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Metric properties of the translation and adaptation to English of the IMFYU scale for measuring the functionality and usability of commercial software

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***Abstract*– The global pandemic caused by the emergence of the COVID-19 virus prompted governments to take stringent measures to protect citizens. One widely declared measure was a social or legal lockdown, which resulted in long periods of quarantine and the migration of activities to the virtual environment where possible. Many companies began to use different software for the first time, for example commercial software. In Peru, a scale that measures the functionality and usability of commercial software already existed, but it was in Spanish and published in a local open access journal. In this study, the original instrument was taken, translated into English and applied to a sample of 30 subjects to measure its metric properties for future analysis. The results of validity, reliability, model fit and confirmatory factor analysis showed that the instrument is suitable for application. We recommend to other researchers to use it in other contexts in order to obtain relevant data that allows discussion and refinement of the instruments.**

***Keywords*— Software, measurement of instrument, scale, virtual environment.**

I. Introduction

The health crisis generated by the novel coronavirus has motivated companies worldwide to completely renew themselves, emphasizing the technological area so that virtuality is used as the priority attention channel, avoiding the mobilization of people and physical contact as much as possible [1]–[5].

The economic reactivation is gradually generated thanks to companies that operate in what is considered “the new normality”, many of them considered essential for humanity, while others operate thanks to authorizations granted by the government [1], [6]–[10].

However, companies that restart operations find themselves having to adopt security measures in order to protect not only their employees, but also their customers through the use of technology. In the case of business operations, the use of software is a necessity [11]–[13].

Commercial software plays a vital role in the modern digital economy, and its importance can be seen in several areas:

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a) Business productivity: Commercial software is used by businesses of all sizes to improve productivity and streamline operations. From accounting software to customer relationship management systems, commercial software can help businesses operate more efficiently and effectively.
b) Innovation: Commercial software is often at the forefront of technological innovation, providing new tools and capabilities that allow users to accomplish tasks that were previously impossible or impractical.
c) Job creation: The commercial software industry is a major employer, creating jobs in areas such as software development, marketing, sales, and customer support.
d) Revenue generation: Commercial software is a significant source of revenue for software developers, who rely on sales of their software to fund ongoing development and research.
e) Social impact: Commercial software can have a significant impact on society, improving healthcare, education, and other critical areas through the development of specialized software tools and platforms.

In Peru, a scale has been developed to measure the functionality and usability of commercial software [14]. However, there is no translation and adaptation to English of this scale, which has motivated researchers to make it available to a wider audience

II. Methodology

The IMFYU scale was used [14], authored by Castillo Diestra and Gutiérrez Gutiérrez in 2018 and based on the recommendations established in the ISO/IEC 9126 standard. The original instrument (in Spanish) consisted of 25 items, with response options of 5 Likert-type alternatives (0 = strongly disagree, 4 = strongly agree) and whose original reliability was 0.8533 according to Cronbach's alpha.

The original instrument was translated in its entirety into English by a professional translator, duly licensed and authorized with a specialty in the English language. The original 25 items of the instrument were inspected, finding that some were intended to be answered in a negative way and others in a positive way. To standardize the responses and to make future statistical processing more agile, items 23 and 24 were intentionally written in a positive way. The scale of responses proposed in the original instrument was respected.

The instrument was submitted to the judgment of 7 experts, whose results of validity were measured by the V. de Aiken coefficient.

It was seen convenient to apply the questionnaire to the totality of users and suppliers of goods and services of a real estate company located in Lima, which recently developed a new commercial software in order to reduce the physical contact during the sanitary emergency originated by the novel coronavirus. The census population was composed of 30 observations, the reliability of the results was calculated and their factor loads were analyzed.

III. RESULTS

Characterization of the sample

The characterization of the sample with respect to the age and sex of the user of the new commercial software is shown in Table I. The sample included mainly male users between 30 and 39 years old.

