Creating a Retail Banking Ontology

Ontological Engineering

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A detailed summary and examination of an initial Retail Banking Ontology created for the Ontological Engineering graduate course taught by Dr. Barry Smith and Ron Rudnicki in the fall semester of 2014. This ontology targets banking products and services offered to the consumer market, with the purpose of helping to address intra- and inter-organizational communication problems, facilitate existing system discovery and technology roadmap planning, and to identify opportunities for operational improvement within traditional retail banking organizations in the United States.
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Introduction

Domain Background
As part of the Fall 2014 offering of the Ontological Engineering course, I focused on creating a Retail Banking Ontology (RBO) to identify, define and explore the terms commonly used within the domain of consumer-focused banks and banking products.

I have worked with a Northeastern regional banking organization for about 18 months in the role of user experience business analyst, with the goal of improving the bank’s website design and usability, as well as the graphical user interfaces for web-based internal bank tools. During that time I have noticed that banks can experience similar organizational problems as other large companies in different domains – including lack of documentation of established products, programs, and processes, difficulties communicating between technical and business teams, and issues with cross-departmental communication.

These types of issues are, by far, not rare. However, based on the problems I faced while learning about the bank when I was hired, I found that organizational communication issues compounded with retail-bank-specific problems create an ontological opportunity. The benefits of creating an ontology that could help banking organizations identify and map their component parts and pieces began to form in my mind.

Retail Banking
Banking is an industry in which organizations offer financial products and services to people, businesses, and other entities. Retail banking is a sector that is targeted specifically towards individual people, estates, and similar non-business-related parties. Pretty much everyone is a customer of a retail bank at one time or another, and products can include checking accounts, savings accounts, loans (such as mortgages), and services (such as safe deposit box rental).

Specific Challenges
Retail banking organizations face a specific set of challenges that other financial service providers may not, which is one of the reasons I focused on retail banking rather than banking as a whole as the domain for this project.

Banks offering retail products have many complex processes and must interact with outside agencies, both regulatory and private sector. Aside from keeping track of the money that customers deposit and withdraw, banks must request transactions be made through an entity called the Automated Clearing House (ACH) in order to send money and confirmations to other banking organizations. Banks must comply with federal and state regulations, and are subject to audits and other regulatory actions.

Retail banking requires a great deal of recordkeeping and transactional precision. This is true of banking and the financial services industry as a whole, however, the impact of small errors in the retail banking domain can have catastrophic impact to individual people’s finances. Since individual people generally have much less complicated banking relationships than large corporations, a person who is unhappy with or cannot trust a particular bank can easily withdraw their money and become the customer of a
competing bank fairly quickly. Banks must be precise in the processing of transactions between accounts and with other organizations and retain all records to comply with regulatory audits and settle disputes when requested.

**Venerable Banks**
Retail banking is an interesting domain when you consider that banking services by far predate modern computer systems. Bank balances were recorded on paper and calculations done directly by people before computers were available. However, recordkeeping was still vital – records of accounts were kept in books and ledgers and sometimes duplicated by hand to protect against loss due to disaster or damage.

Since data management and calculation is so vital to banks, organizations of this nature were early adopters of computer technology when it first became widely available. Banking organizations that are venerable, or were organized amidst the massive technology changes since the 1930s, tend to have many different processing and recordkeeping systems. These may have been added incrementally, and may have been built using different technology from different sources.

Of course, the interval of improvement in technology has sped up markedly since the days of the mainframe in the 1980s – but traditional banks lag behind in adoption of current technology. The reason for this is due to the sensitive nature of the data being kept and the requirements to have accurate records at all times. Since customers can so easily "jump ship" and leave a bank for another, banks are hesitant to make large changes to their systems for fear of system failure, instability or delays in service while a system is being upgraded.

Compounded with the problems of intra- and cross-departmental communication, older banks often find it easier to add new features onto their systems in separate small modules, than to overhaul an entire system for efficiency. It is less risky to add something new if it doesn't impact what already exists, even if some duplicative functions exist.

Since there are obstacles in knowledge sharing and lack of documentation, it is often much cheaper to add on such a product in this way, because finding out what an existing system does, and if it is still relevant or should be changed, take a lot of discovery time and communication time between various departments, increasing the required project timeline, and thus budget, to assess an older system. Thus, traditional banks typically choose the most cost effective method.

