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Buying for the Right Battle: Determining Defense Acquisition Strategies

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Buying for the Right Battle: Determining Defense Acquisition Strategies

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Abstract

The Department of Defense (DoD) acquires operational systems via major defense acquisition programs (MDAPs). An average MDAP today will take about 8 years to deliver a new system (or new capabilities) to the operating forces using existing acquisition processes.

Cycle time is the duration between the start of system development until it is available for use. Programs can execute as planned when program cycle times are shorter than the pace of technology and adversary change. The pace of technology and adversary change is pushing the DoD to streamline acquisition processes and deliver products faster.

This paper presents a subset of research performed. It provides an overview of significant factors related to schedule and schedule growth. It classifies program acquisition strategies into three groups and identifies cycle time–related factors for these strategy groups.

Keywords: Acquisition strategies, Major Defense Acquisition Programs, program cycle times, decision frameworks, program management, predictor variable selection quantitative data analysis

Introduction

Former Secretary of Defense Mattis (2018) emphasized the need to deliver new capabilities at "*the speed of relevance"* (p. 10). The Department of Defense (DoD) will fast-track certain projects and focus priorities and resources to execute these projects. This research speaks to programs in the rest of the portfolio—those developing new capabilities that must accommodate changing priorities and resources and still deliver products on time and as promised.

Programs can execute as planned when program cycle times are shorter than the pace of technology and adversary change. However, the pace of technology and adversary change is pushing the DoD to deliver some capabilities sooner,[1] which often requires leadership involvement, greater risk, cost, effort, and acquisition process modifications.[2] These accelerated programs compete with other acquisition programs for resources and priorities, meaning some still-required programs will deliver required systems to the operating forces later and in smaller quantities than initially planned, unless they can make changes to reduce their cycle times.

Research Scope

This research focused on selected Major Defense Acquisition Programs (MDAPs)[3] active between 2007 through 2018 within the context of a defense-unique market with multiple government stakeholders and increasing demand for reduced cycle time[4] and capability delivery. Major policy changes[5] enacted between 2007 and 2018 provide context for the quantitative analysis of cycle time.[6]

Research Questions and Objectives

The research investigated policy and management issues related to accelerating DoD acquisition processes and addressed the following questions:

1. *What data reported in publicly released reports are significant predictors of program cycle time and schedule change*? In this research, cycle times are in months, and program start means approval to commence engineering and manufacturing development (also called Milestone B). *Schedule change* is the relative percent change relative to original cycle time since program start.
2. *How do these predictors change with acquisition strategies*? Acquisition strategies are detailed plans mandated by the Federal Acquisition Regulations (FAR 7, 2021). They are typically not publicly released but are inferred from observables such as solicitations, contract awards, budget and reporting documentation, and public reports of significant issues and events such as test failures and declaration of Initial Operational Capability (IOC).

The research produced several databases from publicly available sources suitable for research. These are available for research upon request from the authors. Simple regression

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[1] Rapid Acquisition Offices can deliver interim solutions within 2 years of request.

[2] This is called streamlining or tailoring.

[3] MDAPs are weapon system programs with research and development expenditures greater than $300 million or procurement expenditures greater than $1.80 billion indexed to Fiscal Year 1990 constant dollars (MDAP, 2007).

[4] Cycle time is the duration between the start of system development until it is available for use, commonly identified by terms such as Initial Operational Capability (IOC) or Required Asset Availability (RAA).

[5] Specifically, the Weapons System Acquisition Reform Act of 2009, the 2016 National Defense Authorization Act (NDAA), and policy changes prior to January 2020 showcase this increasing demand for reduced cycle time.

[6] For example, the 2016 NDAA Section 804 changes require capability delivery within 5 years of program start to use these authorities.

models of cycle times and cycle time changes identified factors affecting cycle time reduction and growth from historical data.

We examined how these factors change with different acquisition strategies. This paper continues with an overview of recent literature, methodology, a summary of results, and conclusions.

