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ASSESSMENT OF BARRIERS TO EDUCATIONAL TECHNOLOGY ACCEPTANCE

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ABSTRACT

This paper reports on literature related to the assessment of barriers to educational technology assessment. It surveys the development of technology acceptance models from social cognitive theory and innovation diffusion theory through to a unified theory that considers performance expectancy, effort expectancy, and social influence. Because risk is a significant factor in technology assessment, this paper outlines risk assessment processes, beginning with the Fine-Kinney method through to derivation of a risk matrix. Finally, it considers factors related to the validation of technology acceptance survey assessments.

KEYWORDS

Technology, Assessment, Risk, Validity, Model, Education

1. INTRODUCTION

Institutions introducing educational technology to staff and students frequently encounter resistance and negative responses. From learning management systems to automated assessment to large language models, new innovations are often met with a less than enthusiastic response. Often, studies and surveys are undertaken to understand the reasons for these concerns. But there isn't a single set of metrics available to assist in this task.

This paper reports on a study undertaken to study the barriers to technology acceptance in an institutional training environment. The purpose of this assessment is to review criteria for an evaluation of a survey assessing reasons for teacher hesitance to use new learning technologies. It does not report on the study itself, but on the considerations applied as part of the process of validation of the survey instrument. The results of this investigation offer useful advice to others considering similar assessments in the future.

To that end, three major sets of criteria were considered: first, technology assessment models, in order to identify the scope of considerations; second, risk assessment models, to understand how potential harms from new technology may be understood, and third, methods and approaches for the assessment of the reliability and validity of the survey instrument.

2. ACCEPTANCE MODELS

Technology acceptance and diffusion models describe and explain the adoption and deployment of new tools and applications. Adoption theory describes the choices individuals make and is understood in terms of behaviour change. Diffusion theory considers the spread of a technology over time across an organization (Straub, 2009, 627).

These models are largely based in social cognitive theory and describe two major roles for social learning: vicarious experience through modelling (Bandura, 1963, 607), and vicarious experience mediated through the use of a technology (Bandura, 2001, 17). Major factors influencing acceptance decisions include: attention to the behaviour, whether it is retained or recollected, whether it can be reproduced successfully, and whether the agent is motivated to do it again (Straub, 2009, 629).

2.1 Innovation Diffusion Theory

Rogers' Innovation Diffusion Theory (1962) describes five stages of evaluation of an innovation: awareness of the innovation, persuasion of its benefits, decision to adopt the innovation, implementation of the decision, and confirmation of the innovation process. These happen in individuals at different times, resulting in Rogers' 'innovation diffusion curve', which describes the progress of an innovation through early adopters, mainstream and late adopters or laggards.

Adoption is "a decision to make full use of technology innovation as the best course of action available" where innovation is "anything that is perceived as new from the perspective of the adopters and is described by Rogers by five characteristics: relative advantage, compatibility, complexity, traceability, and observability" (Rogers, 1995, 5; Granić, 2023, 184-5). Following Bandura, Rogers also describes the channels of communication through which an innovation is modelled, and the social system, that is, the "a set of interrelated units that are engaged in joint problem-solving to accomplish a common goal" (Rogers, 1995, 23) in which the adoption decision takes place.

2.2 Theory of Planned Behavior

"A person's intention to perform (or not to perform) a behaviour is the immediate determinant of that action" (Azjen, 1985, 12). Changes in intention can be caused by changes in the salience of belief, new information, changes in confidence or commitment, individual differences such as skills, willpower, emotions and compulsions, or external factors such as time, opportunity, and dependence on others.

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Table 1. Factor Analysis of Perceived Usefulness and Ease of Use. By the author; adapted from Davis, 1989, p. 331 (Table 7, Study 2)

Scale Items		Factor 1 (Usefulness)	Factor 2 (Ease of Use)
Usefulness			
1	Work More Quickly	.91	.01
2	Job Performance	.98	−.03
3	Increase Productivity	.98	−.03
4	Effectiveness	.94	.04
5	Makes Job Easier	.95	−.01
6	Useful	.88	.11
Ease of Use			
1	Easy to Learn	−.20	.97
2	Controllable	.19	.83
3	Clear & Understandable	−.04	.89
4	Flexible	.13	.63
5	Easy to Become Skillful	.07	.91
6	Easy to Use	.09	.91

Over time, the original model by was extended through the addition of other constructs (Granić, 2023, 186ff): perceived enjoyment, conformity behaviour, and self-esteem (Yu, 2020); perceived playfulness (Lin and Yeh, 2019); and privacy, infrastructure, institutional support, and access devices (Aburagaga, Agoyi, and Elgedawy (2020)

The Decomposed Theory of Planned Behavior (DTPB) combines TPB and TAM to depict specific beliefs as decomposed into belief constructs (Taylor & Todd, 1995, 147). Factors that impact the acceptance and usage of a technology include: attitude (perceived ease to use, perceived usefulness, and compatibility), subjective norm (peer influence and superior influence), and perceived behavioural control factors (self-efficacy, resource-facilitating conditions, and information technology support).

