Choosing Aircraft-Maintenance-Related Personality Traits with Personality-Oriented Job Analysis Method

Ruozhu Wang[1,2]
[1]School of Psychology, Shanxi Normal University, Xi'an, China
[2]Aeronautical Maintenance Department, Shanghai Civil Aviation College, Shanghai, China
wangruozhu0328@sina.cn

Xuqun You*
School of Psychology
Shanxi Normal University
Xi'an, China
youxuqun@ snnu.edu.cn

***Abstract*—although personality-job fit has shown its importance to job performance, personality-job fit has been seldom involved in aircraft maintenance technician selection and what personality traits are most related to aircraft maintenance practices has not even been clear. We used a Personality-Oriented Job Analysis (POJA) method in order to screen out the most aircraft-maintenance-related personality traits. Under the POJA framework 12 subject matter experts (SME) rated personality traits in terms of relatedness to aircraft maintenance and inter-rater consistency was found; 150 new technicians were tested with Jackson Personality Inventory (JPI) and later were evaluated on maintenance performance, with significant correlation found between SMEs' ratings and criterion validity of the traits. With the POJA method we screened out "organization", "energy" and "responsibility" as the most aircraft-maintenance-related traits and they significantly predicted aircraft maintenance performance.**

Keywords—aircraft maintenance, personality trait, POJA, validation

I. INTRODUCTION

Aircraft maintenance technicians (AMT) are the ones who ensure aircraft airworthiness – the basis of flight safety. An AMT's job includes inspection, removal and installation, troubleshooting, etc. They shall work strictly per standard procedures specified in job cards and manuals, and will more than often work under time pressure and operation pressure (to ensure transport capacity). Like any other job , aircraft maintenance has its particular job requirements supposed to be met by appropriate personnel.

Personnel selection aiming to match person and job requirements has always been focusing on the match between job and the personnel's cognitive attributes (ability, knowledge, experience), whereas job-personality match (non-cognitive) has been neglected so far. It not because people didn't realize the importance of person-job fit but because personality traits didn't show satisfactory prediction. Researchers argued the unsatisfactory prediction was caused by inappropriate methods and they insisted a formal job analysis should be the basis of choosing the most job-related personality traits and thus can improve personality traits' prediction validity[1,2]. POJA methodologies were developed in several studies[2,3,4,5,6]. Generally under POJA framework personality traits are rated in terms of their importance or relevance to a job in order that the most related traits to the job can be screened out. Essentially it's a job analysis on the aspect of the performers' personalities. POJA framework has been proven reliable, for example Fraboni, Raymark and Goffin et al. reported inter-rater consistency in their respective POJA methods[2,4,6]. POJA framework was also reported to have chosen personality traits well predictive of job performance; i.e. the POJA methods were proven to have criterion validity[2,6] . Thus, we assume that by using a reliable and effective POJA method the most aircraft-maintenance-related personality traits will be screened out.

In the process of applying a POJA method, three issues must be taken into consideration. The first is what personality construction a POJA method is based on. Jackson recommended the personality construction should be composed of traits with clear distinctiveness and minimized overlap with each other [7]. The 15 traits in Jackson Personality Inventory showed evidence to meet this requirement, e.g. in Fraboni's research 1995[2]. The second is that the rating system in which SMEs assign job-relatedness ratings to the personality traits should reflect bidirectional relationships commonly occurring in practice [8]. The third issue is with what criterion to prove prediction validity of the traits screened with POJA. To show the evidence that traits chosen using POJA have criterion validity, it is preferable to use actual representative routine practices as criterion [6]. Unfortunately, few POJA researches used actual performance as criterion. Fraboni used self-expected performance as criterion and Cucina, Vasilopoulos & Sehgal took GPA rather than actual job performance as criterion [2,9].

In the process of screening, the most aircraft-maintenance-related personality traits under POJA framework we addressed the three issues above. Our method was established on the 15 traits in Jackson Personality Inventory (JPI); we used a 0-6 rating system , asking SMEs to add notes where they think there was a negative relation between a certain trait and aircraft maintenance job; we also used real typical performance as criterion. Detailed information on the procedure is provided under section three "MATERIALS".

To evaluate the proposed POJA and to test its applicability to aircraft maintenance technician selection we

tested three hypotheses:

H_1: There will be considerable consistency in the POJA trait ratings ascribed to maintenance job by different SMEs. This will be evidenced by high levels of inter-rater reliability in the job(aircraft maintenance)-relatedness ratings of the traits.

H_2: There will be significant correlation between the SMEs' job-relatedness ratings assigned to the traits and the actual job-relatedness of the traits (i.e., the correlations between traits and job performance).

H_3: a standardized composite of the three traits that receive the highest job-relatedness ratings for aircraft maintenance job will predict the job performance significantly.

