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Training and Education Modernization: Analysis of Barriers to Technology Adoption

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Digital Technologies Research Centre

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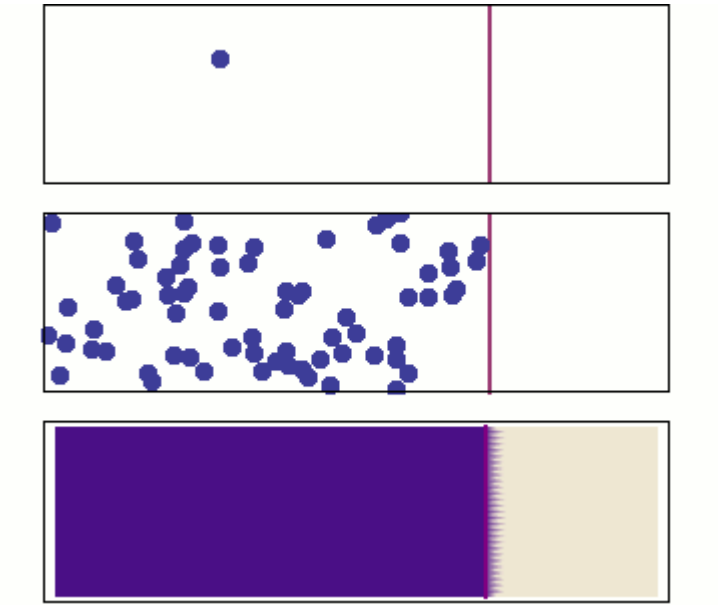
This report examines work by DRDC to develop a model of factors that inhibit the use of learning technology in a Canadian Forces Context. The focus is to assess the background and study methodology undertaken by DRDC. It proceeds in three major states: first, a review of the literature related to technology adoption, risk management, and assessment validation; second, an examination of DRDC's pilot study and proposed wider-scale assessment from the perspective of the literature review; and third, a series of recommendations to DRDC based on the first two parts.

Table of contents

A. Background Literature

Acceptance Models

Diffusion Theory



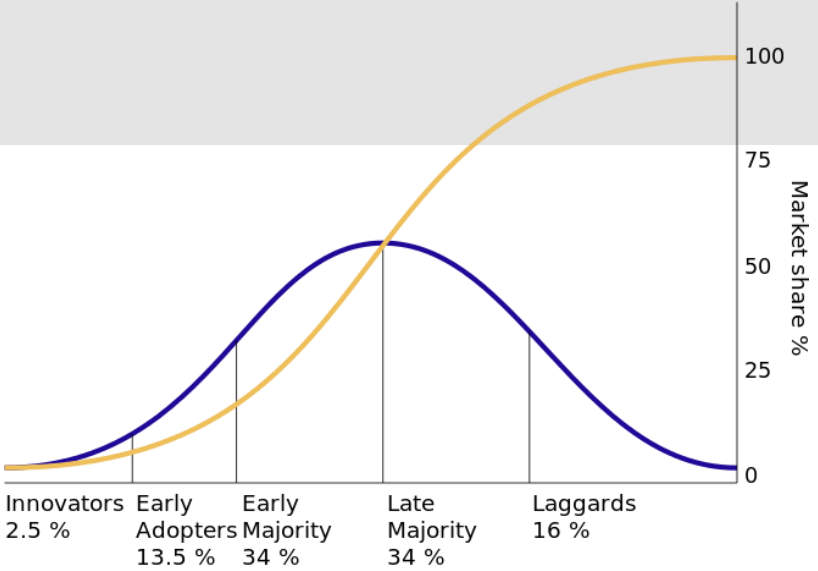
$$\Gamma = 2AC\sqrt{\frac{Dt}{\pi}}$$

- Γ is number of molecules in unit # molecules adsorbed during the time t.
- A is the surface area in unit m^2.
- C is the number concentration of the adsorber molecules in the bulk solution in unit # molecules/m^3.
- D is diffusion coefficient of the adsorber in unit m^2/s.
- t is elapsed time in unit s.

