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MEASURING PERCEIVED HELPFULNESS OF COMPUTERIZED DECISION AID FOR YOUTH

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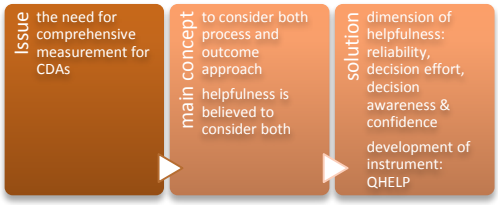
Graphical abstract



Abstract

The nature of a decision aid is to provide assistance to the users. The assistance should be evaluated from two different perspectives, as human decision making models are mostly based on two approaches: process oriented and outcome oriented. Hence, the property of providing useful assistance (i.e., helpfulness) through a decision aid needs to consider both process and outcome factors. This study explores the constructs of measuring helpfulness through a systematic process which result in four dimensions being identified: reliability, decision making effort, decision process awareness, and confidence. A quantitative validation was also reported on measuring perceived helpfulness of a computerized decision aid for youth, known as YouthPDA.

Keywords: Measuring helpfulness, computerized decision aid

Abstrak

Lumrah sesuatu alat bantu keputusan adalan untuk menyediakan bantuan kepada penggunanya. Bantuan tersebut wajar dinilai dari dua perspektif, memandangkan model buat keputusan oleh manusia kebanyakkannya berpandukan dua pendekatan ini; berasaskan proses dan hasil. Oleh itu, aspek menyediakan bantuan yang berguna (i.e. kebolehbantuan) melalui alat bantu keputusan perlu mengambilkira kedua-dua faktor proses dan hasil. Kajian ini meneroka konstruk bagi mengukur kebolehbantuan melalui proses sistematik yang telah mengenalpasti empat dimensi; kebolehsandaran, usaha buat keputusan, kesedaran buat keputusan, dan keyakinan. Satu pengesahan secara kuantitatif turut dilaporkan dalam mengukur persepsi kebolehbantuan alat bantu keputusan berkomputer untuk belia yang dikenali sebagai YouthPDA.

Kata kunci: Kebolehbantuan, alat bantu keputusan berkomputer

1.0 INTRODUCTION

Technology advancement and the elevated lifestyle have witnessed the trend of computerized decision aids (CDA) usage being dominating in my areas. However, the antecedent factors of perceived helpfulness of this tool remain empirical questions in need of rigorous study. There are some salient criteria that can be checked (to certain extent) before an aid is implemented in reality; e.g. whether it is logically sound, implementable and ethically acceptable. Two approaches to evaluation of decision aids - the outcome-oriented approach and the process-oriented approach was discussed in [1].

The former focuses at the consequence of the decision made as a result of the use of a decision aid, whereas the latter concentrates on effects produced by the process itself.

Generally, the focus of either approach is on helping decision maker to make a decision. But, problem will arise when facing with uncertainties issues and when things are far away from being normative (i.e. the way it should be). In terms of decision's outcome, sometime good decision can result in bad outcome. Also, other subjective criteria like the decision maker's satisfaction of the outcome are also doubtful considering the fact that changes in decision maker's actual behavior towards decision making may shade their judgment and beliefs [2]. Then again, the outcome-oriented approach may provide practical index of quality in analyzing the outcome and assessing the related techniques. However, few researchers believed that assessment based on the outcome could be extremely difficult including [1].

On the contrary, in process-oriented approach, the assessments seem to be more realistic and feasible where the focus is on 'what is known when it is made rather than ex post facto' [1]. Among attributes that become the focus of this approach are like the efficiency of the information search, the completeness and logic of all the relevant matters, the decrease in judgmental biases, the awareness raised throughout the process, the clarification of communication or increase in decision maker's self confidence. On another note, process oriented approach also possesses a major drawback in which the evidence that this approach helps to improve people's decision making is only inferred. However, works by [3] could compensate for this drawback, in which the researchers stated that one could also evaluate their decisions based on the process used to reach the decision and claim the decisions as good when they have been achieved through the use of appropriate theoretical based techniques.

