

Job Performance Analysis Using Factor Evaluation System and Process Mining

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Abstract— Job performance is a method to evaluate the performance such as a company or employee by comparing the work that has been finished in that several period with the standard of company. Factor Evaluation System method is one of popular method to used because it has 9 factors to analyze a position. But FES no more detail in spell out each factor, so in this research using process mining to enrich FES application. Process mining using event log that has history of case, activity, time stamp and resources of employee. This paper using AHP to get weight for every FES factor, so each factor have standard to be achieve. Considering the advantages of FES and process mining, this paper proposes the combination FES and process mining to more detailing the factors of FES, which are required for recruitment using factor all factor that have weight; employee monitoring using factor supervisory controls(2), guidelines(3) and personal contacts(6); for employee training using factor knowledge required by the position(1), personal contacts(6), purpose of contacts(7) and work environment(9); remuneration using factor complexity(4), scope and effect(5) and physical demands(8).

Keywords— Job Performance, Factor evaluation System, Process Mining

I. INTRODUCTION

Job performance is one of the most important dependent variables and has been studied for a long decade [1, 2, 3, 4]. There are two types behavior of employee that required to identified job performances for Organizational effectiveness : contextual performance and task performance. Task performance means employees directly involved in transforming raw materials into goods or services which are specific to the job, the core technical skill. contextual performance concerns aspects of individual performance which not straight to their main function [5].

In this study using Factor Evaluation System method to analysing job performance, because there are many research about it [1,6,7]. Factor Evaluated System (FES has used two approaches i.e. point system and grade system. There are nine factors FES that common to most nonsupervisory position in general schedule occupations. To represent the intent of whole factor, several of FES factor have two or more sub-criteria.

[6]. First to using this method the company must has been categorize all position become structural position or functional position. Functional position using classification standard FES. Structural position also called managerial position and to evaluated the job using classification standard FES plus classification to managerial.

The function of FES is to determine the value and class position that exist within the company. The value of position determines how much employee income, and class positions determine the duties and responsibilities held by a position. FES are public documents and should be available for review by anyone interested in their content. Furthermore there are nine factors in FES that not only evaluating duties and responsibilities but understanding about their position making valuation more detail. Thus making FES method widely used. The lack of the FES method is that method has not been able to deal with changes in factors that the company might consider important but not yet in the FES. A less detailed evaluated of employees activities, and FES does not have a standard value for each factor that must be obeyed by the position make the FES method less detail in analyzing job performance. Therefore the FES method is combined with the process mining. Until now there has been no research that discusses about FES method with business processes.

Process mining is a technique in the field of process management that support the analysis of business processes based on event logs [8]. Process mining aims at the extraction of information from a set of real executions (event log) [9]. Using company event log, it can be known that activities that really worked by employees because it has history of case, activity, time stamp and resources of employee [10]. Process mining helped FES method to analyzing the factor become more details. With the result that company can be easily to employee monitoring or give remuneration.

To make this method not only used for knowing the employee performance, so this method must have a weight for each factor. This paper used Analytical Hierarchy Process (AHP) to get the weight. AHP describes complex multi-factor or multi-criteria problems into a hierarchy [11]. With the weight, this method can be used too for recruitment and knowing the weaknesses of employee.

considering the advantages of FES and process mining, this paper proposes the combination FES and process mining to more detailing the factors of FES, which are required for recruitment, employee monitoring, training, remuneration and carrier planning.

II. RESEARCH METHOD

This proposed method is how to enrich FES method with combines the method and the process mining.

Step 1 – Collect all the company event log and standard operating procedure (SOP). SOP is a written set of instruction to be followed in order to achieve uniformity of performance of a specific function. An example of SOP is shown in Fig 1.

