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A Proposed Logic Model for Managing Open Innovation Competitions

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1 Background

For a long time, research and development (R&D) was an internal investment used as a barrier against competitors. The idea was that a big internal investment differentiates organizations in the market. The R&D activity was organized inside the company, and shared with no one until the product or service that resulted from innovation went to the market. (Sloane 2012). A range of factors has induced businesses to engage increasingly in innovation collaborations. The collaborative approach to innovation termed “open innovation” (OI) may be contrasted with the traditional “closed” approach where R&D remains within the boundaries of a firm (Brant and Lohse 2014). Orcik, et al. (2013) suggest that innovation is the process of making changes, large and small, radical and incremental, to products, processes, and services that results in the introduction of something new for the organization, adds value to customers, and contributes to the knowledge store of the organization. To overcome limitations such as cost, resources, competencies, etc., companies may choose to outsource their innovation work by inviting external contributors to develop ideas or solutions to specific predefined problems. An OI approach offers an opportunity for companies to access valuable knowledge from multiple sources.

Chesbrough (2006) defines OI as “the use of purposeful inflows and outflows of knowledge to accelerate innovation internally while also expanding the markets for the external use of innovation.” Kavathekar, et al. (2015) suggest that OI is a model in which organizations utilize external technology, solutions, knowledge capital, and resources early in their innovation process, allowing enterprises to look beyond their four walls to bring in ideas more quickly and frequently to enhance their operations, and save time and money. Wynn, et al. (2015) summarize OI as getting external ideas into an organization to improve its ability to develop new products and services. Benefits of OI include harnessing knowledge from multiple sources to enhance innovation and thus deliver additional value for customers (Brant & Lohse, 2014). OI derives benefit from ideas that organizations do not currently have a use for that others might (Rowell, 2008), to rapidly acquire new knowledge to dramatically shorten the product development lifecycle and deliver new, high-value products to customers faster than the competition (Evan 2015). A firm’s capacity to innovate is increased through the active search for new technologies, information, or knowledge outside their walls, and through cooperation with suppliers and competitors to deliver the ultimate value to the market (Saba and Saba 2016).

Organizations can leverage various OI strategies to increase value of their products and services:

1.1 Co-creation

The practice of collaborative product or service development where developers and stakeholders work together (Fronteer Strategy 2009). Co-creation is also defined as “a process within social and technological networks in which actors integrate their resources to create mutual value” (Orcik, et al. 2013).

1.2 Inside Out

When organizations allow unused and underutilized ideas to go outside the organization for others to employ in their businesses (Chesbrough, 2013). By allowing intellectual property (IP) that is developed internally to be release to the external market, an organization can gain legitimacy, additional support options, and complementary products and services. And releasing an innovation may attract additional ideas and components to the organization contributed by external parties. These contributions can be included in subsequent innovation projects (Wynn, et al. 2015).

1.3 Citizen Science

Using members of the public to voluntarily assist with science related tasks. Tasks can include making observations, collecting and analyzing data, and interpreting results. This type of OI helps organizations to study complex issues by conducting research at large geographic scales and over long periods of time in ways that professional scientists working alone cannot easily duplicate (GAO 2016). CitizenScience.gov¹ identifies five intended outcomes of citizen science:

- Civic community, including improving the economic livelihood of people and communities, enabling communities to solve problems, and improving community resilience
- Conservation, including protecting species and habitats by influencing or supporting conservation goals or policy, and managing or preserving species or sites
- Individual learning, including increasing the interest, efficacy, motivation, knowledge, and skills of project participants
- Programmatic, including capacity building through public engagement, outreach, program improvement or proof of concept
- Research advancement including monitoring baseline conditions, understanding natural systems, building new technologies, and gathering or classifying data

1.4 Crowdsourcing

In citizen science, the public participates voluntarily in the scientific process (i.e., formulating research questions, conducting scientific experiments, collecting and analyzing data, etc.). In crowdsourcing, organizations submit an open call for voluntary assistance from a group of individuals for online distributed problem solving². The term “crowdsourcing” was first cited by *Wired* magazine author Jeff Howe in his 2006 article “The Rise of Crowdsourcing,” where he describes it as “the act of taking a job traditionally performed by a designated agent (employee) and outsourcing it to an undefined generally large group of people in the form of an open call,” in other words applying “open source principles to fields outside of software.” He defined four categories of crowdsourcing— collective intelligence or crowd wisdom; crowd creation; crowd

¹ <https://ccsinventory.wilsoncenter.org/>

² <https://ccsinventory.wilsoncenter.org/about.html>

voting; and crowdfunding. Crowdsourcing typically means that an organization collaborates with a crowd to create innovative ideas, and the effort is usually accompanied by a competition or prize as a motivator (Burton and Blosch 2016). When crowdsourcing the development of a new product, organizations get ideas from people who are expressing a need for that product or service. This means that there is a need that is not being met elsewhere (Ideascale 2016).

1.5 Prize Competition or Challenge

OI competitions are a mechanism to connect creative minds and expertise via crowdsourcing. They are a way to engage with external sources of knowledge such as individual entrepreneurs, students, experts, small firms, etc., who are asked to submit interesting solutions for an OI competition that satisfy certain criteria within a defined timeframe. When an organization identifies a problem to solve or a specific goal it wants to achieve with the assistance of members of the public, it can hold a prize competition or challenge. In a competition, the organization invites interested members of the public to submit potential solutions to the problem or challenge. The organization then evaluates these proposals and provides a monetary or non-monetary award for those that meet specific criteria and are selected as winners (GAO 2016).

OI competitions are becoming an increasingly popular mechanism for encouraging innovation. An increasing number of organizations have adopted OI competitions to realize innovative product or service solutions. OI competitions are the right choice when it is not obvious what combination of skills or technical approach will lead to the best solution for a problem. They are most effective when the problem is complex or novel and for design problems where creativity is crucial (Boudreau and Lakhani, K. 2013). There are a variety of contest types. Before launching an OI competition, organizations should consider the right type of contest to meet organizational goals. Table 1-1 describes the various types of OI competitions.

Table 1-1. OI Competition Types

Type	Description	Source
Analytics/Algorithm Optimization	Analytics, visualization, and algorithm challenges focus on finding better ways to interpret or communicate data. The outcome of an analytics challenge is to obtain the best in breed optimized code, test scenarios, documentation, and/or approach analysis.	www.challenge.gov
Design	Creative design and multimedia challenges can help capture, communicate, and project a concept or aesthetic that would be difficult to achieve with a grant or contract.	www.challenge.gov (IdeaScale 2016)
Entrepreneurship	Entrepreneurship or business plan challenges are competitions used by government, universities, and private sector organizations to help train and equip entrepreneurs, as well as launch their ventures.	www.challenge.gov (Gusteic, et al. 2015) (Kay 2011)
Hackathon	A design sprint-like event in which computer programmers and others involved in software (SW) development, including graphic designers, interface designers, project managers, and others, collaborative intensively on SW projects. A themed hackathon is one in which the projects are confined to a specific problem, such as food sustainability or returning citizens. A civic hackathon is a gathering of	(Headd 2011) (Leckard 2012) (Tauberer 2014)

Type	Description	Source
	technologists for a few days or weeks to build civic-themed software.	
Idea Generation	In idea generation, an organization asks external participants to submit ideas to address a specific issue or problem. An ideation challenge supports new ways of understanding and framing problems, new processes to solve problems, and innovative implementations as solutions to problems. Organizations reach out to the ecosystem in search of innovation ideas, which are then further developed in-house.	www.challenge.gov (GAO 2016) (Burton and Blosch 2016)
Open Data	Organizations mobilize participants to share, explore, and analyze publicly available data sets, and to use the data to conduct research, design data visualizations, or create web and mobile applications and websites that help people access and use the data.	(Mihm 2014)
Opinion Seeking	Used to improve a product or service. Soliciting the opinions of customers, prospects, or the public will provide ideas for process improvement.	(IdeaScale 2016)
Scientific	Scientific challenges seek to promote the understanding for a problem, solution, or outcome using empirical or measurable evidence-based practices.	www.challenge.gov
Software	In a software and application development challenge, an organization asks solvers to create a SW application to solve an existing problem or draw attention to potential uses of available datasets.	www.challenge.gov
Technology	Technology demonstration and hardware challenges seek prototypes, minimal viable product/service, or fully developed solutions to catalyze and demonstrate breakthrough technical innovations.	www.challenge.gov

OI competitions are publicly announced, and potential external problem solvers decide via self-selection whether they want to participate in the process of finding a solution. Lakhani, et al., (2007) refer to this process as “Broadcast Search.” The idea behind the broadcasting of problems is to get the word out as widely as possible about a specific problem, allowing outsiders to contribute to its solution. Third party intermediaries (i.e., Hyve, IdeaScale, InnoCentive, IXL Center, NineSigma, Spigit, Topcoder, etc.) deliver brokering services via broadcast search (Antons, et al. 2012).

Government agencies have been faced with the challenge of finding innovative approaches to deliver technological solutions to agency operations while at the same time dealing with declining tax revenues and calls for more efficient utilization of public resources (Wynn, Pratt and Bradley 2015). The America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education and Science (COMPETES)³ Act of 2007, signed by President George W. Bush, was designed for government agencies to invest in innovation through research and development, and to improve the competitiveness of the United States. It authorized the use of prizes for one or more of the following:

³ Congress.Gov <https://www.congress.gov/bill/110th-congress/house-bill/02272>

- Find solutions to well-defined problems.
- Identify and promote broad ideas and practices to attract attention to them.
- Promote participation to change the behavior of contestants or develop their skills.
- Stimulate innovations with the potential to advance agencies' mission.

In 2009, President Obama released his Strategy for American Innovation, calling for agencies to increase their ability to promote and harness innovation by using policy tools such as prizes and challenges. Coinciding with this release, the Office of Management and Budget (OMB) issued an Open Government Directive, which required executive departments and agencies to take specific actions to further the principles established by the President's memorandum. OMB was tasked with issuing guidance for the increased use of challenges and prizes to develop new tools and approaches to improve open government. OMB M-10-11,⁴ dated 8 March 2010, provides guidance on the use of challenges and prizes to promote open government. In 2010, the General Services Administration (GSA) launched www.challenge.gov.⁵ The site is designed to help agencies find participants for prize competitions and challenges by providing a centralized list of all competitions sponsored by federal agencies. Since its launch, more than 700 competitions have been hosted on the site. GSA also hosts the Challenges and Prizes Community of Practice for agencies to share lessons learned and best practices in OI competitions (Mihm 2014).

Implementing OI competitions can introduce organizational challenges. Cultural change is a major issue in the implementation of OI, for adopting OI may well mean doing things differently, sometimes in direct contradiction to behavior that was neither endorsed nor allowed in the past (Mortara, et al., 2009). Some employees perceive an outside view as an admission of failure (Durst and Stahle 2013). Wynn, Pratt, & Bradley (2015) acknowledged two managerial challenges for leveraging external innovation—identifying and accessing promising ideas developed outside the organization, and developing the capacity to incorporate external ideas and resources to enhance internal innovation. In a longitudinal case study, Antons, et al. (2012) identified 11 barriers to OI competitions—Company Cultural Aspects; Not Invented Here Syndrome (i.e., resistance to outside ideas); Lack of Internal Commitment; Bottom-Up Problems; Insufficient Top Management Support; Insufficient Resources; Open Call of “Wrong” Problems; Unrealistic Expectations; Legal Barriers; Organizational/Administrative Barriers; and Communication Barriers. Bird (2010) reported that for every 1,000 ideas submitted on an open innovation platform, on average just one will be truly radical. She states that this is due to several limitations of the OI model:

- Lacking focus. OI platforms welcome any and every idea. It should be about depth of thought, not breadth of ideas.

⁴ <https://www.congress.gov/bill/110th-congress/house-bill/02272>

⁵ <https://www.challenge.gov/list/>

- Insufficient customer understanding. Generating a radical idea requires deep understanding of customer needs. An OI platform can provide some information on the customer need, but it is typically limited in how much detail can be shared due to technology and IP issues.
- Limited room for discussion. Radical ideas are a combination of ideas, socialization, and evolutions. The process of building and refining ideas requires discussion and collaboration.
- Status quo captivity. Most ideas submitted on OI platforms involve small tweaks to current solutions for existing needs and problems. Coming up with radical ideas requires breaking out of the way things are and managing future possibilities.

As the federal government's use of OI competitions to solve a variety of types of problems continues to grow, OI competition design is also becoming more sophisticated as expertise and capacity (personnel, platforms, and partners) develop (Gustein, et al., 2015). Since the types, outputs, and outcomes of competitions vary so greatly, developing guidance for managing OI competitions is an important task.

2 Objective

This study seeks to review OI competition types, identify a logic model framework to manage competitions, determine its efficiency, and validate the framework as a method of achieving OI competition goals. Research questions include the following:

1. What are the various types of OI competitions?
2. What are the key success elements of OI competitions for organizers?
3. What constitutes a repeatable process for OI competitions?
4. What types of problems are best suited for OI competitions?
5. What are the key success factors of OI competitions for participants?
6. What are the key motivators of OI competitions for participants?
7. What are the managerial implications and benefits of using an OI intermediary to manage competitions?

3 Review of Literature

A logic model framework was created as a key deliverable of the research to depict the OI competition management tasks. The purpose of a logic model is to provide stakeholders with a roadmap describing the sequence of related events connecting the need for the planned program with the programs desired results (W.K. Kellogg Foundation 2004). The framework describes the logical linkages among the elements in managing an OI competition, such as resources, activities, outputs, and short-/long-term outcomes. *Resources* include human and financial resources required to support the OI competition program. *Activities* include all those action steps necessary to produce program outputs. *Outputs* are the products/services provided to the program’s direct customer. *Outcomes* are characterized as changes or benefits resulting from activities and outputs (McLaughlin and Jordan 1999). Resources and activities include “planned work” and outputs; outcomes and impact include “intended results.” The elements of a logic model are shown in Figure 3-1 below.

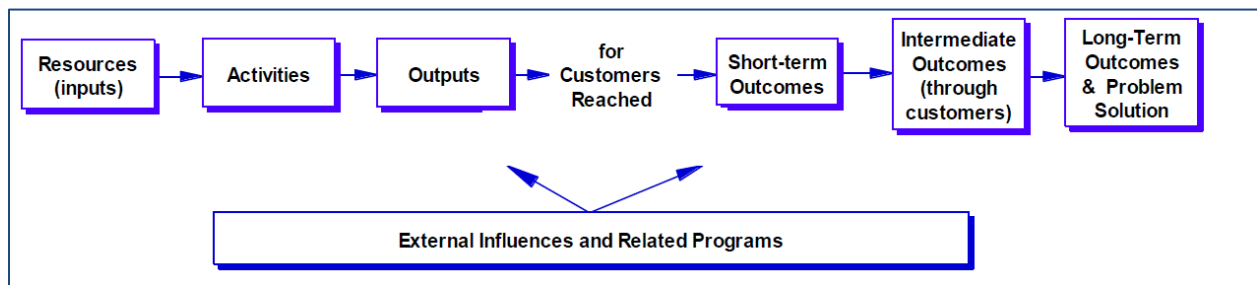


Figure 3-1. Elements of a Logic Model (from McLaughlin & Jordan, 1999)

The review of literature is organized by the elements of a logic model—resources, activities, outputs, and outcomes. Each section represents findings from the literature pertaining to each element.

