S&T Analysis and Management of Innovation Activity IV (STAMINA IV)

Benefit Statements, Benefit-Cost-Risk Analysis, and Integration of Key Performance Indicators (KPIs) and Indicators of Success (IoS) into the S&T Business Process Flow (BPF)

Appendix D: Example KPIs and IoS of S&T R&D Projects

FY24 Annual Report
For Period September 29, 2023, to September 28, 2024

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Appendix D: Example Key Performance Parameters (KPIs) and Indicators of Success (IoS) of S&T R&D Projects

Executive Summary

ES.I. Technical Approach

This document demonstrates the application of a methodology for analyzing articles of R&D projects similar to S&T R&D projects to identify and extract the articles' KPIs and IoS, then classifying them at the research level, the transition and user level, and the financial/commercialization level. The objective was to develop a detailed understanding of KPIs and IoS across the various types of R&D, the R&D lifecycle phase, and across multiple domains.

We started this effort by first reviewing the list of S&T R&D projects approved for STAMINA IV, and selecting a subset on which to demonstrate the process. To provide continuity across the tasks, we selected the same five as Task 1. We then conducted literature reviews to find articles on R&D projects similar to those five. These articles were then reviewed to extract KPIs and IoS

The categorization used provided a framework for accommodating and understanding the diverse breath of metrics used to measure R&D success across the S&T domain. The framework in turn enabled the analysis to focus on the KPIs and IoS of specific interest to this study, namely, R&D Performance KPIs, Operational/User-Level IoS, and Financial KPIs/ROI. By analyzing a range of similar projects, it was possible to identify prevalent KPIs and IoS across multiple articles, highlighting consistent KPI and IoS categories. This consistency suggests that common categories may simplify the effective identification and selection of KPIs and IoS in new S&T R&D projects.

ES.II. Review and Analysis of STAMINA IV S&T R&D Project List

The next technical step was to enhance the information in the STAMINA IV S&T R&D project table with additional information associated with R&D projects for which comparable articles were to be found. The dataset was arranged by year of transition, and additional columns were introduced to enhance the informational depth of each project. These new columns included categories such as Benefit Categories, the various categories of KPIs and IoS, Customer, etc. The aim was to provide a comprehensive view of each R&D project's scope and impact. A total of 12 R&D projects were extensively researched and categorized. The 12 projects included operational domains associated with CBP, TSA, and the USCG. The categorization and the data inserted provided a more detailed and structured overview for better project assessment and alignment, enabling participants to understand the specifics and potential impacts of each R&D project. This step provided a more detailed and organized dataset to support the ensuing comprehensive evaluations of R&D KPIs and IoS, ensuring that all relevant information was captured and easily accessible.

ES.III. Example Key Performance Parameters (KPIs) and Indicators of Success (IoS) of Selected S&T R&D Projects

With the preparation as described in the preceding sections, the team then focused on identifying and categorizing the KPIs and IoS from similar projects. The research was iterative, progressing through increasing refinements, expansions, and clarifications of the KPIs and IoS. In the first pass, general KPIs and IoS were extracted from the similar projects identified. As more articles were reviewed, increased understanding of the domain-relevant KPIs and IoS resulted. Then, subsequent passes of the literature enabled deeper analysis to categorize the KPIs and IoS into specific categories, including PM KPIs (Cost, Resource, Schedule, Risk, Quality), R&D Performance KPIs, Transition KPIs, Operational IoS, and Financial/Commercial KPIS/ROI. The results are refined tables of KPIs and IoS, systematically categorized across similar projects, providing a clear framework to identify the most relevant KPI and IoS categories. This enabled a focus on the critical operational performance and financial indicators, enabling more precise and targeted evaluations of R&D outcomes. Furthermore, this approach ensured that the KPIs and IoS were not only identified but also categorized in a manner that would facilitate easy reference and application in future evaluations.

