

Corrigendum

Forecasting both time varying MTBF of fighter aircraft module and expected demand of minor parts

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Journal of the Operational Research Society (2009) **60**, 1292–1294. doi:10.1057/jors.2009.8

Correction to: *Journal of the Operational Research Society* (2007) **58**, 714–719. doi:10.1057/palgrave.jors.2602198

We made typo-errors in the specification of conditional mean and variance of Weibull distribution:

$$E(T_{ij}|\theta_{ij},\beta)=\Gamma\left(1+\frac{1}{\beta}\right)\theta_{ij},$$

$$V(T_{ij}|\theta_{ij},\beta)=\left\{\Gamma\left(1+\frac{2}{\beta}\right)-\Gamma\left(1+\frac{1}{\beta}\right)^2\right\}\theta_{ij}^2 \quad (3)$$

Equation (3) needs to be replaced with the following:

$$E(T_{ij}|\theta_{ij},\beta)=\Gamma\left(1+\frac{1}{\beta}\right)\theta_{ij}^{\frac{1}{\beta}},$$

$$V(T_{ij}|\theta_{ij},\beta)=\left\{\Gamma\left(1+\frac{2}{\beta}\right)-\Gamma\left(1+\frac{1}{\beta}\right)^2\right\}\theta_{ij}^{\frac{2}{\beta}} \quad \text{(new 3)}$$

Subsequently, the marginal mean (8) and variance (9) need to be replaced as follows:

$$E(T_{ij})=E[E(T_{ij}|\theta_{ij})]=\Gamma\left(1+\frac{1}{\beta}\right)\frac{(\alpha\exp(X_{ij}B))^{1/\beta}\Gamma(\alpha+1-(1/\beta))}{\Gamma(\alpha+1)} \quad \text{(new 8)}$$

$$\begin{aligned}Var(T_{ij})&=E[V(T_{ij}|\theta_{ij})]+V[E(T_{ij}|\theta_{ij})]\\&=\left(\Gamma\left(1+\frac{1}{2\beta}\right)-\Gamma\left(1+\frac{1}{\beta}\right)^2\right)\frac{(\alpha\exp(X_{ij}B))^{2/\beta}\Gamma(\alpha+1-(2/\beta))}{\Gamma(\alpha+1)}\\&\quad+\Gamma\left(1+\frac{1}{\beta}\right)^2\left[\frac{(\alpha\exp(X_{ij}B))^{2/\beta}\Gamma(\alpha+1-(2/\beta))}{\Gamma(\alpha+1)}-\left(\frac{(\alpha\exp(X_{ij}B))^{1/\beta}\Gamma(\alpha+1-(1/\beta))}{\Gamma(\alpha+1)}\right)^2\right]\\&=\Gamma\left(1+\frac{1}{2\beta}\right)\frac{(\alpha\exp(X_{ij}B))^{2/\beta}\Gamma(\alpha+1-(2/\beta))}{\Gamma(\alpha+1)}\\&\quad-\Gamma\left(1+\frac{1}{\beta}\right)^2\left(\frac{(\alpha\exp(X_{ij}B))^{1/\beta}\Gamma(\alpha+1-(1/\beta))}{\Gamma(\alpha+1)}\right)^2\end{aligned} \quad \text{(new 9)}$$

Next both (11) and (12) need to be replaced with the following:

$$\hat{E}(T_{i'j})=\Gamma\left(1+\frac{1}{\hat{\beta}}\right)\frac{(\hat{\alpha}\exp(X_{i'j}\hat{B}))^{1/\hat{\beta}}\Gamma(\hat{\alpha}+1-(1/\hat{\beta}))}{\Gamma(\hat{\alpha}+1)} \quad \text{(new 11)}$$

$$\hat{E}(T_{ij+1})=\Gamma\left(1+\frac{1}{\hat{\beta}}\right)\frac{(\hat{\alpha}\exp(X_{ij+1}\hat{B}))^{1/\hat{\beta}}\Gamma(\hat{\alpha}+1-(1/\hat{\beta}))}{\Gamma(\hat{\alpha}+1)} \quad \text{(new 12)}$$

