Customer Satisfaction Feedback on R&D Projects: Methodology and Application to Homeland Security R&D

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Abstract

Transitioning research and development (R&D) projects into operational environments remains a persistent challenge for government agencies. Traditional evaluation methods often fall short in systematically capturing end-user perspectives, limiting the ability to assess the real-world impact of R&D investments. This paper introduces the Systematic Method for Assessing R&D Transition – Customer Satisfaction (SMART-CS), a structured methodology designed to gather and quantify customer satisfaction feedback (CSF) for R&D projects. By employing standardized survey instruments and state-of-the-art evaluation techniques, SMART-CS enables a consistent evaluation of transition effectiveness and perceived value of R&D products. The methodology is applied to several Department of Homeland Security (DHS) Science & Technology Directorate (S&T) R&D projects, with a focused case study on the U.S. Coast Guard's implementation of the Port Resilience Operational Tactical Enforcement of Terrorism (PROTECT) tool. These findings support the value of SMART-CS as a systematic and replicable methodology for eliciting customer input to inform and improve R&D transition processes.

1. Introduction

The successful transition of research and development (R&D) projects into operational use is a significant challenge for government agencies, particularly those focused on security, defense, and law enforcement. Federal R&D investments are designed to enhance operational effectiveness, yet assessing the success of these projects from the perspective of their end-users remains a persistent challenge. Traditional evaluation methods often lack a structured framework for eliciting customer feedback, making it difficult to systematically measure the benefits and limitations of R&D products after implementation. In response to this gap, this study introduces the Systematic Method for Assessing R&D Transition – Customer Satisfaction (SMART-CS) methodology, a structured approach for eliciting Customer Satisfaction Feedback (CSF) on R&D projects, enabling a standardized assessment of both the transition process and the perceived benefits of R&D outputs.

The SMART-CS methodology was developed to provide a quantifiable and repeatable process for assessing customer satisfaction with R&D transitions. It incorporates a structured survey instrument and aggregation logic to derive satisfaction indices, allowing for a clearer understanding of the effectiveness of R&D investments. This study applies SMART-CS to evaluate multiple R&D projects funded by the Department of Homeland Security (DHS) Science & Technology Directorate (S&T), with a particular focus on a pilot implementation with the U.S. Coast Guard (USCG). The Port Resilience Operational/Tactical Enforcement of Terrorism (PROTECT) tool, an R&D project previously developed for the USCG, serves as a case study to examine the methodology's practical application and effectiveness.

Given the importance of structured feedback in improving R&D project transitions, this study seeks to answer the following research questions: 1) How effective is the SMART-CS methodology in eliciting and quantifying customer satisfaction in the transition of government-funded R&D projects? 2) What insights can be gained from the application of the SMART-CS methodology regarding factors influencing successful R&D transitions?

To address these questions, the study presents findings from a pilot implementation of SMART-CS, including the aggregation of stakeholder responses into satisfaction indices. Additionally, it examines the methodology's broader application across five DHS R&D projects, assessing its reliability in capturing meaningful feedback. By systematically evaluating stakeholder perceptions of R&D transitions, this study contributes to a more data-driven approach for evaluating and improving government-funded R&D programs.

The remainder of this paper is organized as follows: Section 2 reviews relevant literature on customer satisfaction in R&D transitions, structured elicitation methodologies, and government R&D evaluation frameworks. Section 3 outlines the SMART-CS methodology, detailing its design, implementation, and evaluation process. Section 4 presents the pilot implementation results, focusing on the PROTECT R&D project and additional DHS R&D projects. Section 5 discusses key findings and practical implications, and Section 6 concludes with recommendations for future research and improvements to the methodology.

2. Literature Review

2.1 Overview of Literature Review of R&D Customer Satisfaction Feedback (CSF) Methodologies

A targeted literature review identified nine methodologies relevant to R&D customer satisfaction. The methodologies listed in Table 1 span a broad range of theoretical frameworks and approaches. Each methodology listed is summarized below.

Table 1. Nine methodologies relevant to R&D customer satisfaction.

Literature Review
1. Customer Satisfaction Multi-Attribute Utility (CS-MAU)
2. ATT Quest (WWPF & CVA) [2]
3. Customer Perceived Value of Technology (CPVT) [3]
4. Customer Satisfaction Index (CSI) [4]
5. Performance Measurement System (PMS) [5]
6. Quality Management System (QMS) [6]
7. Technology Value Pyramid (TVP) [7]
8. Total Quality Measurement (TQM) [8]
9. USCG R&D Customer Satisfaction (USCG) [9]

2.1.1. Customer Satisfaction Multi-Attribute Utility (CS-MAU)

The CS-MAU approach evaluates customer satisfaction using two key judgment components: the qualitative probability of successful implementation and the perceived benefits if the implementation is successful. Implementation success is assessed using R&D maturity data derived from real-world use. Customer-perceived benefits are evaluated by eliciting criteria and corresponding weights from selected end-users. This structure allows for a utility score that reflects both the likelihood of successful transition and its anticipated value to the customer.