Overview

The DoD executes MDAPs as life-cycle programs, where activities may be binned between development (which includes acquisition), procurement, and operations and support (O&S) phases of life. The F-14 spent 6 years in development, was produced for 22 years, and was operational for 33 years ("F-14 Tomcat," n.d.), or about 17% of its life in development, 61% in production, and 92% in service.[7] Platforms such as ships, aircraft, and vehicles are typically produced using hardware-based facilities with finite production capacities. For example, the Joint Light Tactical Vehicle program has a planned production buy of 58,306 vehicles (Dodaro, 2019). Full rate production at current budget levels is about 2,500 vehicles per year (Department of the Army, 2019), meaning production to meet inventory requirements could continue for over 20 years.

Acquisition Strategies

The DoD buys products, tangible and intangible items, and services collectively described as a *capability*. Acquisition *strategies* are developed by program offices and approved by senior leadership, and contain a statement of need for the capability, an estimated cost and schedule, and the contracting and support plans. Acquisition plans are *statutory* and regulatory documents that explicitly describe the *contracting and competition*[8] approaches (FAR 7.105, 2021). Specific statutory requirements vary depending upon the contracting strategy and include additional detail such as market surveys, performance criteria, and plans and requirements for technology development and risk management, test and evaluation, and security (FAR 7, 2021).

Schoeni (2018) defined three types of government acquisition strategies: coercion, public–private partnerships, and Competition using Open System Architectures . He found that only competition results in innovation (Schoeni, 2018).

The DoD categorized[9] acquisition strategies as acquisition models (Kendall et al., 2015). These include common structures such as hardware and software development, production, and operation and significant program phases and milestones. Programs are encouraged to tailor these models to the planned MDAP's "unique character" (Kendall et al., 2015). The GAO found variations within these models, such as planning to declare initial operational capability before completing initial operational test and evaluation (Dodaro, 2019).

An acquisition strategy defines *production and performance* requirements delivery plans spanning *single-step* or *incremental* schedules. Selected Acquisition Reports (SARs) describe and document production and performance requirements delivery, including production (hardware production line or software replication) and requirements fulfillment (complete or

[7] The F-14 program overlapped development and production and had concurrent production and operational service.

[8] The Federal Acquisition Regulations emphasize full and open competition and fixed-price contracts (FAR 7.105, 2021).

[9] This research was prior to implementation of the Agile Acquisition Framework.

incremental). Incremental upgrades[10] are production expressions of evolutionary acquisition strategies (Sylvester & Ferrara, 2003). By managing production and deployment configurations, incremental upgrades can be used to align production lots with deliveries of capabilities that mature between production versions (Mortlock, 2019).

Mortlock (2019) examined acquisition strategy development based upon assessed technical risk, approved requirements, and planned funding—using data from an actual program history, leading participants through decisions that a program office would make during program strategy development. He found that affordability concerns drive cost and schedule constraints, and despite preferences for single step acquisitions, incremental development is one of few choices for managing risk (Mortlock, 2019).

Acquisition strategies may include multiple acquisitions operating with varying degrees of coordination and interaction, such as unconstrained or complex systems (Stuckey et al., 2017). Rendon et al. (2012) identified system-of-system–related acquisition issues, such as control and program office staffing, and how these issues translate into modifications to contracting and organizational structures.

Georgiev (2010) analyzed defense acquisition strategy from a national perspective as a method to achieve policy goals. He classified defense acquisition strategies into those seeking technology innovation (active or offensive) or those adapting strategies to the current environment (passive or defensive) and the intended technology position (leader, follower, or outsider). He provided a hybrid of strategic and balanced scorecards to improve management decisions and results.

