# Critical Decision Factors for Agile on Federal IT Projects

**Dr. Troy J. Mueller, PMP, CSM**

**The MITRE Corporation, McLean, VA 22102**

tmueller@mitre.org

## ABSTRACT

Agile software development methodologies are replacing the traditional waterfall model as the accepted model in industry and government (Larman & Basili, 2003). Federal information technology (IT) executives often pursue the latest trends in commercial industry with the intent to improve the performance of government IT projects. Constraints specific to the government context such as budget, acquisition, and operations processes can limit adoption of emerging approaches or models. A three-round Delphi study yielded 21 factors that influence the decision to employ Agile development methods on federal IT projects. The survey panel included federal employees and contractor IT experts with experience in one or a combination of the following roles; executive sponsor, program manager, chief engineer/lead technical authority, user representative/lead business authority, or consultant/advisor. The top five factors influencing the choice to employ Agile development methods were 1) Culture, 2) Executive sponsor involvement/support, 3) User involvement, 4) Agency/component leadership, and 5) Change management. Federal IT executives should considers these factors to ensure an informed decision on whether to employ Agile.

**Keywords:** Agile, Decision Factors, Delphi, Federal Government, Information Technology (IT), Software Development

## 1. INTRODUCTION

Agile software development methodologies are replacing the traditional waterfall model as the most commonly used model in industry and government (Larman & Basili, 2003). Federal information technology (IT) executives often pursue the latest trends in commercial industry with the intent to improve the performance of government IT projects. Constraints specific to the government context such as budget, acquisition, and operations processes can limit adoption of emerging approaches or models. Constrained budgets, increasing expectations regarding time-to-need, and demand for improved user experience exacerbate this issue, which often leads to uninformed decisions using ad hoc, if any, criteria and/or processes. Identifying the critical factors that influence the decision in selecting the optimal software development approach for IT projects/programs will contribute to an improved dialogue and decision grounded in the facts of the specific situation.

## 2. BACKGROUND

The waterfall software development model was introduced in 1970 as a structured alternative to the more common code-and-fix method (Futrell, Shafer & Shafer, 2002). Kossiakoff and Sweet (2003) define the waterfall model as "a software life cycle model in which all development processes occur sequentially" (p.456). Various interpretations of the model exist containing differences in the number and names of the phases. The particular variation of the model used in this study is that

depicted in Quality Software Project Management by Futrell, Shafer, and Shafer. This waterfall model consists of a sequential set of activities separated into nine phases with the focus on early requirements and design work, and large blocks of documentation in support of this early effort. The phases consist of concept exploration, system exploration, requirements, design, implementation, installation, operations and support, maintenance, and retirement. Kossiakoff & Sweet assert that the sequential nature of the model allows for feedback between phases providing the opportunity to address issues. (Kossiakoff & Sweet, 2003).

However, as development efforts became more complex, budgets diminished, and users more informed; the waterfall model began to be viewed as rigid and inflexible (Futrell, *et al.*, 2002, pp. 118-119). Anecdotal evidence suggests that waterfall and Agile models evolved in parallel with projects starting on a waterfall path and ultimately embracing changing requirements and running multiple work streams with independent releases of capability. This evolution included incremental and iterative development (IID) and spiral development, both attempting to allow for variation to the strict sequential nature of waterfall. IID acknowledged that large systems could be developed in increments with the final design emerging with the final build, and spiral development provided for risk-driven variation in such area as process, decision points, and user interaction from spiral to spiral (Larman, C. & Basili, V. R., 2003; Boehm, B., & Hansen, W. J, 2000).

Like waterfall, various interpretations, approaches and implementations of Agile development have evolved. For illustrative purposes, the example addressed in this section is the scrum process defined by Schwaber (1995) in his paper presented at the 1995 Object-Oriented Programming, Systems, Languages & Applications (OOPSLA) conference. Schwaber (1995) describes scrum as "an enhancement of the iterative and incremental approach to delivering object-oriented software" (p.3). Scrum consists of three phases with a number of sub phases. These phases are pregame, game, and postgame (Schwaber, 1995). Intense focus on user interaction and efficiency is the theme of Agile development.

A wide range of interpretations of Agile as a term exist; however, there has yet to be a single accepted definition across academia and industry. This is somewhat due to the intent of Agile to be flexible and not constrained to one specific meaning. To be defined would seem to violate the mindset of Agile. Despite this, there are definitions that communicate the mindset, values, and principles.

