Psychometric Analysis of the Short-Form Decision Balance Inventory for Smoking in Zambia

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Abstract

This study aimed to assess the internal consistency and construct validity underlying the smoking decision balance inventory on a Zambian sample. Smoking is a health hazard and one of the leading causes of death. At work economic costs due to smoking include sickness, absenteeism, and employee low performance which leads to a loss of productivity. One instrument that can be used to assess employees' inclination for change in smoking behaviour is the decision balance inventory for smoking. A survey design through Structured Equation Modelling (SEM) was used to achieve the research objectives. 201 employees from the energy sector aged between 23-35 completed the decision balance inventory using a non-probability sampling technique specifically convenient sampling. Measurement model fit was analyzed through confirmatory factor analysis in Lisrel 8, 80. All three subscales obtained acceptable Cronbach alpha coefficients above .70. Statistical results have provided a reasonable fit of the measurement model with the empirical data. Construct validity was established with adequate factor loadings and goodness fit statistics.

Keywords: Psychometric, Zambia, Decision Balance Inventory, Smoking

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Introduction:

Tobacco usage in the form of smoking is a health hazard and is the main lead cause of about 6 to 7 million deaths in the world annually (Kondo et al., 2019; Pichon-Riviere et al., 2020). Tobacco contains about 4700 toxic compounds including nicotine, tar and carbon monoxide that lead to the development of cardiovascular, cerebrovascular and vascular diseases (Swan & Lessov-schlager, 2007). According to Pichon-Riviere et al. (2020), 65% of smoking-related deaths are due to lung cancer worldwide, 44 % of deaths are due to chronic obstructive pulmonary diseases and 22% of deaths are due to ischaemic heart diseases. At places of work, the economic costs of smoking include productivity loss due to smoking breaks, absenteeism as a result of employee illness and premature deaths costing the global economy about 500 billion dollars in loss per year representing up to 1.5% of the gross domestic product of individual countries and up to 15% of all national health expenditures (Picon-Riviere et al., 2020). 8.2% and 11 % of Zambians in urban and rural areas smoke with the majority being males (Muyinza et al., 2020; Nyirenda et al., 2019). Workplaces provide organisations with a tremendous opportunity to reduce global smoking levels in that non-smoking workplaces do improve companies' bottom line by avoiding productivity losses due to employees taking smoking breaks and absences due to sickness hence reducing health care costs. One instrument that has the potential to be used in measuring smoking behaviours in the workplace is the decision balance inventory for smoking.

The original 24-item Decision balance Inventory (DBI) for smoking was developed by Velicer et al. (1985) and measures adolescents' opinions concerning the costs and benefits of engaging in smoking behaviour (Khazaee-Pool et al., 2017). Pallonen et al. (1998) later developed the 12-item short form of the DBI with three factors namely negative thoughts or cons of smoking (6 items), positive social thoughts or social pros (3 items) as well as coping pros (3 items) measured on a five-point Likert scale. Validation studies have proven that the short-form DBI has overall good psychometrics. Properties. In Khazaee-Pool et al. (2017), a .92 Cronbach alpha coefficient was recorded with good construct validity established. Models and theories of the decision balance for smoking were developed and operationalized for the North American and Western European cultures. In-depth investigation of the construct in the African context specifically Zambia has been less visible in psychology literature. Managing employee's health requires conceptualizing, organizing and assessing the decision-balance construct in the Zambian context. However, to the researcher's knowledge, no validation study has been done in Zambia concerning the decision balance inventory.

Objectives:

The broad objective of this study was therefore twofold: Firstly, to explicate the constitutive definition of the decision balance smoking construct, and, secondly to psychometrically evaluate the reliability of the measures and the validity of the construct-referenced inferences derived from the DBI. From this broad research objective, more specific operational research objectives were derived for this study:

i. To explicate the constitutive definition of the decision balance smoking construct that clarifies the connotative meaning of the construct;
ii. To evaluate the reliability of the dimension scores of the DBI; and
iii. To evaluate the construct validity of the DBQ by evaluating the fit of the measurement model implied by the design architecture of the instrument and the

constitutive definition of the construct.