TABLE I
CHARACTERIZATION OF THE SAMPLE (N=30)

Variable		N	%
Age range (years)			
	20 – 29	5	16.67
	30 – 39	13	43.33
	40 – 49	9	30.00
	50 – 59	3	10.00
Gender			
	Male	22	73.33
	Female	8	26.67

Results of validity

The validity of the instrument was quantified by means of the V. of Aiken, whose results are detailed in Table II and express that the overall Aiken's V. coefficient is 0.97 (0.99 for consistency, 0.97 for relevance, and 0.97 for clarity). These results, being very close to 1.00 denote that the questionnaire is valid and applicable

TABLE II
RESULTS OF VALIDITY

Items	Coherence Aiken's V.	Relevance Aiken's V.	Clarity Aiken's V.	General Aiken's V.
1. - The software meets all requirements.	1.00	1.00	0.86	0.95
2. - The software always did what I was expecting.	1.00	0.71	1.00	0.90
3. - There is internal consistency (uniformity of screens, menus, reports, messages and others).	0.71	1.00	1.00	0.90
4. - The results produced by the software are correct.	1.00	1.00	0.86	0.95
5. - Connects and operates easily with other systems.	1.00	1.00	1.00	1.00
6. - The terms used in the software are standardized.	1.00	1.00	1.00	1.00
7. - The symbols (icons) are standardized.	1.00	1.00	1.00	1.00
8. - There is prevention of unauthorized access to the software and its data.	1.00	1.00	1.00	1.00
9. - Appropriate access controls are in place for software, subsystems, functions and data files.	1.00	1.00	1.00	1.00
10. - The software is easy to learn.	1.00	1.00	1.00	1.00
11. - Software commands are easily learned.	1.00	1.00	1.00	1.00
12. - Software information is presented in a clear and understandable manner.	1.00	1.00	1.00	1.00
13. - The terminology used relates well to the work I do.	1.00	0.71	1.00	0.90
14. - The messages that appear on the screen are clear.	1.00	1.00	1.00	1.00
15. - The organization of the menus or information lists seems quite logical.	1.00	1.00	0.86	0.95
16. - The interfaces or screens represent the objects (icons) similar to those in my work environment.	1.00	1.00	1.00	1.00
17. - The presentation of the software is very attractive.	1.00	1.00	1.00	1.00
18. - Data entry messages are understandable.	1.00	1.00	0.71	0.90
19. - Error prevention messages are adequate.	1.00	1.00	1.00	1.00
20. - The type, size and format of the text is correct.	1.00	1.00	1.00	1.00
21. - Easy to move from one part of a task to another.	1.00	1.00	0.86	0.95
22. - Data entry errors can be easily corrected.	1.00	1.00	1.00	1.00
23. - The tasks in the software are simple and do not contain long steps.	1.00	1.00	1.00	1.00
24. - No need to seek help when using this software.	1.00	1.00	1.00	1.00
25. - The software's help information is very useful.	1.00	0.71	1.00	0.90
Average	0.99	0.97	0.97	0.97

Results of the reliability of the measurement scale

To know the reliability of the measurement scale, it was pertinent to apply Cronbach's alpha test, whose result was 0.890 (see Table III). According to generally accepted standards, this result is considered good. As for the item-to-item correlation matrix, it is shown in Table IV.