2.1.2. AT&T Quest (WWPF & CVA)

Fetz (1996) outlines a customer satisfaction measurement approach used within AT&T's internal R&D organization, emphasizing the importance of aligning R&D services with internal customer expectations. The methodology introduced two key components: Worth What Paid For

(WWPF), a single-question metric assessing overall satisfaction by asking customers to rate the service considering both quality and price; and Customer Value Added (CVA), which quantifies perceived value relative to competitors. CVA is calculated by comparing WWPF scores for AT&T services to those of average competitors. Additionally, the methodology utilizes weighted service attributes such as technical expertise, responsiveness, and documentation to identify the drivers of satisfaction.

2.1.3. Customer Perceived Value of Technology (CPVT)

Yoon et al. (2020) introduced the CPVT methodology as a systematic approach for prioritizing R&D projects based on customer-perceived value rather than solely technical potential. The model integrates customer satisfaction, product quality, and technology level using structural equation modeling and opinion mining. The approach consists of three modules: (1) developing an assessment system; (2) analyzing the relationship between technology attributes and customer satisfaction; and (3) establishing a strategy for technological development. By applying this framework to a real-world case (automobile door), the authors demonstrated how customer-perceived value can inform technology development and enhance the efficiency of technology planning based on the customer-perceived value, enabling the launch of new R&D projects.

2.1.4. Customer Satisfaction Index (CSI)

Sarkar and Batabyal (2011) proposed a probabilistic model for evaluating customer satisfaction within R&D organizations. A structured customer feedback data sheet was used to collect responses, where customers graded various quality parameters. The model applied a fault-tree approach, assigning the probability of failure to each parameter based on grade point averages. These were then used to estimate the probability of failure at the customer satisfaction level (CSL). The analysis included statistical testing to determine whether differences existed between customer-to-customer satisfaction levels. In a case study, 88% of customers were found to be fully satisfied, demonstrating the usefulness of the model as a tool for management insight and continuous improvement.

2.1.5. Performance Measurement System (PMS)

The PMS methodology presented in Chiesa & Masella (1996) addresses the challenge of measuring R&D performance, given the intangible nature of its outputs. Traditional systems have relied heavily on input variables or qualitative output assessments. This approach aims to identify quantitative measures linked to R&D activities under full or partial control of R&D managers. Using economic value creation as the normative objective, it develops a performance measurement system that identifies proxy indicators for both R&D effectiveness and efficiency.

2.1.6. Quality Management System (QMS)

Auer, Karjalainen, and Seppänen (1996) describe the development and implementation of a Quality Management System (QMS) for embedded systems R&D at VTT Electronics. The QMS was designed to be practical for real-life R&D projects, emphasizing accessible documentation tools such as plan templates and document skeletons. The system led to improved predictability in project execution and enhanced customer satisfaction. Through internal audits, the organization was able to systematically evaluate and refine R&D procedures. Future improvements were guided by Total Quality Management and Quality Award frameworks, with a focus on customer service and human resources.

2.1.7. Technology Value Pyramid (TVP)

Schwartz, Miller, Plummer, and Fusfeld (2011) describe the Technology Value Pyramid (TVP) as part of a broader effort by the Industrial Research Institute (IRI) to define and measure

R&D effectiveness. Based on survey data from R&D managers across industries, the study found that while the top three metrics for R&D effectiveness have remained consistent over 15 years, their application varies significantly by industry. The findings highlight ongoing challenges with existing metrics and the need for new, adaptable approaches to evaluate R&D value in an evolving environment.

2.1.8. Total Quality Measurement (TQM)

Schumann, Ransley, and Prestwood (1995) present a quality-based framework for measuring R&D performance by treating R&D as a process. The proposed approach focuses on six core elements: people, process, output, internal customers, external customers, and society. Starting with a market-driven objective, the framework guides organizations in selecting relevant measurement types such as internal performance, benchmarking, or competitor assessment based on which process elements are most critical. Rather than relying on a few universal metrics, the model emphasizes selecting a tailored set of key indicators to align with specific strategic goals and quality improvement needs.

2.1.9. USCG R&D Customer Satisfaction (USCG)

Kettel (2014) outlines a transition readiness assessment methodology developed for evaluating Coast Guard (CG) R&D products. The approach draws from the CG Software Development Life Cycle’s Business Case Template and evaluates products across key elements: System Justification, Stakeholders, Benefits, and Costs. These are further broken down into categories such as CG Requirements, Enterprise Architecture, Mission Sponsor, End Users, Product Support, Strategic Alignment, and Funding. Each category includes four transition-related conditions, rated on a scale from 1 to 10. Final scores are plotted on a quadrant chart comparing Mission Criticality to Transition Strength

2.2 Rating Criteria and Ranking of R&D Customer Satisfaction Feedback (CSF) Methodologies

Following discussions within S&T and further consideration of the stipulations in the GAO recommendation, we developed a list of eleven desirable attributes for R&D customer satisfaction feedback methodologies. We then applied Multi-Attribute Utility Analysis to evaluate the nine methodologies presented in Table 1. These attributes were converted into measurable criteria, as shown in Table 2. For each attribute listed in Table 2, we constructed a scale that measures the performance of each of the methodologies listed in Table 1. Eight of the 11 scales are subjective scales with either 4 or 5 anchors. The remaining three scales are all natural, e.g., counts, (expected) percentages, and (expected) hours. Detailed descriptions of these constructed scales and anchors are provided in Appendix A.

