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A Psychometric Process to Develop and Validate a Scale to Measure Attitude towards aAQUA e-Agriservice

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ABSTRACT

Attitude is increasingly being recognised as an important aspect to identify ones preference towards particular thing. The present study has undertaken to evaluate the psychometric properties of a scale developed to measure attitude. The specific development and validation processes used were: item analysis, content and face validity, construct validity using factor analysis, reliability and internal consistency using test-retest reliability and Cronbach's alpha correlation coefficient. The exploratory factor analysis revealed four factors: pessimistic, utility, technical and efficacy perspective. The items on the Attitude Scale (AS) revealed factor loading ≥0.5. Reliability processes indicated that the AS is reliable: Cronbach's alpha o.91 for the overall AS and between 0.77 - 0.90 for the four sub-scales and test-retest revealed stability of the responses. The reliability measure has shown the internal consistency between the items of the scale. The final scale consists of 22 items and the psychometric indicated that it is valid and reliable.

Key words: aAQUA e-Agriservice; Attitude scale; ICT; Reliability; Validity

INTRODUCTION

Agricultural extension has been recognized as an essential mechanism for delivering knowledge (information) and advices to the farming community. Present day agriculture and Indian farming community are facing a multitude of problems to maximize crop and livestock productivity. Despite different approaches and successful technological application, the majority of farmers is not getting basic services due to several reasons. One of them is the lack of getting timely information (Saravanan, 2010). For this, extension agency plays a major role in bridging this gap, to make available the latest technologies at the door step of the farmers. With advent of modern communication tools such as ICTs, are being acts as catalyzing agent to bridge this gap (Sulaiman, 2012). Presently, various forces are at work to change the scenario of the agricultural extension research system from the traditional approaches to the process of technology transfer via modern approaches for facilitating a wide range of demand driven, pluralistic and decentralized extension. Therefore, it is vital to harness ICTs potential to improve farming community.

Attitude is increasingly being recognised as an important aspect of the ones personality. It is an organized predisposition to think, feel, perceive and behave towards a cognitive object. There was no scale available to measure farmers' attitude towards ICTs based e-Agriservice. Therefore, the present study was contemplated to develop and standardize a scale for measuring the dairy farmers' attitude towards the ICT based e-Agriservice, which can contribute to inform scientific and policy discussions on ICT based extension delivery system.

The current study reported the processes used to develop and validate a scale that focuses on the features of the aAQUA e-Agriservice to be used by the dairy farmers of the Maharashtra state. For the purpose of the study attitude was operationalized as the degree of positive or negative feeling of users towards the aAQUA e-Agriservice.

METHODOLOGY

Sampling

The study was conducted in the Maharashtra State, India. The aAQUA e-Agriservice (https://aaqua.persistent.co.in/aaqua/forum/index) was launched as a pilot project in the State in 2003 and still continues to deliver its services to the farmers. Out of eight pilot districts, four districts (Pune, Nasik, Jalna and Amravati) were selected randomly for the present study. The list of

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aAQUA e-Agriservice users was obtained from the service provider of aAQUA (Agrocom Software Technologies Pvt. Ltd., Mumbai). Thirty users' form each district was randomly selected from the list and interviewed personally using the structured interview schedule. Thus, the data were collected from a total of 120 respondents for the purpose and subsequent analysis.

Development of the Attitude Scale (AS)

The items of AS used to measure the attitude of dairy farmers towards aAQUA e-Agriservice were developed based upon literature review, discussions with the extension professionals, ICT experts as well as on the author's own experience and knowledge on the basis of criteria given by Edwards (1957). These items were further assessed and modified based on the summated rating scaling technique as suggested by Likert (1932). It represents the multiple aspects of a concept in a single measure (Hair *et al.,* 2006). The initial draft of the AS contained 55 items was assessed through item analysis.

Item Analysis: It is an initial check while constructing valid and reliable scale. It examines the appropriateness of the scale. The judges were asked to indicate their degree of agreement or disagreement on each statement with three point continuums 'Agree', 'Uncertain' and 'Disagree' with scoring 3, 2, and 1, respectively for positive statements and vice-versa for negative statements. The total individual score of the judges was calculated by summing up the response score of each statement given by individual judges.