Fick's laws of diffusion
By Sbyrnes321 - Own work, Public Domain, https://commons.wikimedia.org/w/index.php?curid=8995324

Acceptance Models

Diffusion as Acceptance



Roger's Innovation Diffusion Theory

- Five stages of diffusion
- Innovation diffusion curve

Theory of Planned Behaviour

- Azjen: A person's intention to is the immediate determinant of that action

Technology Acceptance Model

- TAM considers attitudes, rather than behavioural intentions, as the main predictors of behaviour.

Acceptance Models

Toward a Unified Model

Concerns-Based Adoption Model

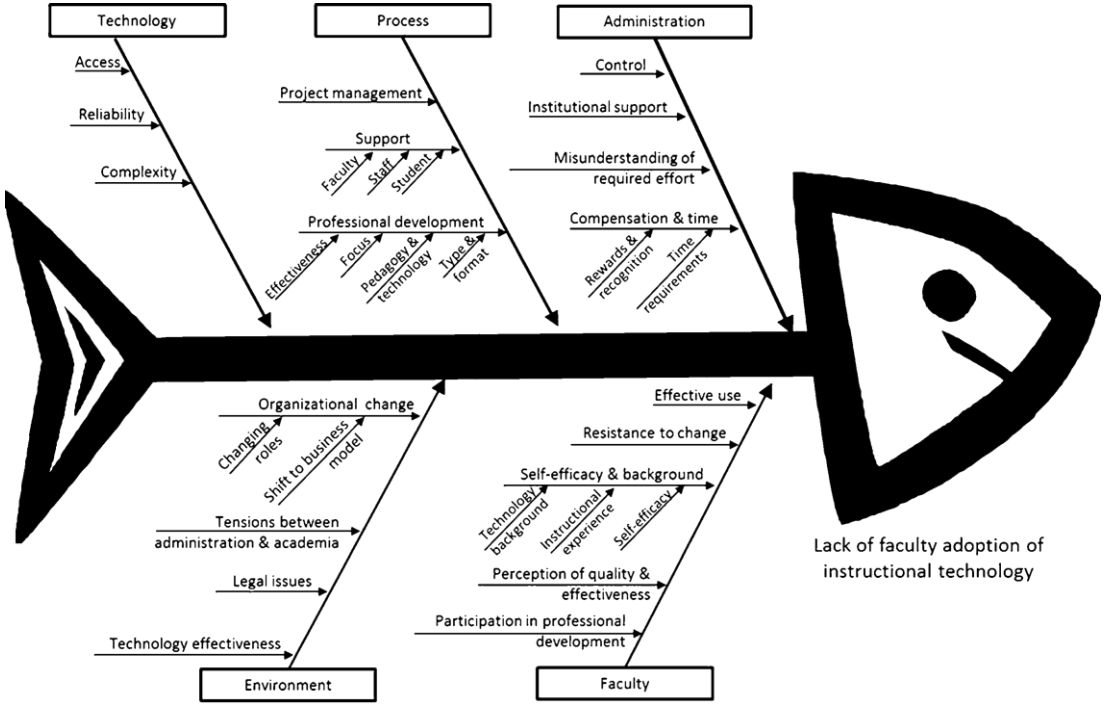
- Straub: “technology adoption is a complex, inherently social, developmental process

Unified Theory of Acceptance and Use of Technology

- three direct determinants of intention to use (performance expectancy, effort expectancy, and social influence)
- two direct determinants of usage behavior (intention and facilitating conditions)