TABLE III
CRONBACH'S ALPHA RESULTS

Cronbach's alpha	N of elements
.870	25

TABLE IV
ITEM-TO-ITEM CORRELATION MATRIX

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1																									
2	.688																								
3	.458	.416																							
4	.659	.489	.245																						
5	.648	.484	.260	.589																					
6	.637	.480	.425	.657	.513																				
7	.267	.285	.245	.453	.168	.275																			
8	.463	.515	.376	.395	.355	.193	.264																		
9	.330	.296	.205	.321	.460	.146	.321	.498																	
10	.000	.110	.000	.095	-.114	.062	.380	-.080	.171																
11	-.031	-.051	-.132	.144	-.012	-.003	.247	.347	.286	.584															
12	-.205	.022	.036	-.026	.160	-.175	.230	.108	.248	.155	.235														
13	-.029	.173	.149	.038	.272	-.158	.038	.240	.297	.000	.212	.371													
14	.035	.252	.149	-.139	.208	-.147	-.139	.176	.513	.197	.168	.341	.464												
15	.056	.114	.241	.338	.236	-.018	.225	.475	.466	-.091	.272	.551	.478	.317											
16	.076	.103	.169	.043	.116	-.285	-.065	.364	.338	-.262	-.043	.247	.485	.528	.545										
17	.206	.255	.189	-.012	.256	.055	-.012	.203	.465	.024	.058	.276	.322	.787	.319	.617									
18	.139	.227	.263	.046	.159	.128	.162	.487	.341	.047	.537	.075	.448	.479	.443	.351	.451								
19	.008	-.070	-.077	.248	.205	-.134	.326	.393	.338	.031	.454	.532	.292	.012	.578	.118	.052	.260							
20	.446	.250	.037	.453	.438	.247	.453	.367	.348	.106	.356	.171	.327	.039	.314	.253	.148	.334	.286						
21	.691	.750	.421	.590	.491	.567	.262	.553	.201	.106	.072	.000	.040	.068	.110	.136	.135	.161	-.119	.548					
22	-.015	.048	.364	-.030	.031	.137	.120	.063	.265	.152	.046	-.049	.346	.289	.252	.187	.112	.347	-.094	-.050	-.042				
23	.327	.323	.143	.401	.387	.335	.527	.370	.343	.432	.568	.348	.015	-.037	.120	-.156	-.061	.235	.370	.461	.386	-.092			
24	-.157	-.223	-.091	.035	-.045	-.055	.266	.049	.027	.586	.658	.151	.021	.060	.097	.024	-.033	.296	.090	.187	.008	.141	.377		
25	.282	.212	.241	.225	.236	.312	.000	.380	.223	.046	.272	.000	.068	.117	.351	.078	.145	.443	.130	.314	.205	.144	.392	.097	

Model fit summary

Minimum value of the discrepancy (CMIN) is showed in Table V, Root mean square residual (RMSR) and goodness of fit index (GFI) in Table VI, Baseline comparisons in Table VII, Parsimony-Adjusted measures in Table VIII, Noncentrality parameter (NCP) in Table IX, Minimum value F, of the discrepancy F (FMIN) in Table X, Root mean squared error of approximation (RMSEA) in Table XI, Akaike information criterion (AIC) in Table XII, Except for a constant scale factor (ECVI) in Table XIII, and Hoelter's "critical N" in Table XIV. The explanation of each coefficient, as well as the formulas applied for its calculation can be found in Akaike (1973, 1978, 1987) [15]–[17], Bentler, & Bonett (1980) [18], Bollen, & Liang (1988) [19], Browne (1982, 1984) [20], [21], Browne, & Cudeck (1993) [22], Hoelter, (1983) [23], James, Mulaik, & Brett (1982) [24], Jöreskog, & Sörbom (1984) [25], Kullback, & Leibler (1951) [24], Mulaik, James, Van Alstine, Bennett, Lind, & Stilwell (1989) [26], Sobel, & Bohrnstedt (1985) [27], Steiger, & Lind (1980) [28], Tanaka, & Huba (1985) [29], and Tucker, & Lewis (1973) [30].

TABLE V
MINIMUM VALUE OF THE DISCREPANCY (CMIN)

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	50	647.316	275	0.000	2.354
Saturated model	325	0.000	0		
Independence model	25	798.314	300	0.000	2.661

NPAR = number of distinct parameters (q) being estimated; CMIN = minimum value, Ĉ of the discrepancy C; DF = degrees of freedom; P = evidence against a null hypothesis; CMIN/DF = minimum discrepancy Ĉ.