Calculation of 't' values: Based upon the total individual scores, the judges were arranged in descending order. The top 25 per cent of judges with their total individual scores were considered as high group and the bottom 25 per cent as the low group so that these two groups provided criterion groups in terms of which to evaluate the individual statements.

Thus, out of 40 judges to whom the statements were administered for the item analysis, 10 judges from, each with highest and lowest scores were used to evaluate the individual statement. The critical ratio, that is the 't' value which is a measure of the extent to which a given statement differentiates between the high and low groups of the respondents for each statement was calculated by using the formula given by Edwards (1957).

$$t = \frac{\bar{X}_H - \bar{X}_L}{\sqrt{\frac{\Sigma(X_H - \bar{X}_H)^2 + \Sigma(X_L - \bar{X}_L)^2}{n\,(n-1)}}}$$

$$\sum (X_H - \bar{X}_H)^2 = \sum X_H{}^2 - \frac{(\Sigma X_H)^2}{n}$$

$$\sum (X_L - \bar{X}_L)^2 = \sum X_L{}^2 - \frac{(\Sigma X_L)^2}{n}$$

$\bar{X}_H$ = The mean score on a given statement for the high group

$\bar{X}_L$ = The mean score on a given statement for the low group

$\sum X_H{}^2$ = Sum of squares of the individual score on a given statement for high group

$\sum X_L{}^2$ = Sum of squares of the individual score on a given statement for low group

$\sum X_H$ = Summation of scores on given statement for high group

$\sum X_L$ = Summation of scores on given statement for low group

n = Number of judges in low and high groups

Validation of the Attitude Scale (AS)

2.2 Translational validity

2.2.1 Content validity

It aims to ascertain appropriateness and relevancy of the content by covering all the attributes under study and is usually undertaken by seven or more experts (Pilot & Hunger 1999; DeVon *et al.* 2007). The content validity of the AS estimated based on clearly defined the conceptual framework of attitude by undertaking a thorough literature review and seeking expert opinion and the results of the item analysis. Experts were asked to review the draft of 22 items AS to ensure consistency with the conceptual framework. Each experts independently rated the relevance of each item on the AS to the conceptual framework using a 3-point Likert scale (1=not relevant, 2= relevant, 3= most relevant). The Content Validity Index (CVI) was used to estimate the validity of the items (Lynn 1996).

2.2.2 Face validity

Face validity indicates the instrument appears to be suitable to the study purpose and content area. It is the easiest validation process to undertake, but it is the weakest form of validity. It evaluates the appearance of the scale in terms of feasibility, readability, consistency of style and formatting, and the clarity of the language used (Haladyna 1999; Trochim 2001; DeVon *et al.* 2007). Thus, face validity is a form of usability rather than reliability. Face validity of the AS was determine by administering scale to the twenty users, randomly selected from non-sampling population by following Likert scale of 1-3 (disagree= 1, agree= 2, strongly agree= 3).

2.3 Construct validity

Construct validity refers to the degree to which the

items on an instrument relate to the relevant theoretical construct (Kane 2001; DeVon *et al.* 2007). It is a quantitative value rather than a qualitative distinction between 'valid' and 'invalid'. It refers to the degree to which the intended independent variable (construct) relates to the proxy independent variable (indicator) (Hunter & Schmidt 1990). For example, in the AS, pessimistic and utility perspective was used as proxy indicators of attitude. When an indicator consists of multiple items, factor analysis is used to determine construct validity. The sampling population for factor analysis was (n=120) user dairy farmers from the four districts in Maharashtra.

2.3.1 Factor analysis

Factor analysis is a technique for identifying groups or clusters of variables towards any object (Field, 2005). These clusters of variables called as a factor, interpret according to the items having a high loading on it, and summarize the items into a small number of factors (Bryman & Cramer 1999). Loading refers to the measure of association between an item and a factor (Bryman & Cramer 2005).