Barriers to Acceptance

Reid:
Categories for barriers to adoption



Risk Management

Fine-Kinney method

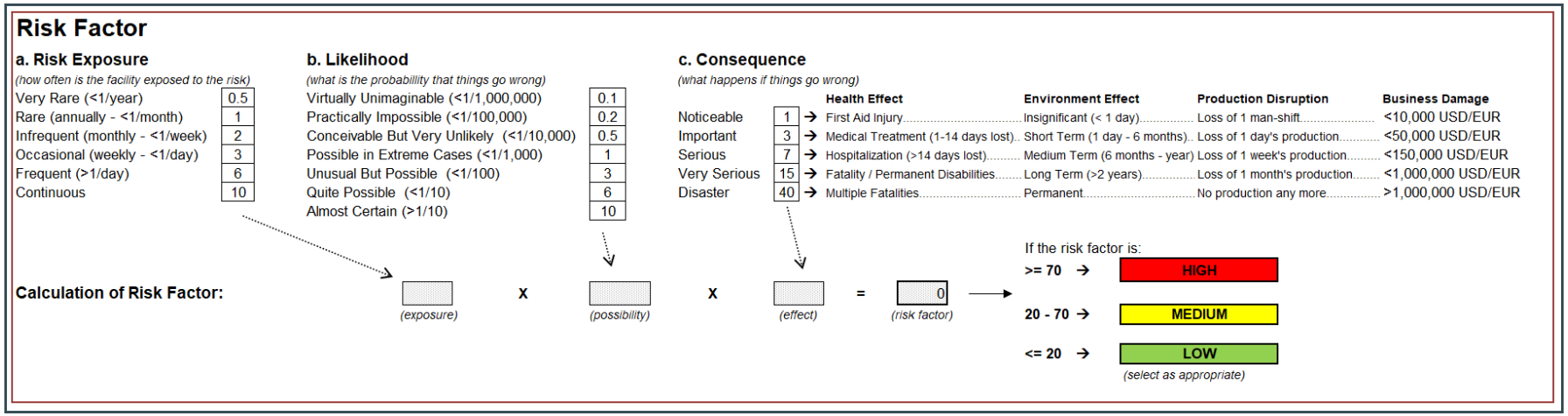
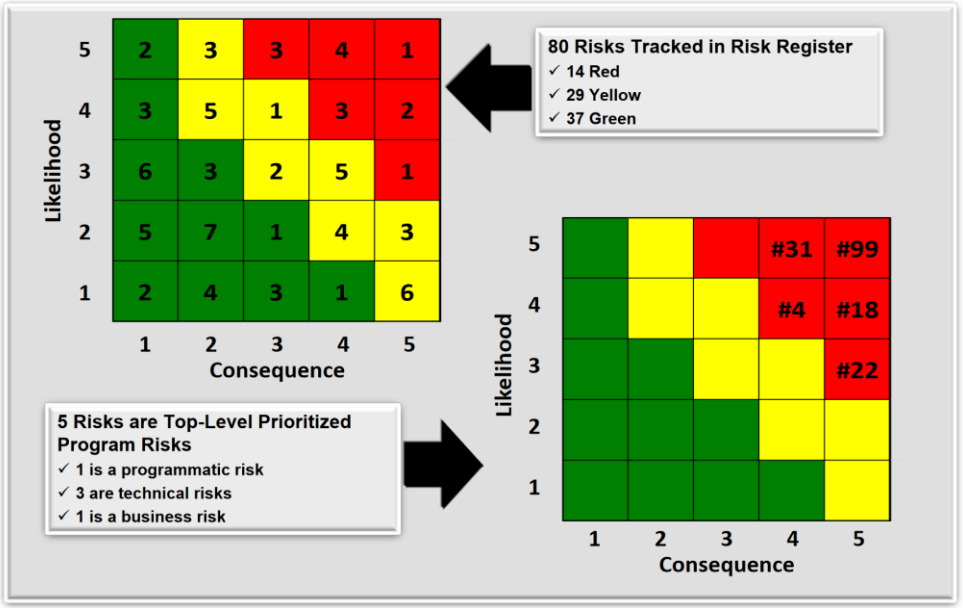


Image source: Enhesa. https://support.enhesa.com/hc/en-us/articles/360043232272-Fine-Kinney-Risk-Ranking-Methodology

Risk Management

Risk Matrix



Consistent predefined likelihood and consequence criteria provide a structured means for evaluating risks so decision makers and program office staff can make objective comparisons" (U.S. DOD, 2017, 23)