Hypotheses:

The construct-referenced inferences on Zambian employees standing on the three-dimensional construct, derived from the DBI, could be considered valid (i.e. permissible) if:

i. The measurement model reflecting the design intention on how the DBI items should reflect the three latent dimensions of the DBI construct shows a close (or at least reasonable) fit;
ii. The unstandardized factor loadings λij are statistically significant ($p < .05$);
iii. The completely standardized factor loadings are large (λij .50);
iv. The unstandardized measurement error variances θδiii are statistically significant ($p < .05$);
v. The completely standardized measurement error variances are small (θδii .75);
vi. The inter-latent decision balance inventory dimensions correlate Φkj statistically significantly ($p < .05$) but are low with each other.

Literature Review:

In health psychology, the Trans theoretical model forms the basis of the decision balance inventory as it relates to smoking cessation. The decision balance is an instrument used to measure the propensity to maintain or change one's smoking habit by considering the perceived advantages (pros) and disadvantages (Cons) of the behaviour shift as in the trans theoretical model (Lim et al.,2022). The Trans theoretical model is a behavioural modification model which posits that the process of health behaviour change can be conceptualized as movement through five stages of change in which individuals weigh the pros and cons of the behaviour shift so that the pros of the behaviour change gain in importance while the cons diminish (Hoeppner et al., 2012). The Trans theoretical model assesses an individual's willingness to engage in a new and better behaviour by guiding the individual through five stages: stages of change, process of change, decision balance, self-efficacy and temptation that describe the willingness to change (Lim et al., 2022). The stages of change explain an individual's thoughts regarding changing behaviours in this case smoking. The process of change explains the methods used by the individual while changing behaviours. Self-efficacy explains the confidence of an individual regarding how long one will bear against the desire for smoking while decision balance explains the advantages and disadvantages of changing to the target behaviour (Zadeh et al., 2015). Smoking cessation is also associated with the struggle model when making decisions related to smoking but is also connected to the decision balance construct.

The original instrument had two factors with good reliability and construct validity as reported in Chen et al. (2006), Spencer et al. (2002) Velicer (1985) and Zadeh et al. (2015). In the latter study model fit was obtained with a RMSEA of 0.000 and goodness of fit indices above 0.90. The two scales obtained Cronbach alpha coefficients of 0.92 and 0.69. In Elliot et al. (2011) the pros scale had a Cronbach coefficient of .91 while the cons had a Cronbach alpha value of .93. In Prochaska et al. (1994) the pro scale had a Cronbach alpha value of 0.87 while the cons sub subscale had a value of 0.90. In Velicer et al. (1985) the two-factor model accounted for only 41% of the observed variance while the two-factor model in Chen et al.(2006) accounted for 74.5% of the variance. Later Pallonen et al. (1998) developed a three-factor short-form decision balance

measure that only accounted for 50% of the variance. In Lim et al. (2022) the three sub-scales of the decision balance inventory had acceptable Cronbach alphas of .867 (smoking con), 0.754 (social pro) and 0.753 (coping pro). Good model fit was obtained with an RMSEA value of 0.08 with goodness of fit indices exceeding .90. The three-factor model in this study accounts for about 65.4% of the variance. In Khazaee-Pool et al. (2017), an overall 0.92 Cronbach alpha value was obtained with the three-factor model accounting for 55.4%. All factor loadings were adequate all above .50. In Hoeppner et al. (2012) a four-factor solution was found namely two pro factors and two con factors with 45% of variance explained. Good model fit was obtained with SRMR < 0.08 and incremental model fit (CFI > 0.95).