Existing regulations and statutes[11] define DoD rapid acquisition strategies. These limits result in limited scope and quantified objectives, senior leadership support and oversight, resource prioritization ahead of other programs, and extensive customization of existing processes to achieve program objectives. Tate (2016) postulated that only a few acquisition strategies are capable of rapid fielding—specifically, *using already mature or developed systems*, *incremental development and production* of limited or narrow capability improvements, and modular upgrades.

Acquisition strategies are generally not publicly available; however, some elements are in publicly available documentation,[12] such as single-step or evolutionary acquisition, technical maturity choices, and constraints on cost, schedule, and performance.

Schedule Growth Predictors

Better Buying Power was a process improvement initiative started by Secretary of Defense Robert Gates in 2010 (Layden, 2012) and expanded by the under secretary of defense for acquisition, technology, and logistics, Frank Kendall, in 2014 (Kendall, 2014)—with policy and direction to “buy more with no more” (Sethi, 2015). The initiative emphasized incentive-type contracts, affordability, and cost savings and realism (Kendall, 2014). Three parameters important to Better Buying Power are procurement quantities, unit cost, and cycle times; this research considers these the *functional objectives* of an acquisition strategy.

Cost growth is related to acquisition strategy factors such as prototyping, contract incentives in development and production, production competition, schedule concurrency, and

[10] Incremental upgrades are also referred to in the literature as block upgrades or release versions.

[11] See https://aida.mitre.org for more information.

[12] These include SARs, annual reports, and budget submissions.

schedule slip (Arena et al., 2006). Foreman (2007) identified longitudinal cost and schedule predictor variables based on SAR data. He showed that cost growth changes are related to procurement quantity changes and depend weakly on schedule growth between production decision (Milestone C) and IOC.

Lorell et al. (2017) compared six MDAPs with extreme cost growth and four with low cost growth and identified five salient program characteristics.[13] They noted, "Most of the extreme cost-growth programs' problems stemmed from a gross underestimation of the complexities and uncertainties … in designing, developing, integrating, and producing very challenging technological systems" (p. 97). While their findings are specific for cost growth, technical maturity and integration complexity are also related to schedule growth (Kamp, 2019).

Holloman et al. (2016) used SAR summary variance data to create cost, time and technical system-level *degree of difficulty* indicators and GAO Annual Assessments of Selected Weapon Systems maturity assessment data to indicate *achieved* technical performance. Using these indicators enables program managers to characterize acquisition performance risk *during execution* from monitoring and control processes such as Earned Value Management.[14]

Jimenez et al. (2016) conducted a literature review to find historical schedule growth predictors and identified statistically significant schedule-related predictors from MDAP SARs. Two variables were positively correlated to schedule growth between program start (Milestone B) and a production decision (Milestone C): research and development funds at program start, and program start on or after 1985. Two additional variables were negatively correlated with growth between Milestones B and C: percent research and development funds at program start, and program being a modification of an existing program or system (Jimenez et al., 2016).

Random forest methods have been used to create predictive contracting performance models (Gill et al., 2019) and provide an efficient method to identify important variables for use in a regression model (Grömping, 2009). Specific implementation issues are in the Methodology section of this paper. Wauters and Vanhoucke (2017) applied K-nearest neighbor methods to forecast project schedule and control methods and found that K-nearest neighbor methods work best for repetitive projects or those with accurate variability estimates. They also found that earned value/earned schedule approaches are best for controlling projects with high uncertainty.

This research fills the gap relating schedule prediction to acquisition strategies and will test two research hypotheses:

- Program cycle time may be predicted from programmatic resources and acquisition strategy decisions (H1).
- Percent change in program cycle time may be predicted from programmatic structural changes (H2).

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[13] These are "insufficient technology maturity and higher integration complexity than anticipated; unclear, unstable, or unrealistic requirements, unrealistic cost estimates, adoption of acquisition strategies and program structures that lacked adequate processes for managing risk through incrementalism or through provision of appropriate oversight and incentives for the prime contractor, (and) use of a combined MS B/C milestone (assuming) that little or no RDT&E is required" (Lorell et al., 2017, pp. ix–x).

