Evaluating of the International Collaboration in S&T Proposal:
How to align the
"Curiosity–driven Research" with the "Mission-oriented Goal"

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Outline

- Introduction
- International Collaboration in S&T Approach
- Research Methodology
- Research Framework
- Demonstration of the Model
- Research Outcome
- Contributions

Why International Collaboration in S&T?

- S&T is a worldwide activity and has a strong international dimension.

- International Collaboration in S&T is regarded by various countries as a critical policy device to help strengthen country's competitiveness because it

  - helps to maintain growth of S&T by addressing Complex and multi-disciplinary problems e.g. CERN

  - helps to solve global challenges and concerns e.g. Bird Flu, Global Warming

  - helps to share R&D costs and risks

  - helps to solve the Brain Drain phenomenon by sharing the skilled people across the borders

International Collaboration in S&T Approach

- Success in International Collaboration in Science and Technology depends on various factors, different players have different perspectives.

  - Governments participate in collaboration in order to meet their country's policy goals.
  - Scientists and researchers establish their contacts through their personal channels or scientific networks in order to pursue their own academic interest regardless of the National S&T Policy.

- There are two significant approaches in ICST Policy making which are "top-down" and "bottom-up" approaches.

The Classical Top-down Policy Making

- Top-down approach starts with the policy decision by governmental officials (often central government).

  - Top-down project is a "**mission-oriented**" or a "**need to do**" project.

- Most likely, the policy is imposed from the top level or central unit with no or less thought given to involvement of those at the bottom level.

- The key players are "**Government and National Policymakers***".*

- The Top-down policy making approach is based on a set of important assumptions.

  - Policy contains clearly defined goals against which performance can be measured.
  - Policy contains clearly defined policy tools for the accomplishment of goals.

The Bottom-up Approach

- Bottom-up approach starts by identifying the network of actors involved in the same area of expertise, who may or may not be in the same geographical area [12].

  - Bottom-up project is a "**curiosity-driven**" project or a "**want to do**" project.

- The key player is "**Individual***" e.g. *researcher or scientist.*

- It is driven by the personal contacts or the common interest as a vehicle for developing a network of interest through various groups of activities e.g. collaborative workshops, international conferences, collaboration projects, visiting programs.

- Researchers self-organize 'spontaneously' into collaborative teams from the bottom up. They may work together to share, or may meet while accessing relatively rare or localized resources.

The Bottom-up Approach (Cont.)

- Through the Bottom-up approach, researchers identify their research areas or topics by various channels

    - The traditional channels:
        - Researcher searches through the academic papers in relevant journals , summarizes the state of knowledge, and tries to scope the puzzle area (state of the art research).
        - Researcher searches through the Research Funding Agency e.g. NSF, in US or ERA in Europe

    - The emerging new channels:
        - Open Access e.g. PubMed, Public Library of Science (PLoS)
        - Crowdsourcing e.g. InnoCentive
        - Social Network in Scientific Community e.g. LinkedIn

- The emerging new channels are useful to researchers around the world, especially to those in developing countries.

