Integrating Sustainability into Ontology Development: The Case of GAO's Fraud Ontology

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ARM: GAO's Applied Research and Methods Team

- **ARM** designs and executes appropriate methodologies to help GAO's mission and operations teams investigate, improve federal government operations, and evaluate federal programs and policies.
- ARM offers expertise in many areas including:
  - Engagement design
  - Qualitative and quantitative social science research methods
  - Economics
  - Library and information science
  - Data analysis
  - Program evaluation
  - Statistics
  - Surveys; and
  - Future-oriented analyses.

FAIS: GAO's Forensic Audits and Investigative Service Team

FAIS provides Congress with high quality forensic audits and investigations of fraud, waste, and abuse; other special investigations; and security and vulnerability assessments.

- **Staff include:**
  - analysts and auditors with forensic auditing experience, including data mining experts,
  - criminal investigators with years of law enforcement experience at executive branch agencies, and
  - many are Certified Fraud Examiners (CFE)
- Operates **FraudNet**, a hotline for reporting suspected fraud, waste, and abuse involving federal funds.

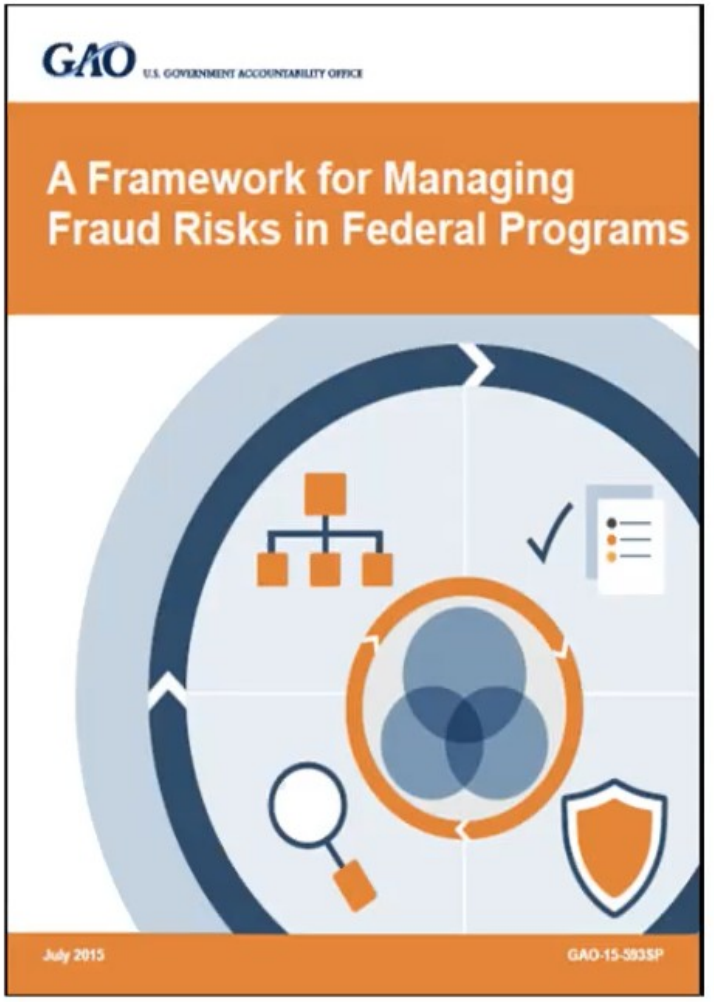
GAO's Fraud Risk Framework

GAO-15-593SP

Effective fraud risk management helps to ensure that federal programs **fulfill their intended purpose, funds are spent effectively, and assets are safeguarded**.

The Framework

- provides guidance to aid federal program managers in strategically managing fraud risks, and
- describes leading practices and conceptualizes these practices into a risk-based framework.



Source: GAO

The challenges that prompted this project…

- There is a lack of common understanding of fraud, including what it is, what it involves, and its impacts.
  - Agencies and Inspector General offices tend to use different terminology, statutes, and indicators.
  - Managers may 1) lack awareness of the full impacts of fraud schemes; 2) assume fraud is the IG's responsibility; 3) discount the importance of fraud among the variety of managed risks; or 3) lack the tools and resources to properly understand the fraud risks in their programs.
- Greater awareness of the need to manage fraud risk does not equal agencies' ability to do so efficiently and effectively.



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Why an ontology?

- Developed from a wide variety of federal cases, our ontology abstracts from the various schemes (instances of fraud) to:
  - create a model of the key characteristics of federal fraud;
  - relationships among those characteristics; and
  - a common language for describing them.