In addition to changing technology and systems over time, many retail banks grow their customer base not only by way of new sales, but by acquiring other retail banks. These other banks have their own systems, which may differ from the main bank’s systems, as well as their own set of data records, which may not be structured in the same way and will regardless need to be retained for audit purposes. This greatly increases the risk of having redundant systems that are difficult to update or maintain.

**Market Opportunities**
Due to changes in the retail banking market in the last ten years, there has been an increase in the amount of competition. Since web- and mobile-based banking has been introduced and greatly
adopted, more people are comfortable using websites to interface with banking services. People find that checking balances on a web page or on their mobile phone is much more convenient than calling a banking customer service line or making a trip to a bank branch.

Additionally, retail banking startups are more numerous, and are proving to be successful since they do not have a large, traditional banking infrastructure to maintain. They avoid having to pay rent or other real estate costs by not offering in-person branch locations. Banks of this type offer telephone customer support, support via online chat and email.

Online and mobile banking services such as mobile check deposit (using a smartphone's camera to take a picture of a paper check, and using that picture to process the check deposit) have overcome suspicion and are accepted by a great number of people. Due to this greater adoption, and the demand for more convenience, even traditional banking organizations are beginning to offer these types of products.

**Agility**

While many venerable “brick and mortar” banking organizations have long valued branch relationships with their retail customers, in that a local bank representative knows and interacts a particular customer in a personal way, the demand for convenience is beginning to outweigh personal relationships in the interest of retail banking customers. Customers are less loyal to their local branch and more likely to shop for the best products, rates, services, and features.

The newer, low-overhead online banks are beginning to erode the customer base of traditional banks, and traditional banks need to react, as their loyal older customers advance in age.

Since traditional banks have to account for their branch overhead, they need to become more agile in providing new technology-based features to their customers in order to compete with online-only banks. The infrastructure and organizational challenges already being faced by older banks, with the reluctance and lack of ability to quickly change their systems to be efficient for the current needs of the banking market, are significant barriers to achieving agility in technical projects. Older banks can be thought of as large ships, which take a lot of time and effort to steer in a different heading.

As a result, mature banks need to carefully examine their processes, agents, systems, and methods of communication to define areas of improvement. An ontology would be a perfect tool to help a bank’s personnel discuss how the bank currently works, which would drive communication on what to improve next.

**Purpose**

The Retail Banking Ontology may provide a means for identifying the current state of a banking organization structure, along with the processes, roles, and data elements that the bank utilizes.
Discovery
Especially for venerable banks and banks that grow via acquisition, the Retail Banking Ontology would provide a means of collaboration between many different business units and technology personnel, for the purpose of discovering what the bank has, and what it would optimally need to function.

For example, a business subject matter expert who is knowledgeable about the various types of retail banking products that are offered could begin to build out the appropriate terms in the ontology, or create relevant individuals. A database expert could examine a schema and come up with a description of the vital data, that could be put into the ontology where appropriate.

Education
An ontology (and the tools that could be created with one), such as knowledgebase tools and wikis, could greatly assist with employee education and new employee onboarding. While many banking organizations offer training programs, a centralized means of examining the bank structure or querying a particular term in a very broad sense is usually lacking.

An example here would be if a new programmer joins with no knowledge of the banking industry, and wants to understand what a business stakeholder meant when they mentioned “bank account holder”, they could examine the ontology and see that a bank account holder is a role with certain qualities, representing a person who owns a bank account, and a bank account is issued by the bank, etc. This is a common question – what does that thing represent, and how does it relate to everything else? An ontology-based solution could serve to be tremendously helpful in employees finding the answer to their particular questions.

Communication
Ontology software such as Protégé are not development-oriented tools. One does not need to be a programmer in order to use or contribute with one of these tools. The lack of dependency on technical expertise can allow the Retail Banking Ontology to become a means of communication between bank departments, and between different banking organizations.