Prior to performing factor analysis, test of sample adequacy was done through Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity. The KMO test is the measure of sampling adequacy, which varies between 0 and 1. The values closer to 1 are better and will yield distinct and reliable factors (Field 2005). Kaiser (1974) recommended accepting values $\geq$ 0.5 and described values between 0.5 - 0.7 as mediocre; 0.7 - 0.8 as good, 0.8 - 0.9 as great, and > 0.9 as superb. Further Bartlett's test of sphericity confirms the adequacy of the sample population by testing the null hypothesis that the variables in the population correlation matrix are uncorrelated and inadequate.

Principal Component Analysis (PCA) was used to undertake factor analysis as it analyzes all the variations of a variable (total variance) and assumed to be perfectly reliable and without error. The eigenvalue and scree plot technique was used to determine how many factors should be retained (Bryman and Cramer, 2005). The general criterion of an eigenvalue $\geq$ 1.00 could misrepresent the most appropriate number of factors (Gorsuch 1983; Heppner et al., 2006). A Scree Plot to depict the descending variances that account for the factors extracted in graph form. The factors that lie before the point at which eigenvalues begin to drop can be retained. Further to depict clearly the group of items into particular factor, varimax orthogonal rotation was undertaken to rotate the factors to maximize the loading on each item and minimize the loading on other factors (Field 2005; Bryman & Cramer 2005).

2.4 Reliability

Reliability refers to the ability of a scale to consistently measure an attribute and how well the items fit together, conceptually (Haladyna 1999; DeVon *et al.* 2007). Although reliability is necessary, is not sufficient to validate an instrument, because an instrument may be reliable but not valid (Beanland *et al.* 1999; Pilot & Hunger 1999, DeVon *et al.* 2007). The standard error of the instrument, independence of sampling, heterogeneity of content, and how the instrument is used are some measure suggested by Cronbach & Shavelson (2004) while determining reliability. In the present study it was estimated using internal consistency and test-retest method.

2.4.1 Internal Consistency Reliability

Internal consistency examines the inter-item correlations within an instrument and indicates how well the items fit together conceptually (Nunnally & Bernstein 1994; DeVon *et al.* 2007). In addition, a total score of all the items is computed to estimate the consistency of the whole interview schedule. For the purpose, Cronbach's alpha coefficient of reliability test was used, as it is widely used as an index of reliability and frequently reported in social and behavioural studies (Sijtsma, 2009; Cronbach, 2004; Zumbo & Rupp, 2004). It is equivalent to the average of the all possible split-half estimates and is the most frequently used reliability statistic to establish internal consistency reliability (Trochim 2001; DeVon *et al.* 2007). Thus, final set of the 22 statements was administered on five point continuum to a group of 40 users of the aAQUA e-Agriservice from non-sample area of the study. The total individual score of each user was calculated by summing up the responses given to all the statements and total item variance was calculated by summing up of all users' responses to the particular item. The Cronbach's alpha coefficient of reliability was measured with the following formula:

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{K} \sigma^2 y_i}{\sigma^2 x}\right)$$

α = Cronbach alpha reliability coefficient
K = Number of items
$\sigma^2 y_i$ = The variance of item i for the current sample of persons
$\sigma^2 x$ = The variance of the observed total test scores

2.4.2 Test-Retest Reliability

Test-retest reliability is computed by administering

the instrument to the same set of respondents on two different occasions, with the assumption that there will be no significant change in the construct under study between the two time slots (Trochim 2001; DeVon *et al.* 2007). A high correlation between the two scores at the different time interval indicates the instrument is stable over the period of time (Haladyna 1999; DeVon *et al.* 2007). In the study, Test-retest reliability of the AS was undertaken by administrating the schedule to 20 users of aAQUA, randomly selected from a non-sampling populations. The first set of response was taken during baseline and later on the second response taken over three weeks later. The non-parametric statistical tests were deemed to be more appropriate than Pearson Correlation Coefficient, when responses were taken using an ordinal scale rated from strongly disagree to strongly agree; (Hilton 1996; Wittkowski 2003; Jakobsson 2004). Therefore, the analysis of responses between the test and the retest was conducted using Wilcoxon non-parametric statistical test to determine whether there were any significant differences between the responses at each time point.