Table 2. Attributes for Evaluating R&D Customer Satisfaction Feedback (CSF) Methodologies.

Attribute	Metric	Best Value	Worst Value
A. Ability to Accommodate Value Tradeoffs	Subjective scale	5	1
B. Ability to Update	Subjective scale	4	1
C. Application Track Record	Natural scale: Real-world applications (count)	10	0
D. Ease/Complexity of Required Responses	Natural (proxy) scale: Incomplete or unusable responses (%)	0%	100%
E. Generalizability and Adaptability	Subjective scale	4	1
F. Impact Uncertainty	Subjective scale	4	1
G. Logical Soundness	Subjective scale	4	1
H. Software Support	Subjective scale	5	1
I. Time Requirements of Customers	Natural scale: Expected training time required (hours)	0	8
J. Transparency and Communication	Subjective scale	4	1
K. Transition Success Uncertainty	Subjective scale	4	1

The complete score matrix for the eleven attributes (columns) and the nine R&D customer satisfaction methodologies (rows) is presented in Table 3. Additionally, a tenth hybrid R&D customer satisfaction methodology (#10) that combines the best-of components from both CS-MAU (#4) and the USCG methodology (#9) was developed and considered in the scoring. All scores are based on consensus judgments of team members using information from the available literature combined with operational experience. The best and worst possible levels for each of the eleven attribute scales are provided in the bottom two rows of Table 3.

Table 3. Literature Review Methodology Evaluation, Raw Scale Scores and Scale Ranges

Raw Scores	A. Ability to Accommodate Value Tradeoffs	B. Ability to Update	C. Application Track Record	*D. Ease/ Complexity of Required Responses	E. Generalizability and Adaptability	F. Impact Uncertainty	G. Logical Soundness	H. Software Support	*I. Time Requirements of Customers (hours)	J. Transparency and Communication	K. Transition Success Uncertainty
1. ATT Quest WWPF & CVA	4	2	10	5%	2	1	3	2	0.5	4	1
Fetz (1996)											
2. Customer Perceived Value of Technology (CPVT)	2	2	1	10%	3	1	3	3	1	2	1
Yoon, Jeong, Lee, Lee (2020)											
3. Customer Satisfaction Index (CSI)	2	2	1	10%	3	1	3	3	1	3	1
Sarkar, Batabyal (2011)											
4. Customer Satisfaction Multi-Attribute Utility (CS-MAU)	5	2	10	10%	4	3	4	5	1	3	3
5. Performance Measurement System (PMS)	2	2	0	10%	2	2	2	2	1	3	2
Chiesa, Masella (1996)											
6. Quality Management System (QMS)	2	2	10	10%	2	4	3	2	1	3	4
Auer, Karjalainen, Sappanen (1996)											
7. Technology Value Pyramid (TVP)	2	2	10	10%	2	1	2	2	1	3	1
Schwartz, Miller, Plummer, Fusfeld (2011)											
8.Total Quality Measurement (TQM)	2	2	0	10%	3	1	2	2	1	3	1
Schumann, Ransley, Prestwood (1995)											
9. USCG	1	2	10	5%	2	3	3	2	0.5	4	4
10. Proposed Hybrid Multi-Attribute Utility (H-MAU)	5	2	0	10%	4	3	4	5	1	4	4
Ranges											
Worst Level	1	1	0	100%	1	1	1	1	8	1	1
Best Level	5	4	10	0%	4	4	4	5	0	4	4

*Note: Customer response times (H) and incomplete or unusable response rates (I) are estimates and will depend on the number and complexity of projects evaluated.

Table 4 indicates that the proposed Hybrid Multi-Attribute Utility methodology (H-MAU) outperforms or equals the other nine methodologies across all attributes except for three (C, D, and I). Even for these three attributes, H-MAU scores very high, suggesting that it would outperform the other nine R&D customer satisfaction methodologies for any reasonable set of weights that does not place all emphasis on one of these three attributes. The scores in Table 4 were aggregated to create an overall index of merit for each of the ten R&D customer satisfaction methodologies, assuming equal weighting for all eleven attributes. This approach assumes that the range from the worst level (0) to the best level (100) of each scale represents a fixed increment in value across attributes.

Table 4. Literature Review Methodology Evaluation, Normalized Scores: Best Level = 100; Worst Level = 0.