Based on this framework, we have developed a logic model for competitions. The review of literature provided a foundation for this logic model, which is summarized in Figure 3-2. As shown in the figure, the model includes *Resources* that are the important inputs required to execute a challenge; the five phases of *Activities*, including Prepare, Develop, Conduct, Award, and Transition; *Outputs*; *Outcomes*; and *Impact*. In our model, we distinguish impacts from outcomes. Impacts are long-term community benefits and enduring changes to the industry. The model also takes into account the *External Factors* and *Constraints* that may affect the staging, execution, and results of a challenge. This logic model framework can serve as a guide for planning, implementation, and evaluation of a competition. The following sections consider findings from the literature in relation to each component of the logic model.

OI Competition Management Framework

Logic model derived from qualitative analysis of the open innovation literature



Figure 3-2. Open Innovation Competition Logic Model

3.1 Resources

Resources include governance, labor, funding, and time. Organizers need to establish effective governance and leadership. The type of governance model established sets the tone for the cooperation and coordination among the team, while leadership establishes its vision and purpose (Wynn, et al., 2015). OI competition governance issues that may need to be addressed include ownership and decision rights, issue escalation, organizational structure, resource commitments, and termination rights and conditions (Marcello, et al., 2015). Building a team is critical to managing an OI contest. A dedicated team with clear roles and responsibilities is needed to manage a successful challenge. Staffing a team depends on the type, duration, and size of the OI competition. Table 3-1 lists team roles identified from the review of literature to consider when managing an OI competition. In a lesson learned review, Bishop (2017) reported that team building takes time; one person can't do or know everything required; and face time is critical for a core team. During interviews with organizers, Antons, et al. (2012) identified insufficient personnel resources as a barrier to managing contests. Goldhammer, et al. (2014) indicated that developing prize rules, advertising, connecting with participants, administering interactions among stakeholders, judging entries, and evaluating the success of the prize after an award all require labor. These activities require a diverse team, with subject matter experts (SMEs) to develop, advertise, and judge the prize, and experienced administrators to run it. Additionally, Wielens & Piller (2012) suggest calculating the human capacities and resources required for the review process of the contest submissions.

Kay (2011) stated that the most significant cost of the implementation of a OI contest is the “cash purse.” Administration costs may be significant too, depending on the scale of the program and the number of participants. OI competitions may require a relatively high operational budget to conduct a landscape review of market players, craft the problem statement, design selection criteria, and award prizes (Goldhammer, et al., 2014). Wielens & Piller (2012) propose creating realistic budgets. The authors suggest reserve in a budget for the implementation of solutions after the contest.

It is important that a OI contest be held to a specific timeline. Solvers and non-solvers see milestones for submissions, judging, announcing the winners, and awarding the prize money as indications of the organizers' ongoing commitment to the program. Each milestone is also a marketing opportunity to bring fresh attention to the OI contest and build reputation equity for the organization (Resnick 2013). Goldhammer, et al. (2014) identified a best practice as having two time periods—for submission development and for judging. The former requires organizers to determine the time likely to reach a particular outcome. A competition period that lasts too long risks losing participant interest, and one that ends too quickly may not give participants enough time to develop solutions.

Table 3-1. Suggested Team Roles

Role	Definition	Source
Administrator	Oversee the success of various innovation programs.	IdeaScale (2016)
Advisory Board	Provide input on prize design and administration.	Goldhammer, et al. (2014)
Analyst	An individual who can parse data for quantitative and qualitative information.	IdeaScale
Communication	Needed to reach potential participants and partners and to raise awareness of the goals, progress, outputs, and outcomes of the prize. A communications team will help articulate the challenge in the most compelling way possible.	Goldhammer, et al. (2014); IdeaScale (2016); National Aeronautics and Space Administration (NASA)
External Experts	To help design a competition focused on addressing specific challenges preventing market development or growth.	Goldhammer, et al. (2014)
IP Management	Determine which party/parties in a collaborative relationship own the rights to the innovative products that are developed.	Marcello, et al. (2015); Wynn, et al. (2015); Goldhammer, et al. (2014); Kay (2011); National Academy of Engineering (1999); Brant & Lohse (2014)
Legal	Consult general council to determine what legal authorities govern their ability to stimulate innovation, acquire goods/services, conduct research for the public good, or work with private organizations for mutual benefit.	Goldhammer, et al. (2014); IdeaScale (2016); NASA
Media Campaign	A tightly managed idea campaign is a critical factor for achieving recognition as a visionary organization. Web designer and communications specialist to create a consistent look and feel for the OI contest. Includes developing a “personality” for the contest.	Resnick (2013); Miller, et al. (2012)
Moderator	Community moderators oversee stimulating the dialogue within an innovation community.	IdeaScale (2016)
Partners	Partnerships to help fund prizes and play various strategic roles in execution. Augment efforts by working with universities.	Goldhammer, et al. (2014); Kavathekar, et al. (2015)
Stakeholder	Consider a wide range of people who might have a stake in the prize and its outcome—potential investors, policy makers, and the general public.	Goldhammer, et al. (2014); McKinsey & Company (2009)

3.2 Activities

Activities are the processes, techniques, tools, events, technology, and actions of a planned program. They may include products—promotional materials and education curricula; services—education and training, counselling; and infrastructure – structure, relationships, and capacity

used to bring about the desired results (W.K. Kellogg Foundation, 2004). For an OI competition, activities focus on the process(es) to plan and execute a competition. The literature review revealed various activities needed to manage an OI competition. A summary of the findings follows.

In a study to identify OI strategies and resources on how government agencies are using competitions, GAO (2016) identified the following practices that agencies used to effectively implement an OI competition:

- Select strategy appropriate for engaging the public and agency’s capabilities.
- Clearly define specific goals and performance measures for the initiative.
- Identify potential metrics for the initiative.
- Identify and engage external stakeholders and potential partners.
- Develop plans for implementing the initiative and recruiting participants.
- Engage participants and partners while implementing the initiative.
- Collect and assess relevant data and report results.
- Sustain communities of interested partners and participants.

Section 24 of the COMPETES act directs the GSA “to develop a contract vehicle to provide agencies access to relevant products and services including technical assistance in structuring and conducting prize competitions to take maximum benefit of the marketplace as they identify and pursue prize competitions to further the policy objectives of the Federal Government.” The GSA has provided technical assistance to over 700 federal government agencies in managing OI competitions. As part of providing this service, the GSA has developed a toolkit using insights drawn from challenge experts across the federal government. The toolkit incorporates five phases—Prepare, Develop, Conduct, Award, Transition (see Figure 3-3). These are the phases of the activities we have adopted in the logic model. The outcome of Phase I, Prepare, is to help organizations identify the goals and desired outcomes of the competition to ensure the most impactful result. The prize competition structure and implementation timeline are created in Phase 2, Develop. Phase 3, Conduct, refers to executing the competition and selecting winners. Phase 4, Award, includes announcing/paying winners, and awarding nonmonetary incentives. Once the competition has been awarded, organizations leverage Phase 5, Transition, to analyze and document the results, outcomes, and impact of the competition.

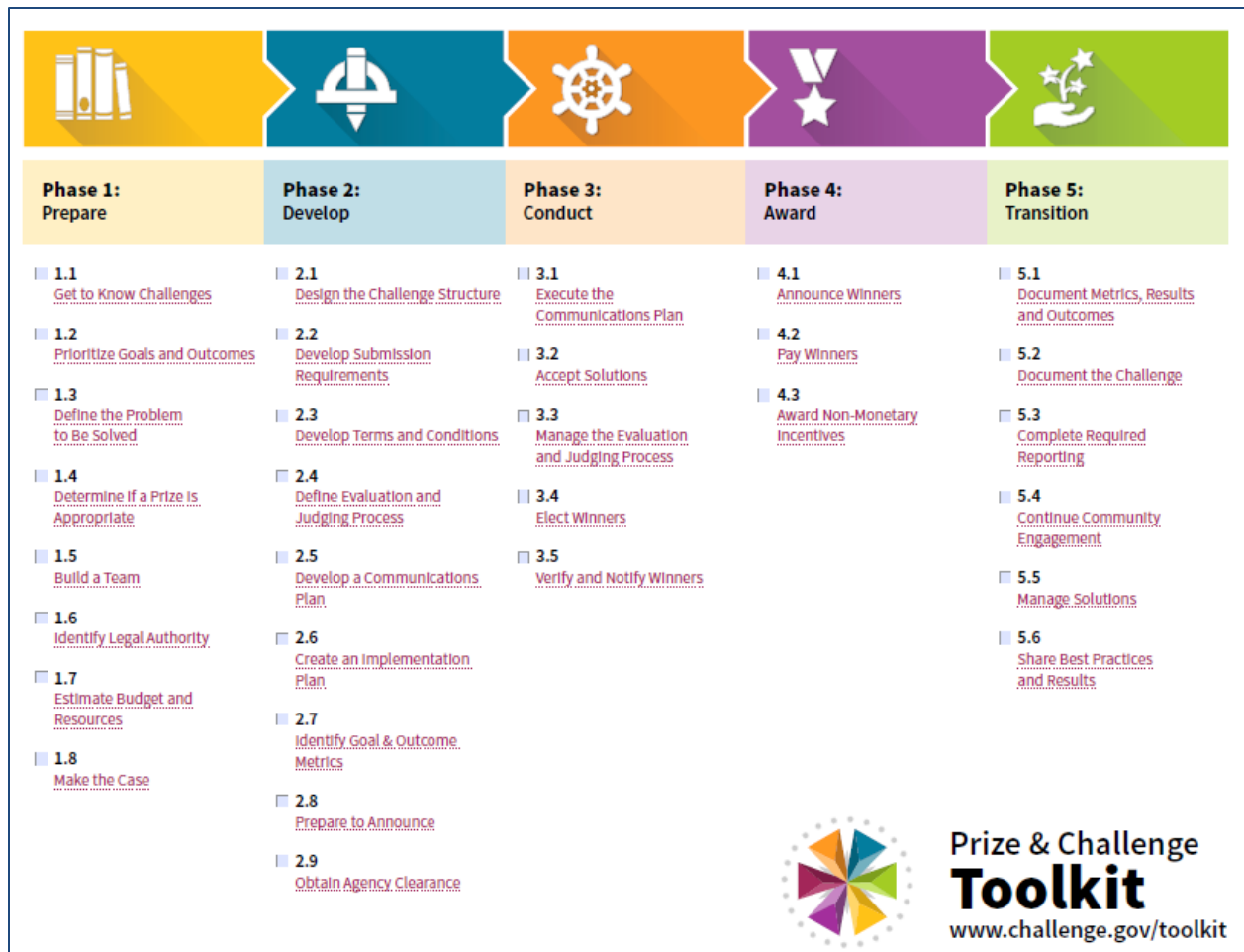


Figure 3-3. GSA Prize and Challenge Toolkit—Project Planning Phases

NASA’s Center of Excellence for Collaborative Innovation (CoECI)⁶ was established in November 2011 at the request of the White House Office of Science and Technology Policy (OSTP). OSTP encouraged NASA to assist other federal agencies in the use of crowdsourced challenges to solve tough, mission-critical problems. In a lesson learned report, they NASA identified four main phases for OI competitions:

- Pre-competition: Problem definition and challenge design
- Competition: Launch and marketing
- Evaluation: Judging and selection of winners
- Post-competition: Solver verification and implementation

In a report from conducting 48 interviews of organizations who managed OI competitions, McKinsey & Company (2009) identified five steps to develop and administer an OI competition (Figure 3-4)). They recommend as the first step formulating an often-inchoate aspiration into a

⁶ <https://www.nasa.gov/offices/COECI/about/overview.html>

concrete set of prize objectives. Second, analyze the motivations of likely participants and develop a prize strategy that addresses them. This strategy, in turn, will shape a series of choices about the prize’s design and process. Finally, invest in the post-prize period, delivering the follow-up and evaluation that ensures that a prize program achieves its intended impact.

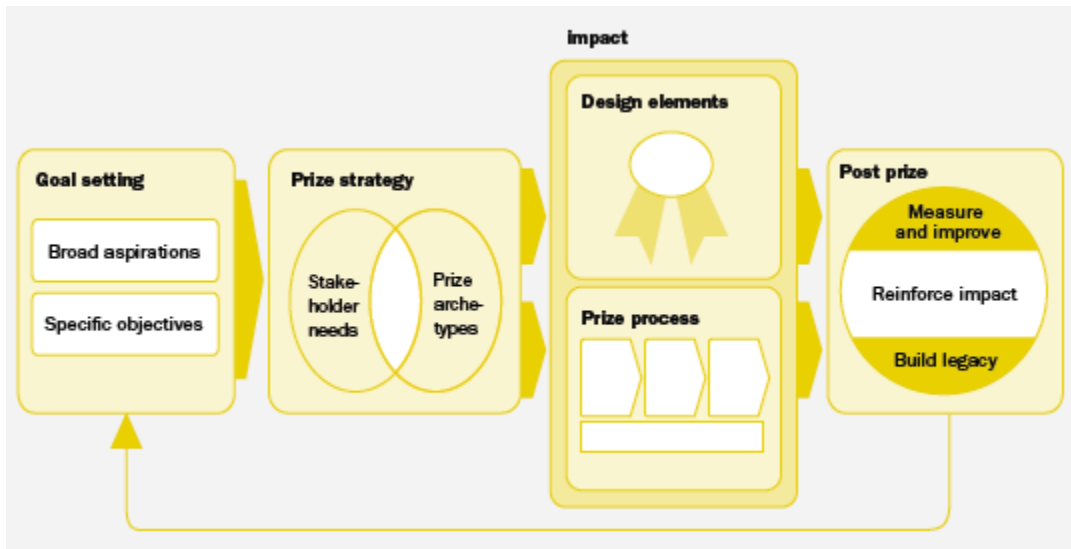


Figure 3-4. OI Design Activities (from McKinsey & Company, 2009)

Kay (2011) reviewed three government OI challenges (Ansari X prize, Northrop Grumman Lunar Lander Challenge, and The Grand and Urban Challenges of the Defense Advance Research Projects Agency) and provided practical insights and recommendations for the design, implementation, and evaluation of innovation prizes. Figure 3-5 shows three phases—Prize Design, Prize Implementation, and Program Evaluation—for designing an OI competition.

Prize Design	
✓	Prize challenge that is exciting, ambitious yet doable, clearly defined and easy to communicate, sufficiently vague as to allow innovation and creativity, and preferably, aligned with commercial opportunities
✓	Cash purse that covers only part of the expected costs of technology development and is balanced with commercial opportunities and other non-monetary benefits of the competition
✓	Prize rules that are simple, unambiguous, transparent, easy to understand, and comply with existing regulations
✓	Scheme to finance program costs that considers existing authorities and possible alternative funding from private sources
Prize Implementation	
✓	Proper use of collaborations and partnerships with individuals and organizations to design, implement, and evaluate the program
✓	Strategic prize announcement that reaches out broader audiences and makes the prize visible
✓	Proper plan of action to manage the competition, gather feedback from prize entrants, and maintain public engagement
✓	Simple and transparent criteria to select the winning entry and objective and independent judges for the competition
Program Evaluation	
✓	Proper evaluation plan to assess effectiveness and efficiency of the program
✓	Evaluation metrics such as technological achievements, investment leverage, prize participation, entrepreneurship, public perception, program continuation, and other outcomes

Figure 3-5. Designing a Prize Competition (from Kay, 2011)

In an exploratory case study about using OI competitions for improving healthcare, Wassrin, et al. (2015) observed four stages: defining, finding participants, collaborating, and leveraging. The first stage focuses on defining the problem to be addressed. The second includes finding suitable participants with relevant knowledge and skills. The third involves the interactive collaboration between the initiator and external participants, which is considered the key value creation process in which innovations are created. The final stage concerns leveraging and exploitation of the collaboration results through integrating the new knowledge into the organization and commercializing the innovation.