II. METHOD

A. Participants

The participants included in the job analysis phase of the project 12 subject matter experts (SMEs) who were very experienced aircraft maintenance technicians working with an airline company in Shanghai and in the criterion validation phase 150 new aircraft maintenance technicians (AMT) who were college students majored in aeronautical maintenance and after graduation worked with the airline company mentioned above as AMTs.

B. Job analysis subject matter experts (SMEs)

Twelve very experienced aircraft maintenance technicians provided job-relatedness ratings with the personality-oriented job analysis (POJA) method. They had been working as an AMT for 7 to 11 years on ramp or at hanger or in workshop (i.e. engaged in line maintenance and scheduled maintenance and component repair), doing actual aircraft maintenance practices. They got involved in the job analysis phase in the form of rating personality traits with Fraboni's personality-oriented job analysis (POJA) scale [2].

Their working year average was 7.8 (SD = 0.9). In job analysis a 10-15 range of SME sample size is customary [4,6,10].

C. Criterion validation participants

150 new aircraft maintenance technicians (AMT) who were soon-to-be-graduates college students majored in aeronautical maintenance and after graduation worked for the airline company mentioned above as an AMT. All of them were male which is consistent with what it is in aviation maintenance industry, with averaged age 19.6 (SD = 0.3). 68 of them worked on the position of line maintenance, 32 scheduled maintenance , 50 components repair. From them we collected personality data and aircraft maintenance performance data.

III. MATERIALS

A. Personality-oriented job analysis (POJA)

- Fraboni's POJA scale (1995)

We collected SMEs'rating data of the 15 traits(Anxiety, Breadth of Interest, complexity, Conformity, Energy, innovation, empathy, organization, responsibility, Risk taking, Self-esteem, Social adroitness, Social participation, Tolerance and Social orthodoxy) in Jackson Personality Inventory (JPI) with Fraboni's POJA scale that was also established on JPI personality construction and included 120 items ,with 8 items under each of the 15 traits[2,11]. One item under "energy" administered to SMEs appears in APPENDIX. This scale demonstrated good inter-rater consistency and construction validity[2].

B. Criterion-validation

- Personality measures - Jackson Personality Inventory (1994)

Jackson Personality Inventory (Jackson,1994) is intended for use among normal population and used for career and vocational counseling. The revised edition (JPI-revised) in 1994 has shown psychometric integrity[2,7]. It consists of 15 scales measuring 15 traits respectively, with 20 items under each of them. Each item score can range from 1 to 7, so each trait score can range from 20 to 140. JPI was administered to the 150 new AMT a couple of months before they graduated from college.

- Criterion (job performance) measures

Criterion measures (appear in APPENDIX) with verbal descriptions of relevant behavior were used to rate the performance of the 150 new technicians on five specific competencies whose coverage and feasibility were confirmed by experts in aircraft maintenance; the five competencies are strictly following procedures in job card, referring to manuals instead of doing tasks according to what is taken for granted, strictly complying with procedures on handling tools and materials, doing practices accurately and quickly, and filling out maintenance records properly. Each competency was rated from 1 to 7, corresponding to from extremely bad to extremely good. After 3 months' work in the airline company, the 150 new technicians were evaluated by the specialist in charge of new employees' assessment using the criterion measures above. Scores across the five competencies were averaged to yield a single score which was taken as criterion score. To avoid the variance caused by different raters, we employed only one specialist in the assessment. The assessment process lasted three months or so, with the new technicians not informed of when and how they would be assessed. The criterion scores for each new technician can range from 5 to 35.

IV. RESULTS AND DISCUSSION

A. inter-rater consistency

Kendall concordance coefficient W was used as an index of inter-rater consistency among the 15 SMEs. Given no same ratings on the 15 traits from any rater, W coefficient was calculated with (1):

$$W=12S/K^2(N^3-N) \quad (1)$$

wherein S (standard deviation) was worked out as 6026, K(the number of raters) was 12 and N (the number of traits to be rated) was 15. Hence , W was equal to 0.149 .

Given N>7 , a χ^2 value was further worked out with (2) , $\chi^2=25.01>\chi^2_{(14)}0.05$ (two-tailed), indicating a significant inter-rater consistency.

$$\chi^2=K(N-1)W \quad (2)$$

Moreover, the pattern of POJA ratings in Table 1 appeared to make sense empirically. For instance, a technician always works under time pressure, meaning he has to finish a large volume of workload in a quite limited

period to ensure the aircraft to be returned to service on time, so "organization" is supposed to be an especially important trait for an AMT; besides, aircraft maintenance practices are demanding physically and mentally, so "energy" is another important trait, too. Therefore, H_1 was supported.