Risk Management

Analytical Hierarchy Process Model

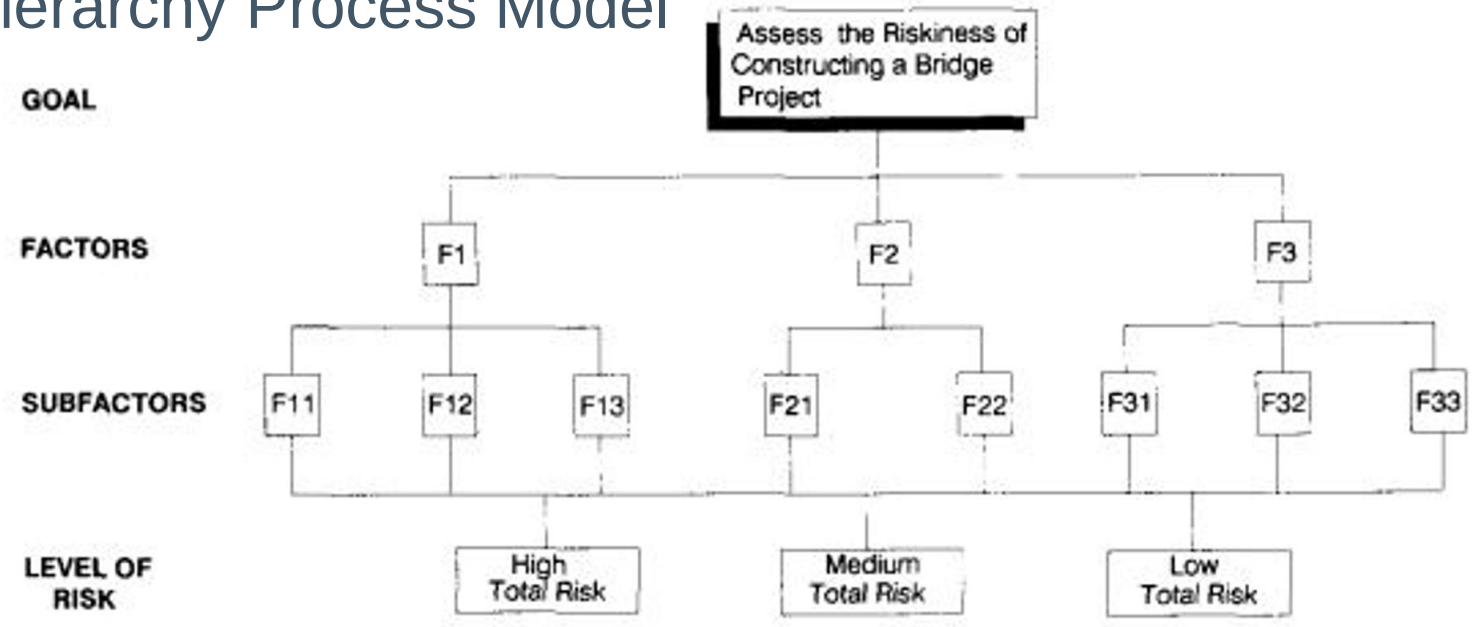


Image from Mustafa and Al-Bahar, 1991, 48

Validation

Validation Protocols

- Content validity – completeness of coverage; assessed by expert review
- Construct validity – e.g. local independence; assessed by comparing the results with established measures of the same concept
- Criterion validity – reliability of indicators; assessed by comparing with other established measured
- Test-Retest validity – consistency; use different forms, contexts
- Internal consistency – same object being assessed; use split halves method

B. DRDC Study

Pilot

A Framework for Barriers

Barriers to the implementation of the Land Vehicle Crew Training System (LVCTS)

- Adapted from Reid
- Some modifications made to categories. Eg:
  - Tension with established practice is added
  - Section on instructors as training stakeholders is expanded

Image: Canadian Army
https://twitter.com/CanadianArmy/status/609436471813083137

Pilot

Some Key Takeaways

- Different sites will use system differently
- Future learners learn different content
- Future trainers will want to train differently
- Users need graded access to system features
- System must have connectivity and “relatedness”

Table 2: *Impact and Presence Ratings with the Same Response Distribution among Locations.*

Code	Barrier	Mode of Impact Rating	Mode of Presence Rating
T1	Technology – Access		Sometimes
T3	Technology – Complexity	Serious	Usually*
P1	Process – Process Management	Moderate*	Usually
P2	Process – Support to Trainers	Serious	
P5	Process – Learner Needs	Moderate*	
E2	Environment – Value of Instructor’s role		Sometimes*
E4	Environment – Legal Concerns		Sometimes*
TS4	Training Stakeholders – Positive perception	Moderate*	

Note: * = most common rating after “No Observation.”