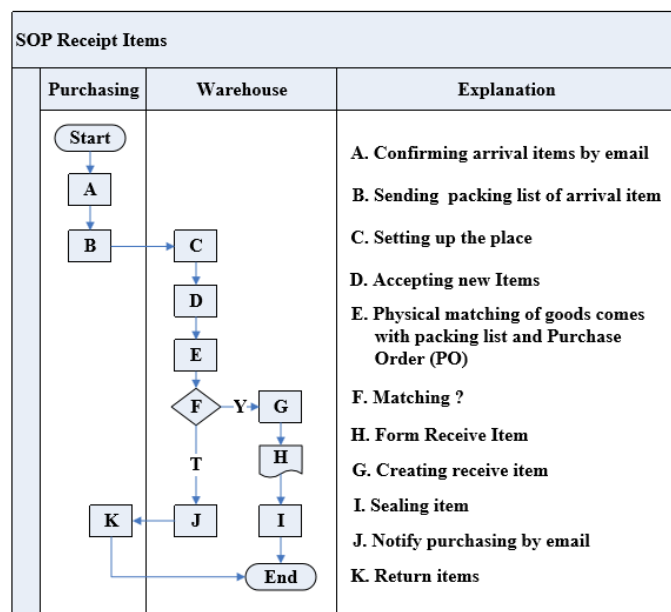


Fig 1. SOP Receipt Items

Table 1. Example of Event Log

Case ID	Activity	Start Timestamp	Complete Timestamp	Resources
01	Confirming arrival items by email	9/1/17 9:00 AM	9/1/17 9:06 AM	Purchasing
01	Sending packing list of arrival item	9/1/17 9:06 AM	9/1/17 9:09 AM	Purchasing
01	Setting up the place	9/1/17 10:00 AM	9/1/17 5:00 PM	Warehouse
01	Accepting new items	9/5/17 8:00 AM	9/5/17 2:00 PM	Warehouse
01	Physical matching of arrived items Purchase Order (PO)	9/6/17 8:00 AM	9/6/17 10:30 AM	Warehouse
01	Receive Item	9/6/17 10:30 AM	12/27/17 11:00 AM	Warehouse

Every position at least have one SOP and it linked with another position. So we must have the event log because it have some certain fields like case id, activity name, timestamp and resources. Table 1. is show the example attributes of the event in the logs. In that table there are case id, the activity name, start and finish time and the resources who did the activity.

Step 2 – From the SOP that have a Microsoft Visio format in Fig 1, drawing it again with YAWL format. YAWL (Yet Another Workflow Language) is an application used to create a business process model. It means, every process in SOP will be decomposed into detail activity based on the record logs. One the biggest challenge in this step is make a simulation models which represent the actual process.

Step 3 – Discovering the business process models. Purposes discovery is to find the process data and process model form which describe the actual activity. If the process model already fit then the next step is analysing the model process using classification standard FES. In the regular FES, each position will be evaluated based on 9 factors. Which is one position have more than one SOP. Table 2 is the description of FES factor.

Table 2 : Description of FES Factor

Factor	Name	Explanation
1	Knowledge Required by the Position	- Level of knowledge and skills are required - How to use skills and knowledge in the work
2	Supervisory Controls	- How to command task work - What is the employee responsibility if doing the work - How will the work be reviewed
3	Guidelines	- Type of guidelines used in doing the work - How much judgment are required to apply the guidelines or develop new guides
4	Complexity	- Character of the assignment - Level of difficulty in identifying what needs to be done - Inhibiting factor and authenticity in doing the work
5	Scope and Effect	- Work objective - Effect from work product
6	Personal Contact	- What is needed and the determination of where the contacts are made
7	Purpose of Contacts	- The reason “personal contact” is done
8	Physical Demands	- The use of physical force that is necessary in such work like frequency and intensity
9	Work Environment	- Physical environment in which the employee works and the specific safety rules or precautions in work

Every factor are not same but related to each other. Such as “purpose of contact factor” is sequel from the “personal contact factor”. But every factor have different point rating. Table 3 is shown the point rating very factor.

Table 3. Rating and Point for FES Factor

Rating	Point FES Factor								
	1	2	3	4	5	6	7	8	9
1	50	25	25	25	25	10	20	5	5
2	200	125	125	75	75	25	50	20	20
3	350	275	275	150	150	60	120	50	50
4	550	450	450	225	225	110	220		
5	750	650	650	325	325				
6	950			450	450				
7	1250								
8	1550								
9	1850								

Rating in FES factor show the level of employee understanding from each factor. Rating higher means increasingly dominating on it job.

Step 4 – After analysing the business process model, then calculated every activities in position using standard FES.

Step 5 - Set the priority FES factor in every position using AHP. This step can be advantages for this research, because FES doesn't has standard value for every factors that must be obeyed by position. The basic step in the AHP method are :

1. Preparing a hierarchy of problems encountered
2. Make a pair-wise comparison matrix based on priority factors
3. Find lambda (λ)
4. Find Consistency Index (CI)

Formula 1, CI aims to search the consistency of index. The good result is closer to zero.

$$CI = \frac{\lambda_{maks} - n}{n - 1}$$

Where :

CI = Consistency Index

N = number of criteria

= number of weight x factor

5. Find the Ratio Consistency Index (CR), CR < 10%

Formula 2, If CR less than 0,1 so the result is consistent. If CR more than or as equal as 0,1 so the result is not

consistent and the pair-wise comparison matrix must be repeated [12,13,14].

$$CR = \frac{CI}{IR}$$

Where :

CR = Consistency Ratio

CI = Consistency Index

IR = Index Ratio (Table 4.)