In a white paper, IdeaScale⁷ (2016), a vendor of idea management platforms that uses crowdsourcing to help organizations find and develop technology, identified the following five phases to managing OI contests:

- Pre-launch Planning: the stage for planning and strategizing
- Idea Collection: the stage for idea submission and collaboration
- Idea Refinement: the state for researching and refining promising ideas
- Idea Review: the stage for prioritizing and building a case for potential innovations

⁷ <https://ideascale.com/>

- Implementation: the stage for creating and launching a new innovation

In another vendor white paper from NineSigma,⁸ Resnick (2013) suggested that an OI competition be held to a specific timeline. The author believed that solvers and non-solvers see milestones for submissions, judging, and announcing the winners as indications of the sponsor’s ongoing commitment to the program. They recommend the following four phases (Figure 6):



Figure 3-6. Grand Challenge Process (from Resnick, 2013)

For the logic model activities section, we leveraged the GSA prize and challenge toolkit as an OI competition process baseline. The GSA has five years’ experience managing challenges, and their process is the most mature and well documented.

3.3 Output

It is important to distinguish “outputs” and “outcomes.” Organizers use “outputs” to describe the specific end results of a prize, such as a software application (app) with particular functionality. In contrast, “outcomes” refer to more general and aspirational goals such as marketing the app and getting a community to use it. Another differentiator is that output refers to tactical results, whereas outcomes refer to strategic objectives (Goldhammer, et al., 2014).

Goldhammer, et al. (2014) identified push and pull mechanisms for getting solutions to problems. Push mechanisms can be used to generate a range of outputs—purchasing services or technologies that are well understood to support early-stage R&D efforts that have uncertain outputs. Push mechanisms such as OI competitions reward participants not for their efforts per se, but for their outputs, such as ideas, prototypes, pilots, or commercial products and services. Conrad (2017) stated that the pull incentive in OI competitions removes an organizer’s risk of contracting with a sole innovator who many not succeed, yet will use up all the sponsor’s resources in the attempt. Goldhammer, et al. (2014) classified outputs of OI competitions in two main areas.

- Developing ideas, technologies, products, or services
 - Attract new ideas.
 - Build prototypes and launch pilots.
 - Stimulate markets.
- Engaging people, organizations, and communities

⁸ <http://www.ninesigma.com/>

- Raise awareness.
- Mobilize action.
- Inspire transformation.

Kay (2011) suggested that OI competitions can address diverse topics and types of achievements, depending upon the ultimate goals of the program. A competition may require participants to deliver a prototype that performs according to certain standards, create a new method to solve an old technical problem, or accomplish a feat that involves the development and/or application of technology. Table 3-2 depicts different types of OI competitions and corresponding outputs identified by the GSA Challenge.gov toolkit.⁹

Table 3-2. Challenge.gov Competition Type and Output

Competition Type	Output
Analytics	Algorithms that provide statistical analysis, machine learning, or coding
Design	An artifact such as graphic, logo, poster, video, computer-assisted designs to communicate a concept
Entrepreneurship	Help train and equip entrepreneurs, as well as launch their ventures
Idea	Innovative implementations as solutions to problems
Scientific	Promote the understanding of a problem, solution, or outcome using empirical or measurable evidence-based practices
Software	Results in one of three distinct types of applications: end user application; back-office application; or enterprise application
Technology	Prototypes or fully developed solutions to catalyze and demonstrate breakthrough technical innovations

3.4 Outcome

As mentioned previously, outputs are the tangible product/service generated by the OI competition, whereas outcomes are more strategic in nature and align with the goals of the competition. Kay (2011) stated that OI competitions may prompt four main types of outcomes—developing technology; leveraging R&D investment; promoting entrepreneurship; or raising awareness by engaging different communities and attracting public attention to areas and issues of interest for the agencies. The National Academy of Engineering (1999) suggested that OI competitions “stretch existing technologies by demonstrating their usefulness,” giving the example of nonstop flights around the globe, one in an airplane and one in a balloon. While neither victory depended on new technologies, both provided dramatic demonstrations of advanced technologies and extensive publicity for aerospace as an exciting field to enter or support. The authors also mentioned that competitions might be used to stimulate nascent or potentially useful technologies that lack robust commercial or federal agency sponsorship. Goldhammer, et al. (2014) suggested that competitions can:

- Build and maintain communities of interest

⁹ <https://www.challenge.gov/toolkit/>

- Create opportunities for public organizations to share costs with private and philanthropic partners
- Demonstrate that government can innovate in service of the public good, and open problem solving to leverage the ingenuity of citizens
- Educate the public and encourage citizen participation
- Foster collaboration among government, academia, the private sector, and individuals
- Reduce the price of new technologies
- Shape commercial markets either to develop technologies, goods, and services directly or to bring innovative prototypes to market for the first time
- Spur private sector participants to commercialize technologies previously limited to government

McKinsey & Company (2009) suggested that competitions achieve the change their sponsors seek by influencing society or specific communities and individuals in seven ways:

- Educating individuals
- Focusing communities on specific problems
- Identifying excellence
- Influencing public perception
- Mobilizing capital
- Mobilizing new talent
- Strengthening problem solving communities

Table 3-3 shows examples of OI competition outcomes from specific case studies in the literature.

Table 3-3. Examples of OI Competition Outcomes

Organization	Outcome	Source
Ashoka	Networking opportunities	McKinsey & Company (2009)
Department of Energy	Advance market commitment	Goldhammer, et al. (2014)
GSA	Balance agency capacity	GAO (2016)
GSA	Build or expand community	GAO (2016)
GSA	Increase public awareness	GAO (2016)
MITRE	Drive technical innovation and accelerate learning across the Counter Unmanned Air System community	Bishop (2017)
NASA	Research advancement	Gusteic, Crusan, Rader, & Ortega (2015)
NASA	NASA operational integration/use	Gusteic, Crusan, Rader, & Ortega (2015)
NASA	External use	Gusteic, Crusan, Rader, & Ortega (2015)

Organization	Outcome	Source
NASA	Education/public outreach	Gusteic, Crusan, Rader, & Ortega (2015)
NASA	Advance state of art/demonstrate proof of concept	Gusteic, Crusan, Rader, & Ortega (2015)
NASA	Enable product to be brought to market	Gusteic, Crusan, Rader, & Ortega (2015)
NASA	Create new aerospace vendors/companies	Gusteic, Crusan, Rader, & Ortega (2015)
NASA	Stimulate the development of new commercial markets and thus new opportunities for business and jobs to form	Ortega (2015)
NASA	Realize new cost savings and encourage the development of better products and solutions on demand	Gusteic, Crusan, Rader, & Ortega (2015)
NASA	Spark engagement and build skills	Goldhammer et al., (2014)
NASA; State and Local Agencies; GSA	Advance the mission	Gusteic, Crusan, Rader, & Ortega (2015); Goldhammer, et al (2014); Kay (2011)
Nesta	Mobilize scalable change	Goldhammer, et al. (2014)
Whirlpool Corporation	Foster technology diffusion	National Academy of Engineering (1999)
World Bank	Drive innovation in the developing world	Goldhammer, et al. (2014)

Goldhammer, et al. (2014) caution organizers that recruiting participants into a competition is not sufficient to mobilize action. Getting participants and larger audiences to act typically requires facilitating the formation of new communities. For this, branding and clear messaging are critical. McKinsey & Company (2009) stated that creating an innovative product or approach alone will not achieve broad societal benefit. Prizes are but one part of an effective change strategy—they are useful, but rarely successful in isolation. Organizers should work to extend impact by using the full portfolio of other instruments such as grants, service programs, convening, or infrastructure investments.

3.5 Impact

Impact refers to the broader long-range benefits of a competition such as transformation of a marketplace, an industry, or change in society (for example, the impact of the invention of the automobile). OI competitions are designed to induce effort by solvers aimed at achieving a specific technical or other performance objective. Education, inspiration, and adoption of the performance objective from the public are usually a major secondary objective of all competitions (National Academy of Engineering, 1999). Practices for measuring the performance before, during, and after an OI are still emerging. For many competitions, impact may be hard to measure. Examples of measuring impact from the literature include the following.

In a survey of prize givers, McKinsey & Company (2009) asked organizers of competitions if they measure impact. Over 40% of respondents say they either “never” or “very rarely” evaluate

the impact of their competitions; 7% report doing so “every few years”; and only 23% annually evaluate the impact of their competitions.

Conrad, et al. (2017) stated that evaluating the impact of the competition assesses the ultimate intended social or developmental impact of the challenge, which may go beyond developing the solution sought by the challenge. The concept of impact should be considered when setting the framework for evaluating a competition. Table 5 contains the authors’ proposed framework:

Table 3-4. Proposed Framework for Evaluating Competitions (from Conrad, et al., 2017)

Evaluation Approach	Description	Questions to Ask
Challenge Performance	Assess participation and outcome of the competition.	-Did the OI contest achieve the intended outcome for which the prize was awarded? -What unintended outcomes did the competition achieve beyond the outcome for which the prize was awarded? -What types of solutions were achieved (or not) and what level of innovation occurred?
Challenge Cost	Compare the cost of a challenge against non-challenge approaches to get a common measure to determine relative cost-effectiveness of your challenge.	Was the competition cost-effective?
Design and Implementation	This topic assesses the quality of the implementation and the appropriateness of the prize mechanism design.	-Was the competition implemented well? -Was the prize mechanism well suited to its context and goals? -What are the key conditions that led to the success of failure of the competition in achieving its outcome? -What are the lessons learned in the design and implementation of the competition?
Solver Participation	Learning about the types of solvers who participate in the challenge is useful when challenge performance depends on the characteristics of the solvers, if the group is diverse, or if there are questions around what influenced participation.	-Did the competition stimulate involvement of capable solvers? -What factors influenced challenge participation and which were most important?
Impact	While a competition ends with the development of a solution, it only has an impact if intended beneficiaries adopt or use it which is not necessarily a requirement of the competition rules.	What evidence exists that the challenge resulted in a solution with the desired social impact?

Determining the impact of OI competitions is not without limitations. Goldhammer, et al. (2014) mentioned that there should be an overall evaluation of the competition during the planning stage to determine whether it is worth conducting the competition. The authors caution that it is not a simple matter of comparing the direct cost of running the prize to the value of the solution produced. They added that measuring changes should not be limited to positive impacts.

Particularly for government agencies, there should be a follow-up to explore whether there have been unintended negative impacts of the prize implementation. Return-on-investment calculations often leave out the wider cost incurred by other parties in the process. An overall “value for effort” calculation, considering positive and negative impacts on those selected and not selected, as well as resources used by other parties, provides a more reliable and comprehensive view of the merit, worth, and value of a competition. They conclude that non-experimental approaches to causal attribution and contribution are useful to identify possible alternative explanations for the impact.

3.6 Program Planning and Evaluation

The logic model framework is useful to consider when planning and evaluating challenges. With planning and evaluation in mind, we identified themes from the literature that covered important evaluation metrics, best practices, and lessons learned. At the planning stage, metrics are important when setting challenge goals and objectives, so that the goals and objectives are measurable and performance can be tracked throughout the phases of staging a challenge. Furthermore, metrics operationalize the measurement of outcomes and eventual impacts so that the results of the competition may be quantified. Figure 3-7 summarizes the metrics we identified from the literature in relation to logic model components.

LM Component and Themes		Metric
Process	Attract	Number of prize startups that get financial support to compete
	Build a Team	Number of consultations by potential entrants
		Number of volunteers, students, and independent inventors engaged Number of organizations that partner with prize entrants (e.g. schools, universities, companies)
	Communications Plan Implementation	Communications and knowledge shared (e.g., measure of quantity) Number and type of media appearances of the program
	Execute the Challenge	Time required to produce the winning entry
Working hours spent by entrants Type and number of officially registered entrants Facilities utilized (e.g., number of logins to portal)		
Frequency of meetings, attendance Number of people attending competition events		
Resource Allocation	In-kind contributions received by entrants	
Output	Deliver Technology	Whether the program finds a prize winner
	Generated Output	Number and quality of the ideas or solutions contributed by all teams New performance records set
	Participation	Number of prize entrants that schedule or perform an attempt to win the prize or qualify for a final event
Outcome	Incentive	Return on Investment
	Mission & Strategy	R&D expenditures by prize entrants Adoption rate of solution/approach Whether the prize program received additional funding (the ultimate measure of success from the agency's projects portfolio perspective) Number and variety of problem-solvers
		Motivation
	Organizational Culture	Growth of community/network
	Participation	Time dedicated to issue area
	Public Education	Number of schools and students involved
	Stimulate Markets	Diffusion, introduction, or commercialization of the technical solution Number of new startups created to enter the competition (prize startups) Number of prize startups that continue their activities beyond the prize deadline Changes in action (e.g., demand) Subsequent investment in area Increase in number of people or organizations engaged in the topic area
Mission & Strategy		Self-sufficiency of sector
Organizational Culture		Improvement in community network performance
Impact	Public benefit (reduced or negated)	Unintended negative consequences
	Public Education	Number of courses created in schools on topics related to the prize
	Raise Awareness	Overall media impressions Unprompted awareness Number of people registered in the prize's online community
		Stimulate Markets
	Transform Industry	Number of research programs reoriented to pursue challenges similar to the prize Masters or Ph.D. theses focused on prize programs

3-7. Logic Model Components and Constructs with Suggested Metrics

3.7 Evaluation Metrics

The literature mentioned metrics regarding Activities, Outputs, Outcomes, and Impact. Activity or process measures include the number of start-ups getting support to engage in the challenge; number of consultations by potential entrants, volunteers, students, and independent inventors engaged; number of partnering organizations; measurable quantities of knowledge shared during engagement; media appearances; time required; frequency of meetings held; attendance at competition events; and in-kind contributions of entrants. Many of the activity metrics could also be considered as resources or inputs. In the literature, it was difficult to differentiate between these components.

Outputs include the number of prize winners, number and quality of ideas or solutions contributed by challenge teams, performance records set, and numbers of participants that perform an attempt to win or qualify for a final round. Outcome metrics include R&D expenditures by challenge entrants, return on investment, adoption rate of the solution, whether the challenge winner received any additional funding after award of the prize, and growth in challenge-related industry business portfolios subsequent to the prize.

Impact metrics include attainment of self-sufficiency and sustainability of solution portfolio, improvements in solution community network, courses created, change in media coverage and impressions (e.g., positive references to the solution), awareness of the general public (for example, as measured by mentions of solution technology in social media), web page views and registrations in online solution technology communities, number of research programs resulting from posing the challenge problem, resulting masters or doctoral theses and publications, and unintended negative consequences.

