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# The Use of COTS in Defense Acquisition Programs: A Research Synthesis and Framework

15<sup>th</sup> Annual Acquisition Research Symposium

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Background

Purpose & Research Question

Theoretical Framework

Methodology

Results

Implications

- The DoD faces 5 key challenges (GAO, 2017):
  1. Rebalance forces and rebuild readiness
  2. Mitigate threats to cyberspace and expand cyber capabilities
  3. Control the escalating costs of programs such as certain weapon systems and military health care, and better manage finances
  4. Strategically manage human capital
  5. Achieve greater efficiencies in business operations
- Limited budget
- Pace of technological change
- Foes adopting commercial technology

- COTS products offer faster development time, reduced cost and higher quality compared to custom development (Torchiano et al., 2002)
- GAP: Though the use of COTS products has been widely researched, COTS product usage is not completely understood.
  - The literature on COTS use is fragmented.
  - 17 years since the last comprehensive synthesis of COTS implementations – then conducted by the Air Force Scientific Advisory Board (Grant, 2000).
  - No known comprehensive synthesis of COTS usage research.

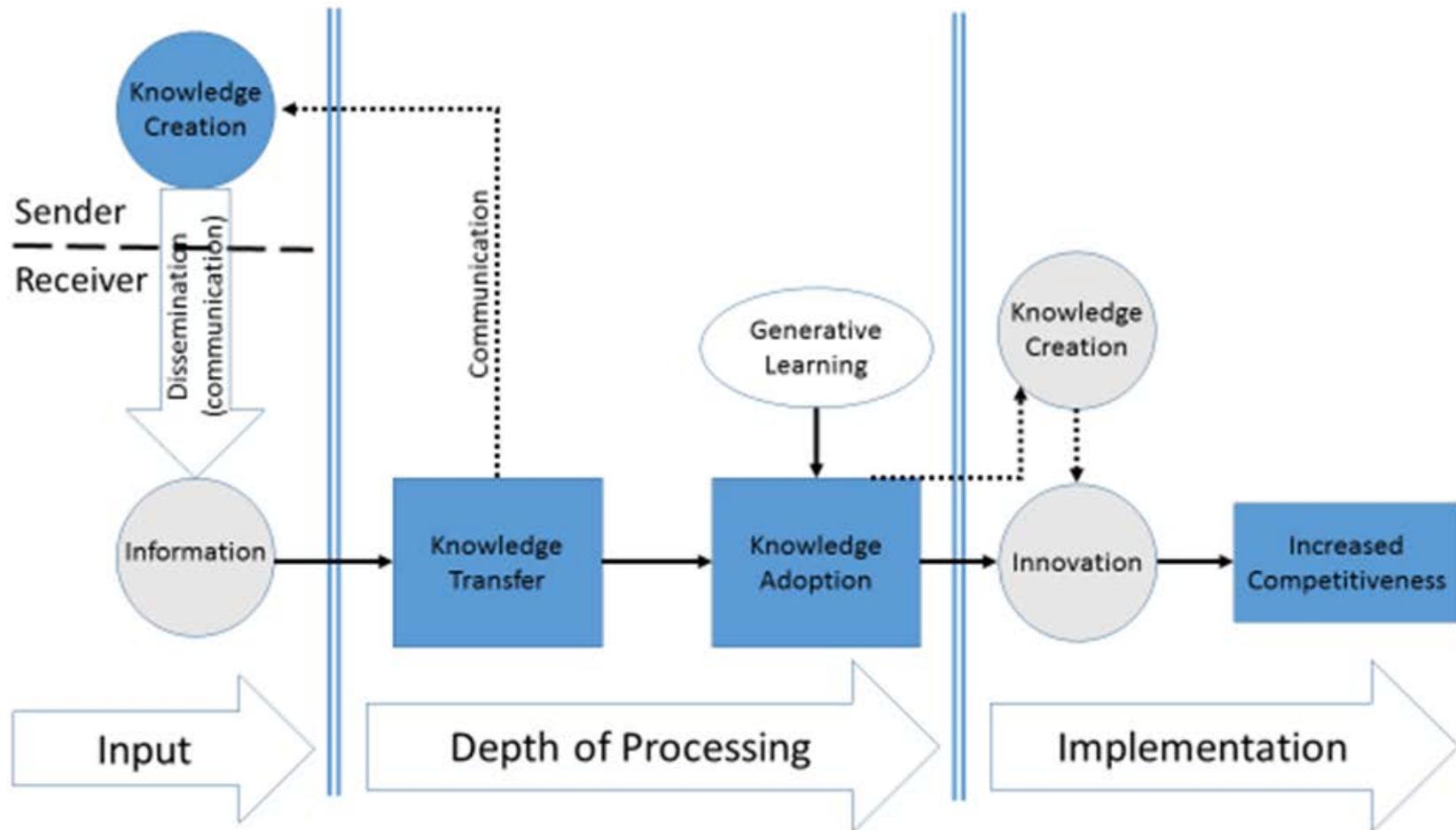
## **Purpose:**

- Review the literature surrounding the use of COTS technology to better understand COTS product implementation performance.

## **Research Questions:**

1. What are the known barriers to COTS implementations?
2. What are the known success factors to COTS implementations?
3. What policies, laws, regulations, and directives govern the use of COTS?
4. What recommendations have been made with respect to COTS implementations?
5. What are the typical research types, contexts, research methods, target markets, and foundational theories utilized in COTS-based research?