Table 4. Table of Index Ratio

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

III. RESULTS AND ANALYSIS

Based on SOP in Fig 1. so the SOP re-drawn using YAWL.

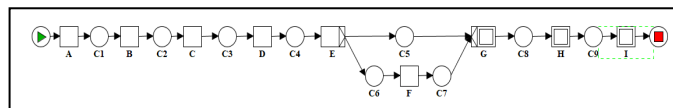


Fig 2. SOP Level 1 – Receipt Items

In Fig 2. There are 9 activity (from “A” until “I”). The powerful draw SOP with YAWL is the business process can be more details. There are 3 double box button that means that activity still have decomposition. Table 5 explain the notation in Fig 2.

Table 5. Explanation Notation SOP Level 1 – Receipt Item

Notation	Activity	Division
A	Confirming arrival items by email	Purchasing
B	Sending packing list of arrival item	Purchasing
C	Setting up the place	Warehouse
D	Accepting new items	Warehouse
E	Physical matching of arrived items Purchase Order (PO)	Warehouse
F	Notify purchasing by email	Warehouse
G	Received Item (2)	Warehouse
H	Sealing Item (2)	Warehouse
I	Entry Mc. Add (2)	Warehouse

From the description table 5. there are 2 activity which is not a warehouse officer jobs. And also have 3 activity that still have decomposition.

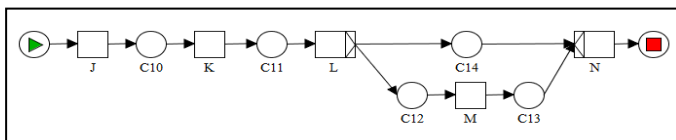


Fig 3. SOP Level 2 – Received Items (G)

Fig 3 describe the “G” notation in Fig 2. Actually “received item” consists of some more activities, but didn’t have decomposition again. The description of Fig 3. is shown in the table below.

Table 6. Description Notation SOP Level 2 – Receipt Items (G)

Notation	Activity	Division
J	Creating New Form on Database	Warehouse
K	Select the Vendor	Warehouse
L	Approving selected PO	Warehouse
M	Edit the number of item received	Warehouse
N	Save Receive Item Form	Warehouse

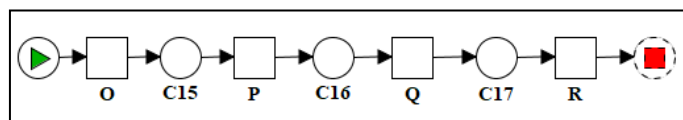


Fig 4. SOP Level 2 – Sealing Item (H)

Activity “Sealing Item” (H) in Fig 2. Explained in Fig 4. SOP level 2 – sealing item didn’t have decomposition but the last activity in this process model will be continued in SOP level 2 – entry Mc. Add. The description of Fig 4. is shown in the table 7.

Table 7. Description Notation SOP Level 2 – Sealing Item (H)

Notation	Activity	Division
O	Writing the seal number	Sales
P	Open the item Packing	Warehouse
Q	Glue the seal	Warehouse
R	Entry Item Database	Warehouse

Activity “writing the seal umber” in warehouse SOP is turn out sales’s.

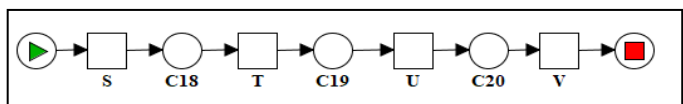


Figure 5. SOP Level 2 – Entry Mc. Add (I)

Fig 5. is the last decomposition on SOP Receipt Items. In this process model all activities are done by the warehouse. The Description of Fig 5 is shown in the table below.

Table 8. Description Notation SOP Level 2 – Entry Mc. Add (I)

Notation	Activity	Division
S	Open the Packing	Warehouse
T	Open the item database	Warehouse
U	Scan Barcode Mc.Add	Warehouse
V	Update item Database	Warehouse

After all business process model are made, so the next step is collect the warehouse activities. Every activity will be analyze using 9 FES factor. The following table is the collection of the activity from SOP Received Items Level 1 and Level 2.