The two following definitions of Agile follow the spirit and intent of the Agile Manifesto's principles regarding interacting with users, creating functioning software, and dealing with change (Agile Alliance, 2001). The first definition by Highsmith (2002) states "agility is the ability to both create and respond to change in order to profit in a turbulent business environment" (p. 29). This definition focuses on accommodating change to improve the position of the firm. In the second definition, "a way of incrementally delivering change so as to get the earliest possible benefit, get feedback early on what works, and change direction accordingly," Wernham (2012) highlights the importance of delivering early in the lifecycle (p. xxviii). His definition also accommodates change and soliciting user involvement. In addition, it emphasizes the incremental nature of Agile. Both definitions express the qualities and benefits of Agile when compared to the waterfall model.

Practitioners often described as a mindset rather than a method or model. One can better understand the mindset when comparing Agile to waterfall. The ritual of large volumes of documentation, the illusion of defined upfront requirements, and structured review gate events buries organizations and project teams in process. Hunt and Thomas (1999) assert that Agile is "an attitude, a style, a philosophy of approaching problems and their solutions" (p. 11). These attitudes and beliefs embody the principles espoused in the Manifesto.

## 3. METHOD

The goal of this study is to provide decision makers with a list of factors that result in actionable information. A three-round Delphi study yielded 21 factors that influence the decision to employ Agile development methods on federal IT projects. A simplified definition of Delphi comes from Powell (2002), "a series of sequential questionnaires or 'rounds,' interspersed by controlled feedback, that seek to gain the most reliable consensus of opinion of a group of experts" (p. 376). This technique allowed the researcher to "capitalize on the diverse experience of the experts" and through anonymity "identify the most important factors by facilitating convergence of the experts' opinions through controlled feedback" (Nakatsu & Iacovou, 2009, p58).

There is extensive published research on decision-making and associated factors; however the literature on decision-making specific to Agile development models is lacking. Delphi is the most effective method in this case due to the limited research and the need to generate a set of factors applicable across the government. This method provided the opportunity to identify and gain agreement on these factors through a series of surveys of experts with each survey building on the other.

A panel of experts was selected from a sample of IT professionals who have either served as the decision maker or as an advisor to the decision maker in one of the following positions or roles; executive Sponsor, program manager, chief engineer/lead technical authority, user representative /lead business authority, and consultant/advisor. All panel members met a minimum set of criteria comprised of academic and professional experience, and past involvement in the decision to implement Agile on Federal IT projects. The three survey rounds included analysis and feedback between rounds to further refine the tool and build consensus.

## 4. RESULTS

Data was collected through the execution of three rounds of surveys of the expert panel. The first was conducted using an electronic survey requesting participants to provide a list of factors that influenced their decision to employ Agile. The list of 21 factors was achieved through analysis, coding, and clustering of responses to open ended questions into primary categories. The second round survey utilized a five-point Likert-type scale to reach consensus on the list of 21 factors. Prioritization of the list of factors was accomplished in round three through statistical analysis of the panel members ranking of factors 1 through 21 (Table 1).