6. What is recommended for more timely and more effective COTS implementations?

## Knowledge Acquisition and Utilization Framework (Beesley and Cooper, 2008)



## Literature Review

- 62 Sources
- Source Types:
  - Peer-Reviewed Journals
  - Conference Proceedings
  - Acquisition Research Program Reports
  - Case Studies
  - GAO Reports
  - DoD Reports
  - Search Engine (Google and Google Scholar)
  - DAU Acquisition Community Connection
  - GAO Bid Protests
  - U.S. Court of Federal Claims Bid Protests
  - Books
  - Trade Press
  - White Papers
  - Guidebooks/Handbooks
  - Patents
  - Conferences/Practitioner Organizations

Search Terms
Commercial Off-The-Shelf
COTS
Open Architecture
Open Source Software
Component-Based Software Engineering
System Development
Commercial Off-The-Shelf Hardware
Reuse
Case Study
White Paper
Department of Defense

Inclusion Criteria	Exclusion Criteria
Defense acquisition context	COTS case studies published prior to 2000
Hardware	COTS Implementations by non-U.S. entities
Software	COTS usage in scientific discovery in which COTS product usage is not the study's focus
Studies of for-profit sector COTS usage	Classified COTS product implementations/programs

- Concept matrices of barriers and success factors
- COTS implementation performance = the key dependent variable in the emerged framework
- Identified emerged patterns/themes
- Each source was classified by its stage in the knowledge management process: knowledge creation, dissemination, knowledge transfer, knowledge adoption, and innovation

## Central Theme

- ***COTS Appropriateness*** - the extent to which a COTS product - adopted for use as-is or integrated into another product or system - can meet the program objectives with very little or no modification without introducing excess risk to cost, schedule, performance, safety, or security.
  - 21-item COTS Appropriateness Likert-type Scale
    - Developed from the emerged antecedents of COTS Appropriateness

