The SWAT Analysis to Measure Workload from Employees of Educational Institution

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Abstract: *Employee performance can be optimized by identifying the workload experienced by these employees. One of them is the measurement method using SWAT to identify employee workload. There are external and internal factors that affect the workload. Ten employees participated in the workload test with times, efforts and stress measurements. The result of the study shows that the performance of employees in carrying out their work is influenced by the burden of the time factor (T) and the burden of mental factors (E).Whereas environmental factors (S) generally do not burden employees. Employees with T prototype criteria tend to have a higher burden in carrying out work as an administration. Whereas employees with E and S prototype criteria tend to have a low load in carrying out work compared to employees with T. prototype criteria. Thus in conclusion, it should be noted for managers of educational institutions to know the results of identification of employee workloads. So they can improve work time efficiency by minimizing error potencies.*

Keywords: SWAT, workload, human performance, ergonomics

1. Introduction

An institution or organization will always strive to maximize their potential in the form of human resources in order to achieve optimal results. Internal and external factors are expected to optimize work performance of its employees. The workload received by an employee shows how long it will take to carry out his work activities according to the ability of the employee. The greater the workload, the shorter the time to work with fatigue and physiological disturbances borne by the employees. While external factors such as overheating temperatures can cause physiological effects on the body like increased fatigue, decreased physical and mental work efficiency, increased heart rate and blood pressure. Job exhaustion results in weakening employees in doing work, so that it can increase errors in work and can result in work accidents.

Therefore, to minimize errors in work, it is necessary to identify employee workloads so that anticipatory actions can be taken if there are employees who have a high workload. This study measured employee workload using SWAT analysis. Several previous studies revealed that the SWAT method is one of the right ways to be used in identifying employee workloads (Ameersing and Ravindra, 2001; Risma and Dedi, 2010; Ainul et al. 2013). However, not many researchers have observed academic employees, even though the work of an employee is vulnerable to errors that can result in poor academic services.

2. Literature

A Research by Risma and Dedi (2010) stated that the SWAT method is a subjective method of measuring mental burden based on workers' perceptions using a combination of three dimensions with its level. The method uses a multidimensional scale with 2 (two) stages of work, namely the creation of scale and value. The results of the study indicate that the workload conditions between the three shifts have a significant difference. The value of the workload from the SWAT score for the morning shift shows a low category; afternoon shift shows low and medium categories, for the night shift the workload is of medium category (Risma and Dedi, 2010). Overall, workers were more concerned with the time factor (39.08%), then stress pressure (33.21%) and mental effort (27.71%) in considering mental workload factors. Similar studies conducted by Ainulet al (2013) stated the importance of the SWAT method is used to improve efficiency in the field of human resources. In some functions there are delays that often occur in completing tasks. One effort to improve the efficiency of human resources requires the right analysis and approach to evaluate the workload of employees so as to optimize the use of work time.

Dimensions in the SWAT method by Reid et al (1989), there are three dimensions, namely Time load is a problem that depends on the amount of free time available and the frequency of overlapping an activity and shows the amount of time available in planning, implementing and monitoring tasks. According to Reidand Nygren (1988) the size of Time load is related to the problem of the level of speed of completing the work and the time limit available in the completion of the work. Mental effort load is guessing or estimating how much mental effort in planning is needed to carry out a task. The size of the mental effort load depends on the complexity of a job that must be processed by the operator to achieve the best performance. Psychological stress load is measuring the amount of risk, confusion, frustration associated with the performance or appearance of a task. The size of the problem depends on factors that affect work performance that can come from the individual itself such as fatigue and fear, or from the environment such as temperature and noise. The use of the SWAT model requires that we do two (2) stages of work, namely Scale Development and Event Scoring (Reidand Nygren, 1988).

1. Scale Development Stage

Subjects were asked to do a card sorting (put cards in order) of twenty-seven cards in combination of the three description

variables (T, E and S) starting from the lowest to highest. Scale development is used to train subjects in obtaining data by observing how to combine dimensions to create individual impressions of workload.