Table 1 *Prioritized List of 21Factors*

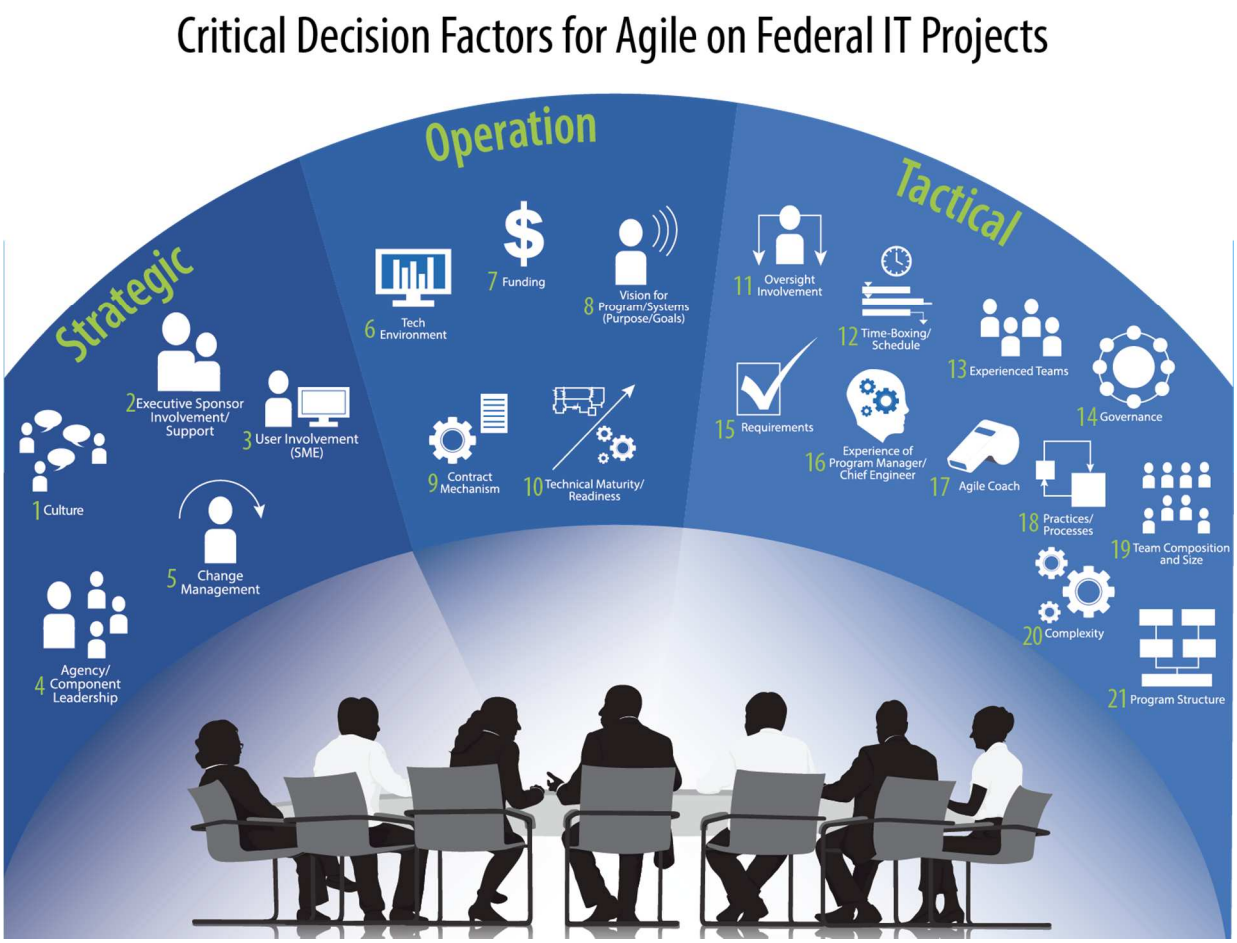
| Rank | Factor Name | Factor Description |
|---|---|---|
| 1 |  Culture | Ability of decision makers, users, program office team members, and contractors to adapt to the culture and demands of Agile, which include increased interaction of project participants and less certainty of project results. |
| 2 |  Executive Sponsor Involvement/Support | Mission/ Business Sponsor/ Product Owner -Participation, Collaboration, Oversight, Acceptance. What is their readiness to participate in the highly iterative Agile environment? |

| | | |
|---|---|---|
| 3 |  User Involvement (SME) | Direct participation of empowered end-users across the lifecycle of the project to shape and prioritize requirements, clarify CONOPs, provide continuous feedback, and test newly developed capabilities. |
| 4 |  Agency/Component Leadership | Support of agency/component leadership to ensure funding availability, stability and flexibility, timely decisions, and continued momentum/enthusiasm. |
| 5 |  Change Management | Employment of Agile in a new environment requires a dedicated change management effort that will facilitate appropriate changes in culture, processes, practices, organizational structure, and engagement and communication with stakeholders. |
| 6 |  Tech Environment | Appropriate technical infrastructure/environment in place to support Agile development. |
| 7 |  Funding | Availability, stability, and flexibility of funding to support Agile development. |
| 8 |  Vision for Program/Systems (Purpose/Goals) | Development and agreement on program purpose and goal, and a clear vision of the desired end state/expected result. |
| 9 |  Contract Mechanism | Availability of a contracting vehicle that is streamlined, allows for a flexible requirements process, supports frequent releases, and sufficiently incentivizes the contractor. |
| 10 |  Technical Maturity/Readiness | Maturity or readiness of technology to be implemented as part of the technical solution. |
| 11 |  Oversight Involvement | Oversight (e.g., requirements, testing, security, enterprise architecture) support of continuous involvement as opposed to conducting gate reviews from a historical perspective. |