Table 9. Activity in SOP Level 1 & Level 2

No	Activity	Resources
1	Setting up the place	indy, kholid, Hafid, Enggal
2	Accepting new items	indy, kholid, Hafid, Enggal
3	Physical matching of arrived items Purchase Order (PO)	Hafid, Bagas
4	Notify purchasing by email	Hafid, Bagas
5	Creating New Form on Database	Hafid, Bagas
6	select the Vendor	Hafid, Bagas
7	Approving selected PO	Hafid, Bagas
8	Edit the number of item received	Bunga, Hafid, Bagas
9	Save Receive Item Form	Hafid, Bagas, Migdad
10	Open the item Packing	Hafid, enggal
11	Glue the seal	Hafid, Bagas
12	Entry Item Database	Enggal
13	Open the Packing	Bagas, hafid
14	Open the item database	Bagas, hafid
15	Scan Barcode Mc.Add	Hafid, Bagas
16	Update Item database	Hafid, Bagas

Actually from all business process model in this research there are 19 activities. But 3 activity actually did by another position i.e purchasing and sales. So, we only just calculated 16 activity for warehouse officer position in SOP Received Items. If one position have more than one SOP just add up all the activity based on the point rating then divided by the total of activity.

FES method become powerful in analyze job performance. The basic FES just analyze a position by the 9 factors, but now the 9 FES factor already analyze 16 activities in a position. Table 10 shows how is FES method works. While have many factors, but FES can not know where are the employee weakness and stronger.

Table 10. FES method in a Position

No	Activity	Point
1	Knowledge Required by the Position	200
2	Supervisory Controls	125
3	Guidelines	125
4	Complexity	75
5	Scope and Effect	75
6	Personal Contact	60
7	Purpose of Contacts	20
8	Physical Demands	20
9	Work Environment	5

When every process in SOP is detailed become activities with process mining so the FES method become more detail. Table 11. Shows how are every activity in SOP Receipt Item from position warehouse officer calculated

Table 11. Activities with Factor FES in SOP Level 1 & Level 2

Activity / Factor										Total
	1	2	3	4	5	6	7	8	9	
C	350	125	125	150	75	25	20	20	5	895
D	50	25	25	25	25	25	20	20	5	220
E	200	125	25	25	25	10	20	20	5	455
F	200	25	25	25	25	25	20	5	5	355
J	50	25	25	25	25	10	20	5	5	190
K	50	25	25	25	25	10	20	5	5	190
L	50	25	25	25	25	10	20	5	5	190
M	50	25	25	25	25	10	20	5	5	190
N	50	25	25	25	25	10	20	5	5	190
P	50	125	25	25	25	10	20	20	5	305
Q	50	125	25	25	75	10	20	20	5	355
R	200	125	25	25	75	10	20	5	5	490
S	50	25	25	25	25	10	20	20	5	205
T	200	25	25	25	25	10	20	5	5	340
U	200	25	25	25	75	10	20	20	5	405
V	50	25	25	25	75	10	20	5	5	240
Total	1850	900	500	525	650	205	320	185	80	5215

Final score for this position obtained from total value for each activity then divided by total activity. Final score for warehouse officer is 5025 point divided by 16 activity equals 326. The proportional basic FES with the FES combined process mining is very different. Score for warehouse officer with basic FES is 705. It's almost doubled score FES with process mining, because its just count up the activities performed by employees.

The best score can be used to determine standard for new recruitment in that position. Using the event log in a period time, this FES method with process mining can analyze average and total time for one task. It's can be use by company to know the capabilities of employee who need training or reward.

For more detail in using FES with process mining, so added weight for each factor. In this research weight gets from the AHP method. Assign the weight start from asking the HRD or manager to determine the priority factor based on 9 FES factor. The factor start from the topmost until the small effect.

The next step is make a pair-wise comparison matrix. Number of columns are based on how many factors are used. Because FES has 9 factor, so we have matrix 9x9. It is shown in the table 12.

Table 12. Weight AHP for SOP Received Items

FES Factor	KR	SE	G	C	WE	PD	SP	POS	PC
Knowledge Required by the Position (KR)	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
Scope and Effect (SE)	0.50	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00
Guidelines (G)	0.33	0.50	1.00	2.00	3.00	4.00	5.00	6.00	7.00
Complexity (C)	0.25	0.33	0.50	1.00	2.00	3.00	4.00	5.00	6.00
Work Environment (WE)	0.20	0.25	0.33	0.50	1.00	2.00	3.00	4.00	5.00
Physical Demands (PD)	0.17	0.20	0.25	0.33	0.50	1.00	2.00	3.00	4.00
Supervisory Control (SP)	0.14	0.17	0.20	0.25	0.33	0.50	1.00	2.00	3.00
Purpose of Contacts (POS)	0.13	0.14	0.17	0.20	0.25	0.33	0.50	1.00	2.00
Personal Contacts (PC)	0.11	0.13	0.14	0.17	0.20	0.25	0.33	0.50	1.00

After calculate the pair-wise comparison matrix, the next step is count the weight from the average every factor.