Helpfulness could be one of the attributes that consider both evaluation (i.e., process and outcome) approaches of a decision aid. Work by [4] provides verification to the earlier statement as they considered two key elements - decision preferences order (i.e., process) and degree of satisfaction with the aid's solution (i.e., outcome) in attempts to propose appropriate methods to measure helpfulness of CDAs.

2.0 MEASURING HELPFULNESS OF CDA

Generally, decision aids are designed and implemented to accomplish specific objectives. One of the objectives of decision aids is to help decision makers to simplify the cognitively difficult process of solving decision problems. According to [4], in the study of decision aids, help can be categorized into two main aspects - solving the decision problem (which highlight the informative potential of CDA) and making the user of the aid more aware of his/her own decision processes (which also known as consciousness raising approach).

It is also argued in [4] that the presence of intuitive preference order (IPO) plays important role. If such an order is absent, it means that users of the aid rely on the prescribed preference order (PPO). The authors suggest the following:

1. Case 1: If there is no IPO, satisfaction expressed by the user of the aid can be used to measure helpfulness.
2. Case 2: If there is an IPO and divergence between IPO and PPO, helpfulness of the aid is measured based on the change in divergence.
3. Case 3: If there is an IPO and convergence between IPO and PPO, helpfulness of the aid is measured based on the continuum of consciousness rising by using the scaling techniques.

The suggestions imply that the consciousness rising aspect seems to be more important when IPO is available.

Dimensions for measuring helpfulness of consumer reviews as an alternative to support consumer's decision making in online environment were presented in [5]. By using Amazon.com as the case study, the author proposes that helpfulness of reviews constitutes of five essential quality dimensions: (a) topical relevancy, (b) reviewer's reputations in the community, (c) ease of understanding, believability and (d) objectivity. The finding in [5] implies that despite its simple nature, the construct of "helpfulness" can provide meaningful way of analyzing tool for decision making.

3.0 DEFINITION OF HELPFULNESS

In clarifying the term "helpfulness" for evaluation of decision aids, this section elaborates the definition of helpfulness and other related terms. Generally, helpfulness is a perception gained normally from the receiver of a service or assistance. However, this study relates the helpfulness factors with the use of an aid in decision-making. Hence, a clear definition should be formulated.

Merriam-Webster defines helpfulness as a noun, which relates to the experience of using a service or assistance. Synonyms that are constantly used interchangeably with this term are like: useful, conducive and facilitative. Also, WordNet defines helpfulness as the "property of providing useful assistance" and "kindliness/friendliness evidence by a kindly and helpful disposition".

Accordingly, the nature of a decision aid is to provide assistance to the users. In decision aid, the assistance can be evaluated from two different perspectives as human decision making models are mostly based on two approaches; process oriented

and outcome oriented [6]. Hence, the property of providing useful assistance (i.e., helpfulness) through a decision aid needs to consider both process and outcome factors. Elaborated explanation on obtaining the constructs in measuring helpfulness of both factors is provided at length in the next section.

4.0 INSTRUMENT DESIGN: METHODOLOGY

In this study an instrument was developed by considering both outcome and process aspects of decision-making (i.e., perceived helpfulness). Figure 1 summarizes the approach visually.

4.1 Elicitation Works

In this study, four dimensions have been proposed as constructs to measure helpfulness. The proposition of the dimensions was elicited from many previous works of CDA in various fields such as management, education, medicine and personal decisions. A total of 22 previous studies on CDA evaluations were reviewed. The findings are tabulated and summarized in Table 1.