This will affect (20), (21) and (23), which need to be replaced with the following:

$$E(Y_{ij})=E[E(Y_{ij}|T_{ij})]=\exp(X_{ij}B_p)\Gamma\left(1+\frac{1}{\beta}\right)\times\frac{(\alpha\exp(X_{ij}B))^{1/\beta}\Gamma(\alpha+1-(1/\beta))}{\Gamma(\alpha+1)} \quad \text{(new 20)}$$

$$\begin{aligned}V(Y_{ij})&=E[V(Y_{ij}|T_{ij})]+V[E(Y_{ij}|T_{ij})]\\&=\frac{[\exp(X_{ij}B_p)]^2}{\alpha_p}\Gamma\left(1+\frac{1}{\beta}\right)(\alpha\exp(X_{ij}B))^{1/\beta}\Gamma\\&\quad\times\left(\alpha+1-\frac{1}{\beta}\right)\Big/\Gamma(\alpha+1)\end{aligned}$$

$$+[\exp(X_{ij}B_p)]^2\left[\Gamma\left(1+\frac{1}{2\beta}\right)\times\frac{(\alpha\exp(X_{ij}B))^{2/\beta}\Gamma(\alpha+1-(2/\beta))}{\Gamma(\alpha+1)}-\Gamma\left(1+\frac{1}{\beta}\right)^2\left(\frac{(\alpha\exp(X_{ij}B))^{1/\beta}\Gamma(\alpha+1-(1/\beta))}{\Gamma(\alpha+1)}\right)^2\right] \quad \text{(new 21)}$$

$$\hat{E}(Y_{i'j})=\exp(X_{i'j}\hat{B}_p)\Gamma\left(1+\frac{1}{\hat{\beta}}\right)\times\frac{(\hat{\alpha}\exp(X_{i'j}\hat{B}))^{1/\hat{\beta}}\Gamma(\hat{\alpha}+1-(1/\hat{\beta}))}{\Gamma(\hat{\alpha}+1)} \quad \text{(new 23)}$$

In addition, we revise the scenarios in Table 5 to be those in new Table 5.

The resulting Table 6 changes to be new Table 6.

In new Table 6, MTBF is calculated by applying new (8) and multiplying it by 24 h. The failure time used to fit the MTBF model is not the time in which the break module has been attached to the aircraft but the real operation time only. In Korean Airforce, fighter aircraft is operated for 1 h per day on average. The MTBF in new Table 6 reflects real time span for MTBF in which the module is equipped with fighter aircraft instead of real operation time of module.

When its MTBF reaches 200 h, we also assume that the break module has to be replaced with a new module via depot level maintenance instead of being repaired at base level maintenance. New Table 6 reflects these phenomena.

New Table 5 Scenarios: the characteristics and operational conditions of modules

Module scenario	*Total weight of the fighter aircraft (unit: ton)*	*Installed season of module*	*The cumulative number of failures (or repairs) of module (unit: number)*
1	4.132	Spring (May 1)	0
2	3.853	Summer (Jun. 1)	1
3	2.221	Autumn (Sep. 1)	2
4	1.357	Winter (Dec. 1)	3

New Table 6 Forecasted MTBF of the four break modules, forecasted demand of piston to be replaced upon the failure of a module

Module		*Spring*				*Summer*					*Autumn*						*Winter*					
1 Cumulative number of module failures (or repairs) (Unit:number)		1	2	3	4	1	2	3	4	1	2	3	1	2	3	1	2	3	1	2	3	1
MTBF (unit:h)		722	433	260	156	722	500	300	180	833	500	199	552	331	199	552	334	200	557	334	200	557
Expected demand of piston (unit:number)		6	12	24	32	4	9	14	28	6	15	31	13	24	31	13	22	30	11	22	30	11
Necessary demand (unit:number)	Season			74				61						127					126			
	Year										388											
2 Cumulative number of module failures (or repairs) (Unit:number)						2	3	4	1	2	3	1	2	3	1	2	3	1	2	3	1	2
MTBF (unit:h)						500	300	178	834	500	199	553	331	199	553	331	200	557	334	200	557	334
Expected demand of piston (unit:number)						7	12	26	5	13	28	12	22	30	12	22	28	9	20	28	9	20
Necessary demand (unit:number)	Season							53						95					114			
	Year										262											
3 Cumulative number of module failures (or repairs) (Unit:number)											3	1	2	3	1	2	3	1	2	3	1	2
MTBF (unit:h)											200	556	333	200	556	333	202	551	336	202	561	336
Expected demand of piston (unit:number)											26	10	20	26	10	20	26	7	18	26	7	18
Necessary demand (unit:number)	Season													112					102			
	Year										214											
4 Cumulative number of module failures (or repairs) (Unit:number)																	4	1	2	3	1	2
MTBF (unit:h)																	121	563	337	202	563	337
Expected demand of piston (unit:number)																	42	6	17	25	6	17
Necessary demand (unit:number)	Season																		113			
	Year										113											