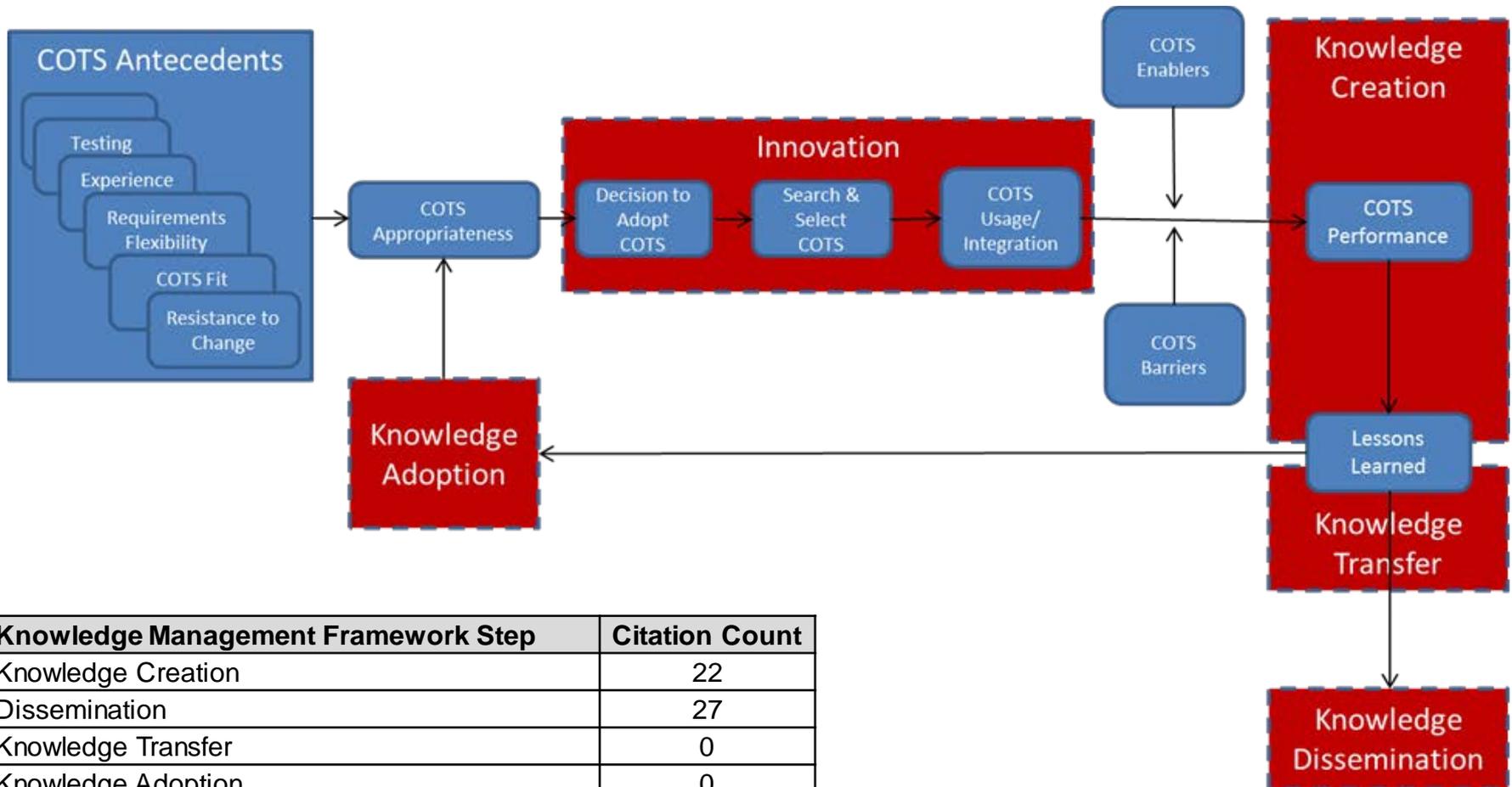
## RQ1: 5 Barriers (86)

- a “black box” design
- organizational resistance to change
- intellectual property constraints
- short product lifecycles
- complexity

## RQ2: 14 Success Factors/Enablers (89)

- fit between requirements and COTS product capabilities
- requirements flexibility
- COTS product experience
- open systems architecture
- robust COTS product evaluation and selection process
- post-adoption COTS product change preparedness
- COTS product training
- communication
- evaluating total cost of ownership
- a priori and post hoc testing
- marketplace knowledge
- leadership
- stakeholder buy-in
- contractual financial incentives