TABLE VI
ROOT MEAN SQUARE RESIDUAL (RMSR) AND GOODNESS OF FIT INDEX (GFI)

Model	RMSR	GFI	AGFI	PGFI
Default model	0.073	0.42	0.315	0.356
Saturated model	0.000	1		
Independence model	0.124	0.312	0.254	0.288

RMSR = root mean square residual; GFI = goodness of fit index; AGFI = adjusted goodness of fit index; PGFI = parsimony goodness of fit index.

TABLE VII
BASELINE COMPARISONS

Model	NFI delta 1	RFI rho 1	IFI delta 2	TLI rho 2	CFI
Default model	0.189	0.115	0.289	0.185	0.253

Saturated model	1.000		1.000		1.000
Independence model	0.000	0.000	0.000	0.000	0.000

NFI = normed fit index; RFI = relative fit index; IFI = incremental fit index; TLI = Tucker-Lewis coefficient; CIF = comparative fit index.

TABLE VIII
PARSIMONY-ADJUSTED MEASURES

Model	PRATIO	PNFI	PCFI
Default model	0.917	0.173	0.232
Saturated model	0.000	0.000	0.000
Independence model	1.000	0.000	0.000

PRATIO = parsimony ratio; PNI = result of applying the parsimony adjustment to the NFI; PCFI = result of applying the parsimony adjustment to the CFI.

TABLE IX
NONCENTRALITY PARAMETER (NCP)

Model	NCP	LO 90	HI 90
Default model	372.316	301.854	450.483
Saturated model	0.000	0.000	0.000
Independence model	498.314	418.346	585.939

NCP = noncentrality parameter; LO 90 = lower boundaries reported in a 90% confidence interval for the population value of several statistics; HI 90 = higher boundaries reported in a 90% confidence interval for the population value of several statistics.

TABLE X
MINIMUM VALUE F, OF THE DISCREPANCY F (FMIN)

Model	FMIN	F 0	LO 90	HI 90
Default model	22.321	12.838	10.409	15.534
Saturated model	0.000	0.000	0.000	0.000
Independence model	27.528	17.183	14.426	20.205

FMIN = minimum value F, of the discrepancy F; F 0 = estimate of F_0; LO 90 = lower boundaries reported in a 90% confidence interval for the population value of several statistics; HI 90 = higher boundaries reported in a 90% confidence interval for the population value of several statistics.

TABLE XI
ROOT MEAN SQUARED ERROR OF APPROXIMATION (RMSEA)

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	0.216	0.195	0.238	0.000
Independence model	0.239	0.219	0.260	0.000

RMSEA = root mean squared error of approximation; LO 90 = lower boundaries reported in a 90% confidence interval for the population value of several statistics; HI 90 = higher boundaries reported in a 90% confidence interval for the population value of several statistics; PCLOSE = a "p value" for testing the null hypothesis that the population RMSEA is no greater than 0.05.

TABLE XII
AKAIKE INFORMATION CRITERION (AIC)

Model	AIC	BCC	BIC	CAIC
Default model	747.316	1613.983	817.376	867.376
Saturated model	650.000	6283.333	1105.389	1430.389
Independence model	848.314	1281.647	883.344	908.344

AIC = Akaike information criterion; BBC = Browne-Cudeck criterion; BIC = Bayes information criterion; CAIC = consistent AIC.

TABLE XIII
EXCEPT FOR A CONSTANT SCALE FACTOR (ECVI)

Model	ECVI	LO 90	HI 90	MECVI
Default model	25.770	23.340	28.465	55.655
Saturated model	22.414	22.414	22.414	216.667
Independence model	29.252	26.495	32.274	44.195

ECVI = except for a constant scale factor; LO 90 = lower boundaries reported in a 90% confidence interval for the population value of several statistics; HI 90 = higher boundaries reported in a 90% confidence interval for the population value of several statistics; MECVI = except for a scale factor.

TABLE XIX
HOELTER'S "CRITICAL N".