The model facilitates:

- Identification of crosscutting fraud
- Internal control decisions
- Understanding
- Measurement
- Collaboration

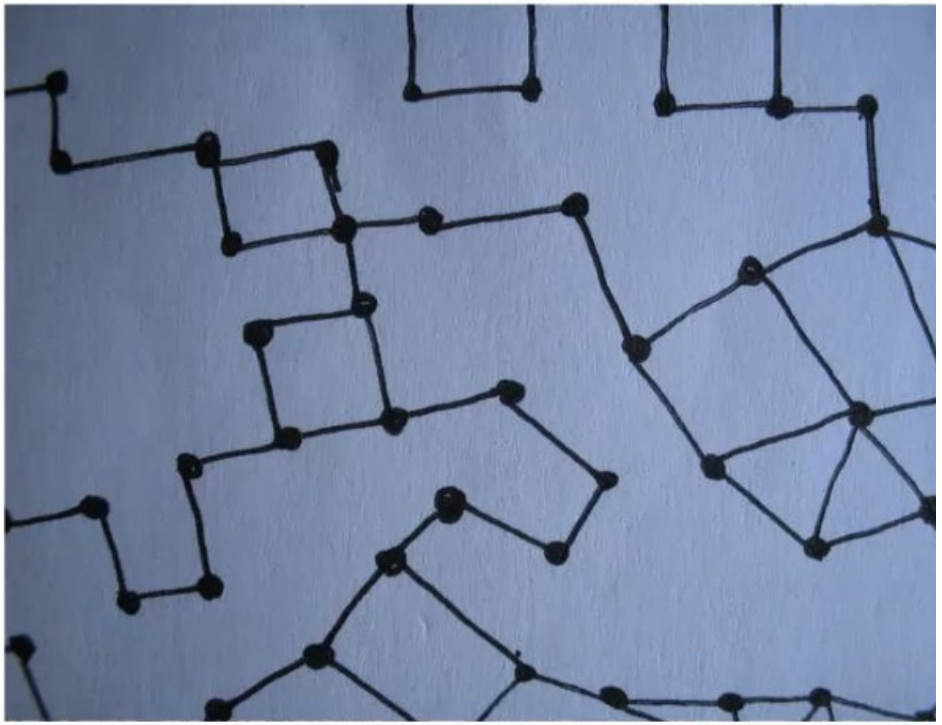


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The concept of a fraud scheme

- GAO's model of a typical fraud scheme has four key components:
  - Federal program or operation
  - Participant
  - Activity
  - Impact



Source: GAO

Other important entities

- Mechanism
- Funding stream
- Revenue stream
- Thing in role



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A fraud scheme example



Source: GAO

Married scientists Jessica Zhang, 45, and Ben Wen, 46, incorporated 2 businesses (United Environment and Energy [UEE] and Advanced Technologies and Materials) through which they intended to fraudulently apply for research grants from multiple departments and agencies.

UEE submitted approximately :

- Thirteen (13) applications to the National Science Foundation [NSF] totaling over $2,600,000;
- Ten (10) applications to the US Department of Energy [DOE] totaling more than $5,000,000; and
- Four (4) applications to the US Department of Agriculture [USDA] totaling approximately $650,000.

Through their companies, the defendants received approximately **$8,400,000** in total grant awards from the NSF, the DOE, and the USDA.

Wen and Zhang were ordered to repay $5.5 million in restitution and all ill-gotten goods were seized.

What is sustainability?

sus*tain*able *adjective* \ sə-ˈstā-nə-bəl \

1 : capable of being sustained

2 a : of, relating to, or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged
// sustainable techniques
// sustainable agriculture

b : of or relating to a lifestyle involving the use of sustainable methods
// sustainable society

Merriam-Webster Dictionary, s.v. "sustainable," accessed April 13, 2021, https://academic.eb.com/levels/collegiate/search/dictionary?query=sustainability&includeLevelThree=1&page=1#

b. *spec.* The property of being environmentally sustainable; the degree to which a process or enterprise is able to be maintained or continued while avoiding the long-term depletion of natural resources.

"sustainability, n.". OED Online. March 2021. Oxford University Press. https://www.oed.com/view/Entry/299890?redirectedFrom=sustainability (accessed April 14, 2021).