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2.4 Concerns-Based Adoption Model

According to Straub (2009) "technology adoption is a complex, inherently social, developmental process; individuals construct unique yet malleable perceptions of technology that influence their adoption decisions. Thus, successfully facilitating technology adoption must address cognitive, emotional, and contextual concerns." Accordingly, the Concerns-Based Adoption Model (CBAN) "includes three diagnostic, judgement-free components, the Stages of Concern (SoC) survey; Levels of Use (LoU) interviews; and Innovation Configuration Maps (ICM). Through 35 survey items, the SoC survey identifies individual attitudes and beliefs of change agents and how they align with the innovation" (Olson, et al., 2020, 50) while the LoU identifies stages of use of the innovation, ranging from 'novice' to 'advanced user'.

2.5 Unified Theory of Acceptance and Use of Technology

Following a review of technology acceptance models (including those listed above), Venkatesh, et al. (2003) extracted common factors tested a model called the Unified Theory of Acceptance and Use of Technology (UTAUT), "which posits three direct determinants of intention to use (performance expectancy, effort expectancy, and social influence) and two direct determinants of usage behavior (intention and facilitating conditions). Significant moderating influences of experience, voluntariness, gender, and age were confirmed as integral features of UTAUT" (Ibid., 467).

2.6 Barriers to Technology Adoption

While the acceptance models discussed above focus on factors influencing technology adoption, it is often useful to focus on the barriers specifically, as for example by Reid (2014). "Unavailable technology is an obvious barrier. Less obvious are the reliability and complexity of available instructional technologies. Because these can be complex, faculty with poor self-efficacy may be reluctant to try them. If a technology is unreliable, faculty turning away from it will influence others to do the same" (386-7).

A comparison of the specific categories identified by Reid and the factors discussed in the acceptance models will reveal a significant degree of overlap. In Reid, however, the point of view or perspective of the person adopting technology assumes greater importance. For example, "Leadership may not understand the complexities of the technologies, or the time needed to master them" (394). This creates a need to study technology adoption from the perspective of different and specific roles within the organization.

3. RISK MANAGEMENT

3.1 Risk Assessment Models

In many cases, teachers are hesitant to adopt new tools because of perceived risks. Assessments of this hesitation need to be informed by the teachers' understanding of risks. A risk assessment profile should be employed to provide a complete description.

These models are largely based in social cognitive theory and describe two major roles for social learning: vicarious experience through modelling (Bandura, 1963, 607), and vicarious experience mediated through the use of a technology (Bandura, 2001, 17). Major factors influencing acceptance decisions include attention to the behaviour, whether it is retained or recollected, whether it can be reproduced successfully, and whether the agent is motivated to do it again (Straub, 2009, 629).

3.2 Fine-Kinney method

The Fine-Kinney method of risk assessment (Fine, 1971; Kinney, 1976) calculates a risk score based on the product of scores for probability, exposure, and consequences. Each is weighted equally; later modifications vary the weighting.