ES.IV. Suggestions for Future Efforts

The literature review for this effort was intentionally focused on articles related to the five case studies, and will perhaps have overlooked niche or emerging research area. Future efforts can perhaps,

1. Increase diversity in literature sources
2. Incorporate a section on limitations and challenges, such as biases
3. Consider feedback from R&D practitioners

Future efforts can definitely be helped out by expanding on the very limited data provided on the S&T R&D projects in the original transmittal spreadsheet. Recommendations for improvement include,

1. Validate data inputs
2. Improve data collection
3. Continuous feedback mechanism
4. Expand the dataset
5. Integrate qualitative data

Finally, the set of KPIs and IoS identified may not be complete due to the limited number of articles analyzed. Other recommendations for improvement include,

1. On-going review and update of KPI and IoS categories
2. Collaborate with stakeholders
3. Develop a benchmarking framework

In conclusion, implementing these recommendations will strengthen the methodology for identifying and categorizing KPIs and IoS in S&T R&D. By addressing specific areas for improvement such as diversifying literature sources, integrating qualitative data, and refining the KPI and IoS frameworks, the methodology will evolve to meet the evolving needs of stakeholders across S&T's diverse organizational settings. This iterative approach ensures that the methodology remains robust, relevant, and practical, ultimately maximizing the societal impact of university research efforts through informed decision-making and strategic resource allocation.

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Example Key Performance Parameters (KPIs) and Indicators of Success (IoS) of S&T R&D Projects

1. Technical Approach

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We started this effort by first reviewing the list of S&T R&D projects approved for STAMINA IV, and selecting a subset on which to demonstrate the process. To provide continuity across the tasks, we selected the same five as Task 1. We then conducted literature reviews to find articles on R&D projects similar to those five. These articles were then reviewed to extract KPIs and IoS in the general categories of,

- Project Management (PM) KPIs (Cost, Resource, Schedule, Risk, Quality)
- R&D Performance KPIs (Technical Performance)
- Transition KPIs (TRL, C&M, Regulatory, Stakeholder Engagement, Integration Flexibility, Documentation and TT)
- Intermediate Output KPIs
- Operational, Impact, and Value IoS
- Post-Transition and Financial KPIs

This categorization was used to provide the framework for accommodating and understanding the diverse breath of metrics used to measure R&D success across the S&T domain. The framework in turn enabled the analysis to focus on the KPIs and IoS of specific interest to this study, namely, R&D Performance KPIs, Operational/User-Level IoS, and Financial KPIs/ROI. By analyzing a range of similar projects, it was possible to identify prevalent KPIs and IoS across multiple articles, highlighting consistent KPI and IoS categories. This consistency suggests that common categories may simplify the effective identification and selection of KPIs and IoS in new S&T R&D projects.

2. Review and Analysis of STAMINA IV S&T R&D Project List

The next technical step was to enhance the information in the STAMINA IV S&T R&D project table with additional information associated with R&D projects for which comparable articles were to be found. The dataset was arranged by year of transition, and additional columns were introduced to enhance the informational depth of each project. These new columns included categories such as Benefit Categories, the various categories of KPIs and IoS, Customer, etc., as shown in Table D-1. The aim was to provide a comprehensive view of each R&D project's scope and impact. A total of 12 R&D projects were extensively researched and categorized. The 12 projects included operational domains associated with CBP, TSA, and the USCG.

Table D-1. Additional Information Added to S&T R&D Project List Table

Additional S&T R&D Project Information Columns
Knowledge Product or Technology Product?
Benefit Category(ies)
Customer
Suitable for BCRAT?
Project Management KPIs
R&D Output KPIs
Operational IoS
Financial KPIs
Other Project Data
Simplified Description of Project Methodology
Past or Other Current Associated Projects
Similar R&D Projects

A segment of the resultant table of information on each S&T R&D project is shown as an example in Table D-2.

Table D-2. Example Segment of Enhanced S&T R&D Project Listing

The expanded table provided a more detailed and organized dataset to support comprehensive evaluations of R&D KPIs and IoS. Benefits of the expanded table included,

1. **Improved Data Usability:**
   - The refined dataset provided a more user-friendly and accessible format, making it easier for stakeholders to navigate and understand the information.
2. **Enhanced Analytical Capabilities:**
   - With the addition of new columns and a clearer chronological structure, the dataset allowed for more sophisticated analyses of project trends, performance, and outcomes over time.
3. **Greater Insight into Project Types:**
   - Categorizing tasks by operational domain (TSA, CBP, US Coast Guard) provided clear distinctions between different types of Task, enabling targeted analysis and better alignment with organizational objectives.
4. **Increased Data Depth and Breadth:**
   - The expanded informational depth, including new metrics and KPIs, provided a more comprehensive view of each project, enabling deeper insights into their impacts and effectiveness.
5. **Enhanced Decision-Making:**
   - The enriched dataset supported more informed decision-making processes by providing detailed and accurate information about project performance and alignment with strategic goals.
6. **Improved Project Assessment:**
   - The additional qualitative and quantitative data allowed for more thorough assessments of project success and impact, beyond just financial metrics.
7. **Stakeholder Engagement:**
   - The detailed overview and additional insights facilitated better communication and engagement with stakeholders, helping them understand the broader implications and success of the project.
8. **Identification of Best Practices:**
   - The structured and detailed dataset enabled the identification of best practices and successful methodologies that could be applied to future projects.