Methodology:

To test the substantive research hypothesis a survey design through structural equation modelling was used. The research hypothesis was evaluated using a sample of 201 employees from the energy sector using a non-probability sampling method specifically convenient sampling. 250 questionnaires were distributed with 205 returned. The sample was comprised of males (42.29%) and females (49.25.0%) with levels of qualification distributed as follows: certificate (9.95 %), diploma (26.87%), bachelor degree (42.79%), master's degree (10.5%), PHD (1.99%) and others (7.96%). The short-form decision balance inventory for smoking was used to collect data. The instrument has 12 items with three sub-scales namely cons (6 items), social pros (3 items) and cop pros (3 items). Ethical clearance for this research study was sought from the research ethics committee of Mulungushi University as a way of mitigating any potential ethical risks relating to the research. Informed consent was sought from research respondents. Confidentiality and anonymity were guaranteed with the purpose of the study explained to participants.

Result and Discussion:

In this study, the problem of missing values was dealt with using the multiple imputation method. According to Raghunatha & Schafer as cited in Dunbar-Isaacson (2006) multiple imputation conducts several imputations for each missing value with each imputation creating a completed data set which could be analyzed separately to obtain multiple estimates of the parameters of the model. Item analysis, exploratory factor analysis and confirmatory factor analysis were used to evaluate the success with which the indicator variables comprising the DBI represent the smoking construct. The statistical package of the Social Sciences (SPSS 26,0) was used to assess the internal consistency between items in the measuring instrument using the Cronbach alpha coefficients (α) $\geq$ .70 (Pallant, 2010). Exploratory factor analysis (EFA) was used to examine the uni-dimensionality assumption about the DBI subscales. The principal-axis factoring extraction method with the direct oblimin-rotated solution was used in SPSS 26.0. In this study, the cut-off point for substantial factor loadings was loadings $\geq$ 0.40 (Hinkin, 1998). Measurement model fit was evaluated using several goodness fit indices root mean square error of approximation (RMSEA), root mean squared residual (RMR), standardized root mean square residual (SRMR) goodness_of-fit index (GFI), adjusted GFI, normed fit index (NFI), non-normed Fit Index (NNFI), comparative fit index (CFI), incremental fit index (IFI), and relative fit index (RFI) as suggested in Bollen (1989).

Missing Values: The use of multiple imputations in treating missing values resulted in an effective sample size of 201.

Table 1: Reliability Coefficients of the Measurement Scales

Scale	No. of items	Cronbach alpha
Cons	6	.826
Pro Soc	2	.753
Cop Pro	3	.826

Reliability Analysis: Results for item analysis for the three sub-scales are shown in Table 1. Reliability coefficients for all three scales can generally be considered to be satisfactory. The cons and the pro subscales obtained Cronbach alpha's of .826 respectively. The reliability coefficient of .559 for the pro-soc sub-scale was below the threshold of .70 and weaker than reported by Khazaee-Pool et al. (2017). The results of this scale are noted as a limitation of this study. One problematic item in this sub-scale was flagged and consequently deleted. This action led to an increase in Cronbach alpha to .753.

Exploratory Factor Analysis: Exploratory factor analysis for all three sub-scales suggests a three-factor structure for the DBI. All three sub-scales were found to be uni-dimensional. All the items comprising the three sub-scales reflected a single underlying factor in each sub-scale. All factor loadings were acceptable (>.50) with variance explained for each factor satisfactory (> 40%). All KMO values were bigger than .60 meaning that the correlational matrix is deemed factor analyzable.

Table 2: Exploratory Factor Analysis Output

Dimension	No. of Items	Factor Loadings	% Variance
Cons	6	.566 -.729	45.178
Pro Soc	2	.750 - .805	41.118
Cop-Pro	3	.613 - .905	63.991

Multivariate Normality: In this study robust maximum likelihood (RML) estimation method was used to normalize the data (Mels, 2003).