RESULTS AND DISCUSSION

Item Analysis

According to the 't' value, a rule of thumb is to reject items with a critical ratio less than 1.75. Higher the 't' value, better the statement in terms of its showing the attitude of the people. The mean score worked out for both the high and low groups. If the two mean scores of a statement are close to each other, it implies that the statement is not able to discriminate well between persons holding different attitudes, and you can safely reject those statements. Retain only those statements where the mean score for the high group and that for the low group are distinct from each other. Out of 54 items, 32 items on the draft AS were deemed to be invalid because they yielded ≤1.75 't' value and were removed from the scale. Thus, 22 (12 positive and 10 negative) items were included in the final scale for subsequent analysis as mentioned in the Table 1.

Table 1: Item analysis and test retest results of the AS using "t" value and Wilcoxon's non-parametric test.

Statements	t value	Asymp. Sig. (P value)
The e-Agriservice empowers me to have control over works.	3.59	0.719
The e-Agriservice improves efficiency of experts and extension workers in reaching a large number of farmers with less effort.	3.21	0.414
It enhances users effectiveness about dairy farming	2.69	0.180
The services provided by the e-Agriservice are not realistic and worthwhile.	2.59	0.348
The e-Agriservice is more of propaganda & less usage for dairy farmers.	2.30	0.458
I could have contacted other source for dairy related queries.	2.30	0.088
The aAQUA e-Agriservice is alternative to the present dairy extension system.	1.80	0.056
The e-Agriservice does not improve the knowledge regarding different aspects of dairy farming.	1.76	0.121
It is not just the agro-advisory service but also develop my capability in dairy farming.	3.64	0.891
The e-Agriservice cannot meet location specific needs of the farmers	3.25	0.016
It provides answers to the farmers' queries within time.	2.47	0.065
Availing the e-Agriservice facility is a time consuming activity.	2.40	0.088
The service provider helps to retain and attract new users with the efficient mobilization of its activities.	2.40	0.234
The internet unavailability obstructs the access and utilization of the e-Agriservice by the farmers.	2.09	0.102
The techno savvy people can benefit more from the aAQUA e-Agriservice.	4.43	0.344
It helps to generate employment opportunities among farming community.	3.28	0.429
The e-Agriservice helps to develop self-reliance among farming community.	3.17	0.414
The aAQUA e-Agriservice should be stopped.	3.15	0.070
It aids to increase income which leads to enhance standard of living	2.68	0.705
The aAQUA e-Agriservice alone would solve the problems of farmers.	2.09	0.304
It is the best means to collect information on market prices of agricultural and non-agricultural products.	1.90	0.180
The weather services provided by the e-Agriservice are satisfactory.	1.76	0.322

Notre: *Negative statements

Translational validity

Content validity

According to the Content Validity Index (CVI), a rating of two or three indicates the content is valid and consistent with the conceptual framework (Lynn 1996). For example, if five of eight content experts rate an item as relevant (2 or 3) the CVI would be 5/8=0.62, which does not meet the 0.87 (7/8) level required, and indicates the item should be dropped (Devon et al., 2007). All the items on the AS were deemed to be valid as they yielded CVIs of 8/10=0.80.

Face validity

All respondents rated each statement at two or three on a Likert scale of 1-3. Eighty nine percent users indicated they understood the statements/ items and observed that it had covered all the aspects of the e-Agriservice.

Factor analysis

To ensure having an appropriate sample size, the Kaiser-Meyer Olkin (KMO) and Bartlett's Test measure of sampling adequacy was used to examine the appropriateness of Factor Analysis.

The approximate of Chi-square was 1767.737 with 231 degrees of freedom, which is significant at 0.01 level of significance. The KMO statistic is greater than 0.60 (0.825). Thus, the data were suitable and supports the factorability of the correlation matrix.

On the first run PCA, the total variance of the draft AS factors was 64.40 per cent, which means at least 50 per cent of the variance could be explained by common factors and is considered to be reasonable (Field, 2005). The communalities of the items on the AS were >0.52. The eigenvalues ≥ 1 were considered for the number of components to be generated.