This categorization and the data inserted provided a more detailed and structured overview for better project assessment and alignment, enabling participants to understand the specifics and potential impacts of each R&D project. This step provided a more detailed and organized dataset to support the ensuing comprehensive evaluations of R&D KPIs and IoS, ensuring that all relevant information was captured and easily accessible.

3. Example Key Performance Parameters (KPIs) and Indicators of Success (IoS) of Selected S&T R&D Projects

With the preparation as described in the preceding sections, the team then focused on identifying and categorizing the KPIs and IoS from similar projects. The research was iterative, progressing through increasing refinements, expansions, and clarifications of the KPIs and IoS. In the first pass, general KPIs and IoS were extracted from the similar projects identified. As more articles were reviewed, increased understanding of the domain-relevant KPIs and IoS resulted. Then, a subsequent pass of the literature enabled deeper analysis to categorize the KPIs and IoS into specific categories, including PM KPIs (Cost, Resource, Schedule, Risk,

Quality), R&D Performance KPIs, Transition KPIs, Operational IoS, and Financial/Commercial KPIS/ROI. A final pass of the literature was then performed to ensure all relevant KPIs and IoS had been categorized accurately, to add any additional KPIs and IoS, as applicable, and to ensure KPIs and IoS were clearly defined and appropriately categorized for better clarity and usability. Data on the KPIs and IoS were captured in Excel files, and an example segment of a typical table extracting KPIs and IoS from the articles is shown in Table D-3. The results of this effort for all the articles reviewed and refined are provided in the tables of KPIs and IoS, shown in Tables D-4 through D-7, systematically categorized across similar projects, providing a clear framework to identify the most relevant KPI and IoS categories.

The framework and approach were found to provide key benefits in the challenges associated with KPI and IoS identification, including,

1. **Enhanced Precision in KPI Identification:**
   - The project successfully identified a comprehensive list of financial and operational KPIs, providing precise metrics to evaluate the success and performance of R&D Task.
2. **Improved KPI Categorization:**
   - By categorizing KPIs into clear and relevant groups, the project ensured that evaluations could be more targeted and aligned with specific financial and operational goals.
3. **Actionable Insights:**
   - The refined and categorized KPIs provided actionable insights for project managers, enabling them to make data-driven decisions to enhance project performance and outcomes.
4. **Standardized Evaluation Framework:**
   - The creation of a standardized framework for KPI identification and categorization facilitated consistent and reliable evaluations across different projects and sectors.
5. **Efficient Data Utilization:**
   - The condensed Excel sheet allowed for efficient data utilization, making it easier for stakeholders to access and analyze key performance indicators.
6. **Benchmarking and Comparative Analysis:**
   - The project enabled effective benchmarking and comparative analysis by providing a clear set of KPIs, allowing organizations to compare their performance against industry standards and peers.
7. **Enhanced Stakeholder Communication:**
   - The clear framework and detailed categorization of KPIs improved communication with stakeholders, helping them understand the financial and operational aspects of project performance.
8. **Support for Strategic Planning:**
   - The detailed insights gained from the KPIs supported strategic planning and decision-making, ensuring that R&D projects were aligned with broader organizational goals and financial objectives.
9. **Identification of Performance Gaps:**
   - The analysis helped identify performance gaps and areas for improvement, enabling organizations to implement targeted strategies to enhance their R&D processes.

This framework and approach enabled a focus on the critical operational performance and financial indicators, enabling more precise and targeted evaluations of R&D outcomes. Furthermore, this approach ensured that the KPIs and IoS were not only identified but also categorized in a manner that would facilitate easy reference and application in future evaluations.

Table D-3. Example segment of a typical table extracting KPIs and IoS from the articles.