3.8 Best Practices

The literature addressed a large number of best practices around running challenges. Many of the best practices stemmed from the need to consider external factors and constraints. We found mention of needs to minimize conflict, friction, and bureaucratic barriers; need to consider the cost structure of potential participants or partners; decision-making authority; flexibility in hiring; legal authority to stage a competition; profile of the larger audience; promoting a knowledge-sharing culture, considering the available infrastructure of established communities; match to potential participants' overall business strategy; and fit within the community ecosystem. With these externalities in mind, it is important to continually monitor trends and the ebb and flow of these various conditions when planning the challenge.

We identified best practices regarding the resources and inputs, many of which could be helpful to consider in the planning stage. These included setting up a central repository or website for the competition, use of SMEs, the right network and mix of partners and participants, governance, data standards, staff recruiting that helps build the trust and confidence of leadership, development of performance indicators and process and outcome metrics, crowdsourcing, setting the prize level, alignment with business strategy, use of an advisory board, getting the right judges, understanding the landscape of potential participants, establishing branding, and engaging the right community leaders to promote the challenge.

Process or activity best practices included inspirational design; multiphased judging; adopting an entrepreneurial approach; building and encouraging trust, openness, and transparency; incentivizing and promoting a culture of innovation; realistic budget and timelines; standardizing the format for submissions; regular touchpoints; publicizing the challenge and the awards; promotion through a marketing campaign; iterative feedback and post-competition review; and applying program evaluation and performance and outcome monitoring methods.

For outputs, outcomes, and impacts, we identified gaining IP rights, sustained communication and publicity post-award, and institutionalized technology transfer and critical to eventual impacts.

Appendix A provides a complete list of best practices summarized from the literature.

3.9 Lessons Learned

We were also able to identify challenge lessons learned from the literature. These included attention to computer security and privacy concerns; adequate sizing of the challenge platform; allowing innovators to focus on what they do best while avoiding distractions; ensuring sustained investments by stakeholders; factoring in administrative costs; ensuring business interest and attention; covering legal issues and barriers; handling misunderstandings, questions, and delays; building communications mechanisms into the challenge platform; attention to scoring algorithms; planning for and handling no-shows; avoiding discrepancies and misstatements; seeking out the right advice about running a challenge; following a project plan and schedule; and recognizing the risks, such as the administrative burden of running a challenge in-house. Appendix B provides a complete list of lessons learned identified in the literature. Figure 3-7 depicts the key best practices and lessons learned.

OI Competition Management Framework

Best practices and lessons learned derived from qualitative analysis of the open innovation literature

Best Practices	<ul style="list-style-type: none"> • Website/competition portal as a central repository with one-stop shopping • Effective governance and leadership with experience in change management and promoting innovation • Advisory board, expert advice, and qualified judges w/o conflicts of interest • Facilitators -- brokers, relationship managers, innovation champion, intermediaries • Resources -- personnel, equipment, time, balance innovation & day-to-day tasks • Defined purpose, scope, approach, roadmap 	<ul style="list-style-type: none"> • Expand number of winners with recognition for best in various categories • Transparent, simple, fair, & unbiased rules • Clearly define selection process, decision rights, compensation calculations • Define clear goals, objectives, and performance metrics for each step • Tailor the problem statement to attract the right range of participants • Include recognition of non-financial measures • Conduct a post-competition review to analyze feedback 	<ul style="list-style-type: none"> • Public leaderboards • Design challenge so winners can be judged in a more automated way • Require a scaling plan as part of the solution • Public rewards: recognition is a reward • Validate the solution (e.g., solutions run through power generation models) 	<ul style="list-style-type: none"> • Build strong branding around the challenge • Sustained communication with participants post-award in blog or newsletter • Use challenge to define metrics for community • Make challenge fun to watch • Design with end use in mind • Design problem statements to lead to broadly workable solutions • Change behaviors, workflows, & processes 	<ul style="list-style-type: none"> • Institutionalize technology transfer • Sustain community through post-award communication • Evaluate design, implement, costs, impact • Post-award marketing • Drive technical innovation and accelerate learning
	Resources	Activities	Outputs	Outcomes	Impact
Lessons Learned	<ul style="list-style-type: none"> • In addition to cash prize, administration costs may be significant • Don't assume website and emails are enough to attract participants • Build a team, face time is critical, establish trust • Develop a schedule, apply knowledge management tools • Get advice from others who have challenge experience 	<ul style="list-style-type: none"> • Computer security and privacy protection • Legal department concerns about the evaluation activities or the application • Communication problems lead to misunderstandings and delays • Modeling and scoring architecture are not trivial issues • Collaboration influences by agendas that participants bring • Automate administrative functions 	<ul style="list-style-type: none"> • Prize designs allow innovators to focus on what they do best • Traditional grants reward effort, competitions reward innovation & output • Leverage expertise of citizens to supplement internal resources • Use motivators to increase participants return on their investments of time, effort, and resources 	<ul style="list-style-type: none"> • Awards may result in winning additional funds through grants and contracts • External suggestions are often not adopted due to NIH syndrome • R&D department may lack interest • Innovators lacked implementation authority 	<ul style="list-style-type: none"> • Sustained success of prize industry requires further investment from stakeholders • Evaluating a prize impact & making refinements is fundamental to success
Mitigating External Factors and Constraints		<ul style="list-style-type: none"> • Navigate internal approval processes for the challenge • Align innovation strategies and culture across multiple partners • Profile of target audience • Make the ecosystem work using effective positioning and leveraging diversity 	<ul style="list-style-type: none"> • Continuously monitor external conditions • Identify trends in other industries and how they may impact innovation • Required standard activities are a barrier to implementing a novel solution • Innovators need support from top management 		

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Figure 3-7. Key OI Competition Best Practices and Lessons Learned from Literature Review

4 Methodology

This exploratory study set out to answer questions about the effectiveness of OI competitions—specifically, to identify success factors for organizers and participants. Exploratory research is conducted when a researcher has a limited amount of experience with or knowledge about a research issue. It is a preliminary step that helps ensure that a more rigorous, conclusive future study will not begin with an inadequate understanding of the nature of the management problem/opportunity space (Zikmund, 2003). The research focused on two interrelated purposes—diagnosis and discovery. “Diagnosis” included identifying and assessing an OI competition process, and identifying motivational patterns of OI competition participants. “Discovery” captured key success factors for hosting OI competitions. A combination of secondary data analysis, experience surveys/interviews, focus group interviews, and a pilot study, was conducted to identify success factors for OI competition organizers and participants. *Secondary data analysis* is a preliminary review of data collected for another purpose to clarify issues/gain insight in the early stages of a research effort. *Experience survey/interview* is a research technique in which individuals who are knowledgeable about a research problem/opportunity are surveyed or interviewed. A *focus group interview* is an unstructured, free-flowing interview with a small group of people. A *pilot study* is a small-scale exploratory research project that uses sampling but does not apply rigorous standards (Zikmund, 2003).

The research into OI competitions was conducted in 2017 as part of The MITRE Corporation’s Research Program – MITRE Innovation Program (MIP).¹⁰ The mission of MITRE’s Office of Corporate Technology is to guide MITRE’s independent R&D program and align the MIP’s strategy with the corporate strategy. The R&D program develops new technologies and innovative uses for existing technologies to solve MITRE’s sponsors’ most critical problems in the near term and in the future. MIP investments seek strategic opportunities across MITRE’s Federally Funded Research and Development Centers (FFRDCs) to shape MITRE’s future work programs, to enhance external partnerships with industry and academia, and to advance transformational capabilities for MITRE’s sponsors that enhance safety, security, and prosperity.

MITRE is uniquely positioned to be an “innovation bridge” between government needs and industry. However, a repeatable process to engage heterogeneous teams from industry/academia for joint problem solving; generate and leverage solutions to problems from industry/academia that can provide an increased capacity for innovation; and create a diverse portfolio of solutions is lacking. The goal of the research was to develop an OI competition logic model framework for MITRE and our government sponsors as a tool to drive problem solving, enhance innovation capacity, and increase external engagement.

A Shewhart cycle— Plan, Do, Study, Act (PDSA) was used as the structure of the research methodology (Table 4-1). PDSA cycles are used as a model for continuous improvement, when starting a new improvement project, when defining a repetitive work process, and/or when planning data collection and analysis to verify and prioritize problems or root causes. “Plan” refers to planning a change or a test aimed at improvement. “Do” is to carry out the change or the test on a small scale. “Study” pertains to studying the results (i.e., what was learned and what

¹⁰ <https://www.mitre.org/research/overview>

went wrong). “Act” is to adopt the change, abandon it, or run through the cycle again (Hunter 2013).

Table 4-1. Phases of PDSA

Phase I—Plan	Phase II—Do	Phase III—Study	Phase IV—Act
1.1 Literature Review OI competitions	2.1 Literature review OI competition examples	3.1 Logic Model Framework Survey	4.1 Host and Manage Pilot
1.2 Informational Interviews	2.2 OI Competition Example Interviews	3.2 Participant Survey	4.2 Participant Interviews
	2.3 Capture Logic Model Framework		

4.1 Phase I—Plan

A review of literature and informational interviews were conducted to gain an understanding of OI and OI competitions in general. The output of this phase was used as the foundation of the introduction, background, and objective of the report. The information collected was also used to generate survey and interview questions for Phases II and III.

4.2 Phase II—Do

Experience surveys/interviews and secondary data analysis were conducted to identify success factors of OI competitions. Experience interviews were conducted with 15 organizations (10 government, three FFRDC, two industry). The purpose of the interviews was to gain insights on the types of OI competitions that are used most frequently and why, and to understand lessons learned, best practices, and overall experiences in managing OI competitions. The secondary data analysis augmented the interviews by providing published information about OI competition success factors.

4.3 Phase III—Study

A logic model framework was created as part of the study to describe linkages among OI competition program resources, activities, outputs, and short-/long-term outcomes. Data to populate the logic model elements was derived from the primary and secondary data captured from the study. The activities portion of the logic model utilized the GSA agency toolkit as an OI competition process baseline, as shown in Figure 4-1.

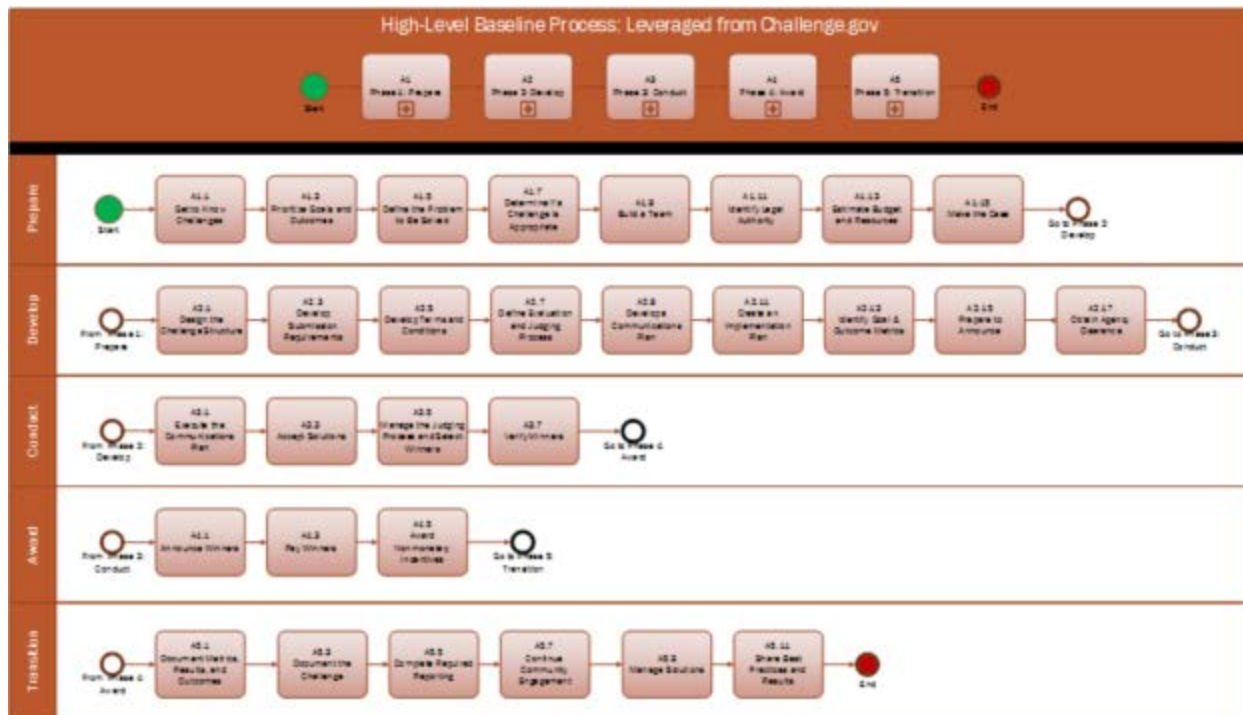


Figure 4-1. Baseline Process Leveraged from GSA Toolkit

A Lean Six Sigma (LSS) approach was used to validate the baseline and identify areas for improvement. LSS is a proven framework to either design or improve a process. Define, Measure, Analyze, Design, Verify (DMADV) is used to design a process; Define, Measure, Analyze, Improve, and Control (DMAIC) is used to improve a process.¹¹ During the early stages of the research, DMADV was used to verify the activities section of the logic model. Later in the research, DMAIC was used to improve the process. Figure 4-2 shows the LSS DMAIC and DMADV processes.

¹¹ <http://www.sixsigmacouncil.org/what-is-six-sigma/>

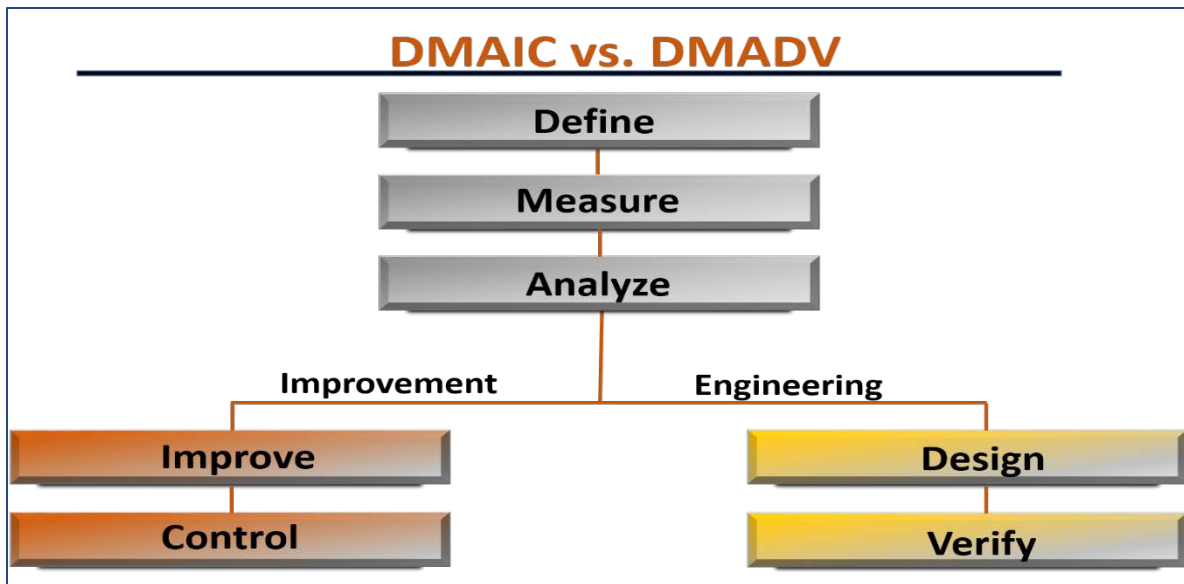


Figure 4-2. LSS DMAIC vs. DMADV

4.4 Phase IV—Act

The modified OI competition logic model from Phase III was leveraged as a project management resource to host an OI competition. The OI competition was managed by an intermediary, the IXL Center. The IXL Center hosts “Innovation Olympics, a competition between selected graduate school teams who develop business case(s) for a compelling business innovation concept. IXL has built a strong network of graduate schools around the world that enables IXL to recruit competing teams that are best suited to the challenges of the sponsoring company. For this study, the Innovation Olympics was co-sponsored by The MITRE Corporation and the Federal Protective Service (FPS) of the Department of Homeland Security. The FPS is part of the National Protection and Programs Directorate and is responsible for law enforcement and protective services at over 9,000 U.S. government buildings throughout the world. While FPS is responsible for the procurement and maintenance of high-performance security systems and protective services at these facilities, most of the actual funding comes from individual building owners and government agencies. Hence, the overall protection systems for these facilities have not necessarily grown or been modernized in the best way across the entire system, resulting in significant gaps that need to be filled. The challenge in this competition is to develop more innovative ways to design/redesign, procure, install, and manage these systems to fill these gaps, and to better protect the buildings, their occupants, and visitors.