2. Axiom Test

Axiom Test is conducted to test the suitability of additive models and consistency of card sorting. In the Axiom Test will be tested three basic properties of the additive model, namely independence, multiple provisions and combined independence. Axiom Test was carried out in stages, with the first step testing the Prototype Axiom Test by using development scale data scales. The criteria for independence and combined independence should be <20, so the respondent's card data collection can be considered to fulfill the basic nature of the additive model on the prototype. Furthermore, data scale development can be handled using the PSS method to produce a SWAT scale. When the axiom is> 20, the Individual Axiom Test must be conducted to investigate whether the respondent's card sorting data can be considered to fulfill the additive model's nature. However, when the Individual Axiom Test results indicate a violation of independence and a combined independence of <20, then the data of the respondent's card can be considered as fulfilling the basic characteristics of the model. Data scale development can be handled by the ISS method to produce a SWAT scale. If the Individual Axiom Test results still show a violation of axiom> 20, then the respondent's data should drop from the study. In this study, Prototype Axiom Test showed that in all prototypes there was a violation of the additive properties <20. This means that the Prototyped Scaling Solution (PSS)

method will be used to produce the SWAT scale.

3. Event Scoring Stage

Then in the scoring event, the subject is asked for SWAT comments on the scoring rating of their work (scale 1 to 3) for each variable T, E, and S of each task (each element of work or in the completion of a job), then the SWAT rating is matched with the results from the card sorting from the SWAT program results in the computer to find out the workload score of each combination. Event scoring is an experiment or situation testing where the investigator digs up information about the workload experienced by the subject for to be corrected(of the problem) to make the load decreases and a SWAT remeasurement can be applied to obtain validation to get a better work performance than before.

3. Method

The method applied in this study is a descriptive research by the help of ten employees who work in the academic part of an educational institution. The selection of these participants is based on the period of service, and the same type of work. The steps of data collection were the respondents asked to sort 27 SWAT cards which contained an explanation of the position of Time Load, Mental Effort, and Psychological Stress. This process must of course be adjusted to the work activities carried out every day, from the order of the lightest workload rating with initials number 1 to the heaviest workload with initials number 27.

4. Result

Table 1: Result of SWAT Card Ordering

Card	The Order of The Respondents									
	1	2	3	4	5	6	7	8	9	10
N	4	1	1	1	1	23	4	4	2	6
B	11	22	2	5	2	2	18	5	7	9
W	23	18	3	8	5	26	2	6	6	5
F	5	23	4	2	3	7	23	7	1	2
J	14	11	5	6	6	22	6	8	4	7
C	25	3	6	9	8	6	21	9	9	3
X	6	15	7	3	4	24	3	1	3	4
S	15	2	8	7	7	1	26	3	8	8
M	24	19	9	4	9	5	25	2	5	1
U	3	14	10	10	10	14	13	26	12	10
G	17	17	11	14	14	17	12	27	15	4
Z	19	4	12	16	12	3	27	25	13	13
V	8	13	13	12	11	25	5	20	11	17
Q	16	21	14	15	15	18	10	21	18	16
ZZ	27	20	15	18	17	15	14	19	17	15
K	9	24	16	11	13	16	11	22	10	12
E	18	26	17	13	16	11	16	24	14	19
R	26	8	18	17	18	9	22	16	16	18
H	2	16	19	20	19	27	1	10	26	20
P	10	27	20	23	21	13	15	12	20	22
D	20	5	21	26	23	19	8	11	24	27
Y	7	25	22	21	20	20	9	13	27	11
A	13	6	23	24	22	4	24	15	19	23
O	22	12	24	25	26	8	20	14	25	26
L	1	10	25	19	24	10	19	23	23	21
T	12	7	26	22	25	12	17	18	21	24
I	21	9	27	27	27	21	7	17	22	25

Table 2: Prototype of Each Respondent with W = 0.3233

Respondent	TES	TSE	ETS	EST	SET	STE	Prototype
1	0.0.4	0.21	0.19	0.41	0.92	0.87	S
2	-0.02	-0.06	-0.04	-0.10	-0.24	-0.23	T
3	1.00	0.96	0.60	0.43	0.30	0.43	T
4	0.92	0.98	0.33	0.19	0.38	0.58	T
5	0.98	0.99	0.52	0.37	0.38	0.54	T
6	0.00	-0.02	-0.19	-0.28	-0.35	-0.29	T
7	0.08	0.09	0.27	0.35	0.40	0.33	S
8	0.48	0.47	0.16	0.04	0.02	0.12	T
9	0.90	0.93	0.29	0.12	0.21	0.32	T
10	0.88	0.90	0.33	0.18	0.27	0.45	T

According to result above, table 2 showed for W value obtained is less than 0.75, then check the prototype axiom value to find out whether the use of scaling prototypes can be used or cannot be used.