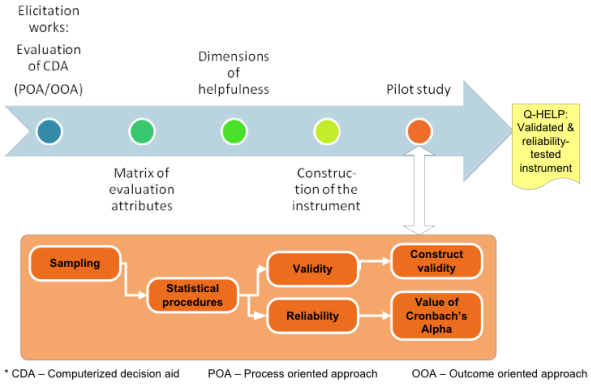


Figure 1 Summary of instrument development

Table 1 Evaluation attributes for various decision support technologies

	Evaluation attributes									
Source	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
[7]							x			
[8]	x					x		x		
[9]				x		x				x
[10]		X		x		x				
[11]	x	x		x		x				
[12]						x				
[13]		x	x							
[14]										x
[15]						x				
[16]								x		
[17]	x						x			
[18]	x			x			x			
[19]	x					x	x			
[20]	x	x					x			
[21]		x		x				x	x	
[4]		x				x			x	
[22]	x	x	x		x		x		x	
[23]		x		x			x			
[24]						x				
[25]		x					x	x		x
[26]					x	x				
[27]	x	x								
TOTAL	**8**	**10**	**2**	**6**	**2**	**10**	**8**	**4**	**3**	**3**

Notes:
A - Reliability/Accuracy/Predictive validity/Perceived benefit
F - Raising awareness/Knowledge acquisition/Understanding problem
B – Mental effort/Perceived cost/Decision time/Decision strategy
G - Confidence in solution or procedure/Motivation/Satisfaction/Affective impact
C - Decision quality
H - Usefulness/Usability/Feasibility
D - Decision effectiveness/Performance perceptions
I - Ease of Use/User Preferences /User-Friendliness
E - Perceived difficulty/decision complexity
J - Persuasiveness/Believability/Reasonableness

As displayed in Table 1, the names of the attributes were overlapped, however, each set of the attribute's names shares common connotation. This study decided to select those attributes with total score more than 40% of total literature reviewed. Hence, attributes A, B, F and G were selected and each was given a new descriptive label that reflects their meaning; reliability (REL), decision making effort (EFF), decision awareness (AWR) and confidence (CON). The selected evaluation attributes are then proposed as the evaluation dimensions which also became the constructs in measuring helpfulness. These constructs were composed as displayed in Figure 2. This study believes that, the all of the dimensions has considered both the process and outcome approaches of CDA's evaluation.

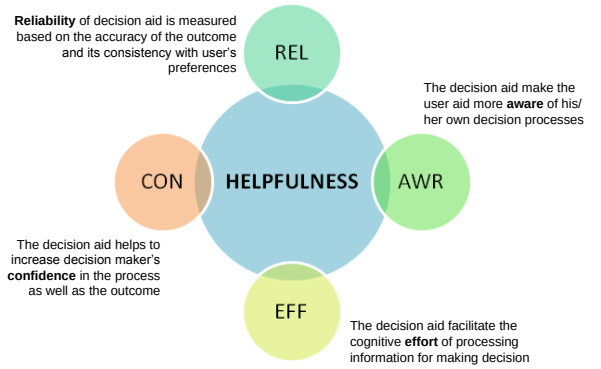


Figure 2 Proposed dimensions for measuring overall helpfulness of CDA

4.2 Construction of the Instrument: Q-HELP

In order to assemble relevant items for each dimension, various existing questionnaires, which measure the same construct, were gathered from previous studies [4, 20, 25, 27, 28]. The items were used for drafting the first version instrument where some of the items are drafted by the researcher without specific reference.

The first draft of the instrument was then validated through expert review for face validity. Face validity is considered as the basic measuring index for content validity. Content validity ensures that the measure includes a sufficient and representative set of items of intended concept [29]. This study manages to engage with three experts in various area; software engineering, human computer interaction and content development. The experts were approached via emails. For the review, each expert was provided with the instrument (in soft copy). In the emails, the experts were briefed about the aspects that they were expected to feed back. From the reviews, the experts found some of the items were not good enough and some did not fit well with the intended construct.

Findings from the review led to some modifications to the first drafted instrument. Modifications included repositioning some of the items, rewording some, and discarding some. The instrument was then named Q-HELP, which contains items related to the four proposed dimensions (i.e., reliability, decision making effort, confidence and decision process awareness) and also the overall helpfulness.

This study measures the users' perceptions on CDA. Hence, scale type measurement is used to quantify these continuous values. Accordingly, each item in Q-HELP was measured on 7-point scale ranging from entirely disagree (denoted by 1) to entirely agree (denoted by 7). The rest of the points are categorised as in Figure 3.