The competition ran from June through September 2017. Table 4-2 shows the four key activities of the competition.

Table 4-2. Innovation Olympic Key Activities

Meeting Objective	Format / Duration
<p>1. Kick-off</p> <ul style="list-style-type: none"> • Official Kick-Off with All TEAMS • CLIENT provides background of organization strategy, key challenges, growth targets, and the boundaries for innovations • CLIENT supplies basic resources to help the teams get started e.g., presentation, report, etc. 	<ul style="list-style-type: none"> • CLIENT presents to all TEAMS • Q&A with teams after the presentation • 1-2 hour Presentation / Q&A
<p>2. Present Fields-of-Play</p> <ul style="list-style-type: none"> • TEAM presents their emerging opportunity and innovation landscapes (“Business Innovation Opportunity Map”) • TEAM suggests 3 – 5 new “Fields-of-Play” and recommends which opportunities to pursue further • CLIENT selects focused Field-of-Play for each TEAM 	<ul style="list-style-type: none"> • Each TEAM presents independently to client. (Other TEAMS may listen in if desired) • 3 Hours for ALL TEAMS to present (30min / team)
<p>3. Present Business Concept</p> <ul style="list-style-type: none"> • TEAM presents 3 – 5 “Business Concepts” and recommends one to create a plan around • CLIENT prioritizes one concept for plan creation 	<ul style="list-style-type: none"> • Each TEAM presents independently to client. (Other TEAMS may listen in if desired). • 3 Hours for ALL TEAMS to present (30min / team)
<p>4. Present Business Case</p> <ul style="list-style-type: none"> • TEAM presents their “Business Case” for the preferred business innovation concept • CLIENT selects the winning team 	<ul style="list-style-type: none"> • Each TEAM presents to the Client and other TEAMS listen in. • 3 Hours for ALL TEAMS to present (30min / team)

Focus groups were conducted with competition organizers and participants at the completion of the competition to discover managerial implications and benefits of using the logic model with an OI competition intermediary.

5 Findings

This study sought to review OI competition types, identify a logic model framework to manage competitions, and determine the efficiency of the framework in achieving OI competition goals. Data was gathered via:

- Interviews with hosts of previous OI competitions
- Logic model process survey with hosts of previous competitions
- Interviews with participants of previous OI competitions
- Interviews with hosts and participants from a pilot competition managed by a third party and co-hosted by MITRE and a MITRE sponsor

Results from the data collection are as follows.

5.1 OI Competition Host Interviews

A total of 16 semi-structured interviews were conducted with government (7), industry (4), FFRDC (4), and consulting (1) organizations that had previously hosted OI competitions. Organizations were selected using a convenience sample. A convenience sample refers to the procedure of obtaining units or people who are most conveniently available (Zikmund 2003).

Participating organizations are listed in Appendix C. Organizations were asked various questions about the types of competitions they managed. Interview questions are provided in Appendix D. Table 5-1 provides a summary of competition types, opportunities addressed, competition output, and target audiences. Each organization had a unique problem to address, and organizers leveraged the competitions to address multiple opportunities, obtain outputs, and reach a diverse target audience.

Table 5-1. Competition Types and Opportunity Addressed

Competition Type	Num.	Opportunity Addressed	Output	Target Audience
Ideation	5	Attract New Ideas Expand Current Business Line Inspire Transformation Process Improvement Mobilize New Talent	Implement process improvement Leverage community to identify a problem and idea to solve Minimal Viable Mock-up/Prototype	Diverse Talent Employees Subject Matter Experts Small Teams Start Ups
Technology Demonstration	4	Attract New Ideas Community Engagement Health Information Technology (IT) Applications Identify Expertise Increase Awareness Market Survey	Minimal Viable Mock-up/Prototype	Academia High School Industry Laboratories Trades
Hackathon	3	Community Engagement Disaster Relief Identify Technical Talent Increase Awareness Mobilizing Capital Relationship Building Technology Development	Minimal Viable Mock-up/Prototype	Academia Diverse Talent Programmers Small Teams Start Ups Venture Communities
Data Analysis	3	Attract New Ideas Community Engagement Identify Technical Talent Identity Resolution Semantic Evaluation Raise Awareness	Algorithm	Academia Diverse Talent Entrepreneurs Small Companies Students Subject Matter Experts
Request for Proposal	1	Technology Development	Research Proposals	Academia

5.2 Key Takeaways from Interviews

While there is not sufficient data to determine correlations between specific competition types and outcomes, the following success factors were discussed:

5.2.1 Consider Both Monetary Awards and Non-Monetary Incentives

Nearly all the competition organizers offered a monetary award. Prizes ranged from \$100 to \$200,000. Interviewees recommended that prize money be commensurate with the amount of time it takes for a participant to provide the expected output. Meaning, if a minimal viable mock-up/prototype is to be developed, then the monetary prize should cover the time it takes the participant(s) to develop the mock-up/prototype. All the organizations also stressed the importance of non-monetary incentives. Many organizations did not have budgets to provide a large monetary prize, but instead leveraged various methods to reward and recognize the top winners. Examples included press releases, conference presentations, honorable mentions in correspondence, participation in panels, recognizing winners as thought leaders, and recognizing winners as contributing to the success of the organization.

5.2.2 Spend Time Preparing for the Event

All organizers discussed the importance of preparing for the event—either as a lesson learned or a best practice. Preparing for the event includes:

- Gain an understanding of what the OI competition is designed for, what phases/steps are needed to be successful, and the time it will take from beginning to end to manage the effort. Read case studies and reach out to SMEs in the field.
- Have a structured process to manage the competition, to include milestones and gates. Have the right person lead the challenge, and a dedicated team to conduct/support the OI competition. There should be funding for all staff involved. Team members must be flexible and have good communication skills and problem-solving capabilities.
- Create a communications plan for how the competition will be marketed both externally and internally. Participants need to understand the rules and process. Company employees should understand the purpose of the competition.
- Don't underestimate resources needed. The need for time, people, and funding was the most frequently cited lesson learned. When asked what they would do differently the next time they hosted an OI competition, interviewees' number one response was securing resources—people, funding, and time—prior to the launch.

5.2.3 Have a Solid Problem Statement before Launching the Competition

Another top lesson learned was the importance of having a fleshed-out problem statement. Some organizers used third party vendors to help with designing the problem statement. Others said that designing the problem statement took a considerable amount of time. One interviewee mentioned that their competition was not successful because the problem statement was too broad.

5.2.4 Success Has Different Meanings

Organizers were asked what their definition of success was BEFORE starting the competition. The most cited answer was “getting enough and/or diversity of submissions.” Many were concerned that their marketing campaign would not be sufficient and there would be few or no responses. Many organizers wanted to have community engagement around a topic before and after the competition. Other responses included “find untapped expertise,” “have the event perceived as fair and valid,” and “have technology advancement to include commercialization.”

5.2.5 Many Unintended Benefits Result from Hosting OI Competitions

Organizers were surprised at the benefits their organizations experienced during the OI competition. The most cited response was how their company was recognized for hosting the competition—press releases, press interviews, peer recognition, etc. Other responses included obtaining new hires, increase in academic collaboration, follow-on work commercializing the product, increase in awareness about a topic, and community engagement.

5.2.6 Be Aware of Factors That Can Impact the Competition

While it is difficult to prepare for all contingencies, there are a few factors that may have a negative effect on managing OI competitions. Organizational culture was discussed most frequently, because many employees are threatened by the organization opening the door for external ideas. Interviewees also mentioned that OI is a change in business process, and it takes time for employees to adjust to this concept. Depending upon the mission of the organization, external factors such as government regulations, changes in administration, and industry trends can also impact the competition.

5.3 Logic Model Process Survey with Hosts from Previous OI Competitions

The GSA agency toolkit was used as a baseline for the activities portion of the logic model. Using the LSS DMADV identified in the methodology, eight organizations that previously managed OI competitions participated in a survey to rate the value of each of the activity phases and steps in the process baseline before and after their competition. Figure 3-1 shows the process steps and sub-steps ratings as either valuable or not valuable before and after their challenges. Process steps deemed non-valuable by 25% or more respondents are circled in red. A description of these follows:

- A2.11 shows that half of the respondents did not value “Creating an Implementation Plan” before the competition, but did value “Creating an Implementation Plan” after they ran a challenge. Recommendation—create awareness of the importance of this process step before.
- A2.17 shows that both before and after the challenge, three respondents did not find “Obtain Agency Clearance” a valuable process step. It is highly possible that this simply was not a requirement for those respondents; however, due to the nature of work done by and for the government, it certainly could be a helpful reminder.

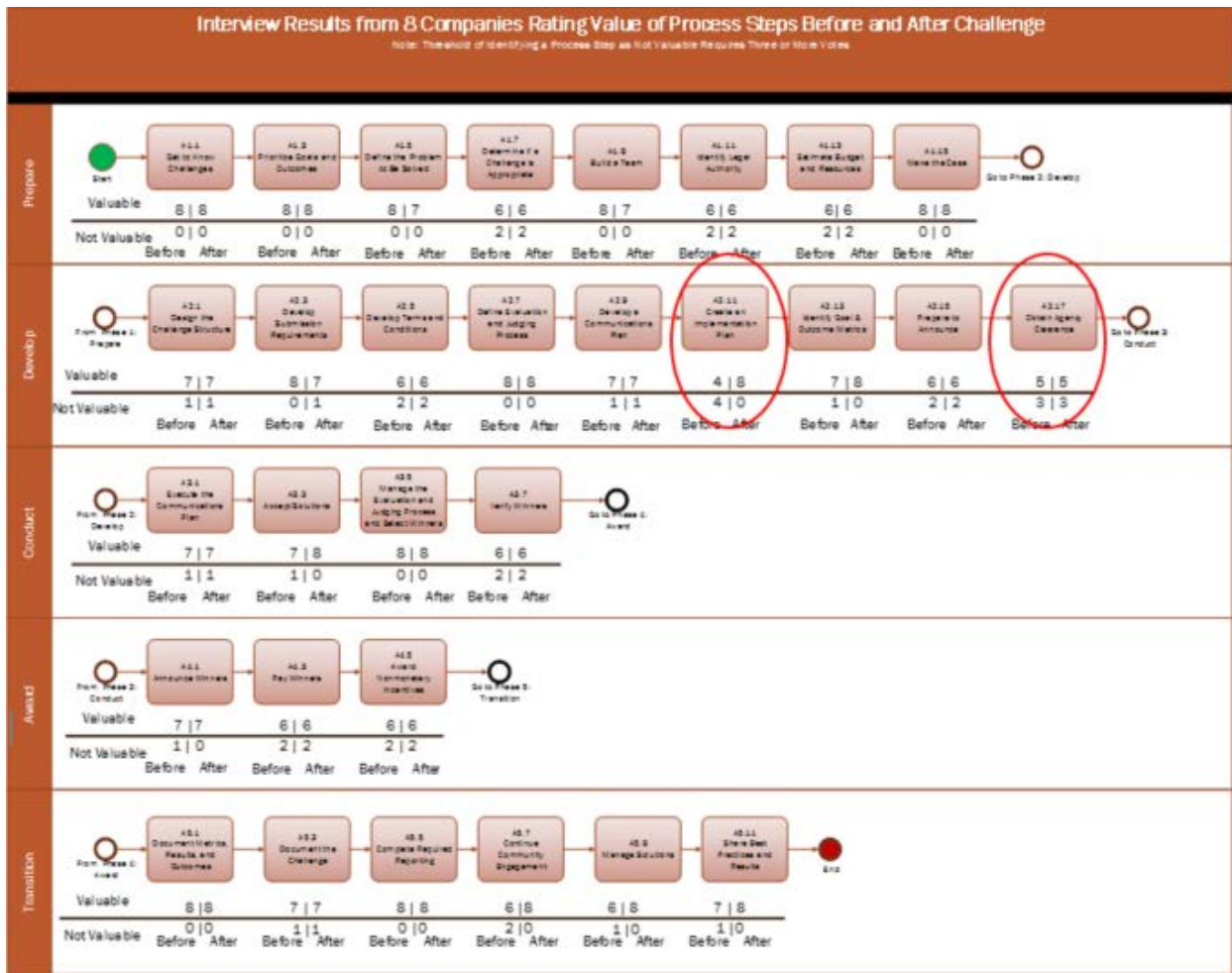


Figure 5-1. Baseline Process Ratings from Survey Results

Using the LLS DMAIC identified in the methodology, a second literature review was conducted of 40 documents to identify processes for open competitions from other sources. There were 78 process steps identified. Out of the 78 process steps identified, 72 were mapped to at least one process step in the COMPETES toolkit baseline. The remaining six process steps not mapped to the baseline were grouped into themes and combined into two new process steps: Preparing the Prize, and Determining and Attracting Participants. The criteria used to recommend these two additional steps were dependent upon the number of sources depicting the process step and the extent to which the process steps were defined. Figure 5-2 depicts the two new suggested steps.