Confirmatory Factor Analysis Results: Goodness of fit statistics for the measurement model are presented in Table 3. An RMSEA value of .0683 means that the model achieved a reasonable fit. All goodness fit indices of CFI (0.959), NFI (0.920), NNFI (0.945) IFI (0.960) and GFI (0.920) are above .90 which is an indication of a good fit. Although the RFI and SRMR values are somewhat below the cutoff yet when one considers the whole array of goodness of fit indices the DBI measurement model achieved an acceptable fit.

Table 3: Goodness of fit Statistics for the DBI measurement Model

Model	RMSEA	Close Fit	SRMR	GFI	CFI	NFI	NNFI	IFI	RFI
Value	.0683	0.0886	0.0660	0.920	0.959	0.920	0.945	0.960	0.893

DBI Measurement Model Factor Loadings: The completely standardized factor loadings for the DBI items as shown in Table 4 are generally satisfactorily large >.50 (Hair, Black, Babin, & Anderson, 2010) except for one item DBI 12 whose value (0.454) had a relatively low loading on its hypothesized latent factor.

Table 4: Completely Standardized Lambda-X Factor Loading Matrix of the DBI measurement model

DBI Item	DBI Value
DBI 6	0.572
DBI 9	0.582
DBI 3	0.735
DBI 11	0.765
DBI 10	0.685
DBI 12	0.454
DBI 14	0.618
DBI 17	0.994
DBI 15	0.629
DBI 12	0.855
DBI 18	0.898

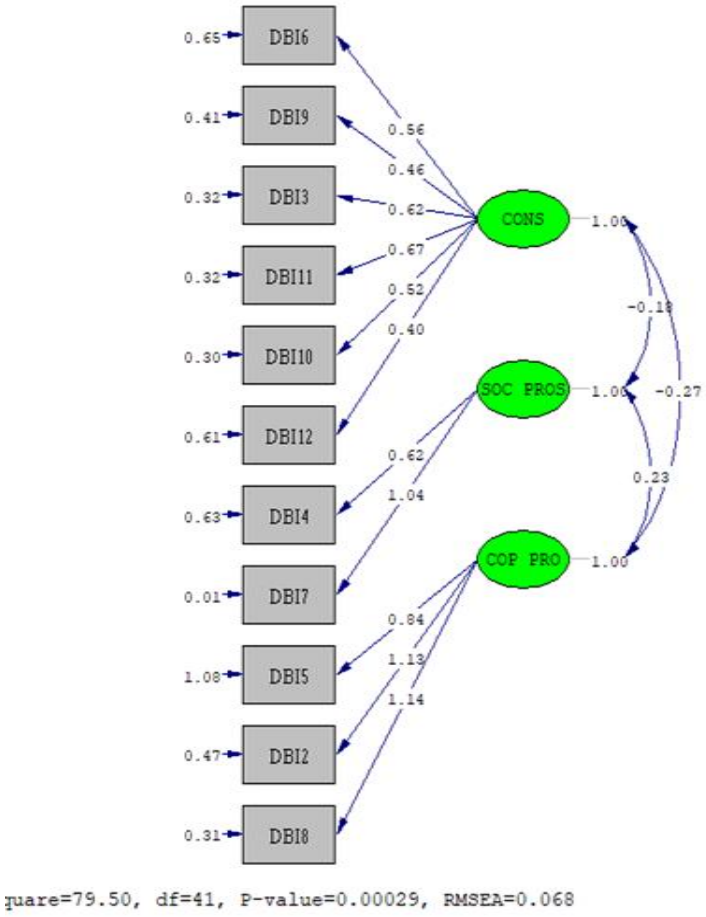

Figure 1: Path Diagram of the Fitted Tri-factor DBI Measurement Model (completely standardized solution)

The completely standardized measurement error variances of the DBI items are shown in Table 5. All the measurement error variances are satisfactorily small (≤ .75) except for item DBI

12 (0.793).