| | | |
|---|---|---|
| 12 |  Time-Boxing/Schedule | Projects that can be structured into time-boxed discrete efforts to provide results, obtain initial feedback, and demonstrate progress that is of benefit to end users validating the program/project is either on course for success or not. |
| 13 |  Experience Teams | Self-organizing team that has direct experience with Agile development methods. |
| 14 |  Governance | Governance processes that support short release timelines from strategy and documentation approval to all the enabling processes (requirements, contracting, testing, certification, etc.) allowing the government to respond to the evolving business environment or improvements in technology. |
| 15 |  Requirements | Requirements flexibility that allows for refinement and prioritization in response to budgets, mission, technology and user understanding. |
| 16 |  Experience of Program Manager and/or Chief Engineer | Selection of Program Managers and/or Chief Engineers with hands-on experience in running an Agile project. |
| 17 |  Agile Coach | Assignment of an Agile coach to provide training and ensure that the team is following the spirit and intent of Agile. |
| 18 |  Practices/Processes | Establishment and execution of Agile practices and processes such as planning, requirements, contracting, development, testing, and certification in a continuous manner. |
| 19 |  Team Composition and Size | Teams sized to manage cross-team integration and consist of the appropriate mix of development staff and supporting staff that is needed to execute the planning. |
| 20 |  Complexity | Complex systems generally consist of multiple subsystems, interfaces, and software languages. They have many dependencies among components of the system and often interdependencies with external systems. For such complex systems, holistic views from several perspectives are needed to determine the best paths for implementation. |

| | | |
|---|---|---|
| 21 | Program Structure | Documented program structure such as (1) single development contractor monitored by Govt. PMO, (2) Multiple development contractors monitored by Govt. PMO, (3) Mixed Development Teams of Government and Contractor(s), or (4) Government led, and staffed with contractor support. |

The spectrum of the 21 factors, distilled from the responses of the expert panel, flow from a strategic to operational then tactical orientation. The focus of the top five factors, which include in rank order, culture, executive sponsor involvement/support, user involvement, agency/component leadership, and change management, could be used as factors supporting any strategic, enterprise-wide decision. Moving to factors 6 through 10 transitions to an operational orientation where environment, funding, and other mechanisms are important to achievement of specific outcomes aligned to strategic initiatives. The second half of the list of factors continues the narrowing of focus to tactical execution of IT programs using Agile methods to deliver capability.



## 5. DISCUSSION

The value of this study is extended by understanding the prioritization of factors by common positions or roles involved in the planning, approval, execution and oversight of Federal IT programs relative to that of the expert panel. The positions or roles are: executive sponsor, program manager, chief engineer/lead technical authority, user representative/lead business authority, and consultant/advisor. This is achieved by analyzing the prioritization of expert panel members that have served in these positions or roles. Improved understanding of personal and professional biases of organizations, staff, and decision makers could lead to a more informed dialogue resulting in decisions that better balance risk and opportunity.

The comparison of factor rankings of the positions or roles was limited to the top five factors to prevent executives from experiencing choice overload. Choice overload is a phenomenon where individuals experience "the negative feeling incurred by the increased difficulty to choose from large sets of high quality recommendations" (Willemsen, Knijnenburg, Graus, Velter-Bremmers & Fu, 2011, p. 14). This phenomenon has a contradictory effect on decision makers. Lists with a large number of recommendations, or in this case factors, are viewed as positive due to the potential to provide increased benefit for the decisions maker; however this magnitude of options allows for increased opportunity cost (Willemsen, *et al.*, 2011). Opportunity cost in this context involves "potential regret of not choosing the best options, and increased expectations which might not be met by the large set" (Willemsen, *et al.*, 2011, p. 14). Federal executives are constantly bombarded with large volumes of information requiring synthesis and distillation; focusing on a top five list for comparison increases the utility of the final product of this study.

The expert panel was dominated by current or former program managers and consultants/advisors comprising 72% of the membership. Table 2 shows that despite making up one-third of the panel, the program manager category only ranked 2 of 5 factors in common with the expert panel ranking. This is contrasted with the consultants/advisors category matching 4 of 5 factors and the chief engineers/lead technical authority category matching 3 of 5 factors in the top five with the expert panel ranking. The differences between the factors ranked in the top five for these three groups can be attributed to incentives. Program managers are incentivized to deliver projects within cost, schedule and budget, chief engineers/lead technical authorities are incentivized to deliver technical capability that meets the needs of the users in their environment, and consultants/advisors are incentivized to contribute to programs success through service offerings that may result in future business.