Table 3: Data of Axioms Independent Prototype

Prototype	Error (from 108 errors)			Explanation
	T to E and S	E to T and S	S to T and E	
Time	8	52	60	Axiom Error Value > 20
Effort	0	0	0	Axiom Error Value< 20
Stress	65	46	22	Axiom Error Value> 20

Table 4: Data of Independency Axioms from Combined Prototype

Prototype	Error (from 108 errors)			Explanation
	T x E to S	E x S to T	S x T to E	
Time	18	64	19	Axiom Error Value> 20
Effort	0	0	0	Axiom Error Value < 20
Stress	51	28	36	Axiom Error Value> 20

The results can be concluded that the prototype type of respondents is the T (time) and S (Stress) prototypes. In Tables 3 and 4 it is found that the independent and independent axiom values for the T (time) and S (Stress) prototypes have an error axiom above 20. Therefore, checking the individual axiom value of the respondent is done.

Table 5: Data of Independent Axioms

Respondent	Error (from 108 error)		
	T to E and S	E to T and S	S to T and E
1	30	36	0
2	60	58	56
3	0	0	0
4	0	46	8
5	0	0	8
6	58	58	52
7	56	58	56
8	14	56	42
9	0	58	56
10	8	58	44

Table 6: Data of Independency Axioms from Combined Prototype

Respondent	Error (from 108 error)		
	T x E to S	E x S to T	S x T to E
1	28	8	8
2	64	58	60
3	0	0	0
4	12	20	2
5	0	12	2
6	58	58	56
7	58	58	54
8	6	66	14
9	16	60	4
10	14	54	12

The results in table 5 and table 6 show that the independent and independent axiom values for individuals have an error value above 20. Therefore, it is advisable to do return card (sorting the card again) by the respondent.

Table 7: The Estimation of Relative Interest from Every Factor (In %)

Respondent	Time	Effort	Stress
1	14,84	8,55	76,61
2	30,27	19,24	50,49
3	69,23	23,08	7,69
4	73,82	4,97	21,21
5	69,78	14,32	15,90
6	21,15	47,05	31,81
7	7,15	38,18	54,67
8	68,85	13,27	17,88
9	95,51	1,55	2,94
10	78,86	9,05	12,10

Table 7 shows that the dimension that gives the most contribution to cognitive workload is the Time dimension, Effort is quite influential on the workload, while Stress has the lowest load on employees.