Image: Martin, Jarmasz & Kirollos, 2021, 9

Pilot

Barriers as Pathways

The survey as an examination of an institution

- ‘Pathways’ offer a more institutional perspective, suggesting means and mechanisms to achieve organizational goals
- Participants to directly address and find pathways for selected barriers which they deemed most salient

Pilot

Barriers as Risks

Consistent with the Analytical Hierarchy Process model. Respondents were asked to report on both the likelihood and the impact of a given outcome.

T1 Barrier Impact: The worst (or any) barrier present on this pathway poses risk to implementation of the technology for learning

Negligible	Minor	Moderate	Serious	Critical	No Observation

T1 Barrier Presence: The worst (or any) barrier is present on this pathway, over time and across situations

Never	Seldom	Sometimes	Usually	Always	No Observation

Study Overview

Questions are again represented as pathways

Administration	A1	*Teachers/trainers control* what technology gets used and how.
Administration	A2	There is evidence for *perceived institutional support* by the organization for adoption of the new technology.
Administration	A3	The *required effort* to implement the new technology is appropriately estimated, preventing abandonment.
Administration	A4	The organization appropriately *recognizes and compensates* the effort of the personnel adopting the new technology.
Administration	A5	The organization provides *sufficient time* to use and learn the new technology, adapt or create new learning opportunities, and to deal with technical problems.

Study Overview

General Considerations

Are respondents talking about other people, or are they talking about themselves? Lack of clarity on this could create a fuzziness in the results.

- Can individuals serve as representative of their ‘kind’ (e.g., their role)?
- Clarity would be essential; it would be important to distinguish between answers given ‘as a person’ and answers given ‘as a role’

Also, individual perceptions are influenced not only by their own experience but also as experienced either by behaviour that is modelled by others or even through broadcast and social media

Study Overview

Scales

Agreement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Frequency	Always	Often	Sometimes	Rarely	Never
Importance	Very Important	Important	Moderately Important	Slightly Important	Unimportant
Quality	Excellent	Good	Fair	Poor	Very Poor
Likelihood	Almost Always True	Usually True	Occasionally True	Usually Not True	Rarely True
Likelihood	Definitely	Probably	Possibly	Probably Not	Definitely Not

Likert scales (Mcleod, 2023).

Study Overview

Scales

- With respect to ‘barrier presence’, is the survey measuring frequency or likelihood?
- With respect to ‘barrier impact’, can the terms employed (from ‘negligible’ to ‘critical’) be thought of as value-laden?
- It is not clear whether the respondent is intended to select ‘the worst’ (however evaluated) barrier or ‘any’ barrier.

Study Overview

Roles

Given that many technology models identify personal, rather than role-based, factors in technology selection, a number of considerations arise.

- It might not be clear to the respondent what stance they are intended to adopt as a respondent to the survey;
- It is not clear that an organization-based or role-based response would result in the most valid or reliable data.

Study Overview

Validity

- Content validity is established by this study
- Overall, construct validity is established, though some issues are raised
- Criterion validity is established by mapping this study with previous work
- Applied to varying cohorts, so an element of test-retest reliability is in place.
- No formal study of internal consistency has been conducted, there are cases where inconsistency may occur.

Study Overview

Specific Considerations

- A need for clarity about instructions and survey process
- Identified instances of vagueness, compound questions
- A few cases where missing elements (identified by ‘?’) are isted
- Respondent might not know the answer to some factual questions
- Some things (e.g., ‘organizational change’) represented passively
- Questions about ‘business model’ have been dropped

These are examples only; please see the study text for the full set of specific considerations.