Table 2 *Top Five Factors by Current or Most Recent Position*

| Rank | Expert Panel | Executive Sponsor | Program Manager | Chief Engineer /Lead Tech Authority | User Rep/Lead Business Authority | Consultant/ Advisor |
|---|---|---|---|---|---|---|
| 1 |  Culture |  Executive Sponsor |  |  Culture |  |  Culture |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Involvement/ Support | Agency/Component Leadership | | Agency/Component Leadership | |
| 2 |  Executive Sponsor Involvement/ Support |  Culture |  Agile Coach |  User Involvement (SME) |  Funding |  User Involvement (SME) |
| 3 |  User Involvement (SME) |  Change Management |  Contract Mechanism |  Executive Sponsor Involvement/ Support |  Tech Environment |  Executive Sponsor Involvement/ Support |
| 4 |  Agency/ Component Leadership |  Experience of Program Manager and/or Chief Engineer |  Funding |  Tech Environment |  Technical Maturity/ Readiness |  Change Management |
| 5 |  Change Management |  Tech Environment |  Executive Sponsor Involvement/ Support |  Experience Teams |  Contract Mechanism |  Oversight Involvement |

## 6. RECOMMENDATIONS AND CONCLUDING REMARKS

Selection of a software development model impacts the ability of a project to successfully deliver capability in a predictable manner, on schedule, and within budget. Federal organizations use governance frameworks and processes to select, plan, execute, and oversee IT projects. Examples of these models include the Department of Defense (DOD) Defense Acquisition Management Framework and the Department of Homeland Security (DHS) Management Directive 102. These models provide a structured decision making approach with decision gates requiring retrospective consideration of specific information such as concepts of operations, analysis of alternatives, and lifecycle cost estimates.

Program managers and chief engineers seeking approval to employ Agile methods should use the factors identified in this study to guide and inform their decision making and address the factors in the program acquisition strategy. Federal IT and non-IT executives involved in the

approval and oversight of IT programs should require program managers to address the appropriate combination of factors prior to release of the Request for Proposal to industry. In DOD this would occur prior to Milestone B and in DHS prior to Acquisition Decision Event 2A. Other Federal agencies have similar decision events that would benefit from the inclusion of this activity.

The analysis of the expert panel's ranking of factors has revealed that there is commonality regarding critical decision factors across the positions or roles involved in the planning, approval, execution and oversight of Federal IT programs. While consideration of these factors can inform decision making, they will not guarantee success. The choice of development models should support the context of the needed capability to increase the probability of success for the users and developers.

## 7. REFERENCES


Agile Alliance. (2001). *Manifesto for Agile software development.* Retrieved from http://www.Agilemanifesto.org/

Boehm, B., & Hansen, W. J. (2000). *Spiral development: Experience, principles, and refinements* (No. CMU/SEI-2000-SR-008). Carnegie-Mellon Univ Pittsburgh PA Software Engineering Inst.

Fasolo, B., McClelland, G. H., & Todd, P. M. (2007). Escaping the tyranny of choice: When fewer attributes make choice easier. Marketing Theory, 7(1), 13-26.

Futrell, R.T., Shafer, D.F., & Shafer, L.I. (2002). *Quality software project management*, Upper Saddle River, NJ: Prentice Hall PTR.

Highsmith, J. (2002). *Agile software development ecosystems*. Boston: Addison-Wesley.

Hunt, A. & Thomas, D. (1999). *The pragmatic programmer: From journeyman to master*. Boston: Addison-Wesley.

Kossiakoff, A. & Sweet, W.N. (2003). *Systems engineering: principles and practice.* Hoboken, NJ: John Wiley & Sons, Inc.

Larman, C. & Basili, V. R. (2003). Iterative and incremental development: A brief history. *IEEE Computer Society,* 36 (6), 47-56.

Nakatsu, R.T. & Iacovou, C.L. (2009). A comparative study of important risk factors involved in offshore and domestic outsourcing of software development projects: A two-panel delphi study. *Information & Management*, 46, 57-68.

Powell, C. (2003). The delphi technique: myths and realities. *Journal of Advanced Nursing*, 41(4), 376-382.

Schwaber, K. (October, 1995). *Scrum development process*. Workshop on Business Object Design and Implementation of the Object-Oriented Programming, Systems, Languages & Applications Conference, Austin, TX.

Wernham, B. (2012). *Agile project management for government*, (1st ed.). London: Maitland and Strong.

Willemsen, M. C., Knijnenburg, B. P., Graus, M. P., Velter-Bremmers, L. C., & Fu, K. (2011). Using latent features diversification to reduce choice difficulty in recommendation lists. *RecSys*, 11, 14-20.