suitable human resource practices to strengthen capabilities and achieve higher performance. Therefore, this study can help the decision maker develop individual and organizational capacities in Kaohsiung Municipal Gangshan Hospital.

## References

Chang, S.Y. and Chen, T.H., 2006. Discriminating relative workload level by data envelopment analysis. *International Journal of Industrial Ergonomics* 36, 773-778.

Chen, T.H., Ho, C.H., Huang, C.M. and Nien, H.Y., 2009. Workloads ranking and improvement for multidimensional rating techniques, *The International Journal of Organizational Innovation* 2(1), 41-52.

Davidson, M., Guilding, C. and Timo, N., 2006. Employment, flexibility and labour market practices of domestic and MNC chain luxury hotels in Australia: Where has accountability gone? *International Journal of Hospitality Management* 25, 193-210.

Firth, L., Mellor, D.J., Moore, K.A. and Loquet, C., 2004. How can managers reduce employee intention to quit?. *Journal of Managerial Psychology* 19, 170-187.

Iverson, R.D. and Pullman, J.A., 2000. Determinants of voluntary turnover and layoffs in an environment of repeated downsizing following a merger: an event history analysis. *Journal of Management* 26, 977-1003.

Kantowitz, B.H.. Workload. In P. A., 1988. Hancock (Ed.). *Human* *factors psychology*, Amsterdam: Elsevier.

Lee, H., Song, R., Cho, Y.S., Lee, G.Z. and Daly, B., 2003. A comprehensive model for predicting burnout in Korean nurses. *Journal of Advanced Nursing* 44, 534-545.

Matthews, R., Legg, S. and Charlton, S., 2003. The effect of cell phone type on drivers subjective workload during concurrent driving and conversing. *Accident Analysis and Prevention* 35, 451-457.

Mayes, D.K., Sims, V.K. and Koonce, J.M., 2001. Comprehension and workload differences for VDT and paper-based reading. *International Journal of Industrial Ergonomics* 28, 367-378.

Miyake, S., 2001. Multivariate workload evaluation combining physiological and subjective measure. *International Journal of Psychophysiology* 40, 233-238.

Pickup, L., Wilson, J.R., Norris, B.J., Mitchell, L. and Morrisroe, G., 2005. The integrated workload scale (IWS): A new self-report tool to assess railway signaler workload. *Applied Ergonomics* 36, 681-693.

Stedmon, A.W., Sharples, S., Littlewood, R., Cox, G., Patel, H. and Wilson, J.R., 2007. Datalink in air traffic management: Human factors issue in communications. *Applied Ergonomics* 38, 473-480.

Veltman, J.A. and Gaillard, A.W.K., 1996. Physiological indices of workload in a simulated flight task. *Biological Psychology* 42, 323-342.

Wickens, C.D. 1992. Engineering Psychology and Human Performance. 2nd Edition. New York: HarperCollins Publishers, p. 560.