The eigenvalues associated with each component represent the variance explained by that particular linear component (Field, 2005). A four factor solution with varimax rotation was deemed to be the most statistically and conceptually appropriate to the AS.

Hair *et al.,* (2006) suggested guidelines for appropriate interpretation of the loading values, indicates a factor loading of ±0.3 means the item is of minimal significance, ±0.4 indicates it is more important, and ±0.5 indicates the factor is significant. Steven (2002) also suggested guideline on acceptance of the loading values as per sample size, as for 50 participants is acceptable loading value 0.72, for 100 participants 0.51, and for 200-300 participants 0.29-0.38.

The sample size used in the AS validation process was 120: as a result, 20 items had ≥ 0.5 loading value and only two items, namely “the weather services provided by the e-Agriservice are satisfactory” and “it provides appropriate answers to farmers' queries within a short period of time” had a loading of 0.477 and o.478 respectively. The factor loading result also proved that the response of individual items in relation to others within the same subscale provides good evidence for content validity.

The final PCA of the four-factor solution with 22 items accounted for 64.40 per cent of the total variance. The factor loadings of the final PCA and their factorial weights are shown in Table 2.

Table 2: The results of the final four factor solution of the AS according to the Principal Component Analysis with Varimax rotation and the internal consistency of each factor

Items	Factor 1	Factor 2	Factor 3	Factor 4
Pessimistic Perspectives (α = 0.90)	**Loadings**			
The e-Agriservice facility is a time consuming activity.	.777			
The e-Agriservice is more of propaganda & less usage for dairy farming.	.768			
I could have contacted other sources for dairy related queries.	.755			
The aAQUA e-Agriservice should be stopped	.743			
The e-Agriservice cannot meet location specific needs of the farmers.	.718			
Utility Perspective (α = 0.81)		**Loadings**		
The e-Agriservice helps to develop self-reliance among farming community.		.778		
The e-Agriservice empowers me to have control over farming activities.		.729		
It is the best means to collect information on market prices of agricultural and non-agricultural products.		.654		
It helps to generate employment opportunities among farming community.		.637		
The e-Agriservice improves efficiency of experts and extension workers in reaching a large number of farmers with less effort.		.567		
The weather services provided by the e-Agriservice are satisfactory.		.477		
Technical Perspectives (α = 0.84)			**Loadings**	
The services provided by the e-Agriservice are not realistic and worthwhile.			.800	
The e-Agriservice does not improve the knowledge regarding different aspects of dairy farming.			.720	
The tech-savvy people can benefit more from the aAQUA e-Agriservice.			.681	
It is not just the agro-advisory service but also develop my capability in dairy farming.			.620	
It aids to increase income which leads to enhance standard of living.			.587	
The service provider helps to retain and attract new users with the efficient mobilisation of its activities.			.519	
Efficacy Perspectives (α = 0.77)				**Loadings**
The aAQUA e-Agriservice is an alternative to the present dairy extension system.				.711
The e-Agriservice alone would solve the problems of farmers.				.696
It enhances users’ effectiveness about dairy farming.				.650

The internet unavailability obstructs the accessibility of the e-Agriservice by the farmers.	.511
It provides appropriate answers to farmers' queries within a short period of time.	.478

Reliability

Internal Consistency Reliability

The statistics of respondents were calculated, which includes the mean of users' score (45.80), variance of score (σ^2x) 92.27 and sum of item variance (σ^2y_i) 12.15. The Cronbach's alpha was found to be excellent 0.910, which is very high and indicates strong internal consistency among the 22 items. DeVellis, 1991; DeVon *et al.,* (2007) reported the alpha should be at least 0.70, is acceptable for a new instrument. The alpha computed for each of the four subscales also exceeded the minimum value for a new tool: all subscales were ≥ 0.75, see Table 2.

Test-retest

Twenty users of aAQUA completed the AS in test and retest in four weeks and Wilcoxon Non-parametric Statistical Test showed no significant differences in the p values at the level of 0.05 in the responses to the items between the two tests, except item number 10 (*i.e.* the e-Agriservice cannot meet location specific needs of the farmers) as mentioned in the Table 1. The results specify that the same set of responses was observed at two different time slots, means the instrument is reliable. With the exception of one item of the factor, 'Pessimistic Perspectives' indicate that the users had variation in responses at two different time slots, as e-Agriservice might be failing to meet location specific needs of the few users during the second level of administering the instrument.