Model	HOELTER 0.5	HOELTER 0.1
Default model	15	15
Independence model	13	14

HOELTER = the largest sample size for which one would accept the hypothesis that a model is correct.

Factorial confirmatory analysis (FCA) diagram

The diagram for FCA was constructed, it shows all factor loads of the model. This can be seen in Fig. 1

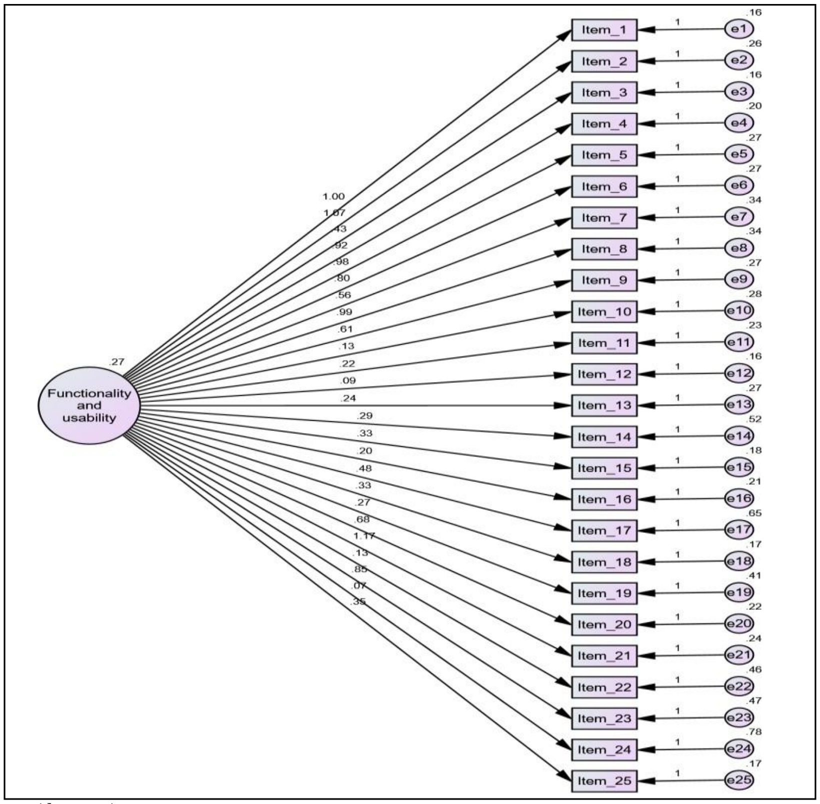

Fig. 1 Factorial confirmatory analysis (diagram).

IV. Final Conclusions and Recommendations

The IMFYU scale, which measures the functionality and usability of commercial software, was adapted and translated into English. Its advantages include:

a) Access to a wider audience: English is a universal language and widely spoken and understood around the world. By translating measurement scales into English, it becomes accessible to a larger audience, which increases the scope of the study.

b) Standardization: Translation of measurement scales into English is essential for standardization purposes. By using a standard language, it ensures that the measurement scales are consistent across different regions and cultures.

c) Reliability and Validity: The translation and adaptation process of measurement scales into English ensures that the measurement scales are reliable and valid. Translators and adaptors take into account the cultural and linguistic differences that may affect the validity of the measurement scales.

d) Comparability: Translation and adaptation of measurement scales into English facilitate the comparability of results across studies. It allows researchers to compare their findings with other studies that have used the same or similar measurement scales.

The instrument developed demonstrates good items of validity and reliability, in addition to powerful factor loads.

We recommend to other researchers to use it in other contexts in order to obtain relevant data that allows discussion and refinement of the instrument.

We plan to expand the sample in the future in order to make more precise measurements for this instrument. Similarly, a large sample could allow us to separate it by sector (e.g. industrial, commercial, services) and contrast results.

Finally, the translation of other instruments that also measure the functionality and usability of commercial software is in the pipeline. This will allow the international audience to have more than one alternative to measure this phenomenon.

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