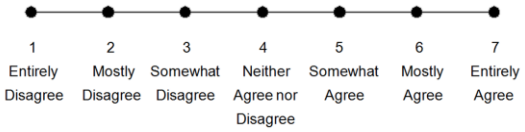


Figure 3 The 7-point Likert-type scale

As mentioned earlier, Q-HELP is partially used as a measure of outcome; hence, scale sensitivity becomes an important concern [30]. Therefore, 7-point scale is more sensitive than a 5-point scale. When concerns with scale reliability, [31] reported that using response options beyond 5 or 7-point do not significantly alter the scale reliability. However, difficulties might arise in generating categorical names as the scales expanded [30]. Hence, based on all the reasons discussed above, this study has decided to use the 7-point Likert-type scale. Next, the Q-HELP instrument was pilot tested to examine its goodness of measures.

4.3 Testing Goodness of Measures: Pilot Study

A pilot study was conducted to be reasonably certain that the instrument does indeed measure the variables it is supposed to (i.e., construct validity), and that it also measure them consistently (i.e., reliability) [29].

For the purpose of the pilot study, Q-HELP was used to measure the helpfulness of a computerized decision aid for career and study among intended sample group of users (i.e. youth community). Convenience sampling was used, in which 154 samples were obtained among students in various undergraduate degree programme at Universiti Utara Malaysia. After validity is assured, the reliability of the measurements must still be considered. Hence, reliability test of the measurement was carried out afterward.

Factor Analysis

In investigating the construct validity of the measure, factor analysis test was conducted. The main aim in running factor analysis test was to verify the

dimensions of the measure that have been operationally defined, as well as indicating which of the items are most suitable for each dimension [29]. The test was run by utilizing Principal Components Analysis extraction method with Varimax Rotation [32].

As rules of thumb, [32] suggest that the following conditions must be met to accept the measures:

1. Rule 1: KMO test ≥ .50
2. Rule 2: In Bartlett's test of sphericity, the significant value of $p < .05$
3. Rule 3: Although factor loadings of ±.30 to ±.40 are minimally acceptable, values greater than ±.50 are generally considered essential for practical significance.

In preparing the data for factor analysis test, KMO test was conducted and resulted in .793 for reliability (REL), .780 for decision making effort (EFF), .830 for confidence (CON), .808 for decision process awareness (AWR), and .783 for overall helpfulness (HLP). It can be noticed that all the values for KMO test satisfy the first rule ($p \geq .50$). The Barlett's test of sphericity also gave the significance level of .00 ($p < .05$) for all dimensions. These values indicate that the second rule was met and the data is ready for factor analysis test. Table 2 displays the factor loadings for all dimensions from the factor analysis test.

As shown Table 2, all the items in Q-HELP are found valid and can be used to represent respective dimensions except for items marked with * which show loadings value less than .50. As stated earlier, factor loadings of ±.50 or greater are considered practically significant, whereas loadings exceeding ±.70 are considered indicative of well-defined structure [32]. The factor analysis test carried out in this study was referring to confirmatory factor analysis. Since the items proposed in Q-HELP were elicited from various previous works, hence it is important to seek confirmation (through factor analysis) to see if these items underlie that proposed dimensions in Q-HELP.

Table 2 Factor loadings for each item in Q-HELP

Items	Loadings
Reliability (REL)	
{name of CDA}* can be relied to function properly.	.741
{name of CDA}* is suitable to my style of decision making.	.767
{name of CDA}* provides the help that I need to make a selection.	.689
{name of CDA}* provides the advice that I require to make my decision.	.607
I would use {name of CDA }* if I were attempting to make a choice that is "good enough" but not necessarily the best.	.408*
{name of CDA }* is suitable even during limited time to make a decision.	.621
The recommended solution reflects my initial preferences.	.461*
Decision making effort (EFF)	
It was very difficult to choose a mobile phone from the available options	.349*
The decision process in {name of CDA }* is logical to me.	.756
The decision process in {name of CDA }* is simple to me.	.803
I understand how decision process in {name of CDA }* works.	.835
I found it very easy to interpret the decision justification provided by {name of CDA }*.	.841
Confidence (CON)	
I am satisfied with the recommended solution.	.868
I am confident that I am able to make selection with {name of CDA }*.	.888
I am confident that I can justify the selection that I made with {name of CDA }*.	.900
I am very pleased with my experience using {name of CDA }*.	.782
Decision process awareness (AWR)	
{name of CDA }* makes me realize I cannot get everything from just one alternative.	.637
{name of CDA }* shows my subconscious decision process.	.809
{name of CDA }* helps me not to be easily influenced by others in making selection.	.807
{name of CDA }* makes me more independent of others in making a selection.	.736
I learned a lot about the problem using {name of CDA }*.	.706
Overall helpfulness (HLP)	
{name of CDA }* is capable of helping me in making a choice.	.746
It was very time consuming to choose a {item} from the available options.	.395*
{name of CDA }* allowed me to carefully consider the decision made.	.771
I feel that the problem in making selection is solved.	.848
{name of CDA }* is an aid for me in clarifying what I want.	.867