Normalized Scores	A. Ability to Accommodate Value Tradeoffs	B. Ability to Update	C. Application Track Record	*D. Ease/ Complexity of Required Responses	E. Generalizability and Adaptability	F. Impact Uncertainty	G. Logical Soundness	H. Software Support	*I. Time Requirements of Customers (hours)	J. Transparency and Communication	K. Transition Success Uncertainty
1. ATT Quest WWPF & CVA	75.0	33.3	100.0	95.0	33.3	0.0	66.7	25.0	93.8	100.0	0.0
Fetz (1996)											
2. Customer Perceived Value of Technology (CPVT)	25.0	33.3	10.0	90.0	66.7	0.0	66.7	50.0	87.5	33.3	0.0
Yoon, Jeong, Lee, Lee (2020)											
3. Customer Satisfaction Index (CSI)	25.0	33.3	10.0	90.0	66.7	0.0	66.7	50.0	87.5	66.7	0.0
Sarkar, Batabyal (2011)											
4. Customer Satisfaction Multi-Attribute Utility (CS-MAU)	100.0	33.3	100.0	90.0	100.0	66.7	100.0	100.0	87.5	66.7	66.7
5. Performance Measurement System (PMS)	25.0	33.3	0.0	90.0	33.3	33.3	33.3	25.0	87.5	66.7	33.3
Chiesa, Masella (1996)											
6. Quality Management System (QMS)	25.0	33.3	100.0	90.0	33.3	100.0	66.7	25.0	87.5	66.7	100.0
Auer, Karjalainen, Sappanen (1996)											
7. Technology Value Pyramid (TVP)	25.0	33.3	100.0	90.0	33.3	0.0	33.3	25.0	87.5	66.7	0.0
Schwartz, Miller, Plummer, Fusfeld (2011)											
8.Total Quality Measurement (TQM)	25.0	33.3	0.0	90.0	66.7	0.0	33.3	25.0	87.5	66.7	0.0
Schumann, Ransley, Prestwood (1995)											
9. USCG	0.0	33.3	100.0	95.0	33.3	66.7	66.7	25.0	93.8	100.0	100.0
10. Proposed Hybrid	100.0	33.3	100.0	90.0	100.0	66.7	100.0	100.0	87.5	100.0	100.0

* Note: Customer response times (H) and incomplete or unusable response rates (I) are estimates and will depend on the number and complexity of projects evaluated

The aggregate scores for each of the methodologies are presented in Figure 1. The top two methodologies are both based on versions of multi-attribute utility analysis (H-MAU and CS-MAU). As seen in Table 4, H-MAU (#10) outperforms CS-MAU (#4) on all attributes, showing that the proposed hybrid methodology, which combines elements of both CS-MAU and the USCG methodology, is the best-in-class for evaluating R&D customer satisfaction.

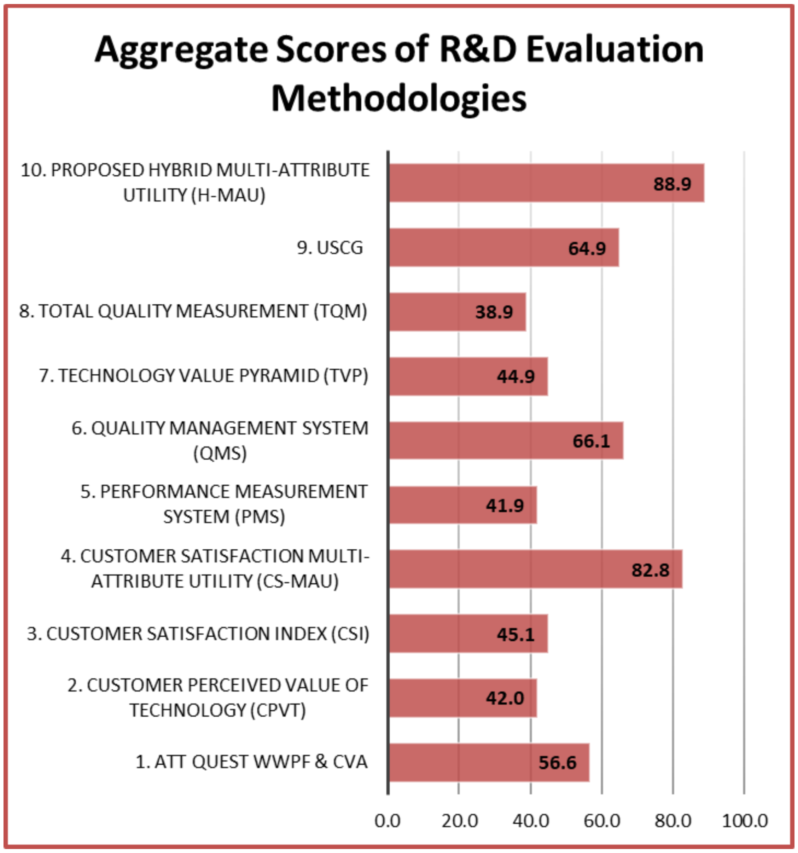

Figure 1. Aggregate Scores of R&D Customer Satisfaction Feedback (CSF) Evaluation Methodologies. Evaluation results assume equal weights across all 11 criteria.