[14] Earned value tools relate project cost and schedule at the work breakdown structure level For a discussion of Earned Value Management, see Wei et al. (2016).

Program Functional Objectives

Program functional objectives—the cost, time to deliver, quantities delivered, and system performance—are the planned outcomes or results of the acquisition strategy. Cantwell et al. (2012) used a systems dynamics model to examine different cost-reducing strategies; all resulted in performance reduction and fewer delivered systems, three of four responses reduced total cost, and three of four achieved required schedule. This research used cycle time, unit cost, and procurement quantities as explicit program functional objectives.

Capili (2018) developed a system dynamics model of how factors such as contract types, schedule, and requirements and policy issues[15] can affect the ability of the government to implement Agile software development. Agile contracting scopes the number of requirements or *story points* during a fixed period of performance and cost (level of effort). Adding requirements during the Agile process results in trades and reductions of story points delivered to stay within schedule and cost constraints. Capili argued that the government acquisition constraints eliminate the ability of Agile processes to adapt to program changes.

Blair et al. (2011) provided examples from National Aeronautics and Space Administration (NASA) systems development and fielding and argued that most problems[16] in aerospace systems are due to problems with technical integration or system engineering deficiencies and failing to understand interactions. However, they also showed that institutional mandates, such as minimizing crew risk, bound what may be eliminated and add time and cost to acquisition strategies.[17]

Wong (2016) argued that the Mine Resistant Ambush-Protected vehicle program was delayed due to two institutional factors: validating the urgency of need and the decision to acquire systems meeting a long-term need or reacting to an urgent threat. These are analogous to Joint Capabilities Integration and Development System (JCIDS) deliberations and approvals of new capability requirements (McKenzie, 2018).

Methodology

This section reviews the research data collected, summarizes the response and predictor variables, and explains the supporting quantitative methods used in the research.

Research Design Overview

The study used data from publicly available reports on MDAPs from 2007 to 2018, from both the GAO annual assessments and Director of Operational Test and Evaluation (DOT&E) annual reports. We used Minitab 18, SPSS, and selected R libraries for statistical analyses. All data sets are in comma-separated variable formats and available from the authors upon request.

Data Collection

The data set contains 162 observations in an Excel spreadsheet. Observations had reports from both the GAO and the DOT&E during the fiscal year. This reduced the quantity of

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[15] As an example, information assurance may be at the same time a story point, a policy, and a contract requirement.

[16] Blair et al. (2011) assert that 80% of problems are due to integration or system engineering failure without substantiation.

[17] They also provided several examples where designs were limited by physics or system engineering maturity (Blair et al., 2011, pp. 87–98) and required extensive systems engineering efforts to deliver the intended system performance.

observations but ensured two independent assessments of program status. SAR data and SAR summary data supplemented GAO information.

The data set was cleaned, filtered, and tested for consistency, correlation, and independence (Marshall & Russell, 2018). These were inspected by variable for correct entry and tested using Dixon's r22 outlier test (Minitab, n.d.) for outliers.

Statistical Methods

We characterized variables and their distributions by means, medians, standard deviations, and skew, kurtosis, and proportions (for categorical variables). We also calculated correlation coefficients and significance for continuous and categorical variables. We used graphing for qualitative data assessment.

Ensemble modeling (Ray, 2017) using the R randomForest package (Liaw, 2018) was used to identify important predictor variables. We compared variable importance from three R random forest packages—randomForest, cforest (Hothorn, 2020), and VSURF (Genuer, 2019)—to estimate variable importance and regression model performance (Grömping, 2009).

We created regression models in Minitab and SPSS relating cycle time to predictor variables. We adjusted models to maximize the predicted coefficient of determination (R-sq[pred]) with the fewest number of terms and inspected residual plots to identify any trends and verify regression assumptions. We tested association and independence of categorical factors to shorter or longer cycle times using chi-square tests. Finally, we used K-means clusters to classify acquisition strategies, subsetted the data into groups, and created regression models by groups to interpret differences in significant variables.