Research Framework
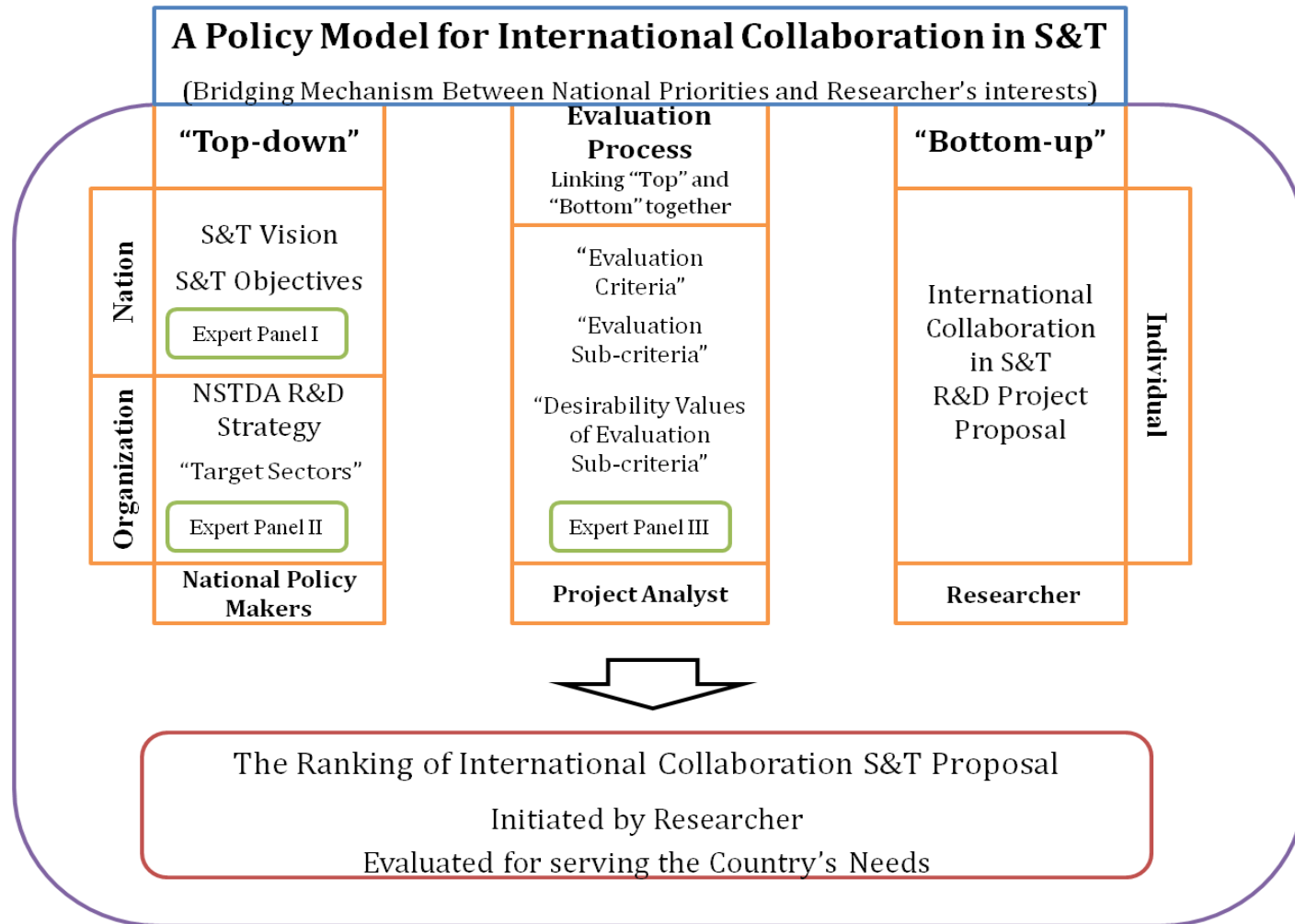
Research Methodology

- Hierarchical Decision Model (HDM) with Quantified Expert Judgment and Desirability Curve.
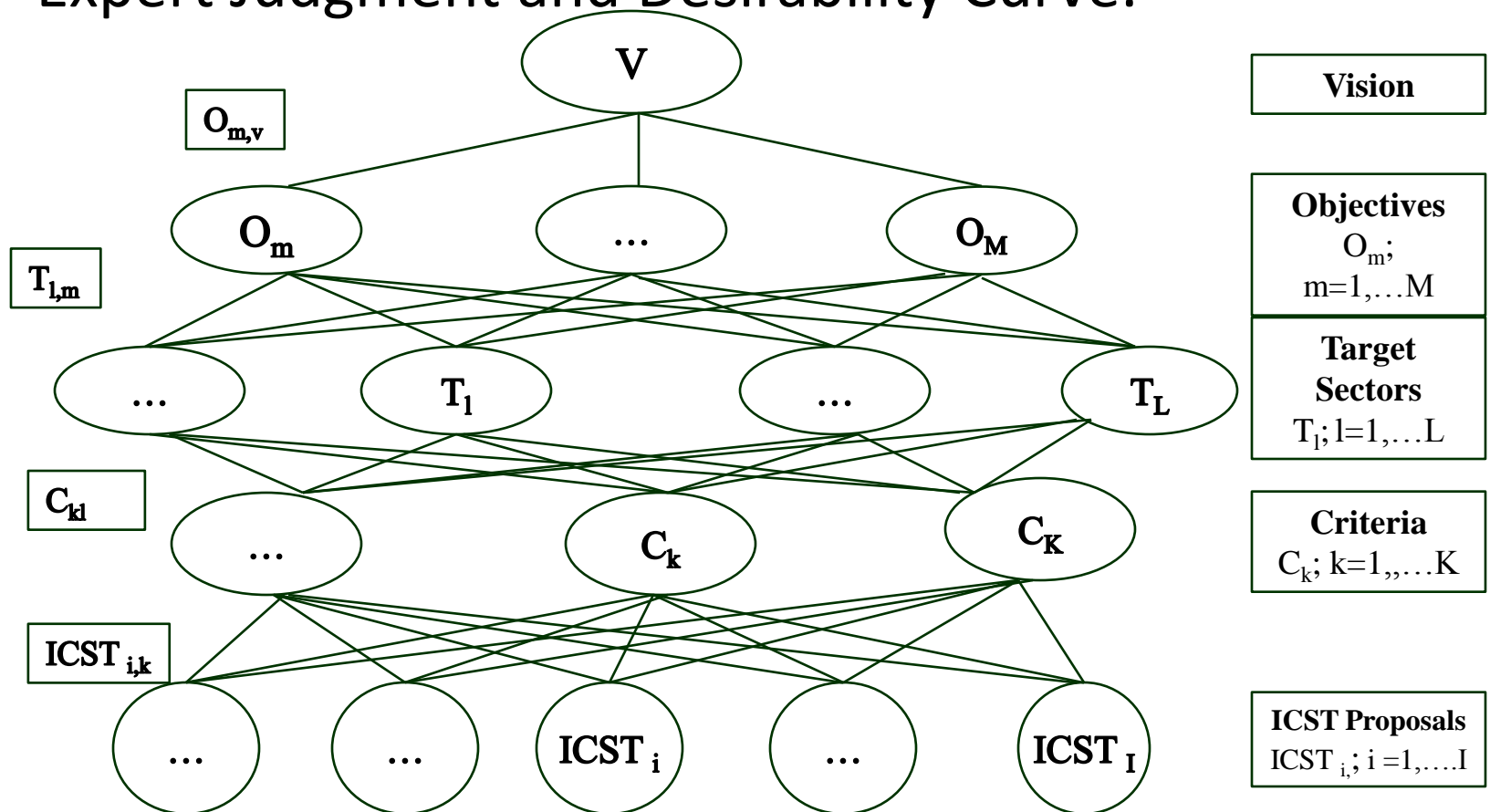
Demonstration of the Model

- The data from National Science and Technology Development Agency (NSTDA) of Ministry of Science and Technology in Thailand was used to demonstrate the model.

- The Top-down approach (Mission-oriented Goal): 1st level, 2nd level & 3rd level

- The Evaluation approach: 4th level
  - Criteria, Sub-criteria and Desirability Curves of sub-criteria

- The Bottom - up approach (Curiosity-driven research) : 5th level

National Science and Technology Development Agency (NSTDA)

- Central Management Office and

- Four National Research Centers:

    - National Bioengineering Technology (BIOTEC)

    - Material Science and Engineering Technology Center (MTEC)

    - National Electronics and Computer Technology Center (NECTEC)

    - National Nanotechnology Center (NANOTEC)

Data Collection

- The first set of data is from the "Mission-oriented Goal":

  - The data about the Country's S&T vision, mission, goals and objectives.
  - The judgment quantification for the hierarchical relationships between consecutive levels of the model.

- The second set of data is from the "Curiosity-driven Research":

  - The data about ICST programs or projects that are initiated by individual researchers in the organization through various channels, e.g. international conferences, diaspora networks, academic social networks
  - The characteristic features of each ICST program/project

Expert Panels

- **Criteria to select the expert member:**

- To provide a balanced representation of opinions, the experts were selected from different backgrounds and different sectors: academic, government, and industry.

- Experts came from various levels of authority:
  - those who make decisions in an organization,
  - those who manage the implementation of the decisions,
  - those who evaluate research proposals.

Expert Panels (Cont.)

- Three Expert Panels were formed. 46 experts in total

  - **Expert Panel I:** 6 Experts
    - Executive directors and Executive deputy directors of the national research centers at the National Science and Technology Development Agency (NSTDA) in the Ministry of Science and Technology (MOST).

  - **Expert Panel II:** 20 Experts
    - They hold high-level executive management positions from private companies, universities, and government organizations.
    - Expert Panel II was divided into four sub-groups related to the four Thailand S&T objectives.