2.3 Recommended Strategic Multi-Attribute Ranking Technique for R&D Customer Satisfaction

Based on the evaluation shown in Figure 1, three methodologies scored the highest: the Multi-Attribute Utility methodology (82.8 out of 100), the Quality Management System (66.1), and the USCG Post Completion Review and related methodologies for R&D project evaluation (64.9). The Quality Management System is conceptually and practically similar to the multi-attribute utility methodology, while the USCG methodology introduces distinct features, such as the use of transition likelihood and distinctions between outcome and process criteria in customer satisfaction. The research team, therefore, developed a hybrid methodology that incorporates the best features of both the USCG and multi-attribute utility methodologies. This hybrid, referred to as the Strategic Multi-Attribute Ranking Technique – Customer Satisfaction

(SMART-CS), is recommended for evaluating R&D customer satisfaction, as described in the following section.

3. The SMART-CS Methodology

This section outlines the components of the methodology, detailing the identification of key stakeholders, the criteria for assessing customer satisfaction, and how the feedback is collected and processed.

3.1 S&T R&D Stakeholders

The success of the SMART-CS methodology depends on engaging the right stakeholders. There are three primary groups of stakeholders involved in the R&D transition process:

1. Feedback Providers (R&D Product customers): These are the end-users and personnel who will directly use the R&D product. They include various leadership, supervisory, and operational roles within the relevant agencies.
2. R&D Performers (Developers): These are the researchers and companies responsible for performing the R&D activities. They are responsible for developing, refining, and delivering the R&D product.
3. Budget Providers and Authorizers: This third group includes Congressional representatives and other policymakers who fund and authorize R&D projects. This group also includes the general public, who ultimately benefit from R&D products designed to improve national security.

In practice, it is essential to clearly identify and engage the appropriate stakeholders early in the SMART-CS process to ensure that all parties affecting the satisfaction score are aligned.

3.2 Customer Satisfaction Criteria

The satisfaction criteria are customized based on the type of R&D product (e.g., software tool, physical technology, or knowledge product) and the anticipated impact (e.g., cost reduction, improved operational efficiency, or better decision-making).

The questions related to the criteria and the measures used in the SMART CS are: 1) Is the R&D product currently in use? (yes/no) 2) If not yet in use, what is the probability of its eventual successful use? (sliding scale from 0-100%) 3) Also, if not yet in use, what is the expected timeline for the anticipated R&D product to be used (sliding scale from weeks to months to years)?

The following outcome question then addressed the likely benefits once used. 1) What are the primary benefits of the R&D product? (select all that apply: cost savings, reduction of effort (e.g., fewer staff hours), improved performance of operations, improved decision making (value of information), improved staff performance through training, and an "other" category to be specified by the respondent.

The magnitude of the benefits is determined by three questions. 1) What is the annual baseline cost (if baseline is not known, assume that it is 100%)?, 2) What is the savings relative to the baseline cost (sliding scale from 0% to 100%), and 3) What is the degree of confidence in the response (low, moderate, high).

3.3 Qualtrics Implementation of SMART-CS

SMART-CS employs the Qualtrics platform, which streamlines the questionnaire process and ensures responses are easily captured. The question flow and branching logic in Qualtrics are designed to adapt to the status of the R&D product (in use or not yet transitioned). For example, if the product is in use, respondents are asked about benefits like cost savings or improved decision-making. If not in use, respondents estimate the probability of eventual use and provide a timeline for deployment. The total time required to complete the questionnaire is around 5-10 minutes. Figure 2 shows the question flow of the questions in the Qualtrics implementation of the SMART-CS methodology.