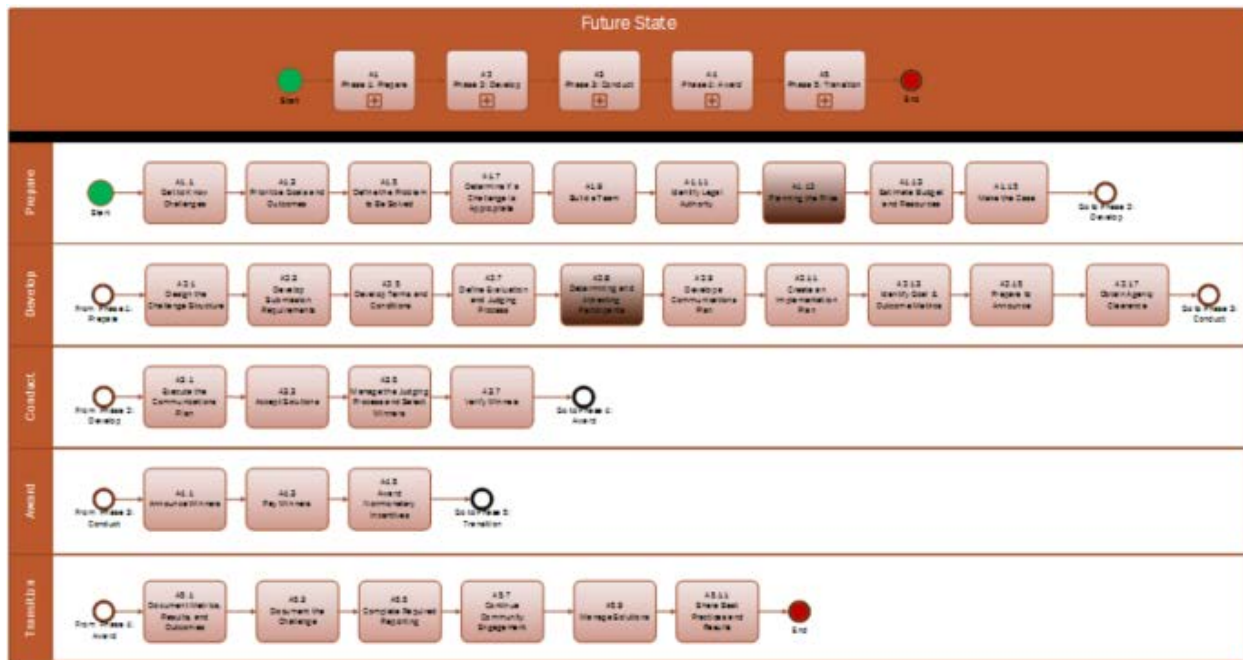


Figure 5-2. Future OI Competition Process

Table 5-2 lists are some aspects that should be included under the two addition process steps:

Table 5-2. Aspects of the New Process Steps

Suggested Process Step	Aspects of Process Step	Supporting Documentation
Planning the Prize	Understanding the stakeholders' needs:	McKinsey & Company. (2009)
	<p>“Primary motivation was not prize money. More interested in reaching other potential funders and building links with other entrepreneurs. Designed prize process to place emphasis on networking. Success depends on a deep understanding of stakeholders and what motivates them. Not merely a guess, but real insight based on disciplined analytical thinking coupled with some inspired listening.”</p>	
	Identifying a prize: Six Prize Archetypes:	McKinsey & Company. (2009)
Determining and Attracting Participants	<p>“What type of prize should be given based upon goals and change levers, and best fits the problem and appeals to the problem solvers motivations”</p>	
	Determining Participants:	McKinsey & Company. (2009)
	<p>“A prize strategy should largely determine the size and composition of its pool of problem solvers.”</p>	
	Attracting Quality Participants	McKinsey & Company. (2009)
	<p>“This activity essentially fills the wide end of a funnel in order impact at the narrow end—the award stage.”</p>	
	Finding Suitable Participants	Wassrin, et al. (2015)

Suggested Process Step	Aspects of Process Step	Supporting Documentation
	Determining Participants	NASA (2015)

5.4 OI Competition Participant Survey

An OI competition participant survey was sent to three groups who participated in OI competitions within the last year—MITRE Internet of Things; MITRE Counter UAS Challenge; and MITRE Next Up Millennial List Serve. A total of 23 responses were received representing four OI competition types: Algorithm 55%; Hackathon 32%; Develop Prototype 9%; and Ideation 4%. The purpose of the survey was to gain an understanding of the perception and experience of participating in an OI competition. Survey questions are listed in Appendix E.

Specifically, the study sought to understand:

- What are the key success factors of OI competitions for participants?
- What are the key motivators of OI competitions for participants?

Both the literature review and lessons learned from interviews of organizers of competitions indicated that a well-defined problem statement is key to the success of an OI competition. Survey participants were asked (scale of 1, strongly disagree, to 5, strongly agree) if there was a well-defined problem statement in the OI competition they participated in. The survey revealed that many participants were not clear about the problem to be solved.

Table 5-3. Participant Survey Result on Well-Defined Problem Statement

Competition Type	Average
Prototype	4.3
Algorithm	3.75
Hackathon	3.71
Ideation	3

In a Deloitte report, Goldhammer, et al. (2014) analyzed over 400 OI competitions and identified six outcomes that designers commonly seek:

- Attract new ideas
- Build prototypes and launch pilots
- Stimulate markets
- Raise awareness
- Mobilize action
- Inspire transformation
- Promote entrepreneurship

The outcomes referenced in the report were listed in the participant survey. Participants were asked the extent to which they agreed (scale of 1, strongly disagree, to 5, strongly agree) about the outcome of the OI competition they participated in. All participants believed “attracting new ideas” was a primary outcome. However, participants were undecided whether there was another purpose for the OI competition (Figure 5-3).

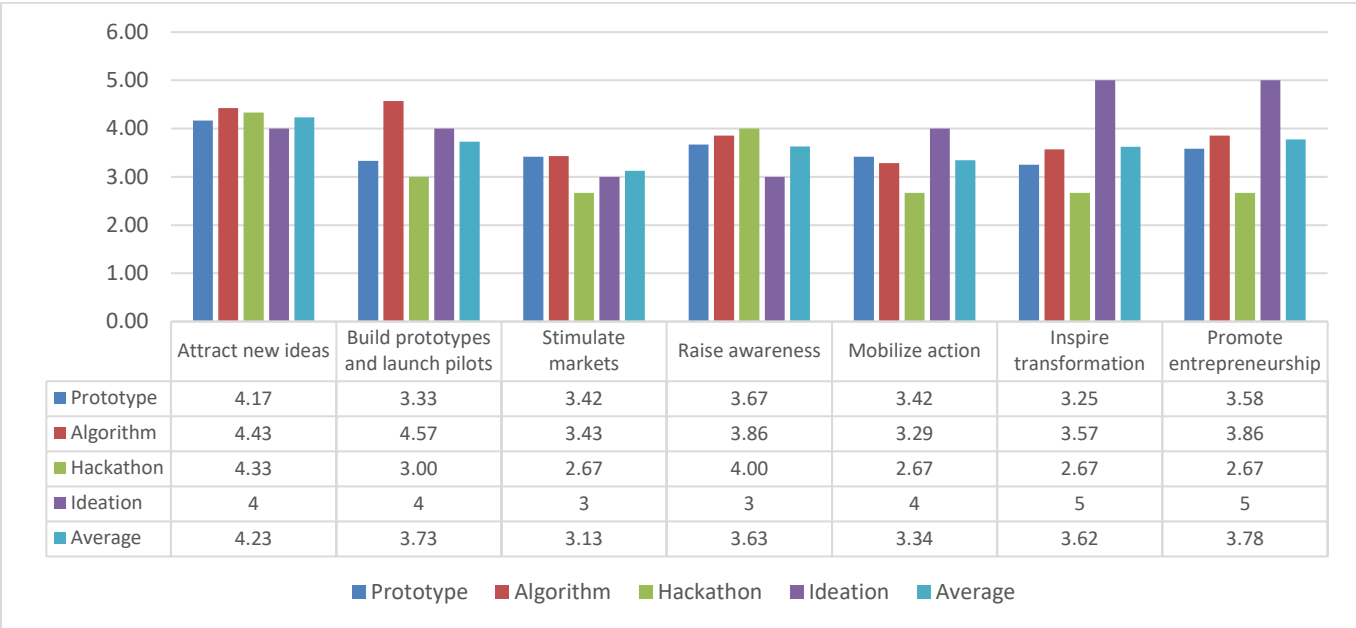


Figure 5-3. Participant Perceptions of OI Competition Outcome

Goldhammer, et al. (2014) identified the following non-monetary incentives that motivate competition participants:

- The challenge of solving a difficult problem
- Passionate about topic
- Collaborating with others
- Contributing to something greater
- Being recognized as a subject matter expert
- Potential follow on work
- Influence public perception

These incentives were listed in the survey, and participants were asked the extent to which they agreed (scale of 1, strongly disagree, to 5, strongly agree) about the incentives for participating in a competition. The responses indicate that they were more motivated to participate based on non-monetary than monetary incentives (Figure 5-4 and Figure 5-3).

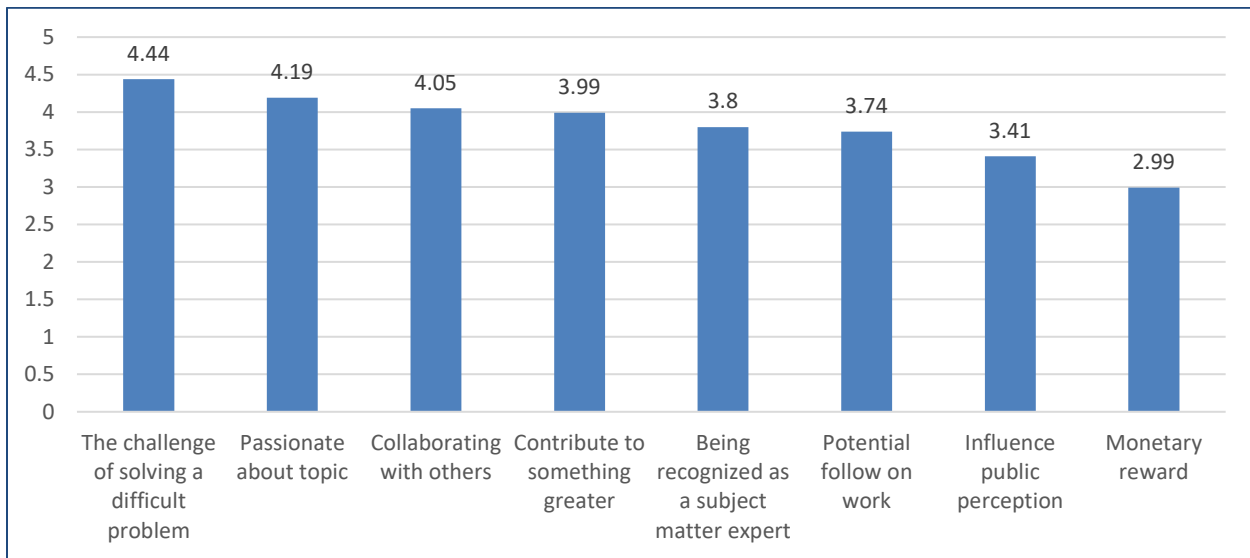


Figure 5-4. Monetary vs Non-Monetary Incentives

Type of Competition	Monetary reward	Potential follow on work	Being recognized as a subject matter expert	The challenge of solving a difficult problem	Collaborating with others	Influence public perception	Contribute to something greater	Passionate about topic
Algorithm	3.38	3.85	3.54	4.38	3.23	3.08	3.46	3.92
Prototype	3	3.67	4	4.5	4.5	4	4.5	4.5
Hackathon	2.57	3.71	3.86	4.43	4.43	3.14	4.00	4.14
Average	2.99	3.74	3.80	4.44	4.05	3.41	3.99	4.19

Figure 5-5. Monetary vs non-monetary Incentives by Competition Type

When asked if they would participate in a OI competition again, two of 24 stated “no” with an explanation that “I may participate under clearer rules,” and “there was not a level playing field.” Two responded “maybe” with no explanation. Twenty said they would participate again. Table 5-4 lists their top reasons.

Table 5-4. Reasons for Participating

Learning Experience	Challenge	Collaboration
<p>“Rich experience for learning”</p> <p>“It’s always good to know how your solution matches up with the problem”</p> <p>“Contribute to a good cause, build reputation, access to resources I normally would not have”</p> <p>“It was a great learning experience, and the environment of a hackathon is so energetic and fast-paced, it’s hard not to have fun the entire time.”</p> <p>“Great learning experience”</p>	<p>“I like real world problems where innovation is the main goal.”</p> <p>“Everyone wants to be challenged to solve hard problems”</p>	<p>“The most valuable part for me was getting to work with people from other parts and leverage their skills and expertise.”</p> <p>“Most value was just having a good time while working on a project”</p> <p>“Meeting new people and working with subject matter experts”</p>

5.5 OI Competition Pilot Interviews

An OI competition managed by IXL Center (third party intermediary) was held June-September 2017. The FPS, Director of the Advanced Technology Security Program, was the client. Five university teams participated. The OI competition follows a five-step process to help university teams progressively develop and test potential solutions and deliver specific outputs every two

weeks. At the end of the competition, two winning teams and their candidate solutions were chosen for the monetary prize.

Interviews were conducted at the end of the competition with the client and the student teams. The following are the key takeaways from the interviews.

5.5.1 Client Interview

FPS was seeking solutions for updating an antiquated business model and outdated technology for protecting its facilities. “We are doing 1970 security in 2017 because it is falling back on what we have always done.” FPS identified five outcomes for hosting the competition:

- Gain an outsider’s perspective
- Obtain a solid foundation to bring forward for making change
- Provide an independent aspect and unbiased recommendation
- Take advantage of a quick-turn, high-level production (energy to think outside the box)
- Gain extra resource capability—workforce multiplier

FPS stated that the OI contest was successful because it yielded “good information and topics to further investigate for taking their program to the next level,” and “most of the business cases are actually very good and have sound technical practices we could integrate into our overall architecture and future plans.” When asked about the value of hosting an OI competition, the response was the “speed, expedience and lack of confining oversight” compared to traditional contracting processes. Feedback on improving the process included a) allowing additional time to provide teams with more context of the FPS business model and operations, b) giving more frequent feedback to the teams, c) having a scoring rubric to evaluate teams, and d) coordinating one-on-one meetings for one hour vs. meeting with all teams over a three-hour period. Most important was the “need to have more time to provide guidance to focus on things that were possible to implement.” In summary, FPS hosted the OI competition because there was no known solution to its problem, and because it was a good model to leverage academia, embrace diverse mind-sets, and enhance FPS innovation capacity. Appendix F lists the interview questions.

5.5.2 University Team Interviews

Four of the five student teams were interviewed to gain perspectives on their experience and motivational factors for participating in the Innovation Olympics. Appendix G lists the interview questions. Highlights from the interviews are below:

Outcome: All student teams recognized that there were two outcomes to the competition—a specific output for the client, and for the student teams an expectation that it would be an excellent learning experience to gain critical thinking skills by applying a structured innovation management process to solve problems.

Problem Statement: While the student teams agreed that the problem statement was clear, they stated that a limitation to their performance was a lack of adequate information about the context of the problem, the industry, and the client’s operating model.

Feedback: All student teams highlighted the importance of feedback throughout the five-phase process. Students stated that the feedback they received after each phase positively influenced

their performance; however, they recommended for future competitions that there should be more opportunities for dedicated feedback sessions.

Team Process: There were three differentiating factors between the winning teams—doing market research, emulating the problem through personal experience, and conducting team meetings in person vs. virtually. Both first- and second-place teams conducted extensive background research to understand the industry. The first-place team mapped out their security and infrastructure experiences working in public buildings. They used the model as an “as-is” stage to better understand the problem. Both the first- and second-place teams met physically; due to locality, the other teams were limited to virtual meetings. The face-to-face meetings helped to build relationships and trust.