  - **Expert Panel III:** 20 Experts
    - Project analysts from NSTDA in every sub-sector of the five NSTDA target sectors.
    - Expert Panel III was divided into five sub-groups according to the NSTDA target sectors, e.g. Rice, Shrimp, Impaired People, etc.

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Evaluation Criteria

- There are **four evaluation criteria** for ICST:
  - **Strategic Importance (SI):**
    - How important is this international collaboration proposal?
  - **Potential Impact (PI):**
    - What is the benefit of having this collaboration proposal?
  - **Human Resource Development (HRD):**
    - How many researchers can benefit from this proposal?
    - What is the significance level of benefit to the researcher?
  - **Matching Fund (MF):**
    - What is the ratio of the matching fund from the international partner to the total funds needed?

Evaluation Sub-criteria

- There are **four sub-criteria** for the **Strategic Importance (SI)** criterion:
    - Building up **national S&T capabilities** through international collaboration
    - Establishing a **global partnership**
    - Providing access to **state-of-the-art knowledge** abroad
    - Attracting highly skilled professionals (**brain gain**)

- There are **five sub-criteria** for the **Potential Impact (PI)** criterion:
    - Meeting the **local challenge**, e.g., white spot on the leaf of Thai Jasmine rice
    - Tackling the **global challenge**, e.g., global warming, HIV, natural disaster
    - Having **knowledge or technology transfer**
    - Creating **joint academic papers**
    - Creating joint research programs or **consortia**

- There are **two sub-criteria** for the **Human Resource Development (HRD)** criterion:

    - **Number of researchers** who would benefit from a particular international collaboration project
    - **Significant benefits** from this international collaboration project to the researcher

Desirability Curves corresponding to the Sub-criteria

■ Desirability Curves corresponding to the sub-criteria were developed.

■ The desirability curve can be linear or non-linear based on the values obtained from the experts.

■ The desirability score from each expert member in the panel is calculated and fitted into a graph.

■ For example, the desirability curve of SI sub-criterion in Agriculture & Food ($SI1_A$), To build up National S&T Capabilities, is shown below.

SI 1- Agriculture & Food

	None	Low	Medium	Good	Excellent
Score	5	30	57.5	77.5	92.5

Desirability Value (y-axis: 0 to 100)
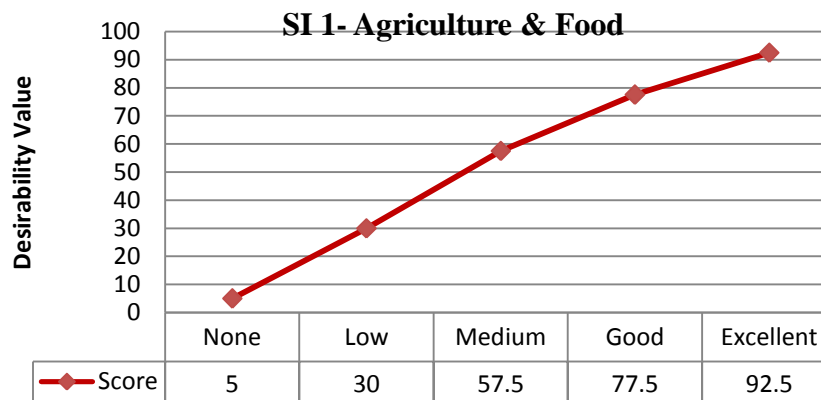
ICST Proposals from Bottom-up

- The ICST proposals were developed by the researchers through their personal interests and emerging new channels, e.g., personal networks, open access, etc.

- Conversion of inputs to data for the model:
  - Project Analysts convert the proposal data to model inputs by

    - Evaluating and interpreting the input provided by the proposers
    - Determining the proposal characteristics
    - Matching the proposal characteristics with the desirability values

Value of ICST Proposals

Four ICST Proposals were obtained from NSTDA Researchers through the bottom-up approach. Their value are calculated by using the formula below.

$$\text{ICST}_i = \sum_{m=1}^{M} \sum_{l=1}^{L} \sum_{kl=1}^{Kl} \sum_{jkl=1}^{Jkl} \text{O}_M^V \cdot \text{T}_l^O \cdot \text{C}_{kl}^t \cdot \text{S}_{jkl}^c \cdot \text{D}(\text{P}_{jkl})_i$$