Table 5: Completely standardized measurement error variances

DBI 6	DBI 9	DBI 3	DBI11	DBI10	DBI12	DBI4	DBI7	DBI5	DBI2	DBI8
0.673	0.661	0.460	0.414	0.531	0.793	0.618	0.012	0.605	0.269	0.193

The squared multiple correlations (R2) of the indicators depict the extent to which the measurement model is adequately represented by the observed variables (Byrne, 1998). Table 6 reveals that 5 items had above-average correlations (> .50) except for 6 items.

Table 6 –Squared multiple correlations for the items of the DBI

DBI 6	DBI 9	DBI 3	DBI11	DBI10	DBI12	DBI4	DBI7	DBI5	DBI2	DBI8
0.327	0.339	0.540	0.586	0.469	0.207	0.382	0.988	0.395	0.731	0.807

In terms of the dissected overarching substantive research hypothesis, the DBI did in a limited way meet this evidentiary burden. Some measurement error variances θδii were statistically significant ($p < .05$) while the unstandardized factor loadings were all insignificant ($p > .05$).

Discriminant Validity: According to Chikampa (2013) excessively high correlations between the latent variables in the phi matrix are in itself very strong evidence of lack of discriminant validity. The phi matrix of the DBI model revealed moderately low correlations (between -0.183 and 0.228) between the three DBI dimensions. Discriminant validity did not present a problem. More sophisticated analyses of the discriminant validity with which the DBI measures the three latent dimensions were not considered necessarily.

Table 7: Inter latent decision balance inventory dimension correlations

	CONS	PRO SOC	COP PRO
CONS	1,00		
PRO SOC	-0.183	1.00	
COP PRO	-0.272	0.228	1.00

This study aimed to investigate the tri-factor structure model of the DBI on a Zambian sample. The DBI tri-factor (cons,pro-soc & cop pro) had acceptable Cronbach's alpha coefficients (α) all above 0.70. These results are consistent with those obtained by Lim et al. (2022), Zadeh et al. (2015), Prochaska (1994) Elliot (2011) and Hoeppner et al. (2012). One problematic item was flagged out these results indicate that the DBI is a dependable measure of smoking in the Zambian context. One problematic item was flagged out leaving the instrument with 11 items. This is one limitation of the study.

Exploratory factor analysis findings were generally satisfactory with a three-factor solution obtained. The model accounts for between 41 to 64% of variance which is consistent with other studies such as in Khazaee-Pool et al. (2017) and Lim et al. (2022). In terms of construct validity, an array of fit statistics indicates an acceptable fit for the DBI measurement model. All the completely standardized factor loadings were adequate except for one item. Similar results were obtained by Khazaee-Pool et al. (2017) as well as Lim (2022).

Model fit was obtained with an RMSEA value of .0683 with good fit statistics above .90.

This is in line with results obtained in other studies such as Zadeh et al. (2015) and Hoeppner et al. (2012) Except for one item all the completely standardized measurement variances met the benchmark of ≤ .75. Discriminant validity was established. However, some items were noisy in terms of the unstandardized factor loadings (p >.05) as well as unstandardized measurement error variances (p>.05). Some items in the Squared multiple correlations had below-average correlations (< .50). Due to limitations noted above human resource practitioners ought to use this instrument with caution.

Conclusion:

The tri-factor structure of the DBI was assessed using confirmatory factor analysis. From the theoretical and managerial perspective, several important implications can be drawn from the results of this study. Theoretically, results of the DBI on the Zambian sample have proved that the instrument has good psychometric properties that warrant its usage in Zambia though in a limited way. The availability of a reliable and validated measuring tool such as the DBI will hasten studies on smoking and prevention in Zambia. A validated DBI instrument can help Zambian managers at workplaces when it comes to strategic human resource management through selection, performance management and health and safety policies. With limitations noted above it is recommended that further validation studies can be done using bigger samples since the instrument was noisy due to a smaller sample size.

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