Note: *excluded from the instrument

Reliability Test

Reliability of a measure is an indication of consistency. In the pilot study, the measure of consistency is examined through the interim consistency reliability test. The value of Cronbach's coefficient alpha was computed and should indicate the value of alpha, $\alpha > .7$ [29] to be accepted as reliable. From the test, all dimensions were found significant as depicted in Table 3. These results show that the measurement were consistent.

Therefore, this measurement can be used for data collection in the main study.

Table 3 Reliability Test

Dimensions	Cronbach's alpha	Number of items
Reliability	.754	5
Decision making effort	.793	4
Confidence	.882	4
Decision process awareness	.785	5
Overall helpfulness	.787	4

5.0 THE EXPERIMENTAL STUDY

The experimental study involved 189 respondents (where 52.4% are male and 47.6% are female) to measure the helpfulness of a CDA known as YouthPDA. YouthPDA is a personalized CDA, which is intended for youth to help choose their study and career path using hybrid intelligences by integrating Personality Traits and Multiple Intelligences data [33]. In YouthPDA, the user profile functions as contextual aware rules for reasoning to take place. The experiment has been conducted into two conditions; in the computer laboratory setting (97 respondents) and in the open environment (92 respondents). Laboratory experiment was carried out where the respondents were given tasks to be completed using the YouthPDA. In addition, walk in experiments have also been carried out at two venues; Malaysia Technology Expo (MTE) 2014 and International Invention Innovation and Technology Exhibition (ITEX) 2014, as well as at two public schools during the SPM results released day.

6.0 FINDINGS

In this study, correlation matrix is used to measure the linearity relationship between factors. Correlation (r) between two factors determines the measurement of the linearity relationship between two factors. Table 4 shows the results of the Pearson's correlation matrix.

As the r value reported as positive and $p < .01$, the findings disclosed that all relationships between factors have a positive relation and are significant at $p<0.01$. Moreover, the findings specify the ensuing hypotheses of this study:

1. As Reliability increases, Helpfulness increases.
2. As Decision Making Effort increases, Helpfulness increases.
3. As Confidence increases, Helpfulness increases.
4. As Decision Process Awareness increases, Helpfulness increases.

Table 4 Pearson's Correlation Matrix

FACTOR	Reliability	Decision Making Effort	Confidence	Decision Process Awareness	Overall Helpfulness
Reliability	1	.726**	.757**	.596**	.708**
		.000	.000	.000	.000
	189	189	189	189	189
Decision Making	.726**	1	.780**	.672**	.706**
Effort	.000		.000	.000	.000
	189	189	189	189	189
Confidence	.757**	.780**	1	.585**	.806**
	.000	.000		.000	.000
	189	189	189	189	189
Decision Process	.596**	.672**	.585**	1	.610**
Awareness	.000	.000	.000		.000
	189	189	189	189	189
Overall	.708**	.706**	.806**	.610**	1
Helpfulness	.000	.000	.000	.000	
	189	189	189	189	189

**: Correlation is significant at the 0.01 level (Pearson Correlation (2-tailed))

7.0 CONCLUSION

The development of Q-HELP is intended to measure the perceived helpfulness aspect of computerized decision aid. Measuring helpfulness is believed to embrace both evaluation approaches of a CDA; the process and outcome approaches, as both are equally important. The present study can also be seen as a modest step toward developing a theoretically sound measurement for CDA. The implications will be beneficial to both scholars and practitioners.

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