Where ICST_i = The value of ICST Proposal i   ; i = 1,…4

$\text{D}(\text{P}_{jkl})_i$ = Desirability value of the project characteristic of Proposal i

corresponding to Sub-criterion jkl

S_{jkl}^c = Contribution of Sub-criterion jkl to Criteria

C_{kl}^t = Contribution of Criterion kl to Target Sectors

T_l^O = Contribution of Target Sector l to Objectives

O_M^V = Contribution of Objective m to the Vision

National S&T Vision

Thailand S&T Vision:
"Strong Economy, with knowledge society and better social well-being"

National S&T Objectives

- Sustainable Competitiveness (0.27)
- Community Economy (0.23)
- Learning Society (0.20)
- Quality of Life & Environment (0.30)

Target Sectors
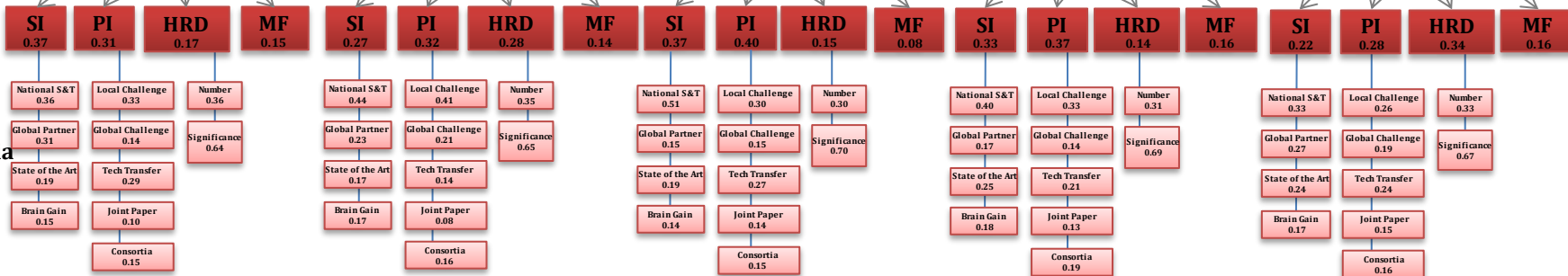
- Agriculture & Food (0.28)
- Energy & Environment (0.22)
- Health & Medicine (0.20)
- Manufacturing & Service (0.17)
- Resources, Communities, & Under-privileged People (0.13)

ICST Criteria

	SI	PI	HRD	MF
Agriculture & Food	0.37	0.31	0.17	0.15
Energy & Environment	0.27	0.32	0.28	0.14
Health & Medicine	0.37	0.40	0.15	0.08
Manufacturing & Service	0.33	0.37	0.14	0.16
Resources, Communities	0.22	0.28	0.34	0.16

ICST Sub-criteria

Agriculture & Food:
- National S&T 0.36 | Local Challenge 0.33 | Number 0.36
- Global Partner 0.31 | Global Challenge 0.14 | Significance 0.64
- State of the Art 0.19 | Tech Transfer 0.29
- Brain Gain 0.15 | Joint Paper 0.10
- Consortia 0.15

Energy & Environment:
- National S&T 0.44 | Local Challenge 0.41 | Number 0.35
- Global Partner 0.23 | Global Challenge 0.21 | Significance 0.65
- State of the Art 0.17 | Tech Transfer 0.14
- Brain Gain 0.17 | Joint Paper 0.08
- Consortia 0.16

Health & Medicine:
- National S&T 0.51 | Local Challenge 0.30 | Number 0.30
- Global Partner 0.15 | Global Challenge 0.15 | Significance 0.70
- State of the Art 0.19 | Tech Transfer 0.27
- Brain Gain 0.14 | Joint Paper 0.14
- Consortia 0.15

Manufacturing & Service:
- National S&T 0.40 | Local Challenge 0.33 | Number 0.31
- Global Partner 0.17 | Global Challenge 0.14 | Significance 0.69
- State of the Art 0.24 | Tech Transfer 0.21
- Brain Gain 0.18 | Joint Paper 0.13
- Consortia 0.19