The final Attitude Scale

It consists of four subscales

Subscale 1: "Pessimistic Perspective", which accounted for 40.36 per cent of the total variance. This factor includes five items and reflects information about negatively worded features of e-Agriservice to seek their agreement and views. The highest loading items were: "the e-Agriservice facility is a time consuming activity" (factor loading of 0.777), "the e-Agriservice is more of propaganda & less usage for dairy farming" (loading of 0.768) and "I could have contacted other sources for dairy related queries" (loading of 0.755).

Subscale 2: "Utility Perspective" accounted for 10.37 per cent of variance and includes six items with very high factor loadings ranging from 0.778 to 0.477. These items refer to the e-Agriservice unique features and importance in farmers' routine farming activities.

Subscale 3: "Technical Perspective" accounted for 8.25 per cent of the variance and includes six items. It focuses on technical aspects of the e-Agriservice. The item "the services provided by the e-Agriservice are not realistic and worthwhile" had the highest loading, 0.800, followed by "the e-Agriservice does not improve the knowledge regarding different aspects of dairy farming" with a loading of 0.720, and "the tech-savvy people can benefit more from the aAQUA e-Agriservice" (0.681).

Subscale 4: "Efficacy Perspective" accounted for 5.41 per cent of the variance and includes five items. Three items explore the positive aspects of the e-Agriservice: "the aAQUA e-Agriservice is an alternative to the present dairy extension system", "It enhances users' effectiveness about dairy farming" "It provides appropriate answers to farmers' queries within a short period of time" with factor loadings of 0.711 to 0.478. Other two items in factor 4 specifically refers as e-Agriservice could be effective tool along with the existing extension system to reach out farmers in effective and efficient ways and internet unavailability was not a major hindrance to utilize the service and had a loading of 0.696 and 0.478 respectively.

DISCUSSION: In social sciences researches, while measuring psychological construct (in this case, Attitude) the authenticity of research depends on the accuracy of measuring instrument or methods. The results of reliability and validity testing of the Attitude Scale (AS) shown it is an accurate measure of attitude towards the aAQUA e-Agriservice. The processes used to validate the AS were rigorous and appropriate. A thorough literature review followed by discussion with research scholars and ICT professionals facilitates to develop the initial set of items for the purpose of the study. The item analysis as the first level check, extracted the invalid items, in terms of distinguishing favourableness of attitude towards the e-Agriservice and subsequent analysis was done on selected items. The face validity was useful in the operationalization of the interview schedule by users of the e-Agriservice, though it is the lowest form of validity. Content validity was useful in assessing the relevancy of the content of the scale. Factor analysis assessed the theoretical construct of the AS. The internal reliability (alpha) proved the consistency between the items; and test-retest shown stability of the responses to the items on the AS over time. Therefore, the AS could be used in extension management and research, for example, ICT service providers could use it in determining the attitude towards a similar kind of ICT projects. The attitude has

been seen as an important characteristic to understand ones behaviour and preference towards a particular object. Many researchers find it difficult to measure one's attitude, largely because attitude is complex phenomena. This paper reported the psychometric development and validation of the AS to measure attitude towards ICT based projects as per the outlook: pessimistic, utility, technical, and efficacy perspectives; which are applicable to all ICT based projects and its users. However, to strengthen the rigor of tools of data collection for further research, the researchers recommend undertaking of Structured Equation Modelling (SEM) and confirmatory factor analysis in a larger sample with users as well as non-users for generalization of the instrument.

CONCLUSION

The ICT is one of the effective media approaches for agricultural development, especially for agricultural extension. As it is playing significant role in supporting and facilitating demand-driven extension in present Information era. To ensure the efficiency and explore the fullest potential of the ICT, it is vital to know the attitude and preferences of the farming community. The present developed attitude scale is a valid and reliable research tool which can be generalized to a wider population of dairy farmers with any other ICT based projects in the rural India.

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