TABLE I PERSONALITY-ORIENTED JOB ANALYSIS: MEANS AND STANDARD DEVIATIONS (SDS)OF TRAIT RELEVANCE RATINGS BY SMES.

Trait	Mean	SD
Anxiety(emotional control)	5.60	7.84
Breadth of Interest	22.68	3.89
complexity	24.00	7.20
conformity	4.36	8.22
Energy Level	**30.22**	2.80
innovation	20.64	6.37
Interpersonal affect (empathy)	0.40	0.12
organization	**30.89**	3.01
responsibility	**28.96**	4.16
Risk taking	1.42 (negative)	2.36
Self-esteem	18.28	6.96
Social adroitness	6.46	7.66
Social participation	6.37	7.24
Tolerance	4.40	3.20
Social orthodoxy	6.88	2.44

Note: although "risk taking" was rated negative, in our rating system it was just calculated using its absolute value, because the rating was an index of relatedness to aircraft maintenance practice and a negative value just indicates the inverse direction. The SME sample size was twelve; the three highest rated traits were bolded.

B. Criterion Validation

The 150 new technicians participating in the criterion validation completed the Jackson Personality Inventory as explained. Descriptive statistics and reliabilities of the 15 scales are shown in table 2. The new technicians were also assessed by the specialist in charge of new employees' assessment with the criterion measures above, per the procedures mentioned in section three "Materials" after three months' maintenance work. Table 3 presents descriptive statistics of the average job performance (criterion) scores of aircraft maintenance practices. According to many findings, operational performance ratings are inflated[6]. Whereas in our study the criterion mean was relatively high, the variance was big enough to engender personality–performance criterion correlations compared with those in the literature[6,12,13]. Although 150 new technicians participated in personality measurement and criterion measurement, 145 of them were brought into the statistics, given the missing values.

TABLE II CRITERION VALIDATION: DESCRIPTIVE STATISTICS AND RELIABILITIES OF PERSONALITY SCALES

Scale	Mean	SD	Reliability
Anxiety(emotional control)	78.16	17.05	0.80
Breadth of Interest	80.18	18.74	0.69
complexity	82.50	13.75	0.70
Conformity	75.39	21.20	0.63
Energy Level	84.51	14.48	0.71
innovation	82.43	18.90	0.79
Interpersonal affect (empathy)	85.50	15.46	0.78
organization	88.27	20.32	0.76
responsibility	84.30	17.88	0.72
Risk taking	80.22	21.47	0.81
Self-esteem	80.36	20.25	0.79
Social adroitness	78.25	13.30	0.72
Social participation	79.39	20.01	0.63
Tolerance	76.38	16.38	0.70
Social orthodoxy	72.30	16.20	0.71

N=145; means and SDs are expressed as average trait scores (min = 20 and max = 140).

TABLE III CRITERION VALIDATION: MEANS AND SDS OF CRITERION (PERFORMANCE) SCORES.

competency	Mean	SD
Following job cards	5.18	1.24
Referring to manual	4.99	1.37
Tools and materials handling	5.79	1.13
competency	**Mean**	**SD**
Doing practices accurately and quickly	5.04	1.15
Filling maintenance records properly	5.06	1.16
Arrogate	5.21	0.87

N=145; only the last row of table 3 were brought into criterion validity calculation; mean of arrogate is expressed as arithmetic average of the five competencies' means.

Pearson product-moment correlations between the new technicians' personality scores and their performance scores were calculated and tested for significance with SPSS 20.0 statistical package, as shown in table 4. Although many of the correlations were small which is basically consistent with other researchers' results on personality-performance correlations, four of them (bolded) reached significant level statistically, with another two "responsibility" and "innovation" quite close to cutoff[6].

Since H_1 has been supported previously, the POJA method in our study should be believed to be reliable and reasonable especially when applied to aircraft maintenance practices, which means the POJA method is applicable to screen out the most aircraft-maintenance-related personality traits. Thus, theoretically ratings in table 1 are supposed to be consistent with personality-criterion correlations, which was a paradigm of studies on criterion validation[2,6]. To provide evidence for this assumption Pearson product-moment correlation coefficient (an index of how well the POJA ratings corresponded to the actual criterion relations) between personality trait ratings and personality-criterion correlations was calculated and tested for significance with SPSS 20.0; the results are shown in Table 5(1st row): POJA ratings were correlated with criterion correlations at a very significant level statistically ($p<0.01$). Therefore H_2 was supported, too.