Resources, Communities:
- National S&T 0.33 | Local Challenge 0.26 | Number 0.33
- Global Partner 0.27 | Global Challenge 0.19 | Significance 0.67
- State of the Art 0.24 | Tech Transfer 0.24
- Brain Gain 0.17 | Joint Paper 0.15
- Consortia 0.16

Desirability Curves

ICST Proposals from Researchers

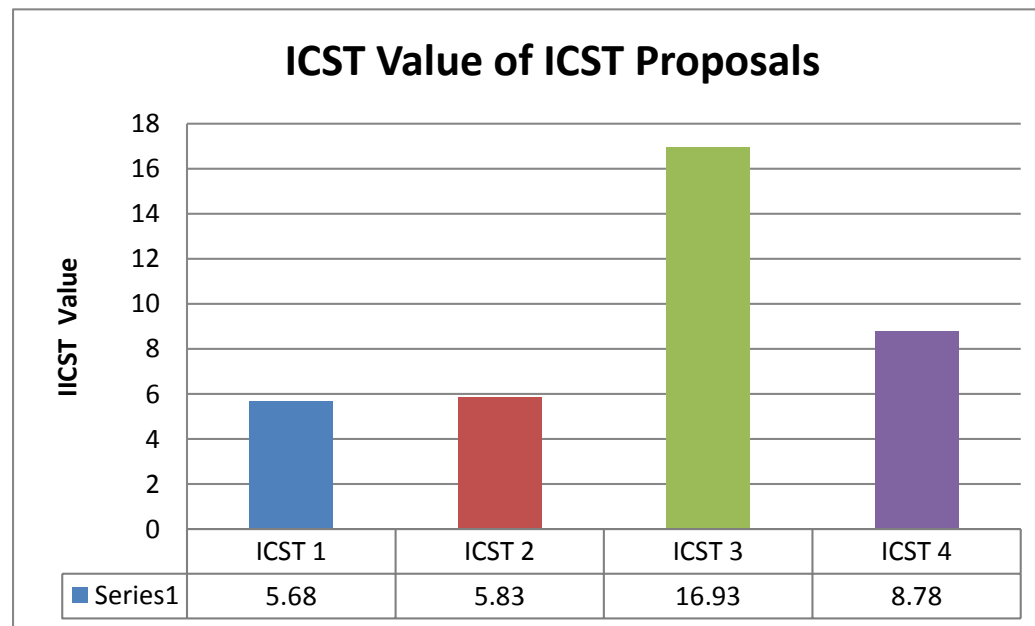- ICST 1 (5.68)
- ICST 2 (5.83)
- ICST 3 (16.93)
- ICST 4 (8.78)

Results

- Proposal 3 has the highest ICST value at 16.93, followed by Proposal 4 at 8.56 and Proposal 2 at 5.83. Proposal 1 is ranked at last place with the ICST value of 5.68.

- Ranking of the four ICST Proposals:

Proposal 3 > Proposal 4 > Proposal 2 > Proposal 1

ICST Value of ICST Proposals

	ICST 1	ICST 2	ICST 3	ICST 4
■ Series1	5.68	5.83	16.93	8.78

Result: Comparison in each sector

- **ICST 1 is in the Manufacturing & Service Sector.**
    - V (ICST 1) = 5.68
    - Max possible value = 15.16
    - V (ICST 1) is 37.5 % of the maximum possible value.

- **ICST 2 is in the Manufacturing & Service and Resources, Communities, and Under-privileged people Sectors.**
    - V (ICST 2) = 5.83
    - Max possible value = 12.61
    - V (ICST 2) is 46.2 % of the maximum possible value.

- **ICST 3 is in the Health & Medicine Sector.**
    - V (ICST 1) = 16.93
    - Max possible value = 18.26
    - V (ICST 3) is 92.7 % of the maximum possible value.

- **ICST 4 is in the Energy & Environment Sector.**
    - V (ICST 4) = 8.78
    - Max possible value = 18.31
    - V (ICST 4) is 48 % of the maximum possible value

Research Outcome

- The expected outcomes of this proposed research are

    - A strategic decision making model for ICST that can help national policy makers make better decisions.

    - The prioritization of ICST projects/programs, which serve the nation's vision and respond to researcher's needs through the linkage between Top-down and Bottom-up approaches.

Validations

- ## Construct Validity
  - Assessment of the quality of the model structure. For this research, the proposed model will be presented to a group of NSTDA experts to verify if the structure of the model is appropriate and reasonable.