Results and Analysis

Cycle Time and Percent Change Cycle Time Regression Results

Random forest analysis identified starting predictor subsets for cycle time and percent change in cycle time regression models. We created a validation data set with a random draw of 44 (27%) of the full data set. A manual step-wise regression on the remaining 118 observations removed predictors with *p* values greater than 0.05 one at a time. Variance inflation factors (VIFs) were all less than 5, indicating no collinearity issues. The final models satisfied all regression assumptions. Table 1 summarizes significant predictors.

Table 1. Significant Regression Predictors

Cycle time (factor unit change = Δ months)	**% cycle time change** (factor unit change = % Δ)
R&D budget: (+)	Procurement budget % Δ (+)
Software approach Agile (-), Hybrid/NA (-) [relative to Waterfall]	DoDI 5000.02 Acq model: Model 4 (-), Models 2,5,6 (+) [relative to Model 1]
Joint (-) Depends on other MDAPS (+)	SVC Army, DoD (-), Navy (+) [relative to AF]
Reuses in-service technology (-) Uses commercial technology (-)	Integration issues (-) # Critical Technology Elements (CTEs) (+)
Financial instability (+)	Financial instability (+) Restructured (+) NM Breach (+)
R-sq(pred)~ 58%	*R-sq(pred)~ 59%*

Factors marked as (+) are associated with increasing cycle times. The factors highlighted in *green* and *yellow* are structural factors. Factors in *red* are either external or caused by external issues. Factors marked as (-) are associated with shorter cycle times.

Strategy structure factors associated with reducing cycle time include execution as a joint program use of an Agile or hybrid (including incremental) software development strategy, use of commercial technologies, and reuse of developed military technology. These factors may be changeable by program offices during execution.

We divided the data set cycle times into four quartiles to test categorical factor associations to MDAP cycle-time historical performance. We used chi-square association tests to test the trained regression model categorical predictors against cycle-time quartiles (Q1 = 1st quartile, Q4 = 4th quartile).

One factor, DoD acquisition model, was retired during this research. Table 2 summarizes the results of testing the association of the now-retired DoD acquisition model types[18] to cycle-time quartiles.

Table 2. DoD Acquisition Plan by Quartile

5000,02 model	Q1	Q2	Q3	Q4	P
1	21	20	22	26	0.000
2	0	1	2	6	
4	4	0	0	2	
5	10	16	17	4	
6	8	1	1	1	
	xx	overrepresented in Q			
	xx	underrepresented in Q			

Model 3, Incrementally Deployed Software Intensive Program, is not in this table as the data set had no such programs. P is the *p* value for the likelihood ratio test and shows a statistically significant association between cycle-time quartiles (columns) and DoD acquisition model (rows). Table 3 shows the quartile grouping of programs by the remaining categorical factors.

[18] One example of a now-retired DoD acquisition model type is Model 1, "Hardware Intensive Program" (Kendall et al., 2015).

Table 3. Quartiles Versus Regression Factors: Full Data Set

Factor	Category	Q1	Q2	Q3	Q4	P
Software approach	Waterfall	17	15	20	26	0.001
	Agile	21	23	20	7	
	Hybrid/NA	5	0	2	6	
Joint	no	32	29	34	34	0.475
	yes	11	9	8	5	
Depends on other MDAPs	no	28	12	14	7	0.000
	yes	15	26	28	32	
Reuses in-service technology	no	12	19	13	15	0.176
	yes	31	19	29	24	
Uses commercial technology	no	21	21	31	35	0.000
	yes	22	17	11	4	
Financial instability	no	27	15	15	6	0.000
	yes	16	23	27	33	

Two factors, joint and reuses in-service technology, did not show an association between the factors and cycle-time quartiles (P greater than 0.05). Programs with Waterfall-type software approaches were associated with longer cycle times (Q4). Programs using Agile and Hybrid-type[19] software approaches were associated with shorter cycle times (Q1). Commercial technology use was associated with shorter cycle times (Q1); programs that did not use commercial technology had longer cycle times (Q4). Finally, two program factors were associated with shorter cycle times (Q1) when they were not present: (a) dependence on other MDAPS and (b) financial instability (i.e., budget change greater than 10%).