TABLE Ⅳ CRITERION VALIDATION: CORRELATIONS OF PERSONALITY TRAITS WITH PERFORMANCE CRITERION

Personality scale	Pearson correlations and p value
Anxiety(emotional control)	0.032(0.701)
Breadth of Interest	**0.176(0.034)**
complexity	0.119(0.153)
conformity	0.061(0.463)
Energy Level	**0.185(0.026)**
innovation	0.126(0.130)
Interpersonal affect (empathy)	0..98(0.241)
organization	**0.224(0.007)**
responsibility	0.141(0.09)
Personality scale	**Pearson correlations and p value**
Risk taking	-0.031(0.711)
Self-esteem	0.019(0.821)
Social adroitness	**0.213(0.010)**
Social participation	0.009(0.912)
Tolerance	0.022(0.790)
Social orthodoxy	0.041(0.627)

N=145. Two-tailed test was used. Significant Pearson correlations and p values are bolded.

C. The three highest-rated traits by the SEMs

Finally we looked at whether the three traits highest rated by the SMEs provided valid prediction of aircraft maintenance performance. The acceptable inter-rater consistency found in section A indicates the SMEs agreed on the importance of each trait for aircraft maintenance job and Fraboni's scale (1995) had no defect[2]. Thus, it is

reasonable to use traits with the highest ratings to predict aircraft maintenance performance. The ultimate goal of POJA is to provide a method of choosing those traits that will be most predictive of successful performance in the respective job. Therefore, we chose three highest-rated traits ; the number of traits is customary in narrowing of choosing traits with a POJA method[2,6]. As shown in table 1 the "organization", "energy", and "responsibility" are the three highest rated traits, with relative small SDs as well, which from another angle indicates the raters had agreement on the importance of those three traits to aircraft maintenance job. We created a composite(X_4) of the three highest-rated traits (standardized organization was expressed as X_1, standardized energy X_2 and standardized responsibility X_3); $X_4=(X_1+X_2+X_3)/3$. We used X_4 to predict criterion (performance) and found a significant Pearson correlation as shown in the second row of table 5. Largely H_3 is supported.

TABLE V EVALUATION OF THE POJIA RATINGS

POJA ratings correlated with criterion correlations and p value	.673	(.006)
Criterion Validity of the top 3 traits and p value	.194	(.019)

Note: ''POJA rating correlated with criterion correlations'' refers to the correlation between a column of POJA trait ratings from Table 1, and the criterion relations from Table 4 (this is based on an N of 15; i.e., the 15 traits). "The top 3 traits" refers to the three traits that were assigned to the highest ratings by the SMEs using the POJA method. ''Criterion Validity of top 3 Traits'' refers to Pearson product-moment correlation of the criterion score with the composite of the ''top 3'' traits (N=145). Two-tailed tests were used in this table.

V. CONCLUSIONS

All of the three hypotheses were supported: the POJA method had high levels of inter-rater reliability, indicating a consistency among SMEs in their judgments of aircraft maintenance-personality traits relevance. Second, significant correlation was found between the POJA job relevance ratings of traits and the actual criterion-validity of the traits. The meaningfulness of ratings using the POJA method was proven empirically. Third, "organization", "energy" and "responsibility" were ultimately screened out as the most aircraft-maintenance-performance-related traits and their good prediction was verified by using their composite to predict performance, suggesting they are valid non-cognitive predictors of aircraft maintenance performance and should be applied in personnel selection. The scales of "organization", "energy" and "responsibility" in Jackson Personnel Inventory involve 60 items totally and can be purchased on internet.

We used "typical" performance(TP) rather than "maximum" performance(MP) as criterion, which may enhance external validity. However it must be pointed out that TP and MP are not the same thing. "TP is what a person generally does on a day-to-day basis, characterized by routine multiple tasks, whereas MP refers to the best possible performance level of which a person is capable, representing an upper limit on actual job performance" [14,15]. The strength of the relation between MP on the job and TP on the job remains open to question [16, 17]. Reference[18] implied personality-performance correlation tends to be higher in TP situation than in MP situation. Thus we expect in the future cross-validation a weaker criterion validity of the "top three traits" may be yielded if a maximum criterion is taken.

VI. APPENDIX

A. Example of POJA scale

How related is "hard, physical labor" to aircraft maintenance practices? Rate it from 0-6, if you think there's a negative relation remark it as negative.

B. Criterion measures:

- strictly following procedures in job card: do tasks step by step ; sign off step by step instead of signing off together after finishing all or signing off without doing the corresponding work.
- referring to manuals instead of doing tasks according to what is taken for granted: before doing task make himself clear about everything in the job card; consult the manual before doing task, check with the manuals for anything unclear .
- strictly complying with procedures on handling tools and materials: check the tooling's availability and serviceability when getting it and check the number of the tools before returning them back to the tools room; check the material's part number, certificate, etc. to make sure to fix the right materials on aircraft; isolate serviceable ones from unserviceable ones.
- doing practices accurately and quickly.
- entering maintenance records properly: enter maintenance records in time; record maintenance information properly and definitely and in detail, to make sure maintenance work can be tracked back with the records.

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