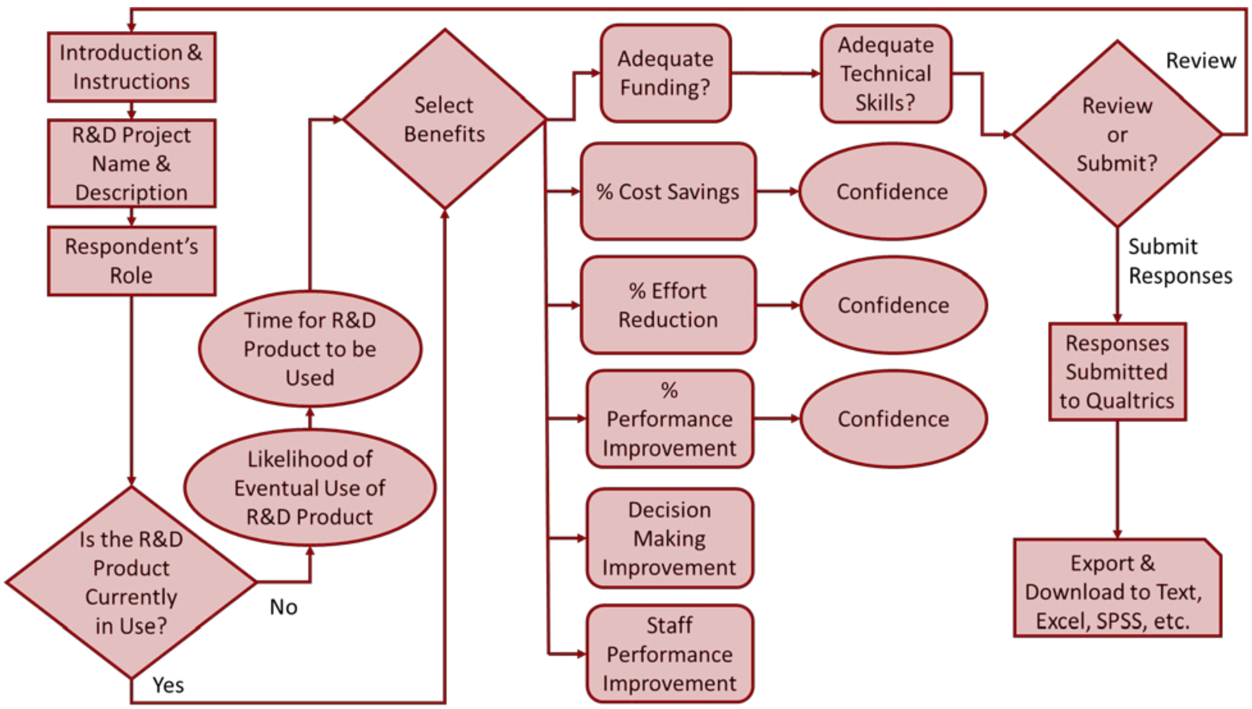

Figure 2. Flowchart of Question Sequencing and Branching in the Qualtrics Implementation of SMART-CS.

The responses to the Qualtrics questionnaire can be downloaded in a relatively compact format. Only minimal post-processing is required to calculate the two aggregate scores—one for outcomes and one for process.

Table 5 presents a streamlined version of the results, excluding irrelevant questions and highlighting the two CSF aggregate scores: one for outcome criteria and one for process criteria.

Table 5. Compact Version of Qualtrics Results with Post-Processing Scores

	Stakeholder 1	Stakeholder 2
STAKEHOLDER INFORMATION		
Type of Stakeholder	R&D Rep	R&D funder
Affiliation	USCG	OUP/CREATE
OUTCOME CRITERIA		
Utilized Before Project Close-Out?	Yes	Yes
Probability of Utilization	1	1
Improvement of operations	yes	yes
Baseline	100	100
Improvement	50%	50%
PROCESS CRITERIA		
Appropriateness of Funding Level	Yes	Yes
Appropriateness of Technical Skills	Yes	Yes
OVERALL OUTCOME SCORE	50	50
OVERALL PROCESS SCORE	100	100

The outcome score is calculated as follows:

*Outcome Score = Probability of Eventual Use * Improvement Score*

Since the baseline metric and estimate are always calibrated to 100%, the effective outcome score depends solely on the probability of eventual use and the improvement score. In most cases, the outcome score will range from 0 to 100. For example, a research product already in use that doubles the baseline performance (i.e., 100% improvement or a 100% reduction in costs or effort) would result in an outcome score of 100.

In rare instances, the improvement score may exceed 100%. In such cases, it is acceptable for the outcome score to exceed 100 as well. Additionally, if there are multiple benefit categories where the total improvement or cost reduction exceeds 100%, the outcome scores across these categories will be added together, potentially resulting in a total score above 100.

The scoring for decision-making and training benefits is handled differently. For improved decision-making, the outcome scores are as follows: No improvement = 0, One-time low-stakes decisions = 25, Multiple low-stakes decisions = 50, One-time high-stakes decisions = 75, Multiple high-stakes decisions = 100. Similarly, for improved staff performance through training, the scores are: No improvement = 0, A few staff members in moderately important areas = 25, Many staff members in moderately important areas = 50, A few staff members in highly important areas = 75, Many staff members in highly important areas = 100. The process score is determined based on the responses to the first two questions—whether the project received adequate funding and if the technical skills were appropriate: No/No = 0, Yes/No = 50, No/Yes = 50, Yes/Yes = 100.

4. Pilot Implementation of the SMART-CS Methodology

4.1 Overview of the USCG Case Study with the PROTECT R&D Project

To gather first-hand feedback on the SMART-CS methodology from a DHS Operational Component, CREATE engaged the U.S. Coast Guard (USCG) in a tabletop exercise (TTX) to evaluate the process. The exercise used the Port Resilience Operational/Tactical Enforcement of Terrorism (PROTECT) R&D project, which had been conducted several years earlier specifically for the USCG.