Predictor Change with Acquisition Strategies

We classified the research data set into three acquisition strategies using K-means clustering with standardized variables on the functional objectives of cycle time, unit cost, and procurement quantities,[20] as shown in Table 4.

Table 4. Acquisition Strategy Clustering Summary

Mean	Cycle time (mo)	Unit cost ($M)	Procurement quantity	Count
High-End	**168**	**2,833**	364	56
Focused	92	175.8	274	64
Volume	99	1.4	**56,044**	42

Each row represents a functional objective, and the mean functional objective value is in the respective column. The maximum value of each column is in **bold**. Two of the three clusters

[19] “Hybrid” included incremental and mixtures of Agile, incremental, evolutionary, or some other approach.

[20] Clustering was on cycle time and the natural log transform of unit cost and procurement quantities.

align with column maxima—acquiring exquisite (“high-end”) capabilities and high unit cost, and acquiring product in large quantities (“volume”). The third cluster represents balancing functional objectives (“focused”) to deliver a capability requiring intermediate quantities and costs. The count column shows the number of observations in the data set in each cluster. Figure 1 shows this strategy grouping.

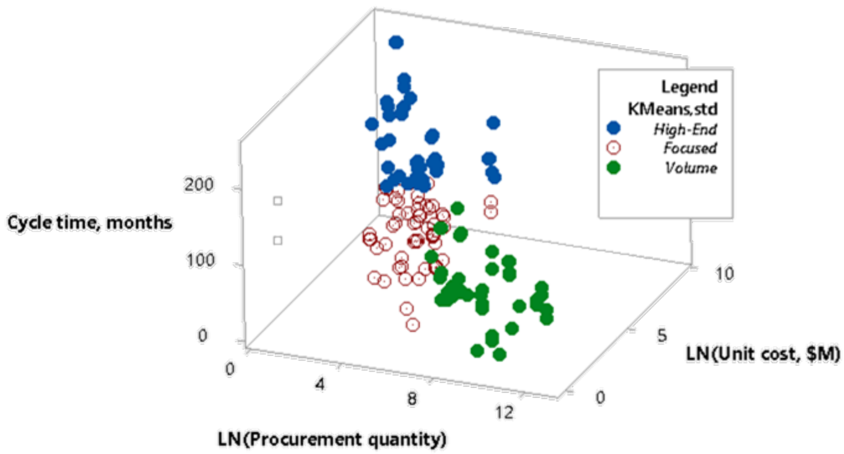

Figure 1. Acquisition Strategy Clusters

This classification strategy is dependent upon the values of the functional objectives and would be different if the classification used other objectives or used different approaches—such as weighting objectives or changing the clustering method. We tested factor significance using the same factors as in Table 1. Table 5 summarizes significant predictors by strategy.

Table 5. Cycle Time Significant Factors by Acquisition Strategy Cluster

High-End	Focused	Volume
R&D Budget (+)	R&D Budget (+)	~~R&D Budget (+)~~
Software approach*: Agile, ~~hybrid~~ (-)	~~Software approach*:~~ ~~Agile, hybrid (-)~~	Software approach*: Agile, hybrid (-)
~~Joint (-)~~ Depend on other MDAPs (+)	~~Joint (-)~~ ~~Depend on other MDAPs (+)~~	Joint (-) ~~Depend on other MDAPs (+)~~
Reuse existing DoD tech (-) ~~Use commercial tech (-)~~	~~Reuse existing DoD tech (-)~~ Use commercial tech (-)	~~Reuse existing DoD tech (-)~~ Use commercial tech (-)
~~Financial instability (+)~~	Financial instability (+)	~~Financial instability (+)~~
R-sq(pred): 27% No Box-Cox transform No outliers removed	R-sq(pred): 46% Box-Cox rounded $\lambda = 0.5$ One outlier removed[22]	R-sq(pred): 82% Box-Cox rounded $\lambda = 0.5$ Two outliers removed[21]