The Three Pillars of Sustainability

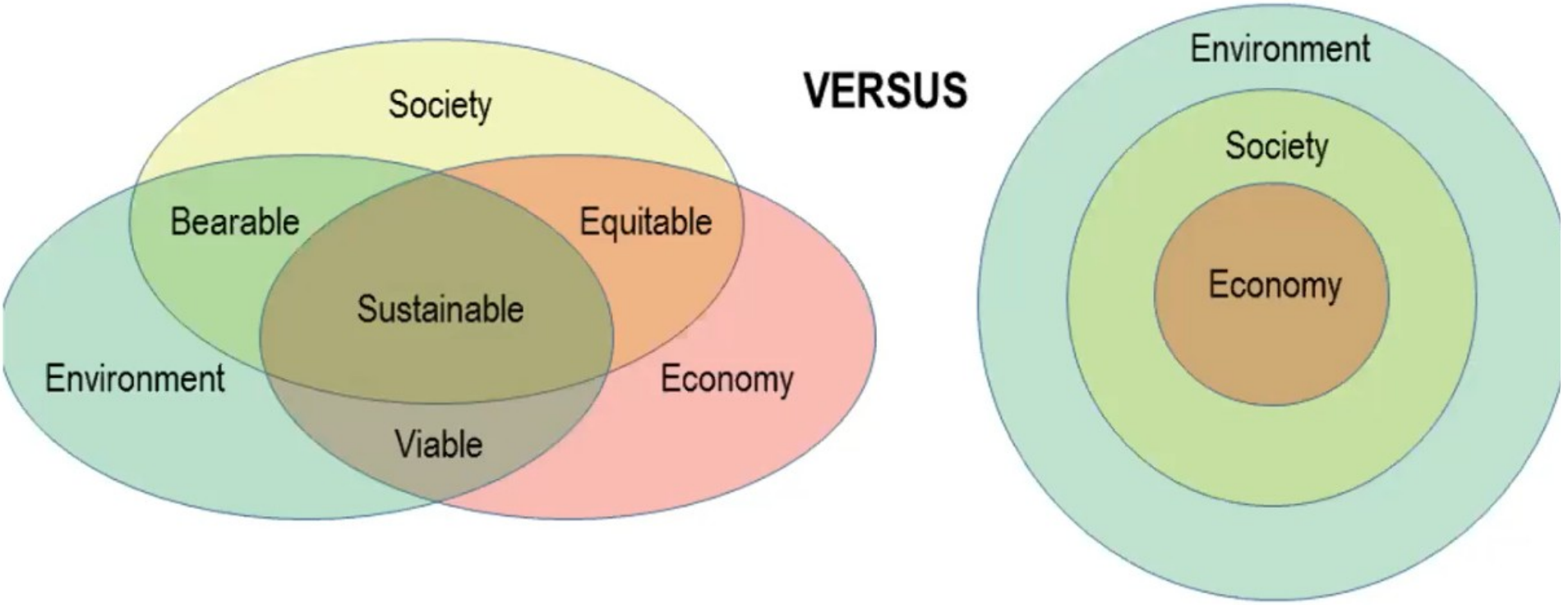
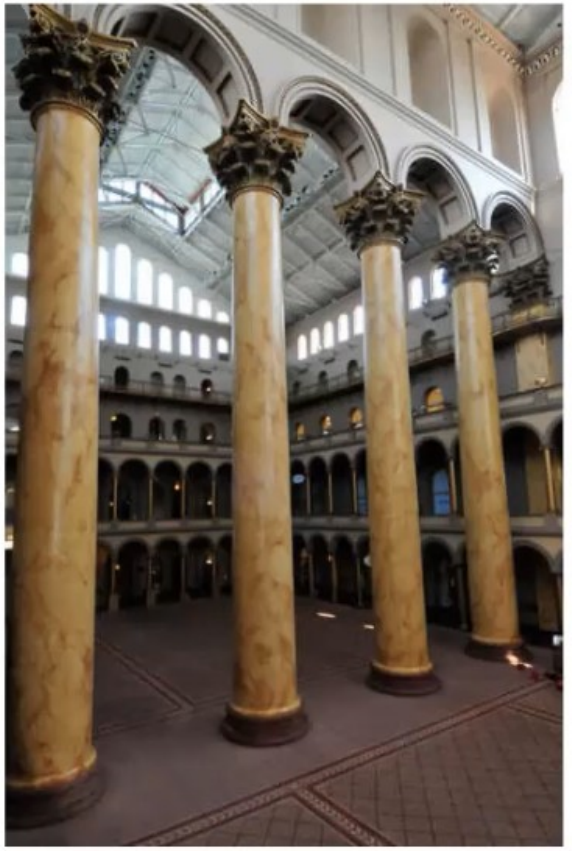


Image from Penn State's College of Earth and Mineral Sciences' OER Initiative, adapted from Gidding et al. (2002)

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Pillar I: Economic viability (Support)

- Work supported within engagement structure
  - Staffed with people with various specialities
  - Discussions with internal stakeholders



Source: GAO

Pillar II: Social equity (Unbiased approach)

- Fair and impartial
  - Part of GAO values
- Constructed from US federal perspective
- Engagement with other communities
  - Interviewed Inspectors General
  - Interviewed federal agencies
  - Shared with international counterparts
  - Shared with knowledgeable individuals



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Additional approaches for social equity

- Appropriate documentation and harmonization
  - Reviewed descriptions of fraud cases
  - Reviewed literature
  - Used authoritative sources for developing natural language definitions
  - Undergoing final editing and harmonization



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Social equity continued

- Standards
  - Using GAO standards for conducting work
  - Using ontology standards and guidance documents
    - ISO 704
    - FIBO guidelines



Source: https://www.eoi.es/blogs/guidopreti/2014/02/04/examples-of-voluntary-and-mandatory-tools-to-preserve-the-environment/
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Pillar III: Environmental Protection (Maintainability)

- How will the ontology be maintained?
  - What strategies will be used for caretaking?
  - Who are the relevant internal stakeholders?
- How will we engage with external stakeholders moving forward?
  - How will feedback be collected and incorporated?
  - What collaborations, if any, should be considered?



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We are actively thinking about Pillar III

- Efforts that are already underway or that are planned
  - Tracking active fraud cases using ontology as a schema
  - Identifying trends in collected fraud schemes
  - Formulating a workflow for updating ontology
  - Brainstorming outreach and collaboration with those in fraud community and beyond

Thank you for listening.

I look forward to hearing your questions and comments.



Photo credit: aboblist.com.