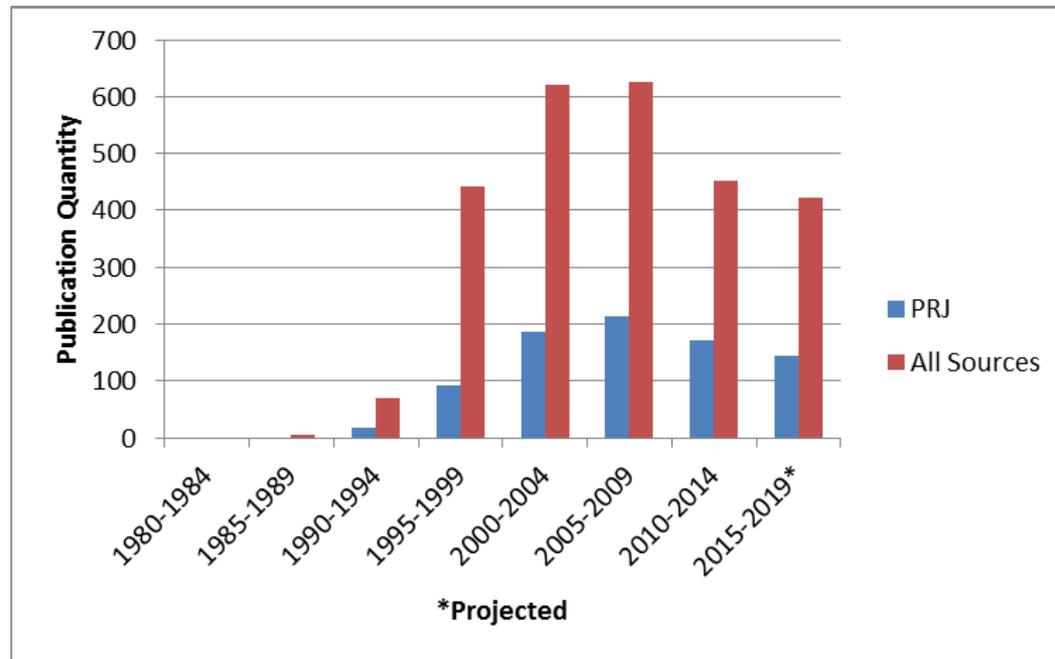
## COTS Product Usage Framework



Knowledge Management Framework Step	Citation Count
Knowledge Creation	22
Dissemination	27
Knowledge Transfer	0
Knowledge Adoption	0
Innovation	7

- RQ 3: What policies, laws, regulations, and directives govern the use of COTS?
  - See Technical Report
- RQ 4: What recommendations have been made with respect to COTS implementations?
  - See Technical Report
- RQ 5: What are the typical research types, contexts, research methods, target markets, and foundational theories utilized in COTS-based research?
  - See Technical Report

- Monitoring the commercial marketplace is key.
  - Technical and scientific details,
  - DOD's existing infrastructure,
  - User needs and desired effects.
  - Issue: Agency Theory
- Commercial off the shelf, as a topic, appears to be waning since 2005-2009.



- Literatures surrounding COTS implementations is *lacking in theoretical grounding* (47/56)
  - Few studies dig into causal relationships explaining or predicting phenomenon.
  - Few *empirical* studies (52%)
- Scholarly rigor in COTS research is lacking – Truth?
  - Few *case studies* (29%) of COTS product usage would qualify as scholarly contributions – most lacked evidence of:
    - Validity
    - Reliability
    - A research question
    - Details of data collection & analysis methodologies

Research Type (Gregor, 2006)	Citation Count
Analyzing (i.e., descriptive; what is)	18
Explaining	9
Predicting	3
Explaining and Predicting	4
Design and Action (i.e., prescriptive; how to)	18

- RQ 6: Select Recommendations
  - 1) Apply the proposed COTS Product Appropriateness scale to prospective programs when contemplating integrating major COTS components
  - 2) Record COTS product implementations in contract action reports
  - 3) COTS product implementations should be catalogued in a central repository in order to make detailed lessons learned available
  - 4) Set maximum program employee turnover rates
  - 5) DOD should not establish quotas for COTS implementations
  - 6) Policy requiring a technical evaluation sub-factor in source selections that: (1) requires offerors to submit their plan for making their deliverables open to competition during sustainment, & (2) allows for meaningful evaluation credit for superior plans.

- RQ 6: Select Recommendations (cont.)
  - 9) Making the extent of COTS implementation one of the criterion for award fee determination
  - 10) Where applicable, add to CPARS an assessment of: (1) the extent of COTS product usage and (2) COTS product implementation effectiveness
  - 11) Expand the scope of the DOD's Strategic Capabilities Office (CSO) organized as a Janus-facing organization around desired effects and simultaneously around commercial industries.
  - 12) Build structure to facilitate knowledge management and absorptive capacity

- RQ 6: 16 Recommendations (cont.)
  - 15) Case studies of COTS product usage should demonstrate greater methodological rigor
  - 16) The DOD should leverage its commercial business internships, such as the Air Force's Education With Industry program and the Navy's Supply Corps Training With Industry program, to glean commercial practices with respect to new product design, development, manufacturing, and sustainment.

## Future Research Directions:

- Research does not address the issue of security involved with adopting COTS products
- Very little research addresses counterfeiting
- Research hardly addressed the issue of intellectual property (IP) involved with adopting COTS products

## Limitations

- Selective inclusion of studies
- Differential subjective weighting of studies in the interpretation of findings
- Archival sources only - excludes classified and unpublished/unknown COTS usage
- Somewhat arbitrary threshold for a pattern