The Port Resilience Operational/Tactical Enforcement of Terrorism (PROTECT) tool is a software program designed to generate a “smart” randomization schedule for U.S. Coast Guard harbor patrols. It accounts for the value of potential terrorist targets and the limited resources available for patrolling. High-value targets receive more frequent protection than lower-value targets, while PROTECT maximizes uncertainty about which target is being guarded at any given time. Even if adversaries observe the patrol schedule, the system ensures unpredictability, making it difficult for them to anticipate which locations will be protected (Shieh et al., 2015).

The elicitation session provided an overview of the SMART-CS methodology, reviewed the objectives of the TTX and the PROTECT project, and then engaged two stakeholders in responding to the Qualtrics elicitation. The results of this session are detailed in the following sections.

4.2 PROTECT Pilot

The SMART-CS methodology was pilot-tested for the PROTECT R&D project, as described in Section 4.1. Two stakeholders participated in the pilot test: (1) an R&D staff member and (2) the former director of the COE that funded the PROTECT project. Each independently accessed the Qualtrics survey tool and successfully completed all questions.

As shown in Table 5, their responses were closely aligned. Both stakeholders agreed that PROTECT had been successfully implemented and that its primary benefit was improved operations. They estimated a 50% improvement in operations and confirmed that funding and technical skill resources were adequate for the project. This small-scale pilot suggests that the Qualtrics survey instrument effectively captures the customer satisfaction data required for the SMART-CS methodology.

The stakeholder inputs from the pilot study, presented in Table 6, were analyzed using the SMART-CS aggregation logic to generate two indices of customer satisfaction: one reflecting the benefits provided by the R&D product and the other assessing the R&D project's process experience.

As shown in Table 5, the PROTECT project received a benefit score of 50, based on a 50% improvement in one of the five benefit categories—Improvement of Operations. Since no benefits were reported in the other four categories, no additional components were included in the SMART-CS benefit score. The process score for the PROTECT project was a perfect 100, as both funding and technical expertise were deemed adequate for the R&D development.

5. Additional Pilot Results and Tools/Templates.

Five full-scale pilot studies of the S&T R&D Customer Satisfaction Feedback (CSF) methodology using the SMART-CS tool demonstrated its effectiveness in capturing stakeholder feedback on R&D project outcomes. The results provide key insights into customer satisfaction and inform improvements to internal S&T processes.

These pilot results will guide the future expansion of customer feedback collection within the S&T matrix structure and streamline the CSF process for effective implementation across S&T's R&D portfolio. Table 6 presents the results of the pilot projects, highlighting the R&D CSF Transition Benefit Ratings, Likelihood of Transition, Risk-Adjusted Transition Uptake Benefit Ratings, and S&T R&D Process Ratings. These metrics provide a structured approach for evaluating R&D project impact and transition potential.

Table 6. Summary of SMART-CS Pilot R&D Project Ratings and NDAA Tracking Recommendations.

CSF PILOT R&D PROJECT	R&D CSF Transition Benefit Rating	Likelihood of Transition	Risk-Adjusted Transition Uptake Benefit Rating	S&T R&D Process Rating	NDAA Future Year Tracking Recommendation
Augmented Reality Sand Table (ARES) for CBP/USBP	66	10%	8	81	No
Common Viewer System (CVS) for CBP/OFO	81	100%	81	85	Yes, Years 1-3
Enhanced Dynamic Geo-Social Environment (EDGE) Virtual Training for CBP/USBP	100	15%	15	100	No
Resilient Position, Navigation, and Timing (PNT) Conformance Framework for CISA	100	100%	100	100	Yes, Years 1-3
TITANIC for USCG	80	85%	67	84	Yes, Years 1-3

Definitions of Key CSF Ratings:

R&D Transition Benefit CSF Rating (0-100 scale): This rating represents the R&D customer's satisfaction with the transition product. It reflects the potential benefit to the customer if the product is successfully transitioned and implemented. The score is a weighted average of normalized ratings across relevant benefit categories, including cost savings, reduction of effort, improved performance, enhanced decision-making, and improved staff performance. A score of 100 represents the highest possible benefit across all categories, while a score of 0 indicates the lowest possible benefit.

Likelihood of a Successful Transition (0-100%): This represents the probability, as estimated by the R&D customer, that the transition product will successfully move into operational use. A score of 0% indicates that transition and implementation are highly unlikely, while a score of 100% means the product has already been or will certainly be implemented.

Risk-Adjusted Transition Uptake Benefit CSF Rating: This score adjusts the Transition Benefit CSF Rating based on the likelihood of successful implementation. It is calculated as the product of the R&D Transition Benefit CSF Rating and the Likelihood of Transition score.

S&T R&D Process CSF Rating (0-100 scale): This rating evaluates the R&D customer's satisfaction with S&T's process for conducting the R&D project. It considers whether the necessary resources and technical expertise were provided for successful project execution. The rating is derived from an equally weighted average of resource and expertise scores, where 0 represents inadequate support and 100 indicates full adequacy.