C. Recommendations

Validation

Criterion validation

The survey should be validated against similar surveys of technological barriers.

Test-Retest Reliability

Survey questions should be tested in other contexts to assess reliability.

- a shorter version of the survey should be applied as a questionnaire to similar target populations

Format and Process

Clarity of Intent and Focus

The survey should continue to be administered in the context of a focus group.

Clearly define when personal perspective or objective assessments are required.

- all direction to the respondent regarding personal stance, perspective or point of view be clearly defined in survey results.

The impact of requiring respondents to take a role-based or organizational perspective should be studied.

Format and Process

Scales

Provide as much guidance as possible to respondents regarding how barriers are described.

- A barrier must be a single specific item
- It must be the sort of thing that can be observed or believed by the respondent
- The directionality of statements must be clear and consistent (e.g.., respondents should not define one barrier as ‘working technology’ and another barrier as ‘no instructions’)

Survey Contents

Barriers and Pathways

Research into social factors influencing technology adoption and diffusion be conducted.

- For example, consider questions about whether ‘coolness’ of tech is a factor
- Ask whether such factors are actually out of scope in a barriers model

Validate ‘pathways’ terminology

- ‘Barriers’ and ‘Pathways’ are not symmetric
- Describing barriers in terms of the pathways to resolution may change the outcome of the survey

Survey Contents

Double Negatives

Survey options should not be expressed as double negatives.

Complex Questions

Complex questions should be revised.

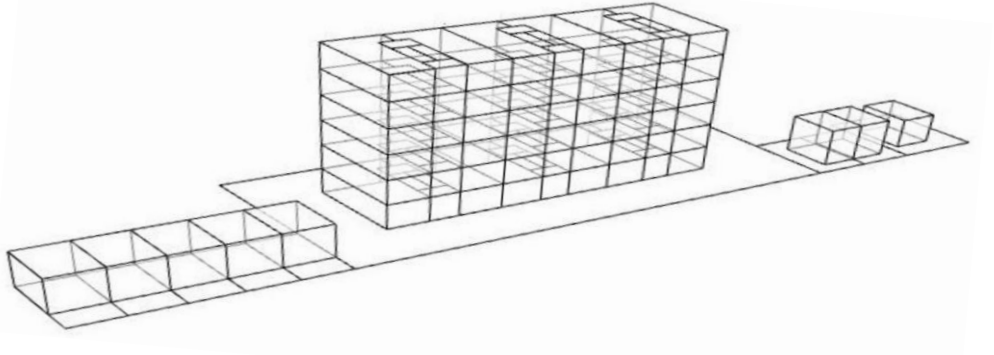
- Risk of creating complex questions as a consequence of conflating agency for change with the change itself.
- Third level – bullet
  - Fourth level – bullet

Survey Contents

Ontological Considerations

Respondents should be asked about evidence, not existence.

- If respondents do not know the answer, they may fail to respond, they may guess, or they may try to anticipate what answer the questioner is expecting
- The presentation of the question in conjunction with a request for examples also may help with this.



Survey Contents

Specificity

Questions should reflect what technology is being discussed

Clearly instruct respondents how to select which barrier to address.

- A suggested wording follows:
  1. “Identify whether or not in your role, you saw examples of a pathway or barrier at the observed organizational level during the specified exposure.”
  2. “Considering the instance of the worst barrier, rate the degree to which the barrier was absent or present.”
  3. “Then, estimate, in your opinion, how that barrier would impact the successful use of the technology.”

Concluding Remarks

1. This review is the first part of a validation process, necessary in order to ensure that the survey measures what it is intended to measure, and does so reliably.
2. Certainly, the survey should continue to be administered as a focus group.
3. Because of the modifications undertaken in order to obtain better results, it is necessary to be clear about what is being asked and who is being asked, and the terminology employed in representing barriers as pathways can sometimes be confusing.
4. With the need for such clarity fully articulated, the survey can be used to obtain precise and useful data regarding the adoption of learning technology in a specific organizational context.

Thank you

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