Table 13. Weights of FES Factor

FES Factor	Weight	λ max
Knowledge Required by the Position (KR)	0.31	2.98
Scope and Effect (SE)	0.22	2.13
Guidelines (G)	0.15	1.50
Complexity (C)	0.11	1.04
Work Environment (WE)	0.08	0.71
Physical Demands (PD)	0.05	0.49
Supervisory Control (SP)	0.04	0.34
Purpose of Contacts (POS)	0.03	0.24
Personal Contacts (PC)	0.02	0.17

To test consistency of factor weight is gets from Random Consistency index (CR). The following are calculations using formula 1 and formula 2.

$$CI = \frac{9.60 - 9}{9 - 1} = 0.075$$

$$CR = \frac{0.075}{1.45} = 0.05 < 10\%$$

A Weight make a FES factor more powerful in analyzing job performance. This weight can shows the strength and weakness from the employee. The company can used the weight to standard for training employee to improve employee skill. But this weight can used to fired the lazy and can not improve employee. All the history recorded in event log and processed with FES method with process mining and AHP.

Table 14. FES with weight in activities

Activity	Total	FES Factor								
		1	2	3	4	5	6	7	8	9
C	895	196.9	134.2	98.5	268.5	35.8	17.9	26.9	71.6	44.8
D	220	48.4	33	24.2	66	8.8	4.4	6.6	17.6	11
E	455	100.1	68.2	50.1	136.5	18.2	9.1	13.7	36.4	22.8
F	355	78.1	53.2	39.1	106.5	14.2	7.1	10.7	28.4	17.8
J	190	41.8	28.5	20.9	57	7.6	3.8	5.7	15.2	9.5
K	190	41.8	28.5	20.9	57	7.6	3.8	5.7	15.2	9.5
L	190	41.8	28.5	20.9	57	7.6	3.8	5.7	15.2	9.5
M	190	41.8	28.5	20.9	57	7.6	3.8	5.7	15.2	9.5
N	190	41.8	28.5	20.9	57	7.6	3.8	5.7	15.2	9.5
P	305	67.1	45.7	33.6	91.5	12.2	6.1	9.15	24.4	15.3
Q	355	78.1	53.2	39.1	106.5	14.2	7.1	10.7	28.4	17.3
R	490	107.8	73.5	53.9	147	19.6	9.8	14.7	39.2	24.5
S	205	45.1	30.7	22.6	61.5	8.2	4.1	6.15	16.4	10.3
T	340	74.8	51	37.4	102	13.6	6.8	10.2	27.2	17
U	405	89.1	60.7	44.6	121.5	16.2	8.1	12.2	32.4	20.3
V	240	52.8	36	26.4	72	9.6	4.8	7.2	19.2	12

Table 14 is the weight for each activity obtained from the value activity in table 11 that multiplied by the weight of FES factor. In table 11 the factors that have passed the standard are marked in red.

Considering the advantages of FES and process mining, this paper proposes the combination FES and process mining i.e :

1. Employee Monitoring

The company can use details of activities to notice deviation that maybe caused by employee. Based on FES which includes factor to monitor the employee are supervisory control (2), guidelines (3) and personal contacts (6).

2. Remuneration

If the result of monitoring is good, so the employee have a right to get reward or remuneration. Complexity (4), scope and effect (5), and physical demands (8) are FES factor that affect to give it.

3. Employee Training

Training of employee is a must to increase a job performance in company. With this method, the company can find which part of the employee who need training. Which became the basis for decision-making training on FES is knowledge required by the position (1), purpose of contacts (7), personal contacts (6) and "work environment (9).

4. Recruitment

With the help of AHP , the combination of FES and process mining became more powerful. FES not only use for analyze job performance but for recruitment new employee because all the factor in FES have standard.

IV. CONCLUSION

Based on research, this paper proposed a new method for job performance analyzing using Factor Evaluation System and process mining. Before this paper, usually company just using FES to analyze job performance. And this paper using AHP to get weight for each factor. This weight aims so that company not only just using this method for remuneration and career planning, but for recruitment and planning too.

The work was tested on a real-life event log data which are taken from an organization which has a focus on selling and distribution fiber optic. The result shows that this offered method is more details in analyzing job performance i.e employee monitoring using factors 2,3,6; remuneration using factor 4,5,8; employee training using factors 1,6,7,9; recruitment using all factor which have weight standard.

For future works, the standard score for every factor must be arrange according the company needs.

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