* Relative to Waterfall

[21] The outliers were removed to meet regression residual linearity assumptions.

Crossed-out and red factors (~~example~~) were not significant. Two groups had fewer significant predictors and a similar or better R-sq(predicted). The High-End group needed additional factors to improve model performance.[22] Table 6 shows percent cycle-time change for these same groups with the same coding as before.

Table 6. Percent Change in Cycle Time for Strategy Groups

High-End	Focused	Volume
Procurement Budget Change (+)	Procurement Budget Change (+)	~~Procurement Budget Change (+)~~
~~DoD 5000.02 (old) model **:~~ ~~2,5,6 (+), 4 (-)~~	~~DoD 5000.02 (old) model **:~~ ~~2,5,6 (+), 4 (-)~~	~~DoD 5000.02 (old) model **:~~ ~~2,5,6 (+), 4 (-)~~
Service ~~(relative to AF):~~ Navy (+), Army~~, DoD (-)~~	Service (relative to AF): Navy (+), Army, DoD (-)	Service (relative to AF): Navy (-), Army, DoD (-)
~~Integration issues (-)~~ ~~# Critical Tech Elements (+)~~	~~Integration issues (-)~~ # Critical Tech Elements (+)	~~Integration issues (-)~~ # Critical Tech Elements (+)
~~Financial instability (+)~~ Restructure (+), ~~NM breach (+)~~	Financial instability (+) ~~Restructure (+),~~ ~~NM breach (+)~~	Financial instability (+) ~~Restructure (+),~~ ~~NM breach (+)~~
R-sq(pred): 61% Two outliers removed	R-sq(pred): 55%	R-sq(pred): 48%

Use of commercial technology, dependence on other programs, the number of critical technologies, and research budgets tended to differentiate between High-End, Focused, and Volume strategies. Volume strategy cycle time and change in cycle time were not related to research budgets and procurement budget changes but did reflect software development process differences. High-End strategies were not sensitive to the number of critical technology elements. Focused strategies were sensitive to financial instabilities.

Conclusions and Future Work.

Conclusions

Initial structural and strategy decisions affect cycle-time outcomes. Program cycle times are related to program resources and acquisition strategy decisions, and percent change in program cycle time is related to program structural changes. Significant cycle-time predictors include the size of research and development budgets, deciding to use commercial or reuse existing in-service technology, and avoiding dependency on other programs. Schedule change

[22] In this case, unit cost (+) and change in unit cost (+) were significant predictors for High-End programs.

(as measured by percent change in cycle time) was related to changing procurement budgets, the number of critical technology elements in a program, and financial (budgetary) stability.

Classifying MDAP acquisition strategies based on functional objectives of cycle time, unit cost, and procurement quantities highlighted how different factors, such as use of commercial technology or reuse of existing technology, were associated with reduced cycle times and early program decisions. We showed how significant cycle time and schedule growth predictors changed with acquisition strategies.

Relevance and Contribution to the Practice

This research provided quantitative insight into acquisition strategy factors affecting program cycle times and cycle-time growth. The associations between objectives and structural factors affect cycle times and identified significant acquisition strategy choices made during program development related to cycle-time outcomes.

Recommendations

These results reflect the use of public data and may not apply to non-MDAP programs. Future research should re-perform this research on a larger government-controlled data set and internal program documentation and compare findings with open-source results.

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