External Factors: As part of the Innovation Olympics, student teams conducted a technology assessment on the state of the art of security monitoring technologies. The teams stated when reaching out to industry/companies of security monitoring technologies that there was limited data available, and many companies did not want to share information with them.

Motivating Factors: All student teams were both interested and passionate about participating in the Innovation Olympics. Although there was a monetary factor, none of the student teams mentioned that money was the reason they participated. Instead, many non-monetary factors were identified—learn how to engage with clients; learn a structured innovation management process; learn about problems in industry and government; desire for competition; desire to gain an innovation management certificate for future work; and gain consulting experience for future jobs. When teams were asked if they benefited from participating in the competition regardless of whether they were selected or not, all responses were positive. Comments included:

- “Yes, the best part is that you are able to deal with real world problems and engage with clients.”
- “Our team had diverse backgrounds, this helped us learn how to work together.
- “It was a great learning opportunity to get involved and solve a problem.”
- “Based on this experience I am confident as a business student that I can work on other projects and come up with solutions.”
- “This was a valuable experience and I got a lot out of it.”
- “Yes, I wanted to learn something new and work as a team on the project and apply what we learned and that is what we did.”
- “After we finished we all said it doesn’t matter if we win or lose, because we learned a lot.”
- “This experience was intense but good to prove to us that we could make it no matter how hard it is and that there may be some bad endings but we developed the team dynamics to make it through the competition.”

Evaluation: While the student teams agreed that their final business case presentation would be used to select a first- and second-place winner, many of the participants were unclear how their contribution would be evaluated. It was recommended that a scoring rubric be created and shared prior to the competition.

Improvements: When asked how the process could be improved, all students were very positive about their experience and the process, and stated that the IXL Center provided an excellent program, and coached and mentored them throughout the competition. The students did

comment on how intense and time-consuming the process was; however, despite the difficulty, they all would participate again.

6 Conclusion

This exploratory study was designed to review OI competition types, identify a logic model framework to manage competitions, determine its efficiency, and validate the framework as a method of achieving OI competition goals. There were seven research questions. This section provides responses to the research questions.

6.1 What Are the Types of OI Competitions?

Table 6-1 lists the 10 types competitions identified from the study. MITRE and our government sponsors most frequently use Hackathons, Idea Generation, Scientific, and Technical competitions.

Table 6-1. OI Competition Types

Type	Description
Analytics/algorithm Optimization	Analytics, visualization, and algorithm challenges focus on finding better ways to interpret or communicate data. The outcome of an analytics challenge is to obtain the best-in-breed optimized code, test scenarios, documentation, and/or approach analysis.
Design	Creative design and multimedia challenges can help capture, communicate, and project a concept or aesthetic that would be difficult to achieve with a grant or contract.
Entrepreneurship	Entrepreneurship or business plan challenges are competitions used by government, universities, and private sector organizations to help train and equip entrepreneurs, as well as launch their ventures.
Hackathon	A design sprint-like event in which computer programmers and others involved in SW development, including graphic designers, interface designers, project managers, and others, collaborative intensively on SW projects. A themed hackathon is one in which the projects are confined to a specific problem, such as food sustainability or returning citizens. A civic hackathon is a gathering of technologists for a few days or weeks to build civic-themed software.
Idea Generation	In idea generation, an organization asks external participants to submit ideas to address a specific issue or problem. An ideation challenge supports new ways of understanding and framing problems, new processes to solve problems, and innovative implementations as solutions to problems. Organizations reach out to the ecosystem in search of innovation ideas, which are then further developed in-house.
Open Data	Organizations mobilize participants to share, explore, and analyze publicly available data sets, and to use the data to conduct research, design data visualizations, or create web and mobile applications and websites that help people access and use the data.
Opinion Seeking	Used to improve a product or service. Soliciting the opinions of customers, prospects, or the public will provide ideas for process improvement.
Scientific	Scientific challenges seek to promote the understanding for a problem, solution, or outcome using empirical or measurable evidence-based practices.
Software	In a software and application development challenge, an organization asks solvers to create an SW application to solve an existing problem or draw attention to potential uses of available data sets.
Technology	Technology demonstration and hardware challenges seek prototypes, minimal viable product/service, or fully developed solutions to catalyze and demonstrate breakthrough technical innovations.

6.2 What Are the Key Success Elements of OI Competitions for Organizers?

The review of literature identified several best practices and lessons learned, which are depicted in Figure 3-7 and Appendix A. Interviews with contest organizers revealed the following six considerations for managing an OI competition:

1. **Consider both monetary awards and non-monetary incentives.** Nearly all the competition organizers offered a monetary award; however, organizers stressed the importance of non-monetary incentives. Many organizations did not have budgets to provide a large monetary prize, but instead leveraged various methods to reward and recognize the top winners.
2. **Spend time preparing for the event.** All competition organizers discussed the importance of preparing for the event—either as a lesson learned or a best practice. When asked what they would do differently the next time they hosted a OI competition, the unanimous response was securing resources—people, funding, and time—prior to the launch.
3. **Have a solid problem statement before launching the competition.** A top lesson learned from competition organizers was the importance of having a fleshed-out problem statement.
4. **Success has different meanings, depending upon the nature of the competition.** Organizers were asked what their definition of success was BEFORE starting the competition. The most cited answer was “getting enough and/or diversity of submissions”. Others wanted to “find untapped expertise”, “have the event perceived as fair and valid”, and “to have technology advancement to include commercialization”.
5. **There are many unintended benefits that result from hosting OI competitions.** Organizers were surprised at the benefits their organizations received during the OI competition such as how their company was recognized for hosting an OI competition, obtaining new hires, increase in academic collaboration, follow on work commercializing the product, increase in awareness about a topic, and community engagement.
6. **Be aware of factors that can impact the competition.** Organizational culture change was discussed most frequently as a barrier to OI because many employees are threatened by the organization opening their doors for external ideas, also known as the “not invented here syndrome.”

6.3 What constitutes a repeatable process for OI competitions?

The key deliverable as part of this research study was the development of a logic model framework to depict an OI competition management tasks (resources, activities, output, outcome, impact). The GSA challenge toolkit was used as a baseline to identify activity phases and steps. A LSS method was used to compare the baseline against processes identified primary and secondary data sources. A logic model was then updated to incorporate the changes. The full framework is shown in figure 2.

6.4 What types of problems are best suited for OI competitions?

This was the most difficult research question to obtain consensus on. Perhaps it is because there is no one formula since each OI competition addresses a unique problem, and a set of potential participants whose incentives must be carefully understood.

When OI competition organizers were asked what type of problems are best suited for OI competitions the results included; when broader subject matter expertise is needed, to use existing technology in new ways, when there is a unique problem set, when a big impact is needed, to engage the workforce, to develop a prototype, for new business opportunities, and when there is no known solution.

Both the literature and interviews with organizers of competitions caution that if there is not a defined problem statement then the outcome may not be ideal, and it will cause frustration with participants. Goldhammer, et al., (2014) stated that because problem definition involves grappling with a great deal of ambiguity it is arguably the most difficult part of prize design. They suggest organizers start by developing a clear understanding the outcome they seek and the different ways they can achieve them. Specifying the outcome establishes the broad set of aspirations, whereas problem statement definition more narrowly frames the need the prize will ultimately address.

6.5 What are the key success factors of OI competitions for participants?

Little data exists in the literature about participant experience and perception of joining a OI competition. As a part of the study when OI competition participants were surveyed and asked, “what could the challenge host do to help you succeed” the responses included being clearer about evaluation criteria, obtaining frequent feedback, and more time to socialize and collaborate before the competition.

6.6 What are the key motivators of OI competitions for participants?

OI Competition participants were surveyed and asked about what motivated them to participate in a competition. The responses indicated that they were more motivated to participate based more on non-monetary vs monetary incentives. Non-monetary incentives included: the challenge of solving a difficult problem, passionate about topic, collaborating with others, contributing to something greater, being recognized a subject matter expert, potential follow on work, and influencing public perception. When participants were asked if they would participate in a OI contest again, the most cited reasons for participating was the learning experience, problem solving, and the opportunity to collaborate with peers.

Organizers should be aware of the non-monetary reasons participants join competitions so that incentives can be designed into the competition.

6.7 What are the managerial implications and benefits of using an OI intermediary to manage competitions?

A key benefit of hosting an open competition is because it is considered a good alternative to traditional subcontracting processes, particularly “speed, expedience, and lack of confining oversight” as cited in the interviews. A key benefit to having a third-party facilitate an OI competition is leveraging the experience in formulating problem statements, and a following a well-defined process for managing a competition.

It is important to note that during the pilot competition, the five student teams were very interested and passionate about being in the competition. Although there was a monetary factor, none of the student teams mentioned that money was the reason they participated. Instead, many non-monetary factors were identified – learn how to engage with clients; learn a structured innovation management process; learn about problems in industry and government; desire for competition; desire to gain an innovation management certificate for future work; and gaining consulting experience for future jobs. When teams were asked if they benefited from participating in the competition regardless if they were selected or not, all responses were positive.

7 Recommendations

A logic model framework was created as a key deliverable of the research to depict the OI competition management tasks. The content was generated through various means – a review of literature, process validation, and host interviews. The framework describes the logical linkages among the elements in managing an OI competition, such as resources, activities, outputs, and short-/long-term outcomes. We suggest OI competition hosts leverage the OI logic model to plan and manage future OI competitions. To use the model, hosts should review the elements to familiarize staff and stakeholders with the content, keeping in mind that the model provides the framework for managing a OI competition and provides a means to measure performance – specifically accountability, and communicating the value of the OI competition. While using the model it is important to monitor each of the elements and steps within the elements and improve for future use.

A constraint during the study was that the model was not completed in time to use as a management tool for the pilot OI competition. However, retrospectively, the researchers recommend the following considerations when designing new OI competitions using the model:

Don't Skip Planning your Resources

The Resources Element assists the OI competition host in formally starting the competition. This phase of the program involves identifying stakeholders and managing their expectations. It also provides a vision for the competition in terms of the organizations strategic objectives, the scope, any known constraints. Most importantly it provides the host the opportunity to identify resources – staffing, schedule, infrastructure, and governance. During interviews, OI competition organizers stated that they underestimated the importance of coordinating time, resources and funding.

The *Activities Element* is Where Most Management Time is Spent

Activities consists of preparing, developing, conducting, awarding, and transitioning the competition. It is important to be familiar with the various steps for they can vary depending upon the purpose of the competition. Suggest creating a Role & Responsibility Chart (RACI)¹² assigning activities and responsible parties to ensure accountability for each stage and task.

Demonstrate your OI Competition Progress

It is common to think that organizing OI competitions ends after awarding the prize. However, organizers should think in terms of demonstrating the success of the competition. Measurement should be baked into the framework and include outputs, outcomes and impact. Outputs are a tangible item (i.e., service, product, delivery implementation). Outcomes identify short and long term outcomes expected to be achieved. Lastly, Impact describes the impact within a specific community 7-10 years as a result of your competition.

Leverage Lessons Learned and Best Practices

¹² https://pmicie.org/images/downloads/raci_r_web3_1.pdf

The review of literature produced numerous best practices and lessons learned, more than was possible to contain in the study. We aligned many of these items with the logic model to demonstrate lessons learned and best practices with each logic model element (i.e., resources, activities, outputs, outcomes, and impact). Suggest reading through each of the items as part of setting up future OI competitions to learn from past challenges.

8 Future Research

The OI competition space is very broad and still a relatively new strategy for organizations. The review of literature captured many suggestions for future research, which are summarized in three main themes—Competition Design, Impact, and Motivators. Other mentions include Infrastructure, Performance Management, and Resources.

Table 8-1. Future Areas for Research

Theme	Activity	Source
Competition Design	More guidance on competition design	Wassrin, et al. (2015)
Competition Design	How to appropriately identify problems that are well suited to OI approaches	Gusteric (2015)
Competition Design	Current and potential participants are asking when they should use prizes and how they can develop and deliver effective ones	McKinsey & Company
Competition Design	Investigate combinations of design elements that can increase the likelihood of success	Goldhammer, et al. (2014)
Impact	Further study of how often various types of prizes lead to societal benefit at scale	Goldhammer, et al. (2014)
Impact	Evaluation of prize effectiveness and impact	McKinsey & Company
Impact	Quantification of return on investment for different prizes	Goldhammer, et al. (2014)
Impact	Expand evaluation of various challenges	Goldhammer, et al. (2014)
Impact	Investigate differences between OI approaches that address technological innovations and those that address service and/or societal innovations	Durst & Stahle (2013)
Impact	Longitudinal studies on OI competitions to determine longer term impact	Durst & Stahle (2013)
Impact	Country comparisons using OI	Durst & Stahle (2013)
Impact	A better understanding of the downsides of having an OI process	Durst & Stahle (2013)
Influence-Motivation	Competitor motivation and behavior	McKinsey & Company
Influence-Motivation	More empirical research is needed to investigate what drives contributors in different projects	Hoavanaughs (2011)
Influence-Motivation	Most OI studies are in U.S. and Europe. It might be the case that differences in culture could yield different motivations for participating in OI projects	Hoavanaughs (2011)
Infrastructure	Centralization of a comprehensive and consistent database on prizes	McKinsey & Company
Performance Management	Develop a set of metrics to guide performance management and resource allocation	Gusteric (2015)
Resources-Roles	Understanding the contribution of HR management to OI	Durst & Stahle (2013)

In addition to what was generated from the research, this study identified the following future research needs.

- Articles about OI competitions tend to report on the positive outputs/outcome; very little data exists on competitions that are considered unsuccessful. It is important to understand both success criteria and why competitions are deemed unsuccessful.
- There is little data about the perception, experience, and motivating factors of competition participants. More research is needed to determine the benefits of participating in competitions so that organizers can refine their processes.
- The logic model was collected through a review of literature and survey responses. We were not able to validate the entire model as part of the survey. We suggest the model be used to host an OI competition and continue to be updated.
- Research is needed on how to measure potential impact and economic benefits before they are realized (e.g., causal modeling and economic simulation).