Table D-4. Operational KPIs and IoS from Canine Articles.

Table D-5. Operational KPIs and IoS from Cybersecurity Articles.

Table D-6. Operational KPIs and IoS from Water Distribution Articles.

Table D-7. Operational KPIs and IoS from Shoe Scanner Articles.

4. Suggestions for Future Efforts

The literature review for this effort was intentionally focused on articles related to the five case studies, and will perhaps have overlooked niche or emerging research area. Future efforts can perhaps,

1. **Increase Diversity in Literature Sources:**
   - **Detail:** Expand beyond traditional academic databases to include literature, industry reports, and international journals.
   - **Implementation:** Implement systematic search strategies encompassing a wider geographical and disciplinary scope.
   - **Impact:** Enhance the robustness and applicability of identified KPIs and IoS by incorporating insights from diverse sources.
2. **Incorporate a Section on Limitations and Challenges:**
   - **Detail:** Explicitly discuss constraints such as publication bias, geographic bias, and language limitations.
   - **Implementation:** Include a methodological appendix outlining search criteria and inclusion/exclusion criteria.
   - **Impact:** Improve transparency and reliability of the literature review findings.
3. **Consider Feedback from R&D Practitioners:**
   - **Detail:** Validate identified KPIs and IoS with feedback from practitioners.
   - **Implementation:** Conduct interviews or surveys with R&D professionals.
   - **Impact:** Ensure relevance across different sectors and organizational contexts.

Future efforts can definitely be helped out by expanding on the very limited data provided on the S&T R&D projects in the original transmittal spreadsheet. Recommendations for improvement include,

1. **Validate Data Inputs:**
   - **Detail:** Implement a robust validation process for data entries.
   - **Implementation:** Cross-reference with additional sources and conduct peer reviews.
   - **Impact:** Ensure accuracy and completeness of data inputs.
2. **Improve Data Collection:**
   - **Detail:** Expand data collection to gather more comprehensive project information.
   - **Implementation:** Develop structured interview protocols or case study templates.
   - **Impact:** Provide a nuanced understanding of project impacts, complementing quantitative metrics.
3. **Continuous Feedback Mechanism:**
   - **Detail:** Establish a feedback loop with stakeholders.
   - **Implementation:** Regularly review and refine the table based on stakeholder input.
   - **Impact:** Ensure categorizations and data remain relevant and reflective of evolving trends.
4. **Expand the Dataset:**

- **Detail:** Increase the number of projects and extend the timeframe.
- **Implementation:** Regularly update with new entries and historical data.
- **Impact:** Facilitate deeper insights into R&D project trends and impacts.

5. **Integrate Qualitative Data:**
   - **Detail:** Supplement quantitative metrics with qualitative insights.
   - **Implementation:** Conduct structured interviews with project stakeholders.
   - **Impact:** Enhance the richness of insights into project outcomes and challenges.

Finally, the set of KPIs and IoS identified may not be complete due to the limited number of articles analyzed. Other recommendations for improvement include,

1. **Ongoing Review and Update of KPI and IoS Categories:**
   - **Detail:** Establish a regular review cycle to reassess KPI and IoS categories.
   - **Implementation:** Engage a multidisciplinary advisory panel.
   - **Impact:** Ensure the KPIs and IoS reflect evolving industry standards and best practices.

2. **Collaborate with Stakeholders:**
   - **Detail:** Validate the relevance and applicability of identified KPIs and IoS.
   - **Implementation:** Conduct workshops, focus groups, or surveys.
   - **Impact:** Enhance stakeholder confidence and ensure comprehensive KPIs and IoS.

3. **Develop a Benchmarking Framework:**
   - **Detail:** Create a framework for benchmarking KPI and IoS performance against industry peers.
   - **Implementation:** Establish performance benchmarks and comparison metrics.
   - **Impact:** Provide context and actionable insights for performance evaluation.

In conclusion, implementing these recommendations will strengthen the methodology for identifying and categorizing KPIs and IoS in S&T R&D. By addressing specific areas for improvement such as diversifying literature sources, integrating qualitative data, and refining the KPI and IoS frameworks, the methodology will evolve to meet the evolving needs of stakeholders across S&T's diverse organizational settings. This iterative approach ensures that the methodology remains robust, relevant, and practical, ultimately maximizing the societal impact of university research efforts through informed decision-making and strategic resource allocation.

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