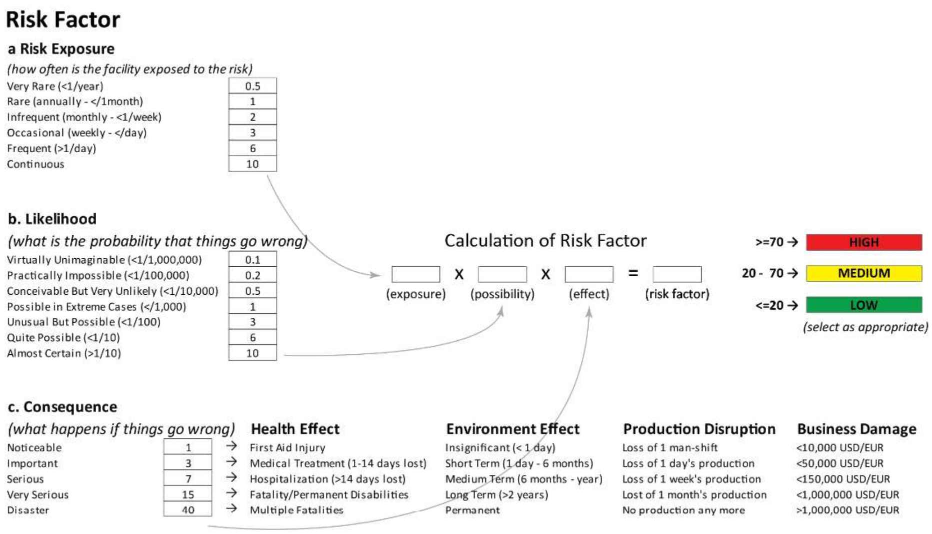

Figure 1. Risk Factors. By the Authors. Adapted from Enhesa. https://support.enhesa.com/hc/en-us/articles/360043232272-Fine-Kinney-Risk-Ranking-Methodology

3.3 Analytical Hierarchy Process Model

The Analytical Hierarchy Process model is a method for weighting and combining multiple goals or outcomes and multiple criteria in order to obtain weighted outcomes (Harker, 1989, 8). Risks are assessed using a risk classification scheme organizing risk factors according to categories, for example, ‘acts of god’, ‘financial’, ‘design’, etc., with subfactors being identified under each, forming a hierarchy (Mustafa and Al-Bahar, 1991, 48).

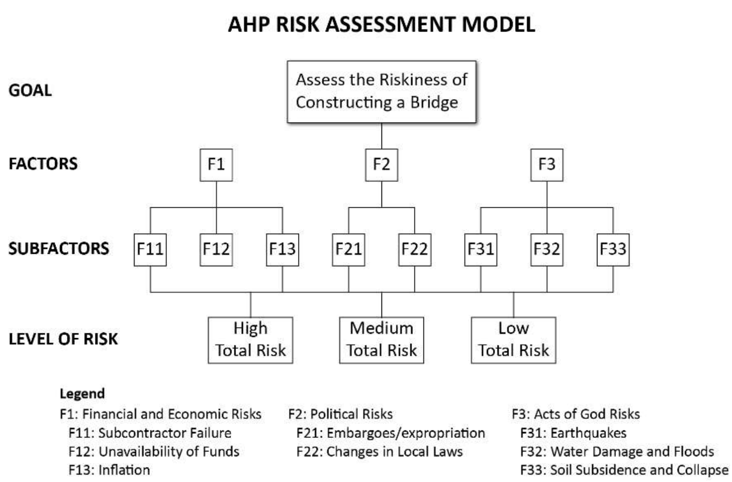

Figure 2. AHP Risk Assessment Model. By the authors. Adapted from Mustafa and Al-Bahar, 1991, 48

3.4 Risk Matrix

A risk matrix combines the first two elements of the Fine-Kinney model. For example, the U.S. Department of Defense describes it as follows: "Consistent predefined likelihood and consequence criteria provide a structured means for evaluating risks so decision makers and program office staff can make objective comparisons" (DOD, 2017, 23). Risks may be further weighted by other factors, for example, cost to mitigate (Ibid. 29). A red-yellow-green colour scheme is characteristically employed to illustrate the final risk score. A risk assessment may be combined with an 'opportunity management' calculation in order to weight benefits in addition (Ibid. 43).

Having the teacher perform the risk assessment as described by one of these three models will focus an understanding of their concerns and the basis for their objection.

4. VALIDATION

Studies such as the one described in this report are subject to the reliability and validity assessment to determine how well they measure the phenomena they are investigating; as commonly understood, reliability refers to the consistency of a measure, while validity refers to the accuracy of a measure. The measures surveyed here consider both aspects, and the list is drawn both from formal studies of research assessment (AERA, 2014) as well as literature related to more specific forms of assessment.

4.1 Content Validity

An assessment of content validity concerns the degree of correlation of test scores with external criteria (Cureton (1951) in Sireci, 1998, 88) and includes elements of content representativeness and content relevance (Messick, 1975) or process (Tenopyr, 1977).

Content validity involves assessing whether the questions in the survey cover the entire range of issues or concepts being studied. This is done by having subject matter experts review the survey questions to ensure that they are relevant, appropriate, and comprehensive (Olsen, 2010, 136).