Appendix A Open Innovation Contest Best Practices

LM Category	Activity Phase	Best Practice
Activities	Award	Publicize awards and underlying issues
Activities	Award	Expand number of winners with recognition for best in various categories
Activities	Conduct	Multiple selection rounds
Activities	Conduct	Hold mini challenges
Activities	Conduct	Regular touchpoints between designers and participants and regular communications
Activities	Conduct	Keep the consumer involved
Activities	Conduct	Offer participants PR opportunities and unique access to markets during the competition
Activities	Conduct	Use iterative feedback
Activities	Conduct	Promote competitor collaboration and interaction, include dialog with community
Activities	Conduct	MITRE phases -- beta, production, validation
Activities	Conduct	Two tracks -- open and conventional (no exchange between participants)
Activities	Conduct	Transparent, simple, fair, and unbiased rules
Activities	Conduct	Work with a third party to manage the challenge
Activities	Conduct	Multi-phased judging
Activities	Develop	Clearly define selection process, decision rights, compensation calculations
Activities	Develop	Educate team about open innovation
Activities	Develop	Trade-offs of open identity among participants
Activities	Develop	Divide challenge into parts ("small bites")
Activities	Develop	Standardize submissions and weight criteria
Activities	Develop	Hold public comment period on draft rules
Activities	Develop	Multi-channel marketing campaign
Activities	Develop	Manage and monitor resource flows
Activities	Develop	Structure format of submissions to ease evaluation (judging) [white window mats and size constraints]
Activities	Develop	Offer industry experts incentives to be involved
Activities	Develop	Build trust with participants
Activities	Prepare	Incentivize and promote culture for innovation
Activities	Prepare	Conduct gap analysis
Activities	Prepare	Draft risk mitigation plan
Activities	Prepare	Realistic budget and timelines

LM Category	Activity Phase	Best Practice
Activities	Prepare	Define clear goals, objectives, and performance metrics for each step
Activities	Prepare	Deconstruct the problem
Activities	Prepare	Tailor the problem statement to attract the right range of participants
Activities	Prepare	Structure the challenge around the maturity level of the technology
Activities	Prepare	Understand phases and life cycle and radical vs. incremental change
Activities	Prepare	Attention to roles of people
Activities	Prepare	Where possible, decompose the problem
Activities	Prepare	Include recognition of non-financial measures
Activities	Prepare	Manage and leverage IP, align with incentives
Activities	Prepare	Designed to be inspirational
Activities	Prepare	Adopt entrepreneurial and collaborative approach
Activities	Transition	Evaluate impacts
Activities	Transition	Post-award incentives to refine solutions
Activities	Transition	Develop cycle with repeated challenges and process improvement
Activities	Transition	Sustained marketing effort that continually revitalizes the message
Activities	Transition	Conduct a post-competition review to analyze feedback
Activities	Transition	Prepare for the deployment phase
Activities	Transition	Feedback and guidance for submissions in multiple rounds
Activity	Transition	Plan in advance for future rounds
Constraint		Encourage openness and transparency
Constraint		minimize friction and bureaucracy
Constraint		Participant cost structure
Constraint		Decision-making authority
Constraint		Create an innovation culture within the legal team
Constraint		Navigate internal approval processes for the challenge
Constraint		Align innovation strategies and culture across multiple partners
Constraint		Gain legal authority to implement a competition or innovation
External factors		Profile of target audience
External factors		Knowledge-sharing culture
External factors		Infrastructure from established communities
External factors		Match with overall strategy, industry-level variables, and cultural transformation principles

LM Category	Activity Phase	Best Practice
External factors		Make the ecosystem work using effective positioning and leveraging diversity
External factors		Continuously monitor external conditions
External Factors		Identify trends in other industries and how they may impact innovation
Impact		Institutionalize technology transfer
Impact		Sustain community through post-award communication
Impact		Evaluate design, implementation, costs, impact
Impact		Post-award marketing
Outcome		Build strong branding around the challenge
Outcome		Sustained communication with participants post-award, develop blog or newsletter
Outcome		Use challenge to define metrics for community
Outcome		Make challenge fun to watch
Outcome		Design with end use in mind
Outcome		Design problem statements to lead to broadly workable solutions
Output		Public leaderboards
Output		Design challenge so that winners can be judged in a more automated way
Output		Require a scaling plan as part of the solution
Output		Publicity of rewards -- recognition is a reward
Output		Validate the solution (e.g., solutions run through power generation models)
Resources		Increase hiring flexibility to bring high-demand skills into government
Resources		Website/competition portal as a central repository with one-stop shopping
Resources		Use of SMEs
Resources		Choose a strategically networked structure that aligns
Resources		Choose the right mix of individuals and participants
Resources		Governance
Resources		Standards for collecting, storing, sharing data
Resources		Recruit staff who can build trust with leadership
Resources		Select task that is suitable for crowd sourcing
Resources		Select intermediaries suited to the task or manage internally
Resources		Effective governance and leadership with experience in change management and promoting innovation
Resources		Prize commensurate with effort
Resources		Seek participants aligned with strategy

LM Category	Activity Phase	Best Practice
Resources		Advisory board, expert advice, and qualified judges w/o conflicts of interest
Resources		Understand landscape of potential participants
Resources		Independent evaluators without conflict of interest
Resources		Engage PR experts
Resources		Social media feeds
Resources		Employ staff with knowledge of marketing campaigns
Resources		Engage partners who can increase depth of interaction with communities
Resources		Design elements such as competition structure
Resources		Engage partners with strong brands
Resources		Neutral community leaders to promote the challenge
Resources		Include motivators tailored to the target community of problem solvers
Resources		Facilitators -- brokers, relationship managers, innovation champion, intermediaries
Resources		Resources -- personnel, equipment, time, balance innovation and day-to-day tasks
Resources		Make state business rules underlying benefit decisions publicly available
Resources		Design archetypes
Resources		Defined purpose, scope, approach, roadmap
Resources		Compile data on prizes
Resources		Reach out to ecosystem to collect innovative ideas
Resources		Web designer and communications specialist
Resources		Put thought into scoring process
Resources		Crowdsourcing
Resources		Establish/utilize a center of excellence
Resources		Collaboration between technology and market experts

Appendix B Open Innovation Competition Lessons Learned

LM Category	Lessons Learned
Activities	Computer security and privacy protection
Activities	Legal department concerns about the evaluation activities or the application
Activities	Communication problems lead to misunderstandings and delays
Activities	Apply thorough test plans to platform
Activities	Modeling and scoring architecture are not trivial issues
Activities	Participants desire collaboration
Activities	Collaboration influences by agendas that participants bring
Activities	Automate administrative functions
Constraint	Required standard Activities are a barrier to implementing a novel solution
Constraint	Innovators need support from top management
Impact	Sustained success of prize industry requires further investment from stakeholders
Outcome	Awards may result in winning additional funds through grants and contracts
Outcome	External suggestions are often not adopted due to NIH syndrome
Outcome	R&D department may lack interest
Outcome	Innovators lacked implementation authority
Output	Prize designs allow innovators to focus on what they do best
Resources	Choice of platform for big data was not the best
Resources	In addition to cash prize, administration costs may be significant
Resources	Insufficient resources for useful results
Resources	Problem is largely unsolvable or a minor problem with weak commitment
Resources	Unrealistic expectations for a solution
Resources	Benefits of working with web designers and communications specialists
Resources	Build utility, administration, and reporting functions into competition platform back end
Resources	Have clear goals and requirements specified up front
Resources	No shows due to lack of outreach
Resources	Difficult to attract participants
Resources	Avoid discrepancies in challenge statements
Resources	Don't underestimate importance of clearly defining the problem
Resources	Don't assume website and emails are enough to attract participants
Resources	Identify relevant knowledge sets and competencies
Resources	Encourage challenge sponsors to clearly define what outcomes they seek and apply outcomes-driven design approach
Resources	Incentive prize not best for incentivizing technology development, better for integration or new ways of applying existing technologies
Resources	Prizes fail when sponsor does not understand how much investment is required beyond the award itself

LM	Lessons Learned
Category	
Resources	Build a team, face time is critical, establish trust
Resources	Develop a schedule, apply knowledge management tools
Resources	Get advice from others who have challenge experience

Appendix C Informational and Case Study Organizations Interviewed

#	Name	Title	Company	Interview Type
1	Emily Tucker	Accenture Ventures Open Innovation Manager	Accenture	Informational
2	Katherine Dransfield	Innovation Manager	Applied Materials	Informational
3	Dan Bieler	Open Innovation Analyst	Forrester	Informational
4	Ann Marie Dumais	Open Innovation Leader Global Strategy	General Electric (GE)	Informational
5	Kelly Olson Tammy White	Acting director, Open Innovation Portfolio Senior IT Platform and Communications Specialist	General Services Administration (GSA)	Informational
6	Sandeep Patel	Open Innovation Manager at US Department of Health and Human Services	HHS	Case Study
7	Adam Wong	Senior Innovation Analyst	HHS	Case Study
8	Ben Solomon	Head of the Fed Tech Program	Hyperion Technologies	Case Study
9	Gerald Grunewald Stewart Forsyth	Vice President, Technology/R&D	Invista Intermediates	Case Study
10	Randall Wright	Senior Liaison Officer	Massachusetts Institute of Technology (MIT)	Informational
11	Bill Kernick	Principal at MD5 National Security Technology Accelerator	MD5	Case Study
12	Rod Holland	Division Technology Integrator	MITRE	Informational
13	Jonathan Rotner	Lead Sensors System Engineer	MITRE	Case Study
14	John Henderson	Artificial Intelligence Engineer, Principal	MITRE	Informational
15	Ozgur Eris	Chief Scientist for Collaboration and Social Computing	MITRE	Informational

#	Name	Title	Company	Interview Type
16	Michael Balazs	Technology Integrator	MITRE	Case Study
17	Chris Schmidt	Department Chief Engineer	MITRE	Case Study
18	Duane Blackburn	S&T Policy Analyst	MITRE	Case Study
19	Keith Miller	Chief Scientist for Identity Intelligence	MITRE	Case Study
20	Paul Sywulych	Partner, Enterprise Innovation at Morneau Shepell	Morneau Shepell	Case Study
21	Lynn Buquo Carolyn Woolverton	NOIS Contracting Officer's Representative	NASA Center of Excellence for Collaborative Innovation (CoECI)	Informational
22	Tammi Marcoullier	Open Innovation & Crowdsourcing Manager	National Institute of Standards and Technology (NIST)	Informational
23	FL Dammann	Special Projects Lead for the Executive Officer	National Institute on Alcohol Abuse and Alcoholism	Case Study
24	Adrian Denvir Angela Delegard	Open Innovation Manager	NCH Corporation	Informational
25	Robert Ashcraft	Staff Engineer/Manager Open Innovation Group	Samsung	Case Study
26	Saif Mohammad	Contest Organizer	SemEval	Case Study
27	Kevin McTigue	Open Innovation Program Director	US Department of Health and Human Services (HHS)	Case Study
28	Garth Jenson	Director for Innovation	US Naval Special Warfare command (NSWC)	Case Study
29	Cenk Guler	Innovation Programs Manager	Westinghouse	Case Study

Appendix D OI Competition Host Interview Questions

1. What best describes your industry?
2. What was the title of the competition?
3. What was the problem you were trying to solve?
4. What was the intended outcome of the competition? (attract new ideas, build prototypes and launch pilots, stimulate markets, raise awareness, mobilize action, inspire transformation, promoting entrepreneurship)
5. What was the intended output (the specific result) of the competition? (idea, prototype, develop technology, pilot, commercial product, service)
6. Who were you targeting to be a participant? (existing corporations in the field, new entrants, small teams, large teams, etc.)
7. Who did you receive responses from?
8. What was the prize reward? (monetary, non-monetary)
9. What was the prize structure? (first to achieve, best in class, etc.)
10. What was your definition of success before the event?
11. Did you achieve success?
12. What worked (Best Practices)
13. What didn't (Lessons Learned)
14. What did you think was important before the event vs what did you find was important during the event?
15. Where there any external factors affect the challenge implementation and outcomes (if applicable)
16. What unintended outcomes did the challenge achieve beyond the outcome for which the prize was awarded
17. Would you consider using the challenge model in the future. Why?
18. What was the top lessons learned in the design and implementation of the innovation competition?
19. What do you believe the perception of the event was from the participants?
20. If you were to redo the competition today, what would you do differently?

Appendix E OI competition Participants Survey Questions

1. What organization hosted the competition?
2. What was the title of the competition?
3. What was the problem that was being worked?
4. What was the intended outcome of the competition?
5. What was the intended output (the specific result) of the competition?

Please indicate the extent to which you agree or disagree with the following statements (Likert 1=Strongly Disagree/5=Strongly Agree):

6. There was a well-defined problem statement
7. The following factors motivated me to participate in the competition (monetary reward; potential follow on work; being recognized as a subject matter expert; the challenge of solving a difficult problem; collaborating with others; influence public perception; contribute to something greater; passionate about topic)
8. What positively influenced your performance in the competition (Competition design; Governance; Reputation; Networking Opportunities; Collaboration opportunities; Financial Gain)
9. What negatively influenced your performance in the competition (Unclear expectations, Lack of responses to questions; unclear evaluation criteria, unfair selection process)
10. The competition was managed well
11. It was clear how my contribution/my team would be evaluated
12. I benefited from participating regardless of whether I received a prize

Please tell us about your user experience

13. The organizers informed me who was selected as the finalists of the competition (Y/N)
14. I was selected for a prize and/or rewarded for my contributions (Y/N)
15. If yes, what did you receive (Monetary/Non-monetary)
16. How could the competition host have incentivized you to do better? (Open ended)
17. How could the challenge host have helped you to succeed? (Open ended)
18. Would you participate in an event like this again? Please explain (Open ended)

Appendix F Appendix F – OI Competition Pilot Host Interview Questions

1. How does this competition fit with your overall portfolio and strategic plans?
2. Why did you select this topic/problem for the challenge?
3. Did you achieve success? How did you measure success?
4. What was the value of hosting and managing the open innovation contest?
5. How could process be improved?
6. Can you provide feedback on resource allocation, schedule, should more/less time be spent on process phases/steps?
7. Can you give feedback on the judging process? Methods used, how can judging be improved?
8. What was the prize reward? (monetary, non-monetary)
9. What did you think was important before the event vs what did you find was important during/after the event?
10. Where there any external factors affect the challenge implementation and outcomes (if applicable). Includes barriers and constraints.
11. What unintended outcomes/benefits did the challenge achieve beyond the outcome for which the prize was awarded
12. If you were to redo the competition today, what would you do differently?
13. What long term impact is anticipated?
14. What will you do with the solutions?
15. What was the top lessons learned/best practices in the design and implementation of the competition?
16. Would you consider using the challenge model in the future. Why?

Appendix G OI Competition Pilot Participant Interview Questions

1. What was the intended outcome of the competition?
2. What was the intended output (the specific end result) of the competition?
3. Was there was a well-defined problem statement?
4. Any feedback on the phases of the process – idea generation innovation intent, fields of play, business concept, business case, and selection?
5. Did you get enough information throughout the process? What was lacking.
6. What was your process in coming up with ideas and preparing for the various phases
7. Where there any external factors affect the challenge implementation and outcomes (if applicable). Includes barriers and constraints.
8. What motivated you to participate in the competition?
9. What positively influenced your performance in the competition?
10. What obstacles impeded your performance in the competition?
11. It was clear how my contribution/my team would be evaluated
12. I benefited from participating regardless of whether I received a prize. If so how?
13. How could the challenge host have helped you to succeed?
14. Would you participate in an event like this again? Please explain
15. What was the top lessons learned/best practices in the design and implementation of the competition?
16. What advice would you give us about the implementation process/how it was managed?
17. What plans do you have to utilize information gained in the future/impact on career plans?
18. How would you measure success and key factors leading to success or failure?
19. Can you provide feedback on resource allocation, schedule, should more/less time be spent on process phases/steps?

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Appendix I Acronyms

CoECI	Center of Excellence for Collaborative Innovation
COMPETES	Creating Opportunities to Meaningfully Promote Excellence in Technology, Education and Science
DMADV	Define, Measure, Analyze, Design, Verify
DMAIC	Define, Measure, Analyze, Improve, and Control
FFRDC	Federally Funded Research and Development Center
FPS	Federal Protective Service
GSA	General Services Administration
IP	intellectual property
IT	Information Technology
LSS	Lean Six Sigma
NASA	National Aeronautics and Space Administration
OI	open innovation
OMB	Office of Management and Budget
OSTP	Office of Science and Technology Policy
PDSA	Plan, Do, Study, Act
R&D	Research and Development
SME	Subject Matter Expert
SW	Software

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