- ## Content Validity
  - The degree to which a measure covers the range of meaning included within the concept. It will be performed to test the readiness of the instruments that are used for collecting the data from the respondents. For this research, before the instrument is distributed, it will be tested by a group of related people at NSTDA.

- ## Criteria-Related Validity
  - The degree to which the predictor is adequate in capturing the relevant aspects of the criterion. The criteria-related validity will be completed after the results of the proposed model are presented. It will present how well the proposed model predicts the result. For this research, the expert panels from NSTDA will be asked to check the model results and determine the level of their agreements.

Contributions

- **Contribution to Academia:**

  - The intellectual merit of this research is the development of a strategic policy model that bridges the gap between the top-down and bottom-up approaches. Every organization and country can benefit from the model by applying this comprehensive approach and using the structure of this Strategic Policy Model in ICST with their own data.

- **Contribution to Methodology:**

  - Having a comprehensive approach which integrates multiple methodologies, such as HDM and expert judgment quantification, significantly helps in developing a strategic policy model for international collaboration in S&T.

Contributions (Cont.)

- **Contribution to Management Practice:**

    - Understanding the process of international collaboration in S&T provides great opportunities for all stakeholders. National policymakers, researchers, and project analysts can work together with the same expectations and understanding.

- **Contribution to Thailand:**

    - The analysis of these results can help Thailand's national policymakers to make better decisions about participating in international collaboration in S&T.

    - At the same time, this model enhances the ability of NSTDA researchers to manage their ICST research. It helps them to adjust their research interests to align with the organization's objectives and the country's needs.

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Question?

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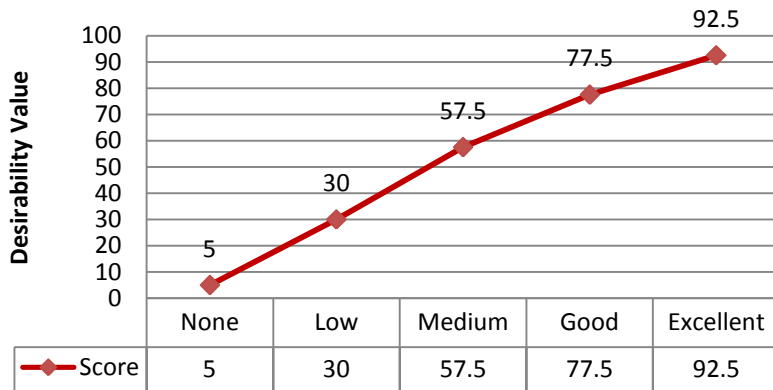
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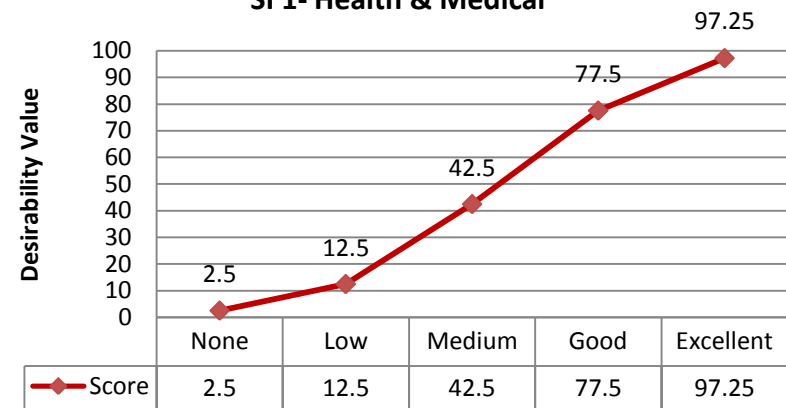Email: patts@pdx.edu

Backup Slides

Desirability Curves of all Sub-criteria of every Target Sectors: Example

- **SI 1: To build up national S&T capabilities through international collaboration**

SI 1- Agriculture & Food

Score	None	Low	Medium	Good	Excellent
Score	5	30	57.5	77.5	92.5

SI 1- Health & Medical

Score	None	Low	Medium	Good	Excellent
Score	2.5	12.5	42.5	77.5	97.25

SI 1- Energy & Environment

Score	None	Low	Medium	Good	Excellent
Score	6.25	44.5	66.75	83	98.75