Table 8: The Solution Scale of SWAT for Individual Employee

No	Combination of Workload	Letter	Scale of SWAT from respondent number -									
			1	2	3	4	5	6	7	8	9	10
1	111	N	12,6	81,8	0	1,7	0	78.9	1.0	2.2	0.9	9.0
2	112	B	50,9	70,2	3,8	22,9	9.6	47.0	55.7	20.1	0.7	16.8
3	113	W	89,2	31,3	7,7	17,4	15.9	55.4	54.1	13.9	3.6	21.1
4	121	F	5,4	86,2	11,5	0	8.3	55.0	38.4	13.3	1.8	0
5	122	J	43,7	74,6	15,4	21,2	17.9	23.2	93.1	31.1	1.6	7.8
6	123	C	82,0	35,7	19,2	15,7	24.2	31.5	91.5	25.0	4.5	12.1
7	131	X	4,0	66,9	23,1	5,0	14.3	31.8	39.2	0	0.3	4.2
8	132	S	42,4	55,3	26,9	26,2	23.9	0	93.8	17.9	0	12.0
9	133	M	80,7	16,5	30,8	20,7	30.2	8.3	92.2	11.7	2.9	16.3
10	211	U	8,6	95,6	34,6	38,6	34.9	90.7	7.1	69.7	48.7	76.1
11	212	G	46,9	84,0	38,5	59,8	44.5	58.9	61.8	87.5	48.4	83.9
12	213	Z	85,2	45,1	42,3	54,3	50.8	67.2	60.3	81.4	51.4	88.1
13	221	V	1,4	100	46,2	36,9	43.2	66.8	44.6	80.7	49.6	67.0
14	222	Q	39,7	88,4	50,0	58,1	52.8	35.0	99.2	98.6	49.3	74.8
15	223	ZZ	78,0	49,5	53,8	52,6	59.1	43.4	97.7	92.5	52.2	79.1
16	231	K	0	80,8	57,7	41,9	49.2	43.7	45.3	67.5	48.0	71.2
17	232	E	38,3	89,2	61,5	63,1	58.8	11.9	100	85.4	47.8	79.0
18	233	R	76,6	30,3	65,4	57,6	65.1	20.2	98.4	79.2	50.7	83.3
19	311	H	23,4	65,4	69,2	75,5	69.8	100	0	71.0	96.4	87.9
20	312	P	61,7	53,7	73,1	96,7	79.4	68.2	54.7	88.9	96.2	95.7
21	313	D	100	14,9	76,9	91,2	85.7	76.5	53.1	82.8	99.1	100
22	321	Y	16,2	69,7	80,8	73,8	78.1	76.1	37.4	82.1	97.3	78.9
23	322	A	54,5	58,1	84,6	95,0	87.7	44.3	92.1	100	97.1	86.7
24	323	O	92,8	19,2	88,5	89,5	94.0	52.6	90.5	93.9	100	91.0
25	331	L	14,8	50,5	92,3	78,8	84.1	53.0	38.2	68.9	95.8	83.0
26	332	T	53,1	38,9	96,2	100	93.7	21.1	92.9	86.7	95.5	90.8
27	333	I	91,4	0	100	94.5	100	29.5	91.3	80.6	98.4	95.1

Table 9: Scoring Value for Employees' Work

Job Description	Event Scoring	Respondent Number-										
		1	2	3	4	5	6	7	8	9	10	
Typing	T	2	1	2	3	2	3	2	2	2	2	
	E	1	2	2	3	2	2	3	2	1	2	
	S	1	3	3	2	2	3	3	2	2	2	Explanation :
SWAT Rescale		8,6	35,7	53,8	100	52,8	52.6	98.4	98.6	48.4	74.8	• L = Low
Subjective Load		L	L	M	H	M	M	H	H	M	H	• M = Moderate
Format Set Up	T	2	2	2	2	2	2	2	1	1	2	• H = High
	E	2	1	2	2	2	3	1	1	2	2	
	S	1	3	2	2	3	3	3	1	1	2	
SWAT Rescale		1,4	45,1	50,0	58,1	59,1	20.2	60.3	2.2	1.8	74.8	
Subjective Load		L	M	M	M	M	L	H	L	L	H	

Table 10: Conversion Result of SWAT to Entire Work from Employees

Job Description	Respondent Number-										Explanation :
	1	2	3	4	5	6	7	8	9	10	• L = Low
Typing	8,6	35,7	53,8	100	52,8	52,6	98,4	98,6	48,4	74,8	• M = Moderate
Format Set Up	1,4	45,1	50	58,1	59,1	20,2	60,3	2,2	1,8	74,8	• H = High
Total	10	80,8	103,8	158,1	111,9	72,8	158,7	100,8	50,2	149,6	
Mean	5	40,4	51,9	79,05	55,95	36,4	79,35	50,4	25,1	74,8	
Subjective Load	L	M	M	H	M	L	H	M	L	H	

5. Conclusion

The result of this study reports that the performance of employees in carrying out their work is influenced by the burden of the time factor (T) and the burden of mental factors (E). While for environmental factors (S) in general do not burden employees. Employees with T prototype criteria tend to have a higher burden in carrying out work (typing) when compared with employees who have E or S prototype criteria. While employees with E prototype criteria tend to have low loads until being in carrying out the work (setting the format) when compared to the employee with the T prototype criteria or the S prototype. Employee criteria with S prototype tends to have a low load in carrying out types of work such as administration, when compared with employees with T prototype and Prototype E. Criteria. Therefore, there must be a concern from managers of educational institutions to obtain records from employee workload scores to be able to increase the efficiency of work time by minimizing potential errors.

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