The SMART-CS methodology aggregates stakeholder responses to derive these ratings, generating both quantitative scores and qualitative feedback. While statistical analysis is limited due to the small sample size, the numerical ratings provide a familiar 0-100 scale for future benchmarking. More importantly, stakeholder comments offer valuable insights into both strengths and areas for improvement within specific projects and S&T's broader R&D processes.

6. Conclusions

The application of the SMART-CS methodology provides a valuable approach to capturing customer satisfaction feedback in the context of R&D projects, particularly within the Department of Homeland Security's (DHS) operational components. The pilot tests conducted with the PROTECT R&D project, as well as subsequent full-scale pilots, have demonstrated the tool's effectiveness in generating actionable insights. By combining both quantitative scores and qualitative feedback, the methodology offers a comprehensive view of R&D project performance, from both the outcomes and the process perspectives.

The continued use of the SMART-CS methodology can support decision-making regarding funding and project continuation, as well as provide valuable input for future R&D efforts. By further expanding the collection of customer feedback and refining the CSF process, it will be possible to enhance the effectiveness of R&D efforts across DHS, ultimately leading to better outcomes for the nation's security.

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Appendix A: Attributes and Scales for Evaluating R&D Customer Satisfaction Methodologies

A.1. Ability to Accommodate Value Tradeoffs

Ease of explicitly assessing and modeling value trade-offs among conflicting R&D evaluation criteria

1. Methodology cannot capture trade-offs
2. Methodology could be adapted to capture an ordinal measure of trade-offs
3. Methodology could be adapted to capture trade-offs in the form of weight ratios
4. Methodology includes assessment of trade-offs for an additive model
5. Methodology includes assessment of trade-offs that allow for non-additive (interactive) value models capturing attribute synergies

A.2. Ability to Update

Adaptability of the R&D evaluation methodology for periodic updating

1. No facility for updating specified; would be equivalent to "starting over"
2. No facility for updating specified, but the methodology could be adapted to allow for new customer feedback over time
3. Methodology anticipates the need to add new customer feedback over time, but does not include the ability to map changes over time
4. Methodology explicitly captures and models customer feedback over time and analyzes changes

A.3. Application Track Record

Quality and size of documented applications of the R&D evaluation methodology

- Natural Scale: Count of actual applications (not "toy" demonstrations) of methodology
- Worst Level: 0 applications
- Best Level: 10 (or more) applications

A.4. Ease/Complexity of Required Responses

Expected difficulty of customers in providing the inputs required by the R&D evaluation methodology

- Proxy attribute: Expected % of respondents who provide incomplete or unusable responses
- Worst Level: 100%
- Best Level: 0%

A.5. Generalizability and Adaptability

Applicability of the methodology to a diverse range of different domains, projects, and customers

1. Designed for a particular narrow R&D domain and not easily generalized
2. Designed for a particular narrow R&D domain and could be generalized to other domains
3. Designed for a range of R&D domains and could be generalized to other domains
4. Completely general methodology applicable to virtually any R&D domain

A.6. Impact Uncertainty

Adaptability of the methodology to account for uncertainty about the impact of R&D, conditional on successful use

1. Not readily adaptable
2. Adaptable to obtain qualitative measures of use success uncertainty
3. Adaptable to obtain probabilistic measures of use success uncertainty
4. Incorporated into the methodology

A.7. Logical Soundness

Extent to which R&D evaluation methodology is based on theoretically defensible rationale

1. Methodology is completely ad hoc, with no rationale
2. Methodology not based on a given rationale, but does follow prior R&D evaluation tradition
3. Methodology based on a rationale that is internally consistent
4. Methodology based on a carefully constructed axiomatic foundation

A.8. Software Support

Level of software support available

1. None available
2. Methodology is amenable to the use of generic software for survey delivery and statistical analysis.
3. Specialized software developed for collecting customer feedback
4. Specialized software developed for collecting and analyzing customer feedback responses
5. Specialized software developed for collecting, analyzing, and communicating results, including sensitivity analysis of customer feedback responses

A.9. Time Requirements of Customers

Total time required of customer respondents, including time for training if required, and time answering questions

- Natural Scale, average hours required
- Worst Level = 8.0 hours (1 day)
- Best Level = 0.0 hours (uses existing data)

A.10. Transparency and Communication

Extent to which the procedures, models, and results of the R&D evaluation methodology can be communicated and understood

1. Methodology is a black box; procedures and results are extremely difficult to communicate.
2. Methodology is complicated and requires extensive effort and training to communicate.
3. Methodology can be communicated and understood with moderate effort and training.
4. Methodology is highly intuitive and can be easily communicated with little effort and no training.

A.11. Eventual Use Success Uncertainty

Adaptability of the methodology to account for uncertainty about eventual use success

1. Not readily adaptable
2. Adaptable to obtain qualitative measures of use success uncertainty
3. Adaptable to obtain probabilistic measures of use success uncertainty
4. Incorporated into the methodology