4.2 Construct Validity

Construct validity is similar to content validity, though it refers specifically to the structure or construction of the concept intended to be measured. This construct may be depicted using a Rasch model, which defines how data should be structured in order to obtain measurements from it. In a Likert survey, where respondents the option that best describes their attitudes, beliefs, and experiences, the Rasch model measures such factors as the unidimensionality and local independence of those options (Yamashita, 2022, 4).

Construct validity may be assessed by testing the survey and comparing the results with established measures of the same concept. This may be represented as a mapping of the questions in the survey or questionnaire to the structure of the concept being measured, and determination that response options do not overlap or extend beyond the construct being measured.

4.3 Criterion Validity

Wikipedia defines criterion validity, or criterion-related validity, as "the extent to which an operationalization of a construct, such as a test, relates to, or predicts, a theoretical representation of the construct - the criterion". For example, if the test measures X as a barrier to Y, then in a model of the concept, the unmitigated presence of X would predict an absence of Y.

The American Educational Research Association (AERA, 2014, 29) recommends that "the description of each criterion variable should include evidence concerning its reliability, the extent to which it represents the intended construct (e.g., task performance on the job), and the extent to which it is likely to be influenced by extraneous sources of variance." In any systems model, this extent may be high. That is, to continue the example, the description considers additional or alternative explanations for the absence of Y.

Criterion validity involves comparing the survey results with another established measure of the same construct to ensure that they are consistent (Fink, 2010). For example, if a survey is measuring job satisfaction, the results could be compared with another established job satisfaction scale.

4.4 Test-Retest Reliability

Typically, test-retest reliability involves administering the survey twice to the same group of people and comparing the results to ensure that they are consistent. This is done to assess the stability of the survey over time. As AERSA (2014, 39) states, "The overall reliability/precision, given error variance due to the sampling of forms, occasions, and raters, can be estimated through a test-retest study involving different forms administered on different occasions and scored by different raters."

In some cases, it may be impractical to administer the same survey to the same people, as the application of the survey the first time may influence responses the second time, particularly when the survey is administered in the context of a focus group. In such a case, it may be sufficient to administer the same survey twice to the same type of people. The focus of test-retest is to assess the questions, not the specific individuals; "Information about random fluctuations in scores is essential for understanding the reliability of change scores—that is, for distinguishing random short-term score differences from true improvements or deteriorations over time" (Polit, 2014, 1714).

4.5 Internal Consistency

Internal consistency involves assessing the extent to which the questions in the survey are measuring the same construct. For example, if some questions are asking about the objective existence of an entity, and other questions are asking about a respondent's perceptions of an entity, the questions are not measuring the same construct. Assessment of internal consistency may be considered conceptually, as in the example just given, or by using statistical techniques such as coefficient alpha to assess the inter-correlation between the survey items (Cronbach, 1951).

The coefficient alpha is "an internal-consistency reliability coefficient based on the number of parts into which a test is partitioned (e.g., items, subtests, or raters), the interrelationships of the parts, and the total test score variance." It is also called Cronbach's alpha and, for dichotomous items, KR-20 (AERA 2014 217). The internal-consistency coefficient is "an index of the reliability of test scores derived from the statistical interrelationships among item responses or scores on separate parts of a test" (AERA 2014 220).

To assess the internal-consistency coefficient a method such as the split-halves method may be employed, where "scores on two more-or-less parallel halves of the test (e.g., odd-numbered items and even-numbered items) are correlated, and the resulting half-test reliability coefficient is statistically adjusted to estimate reliability for the full-length test" (AERA 2014 35-36).

5. DISCUSSION

This paper survey three major sets of factors related to the assessment of barriers to technology acceptance. While it does not set out to prescribe any particular approach or set of survey questions, it identifies major parameters such studies should encompass. The first section reviewed the progress of technology acceptance models, cumulating with UTAUT, and the need to consider performance expectancy, effort expectancy, and social influence along with two direct determinants of usage behavior: intention and facilitating conditions. It also detailed the construction of a risk matrix and a method for weighting and combining multiple goals or outcomes and multiple criteria. Finally, it considered several methods for survey instrument validation to ensure all and only factors related to technology acceptance are measured.

Though these sets of considerations are well-known by those with experience in the field, it is unusual to see all these sets of factors considered in published studies of teacher and student attitudes with respect to the adoption of new technology. Hence, they are collected here and offered as a model for the assessment of surveys and studies of technology adoption.

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