As a bank embarks on a discovery task and has different employees examine the systems and processes and adds them to the ontology, business experts can contribute with the same tool that technology experts are using. For business and financial experts, discussing data often involves the need to have a technical resource “translate” a database schema or other technical document so that they can understand it. Instead of needing to take this extra step, non-technical experts need only learn enough about the ontology tools to be able to contribute themselves as well as validate the contributions of technical teams. Even if system documentation exists, it may not be easy for a non-technical person to understand the overall meaning, and the ontology would allow for an easy way to map objects and relationships. “A picture is worth a thousand words,” and ontology tools allow for automatic generation of relationship mappings that would facilitate discussion between technical and non-technical personnel.

Additionally, communication issues between outside entities and a bank can also be helped through the use of the RBO or derivatives. An example of such would be if the Federal Reserve requires and audit of
a bank’s data. Commonly, audits take a tremendous amount of time because the regulators need to ask for specific data, the bank personnel need to understand what the regulators actually want, and then they need to find it in the bank’s system. Oftentimes, this takes several iterations as the bank provides what they think the regulators wanted, when after the regulators examine the data, they discover that they actually “meant to ask for something else entirely,” starting a new round of discussion and data discovery.

An ontology that both regulators and banks could agree to and utilize would serve as a common language when making these requests, or for retrieving information to fulfill such a request.

Planning
The Retail Banking Ontology could also assist in planning for system optimization. As a banking organization maps its systems and processes into the RBO, individuals with similar functions and definitions could be identified. If the functions and processes associated with these systems were very similar, but duplicative in some way, opportunities for optimization and consolidation would be easier to see. The relationships between these types of systems could be mapped as well, making possible cost and infrastructure reduction benefits stand out. Relationship diagrams could also be generated to convey these ideas to management stakeholders as an aid to discussion and planning.

Resources
Three ontologies were imported into RBO with varying degrees of success. In the future, use of OntoFox (http://ontofox.hegroupl.org) will be leveraged to allow for remote ontology files to be imported, but there are still challenges with the import process due to the variations in ontology structure.

BFO 2.0
The Basic Formal Ontology, version 2 (BFO2: https://code.google.com/p/bfo/) serves as the foundation for the Retail Banking Ontology. Since the RBO describes people, roles, functions, processes, events, histories, relationships, as well as information artifacts, importing BFO 2.0 was an obvious choice.

FIBO
The Financial Industry Business Ontology (FIBO: http://www.omg.org/hot-topics/finance.htm) defines many financial terms and entities. Entities such as cash, equity, currency, and others pertaining to value and the ideas of financial obligation and agreements are good fits with the Retail Banking Ontology. FIBO also includes an organization component, which describes organizational units, members, agents, legal entities, and corporations, which can all be used to describe different parts of retail banks.

While FIBO has a tremendous amount of usable terms, there were also significant difficulties in merging FIBO classes into the BFO2 foundational structure. FIBO does not utilize BFO as a base, and introduces some terms that don’t fit well into any BFO2 category, such as “agent-in-role,” which is classified in FIBO to be an object. This seems to duplicate the BFO method of defining a role and then having a person (or other entity) as the “bearer of” a role. The definition given for “agent-in-role” is not clear: “An agent-in-role is a relative concept that ties an autonomous agent to a role they are playing in
a given situational context.” This seems to be an attempt to assign a relationship as an entity, and doesn’t seem as useful as something like “agent is_bearer_of role” where “is_bearer_of” is the relation between agent and role.

FIBO also contains terms that lack clear definitions, such as “Concept” (An idea or notion; a unit of thought) and “Concept Scheme.” Some entities, such as “List,” do not always show definitions depending on how they are imported. In order for FIBO to be more easily linked to other ontologies, documentation and structure improvements are needed.

**IAO**

An additional ontology was included after FIBO once I decided that the bank account entity had related information artifacts. The Information Artifact Ontology (IAO: [https://code.google.com/p/information-artifact-ontology/](https://code.google.com/p/information-artifact-ontology/)) is a BFO-based ontology that details data-related terms. The highest-level useful term for RBO was “information content entity,” equivalent to “information artifact.”

Other useful terms include “directive information entity,” which can contain entities relating to the plans and specifications of an item. I chose to house “banking product specification” beneath this term, and other child terms like “source code module” and “data format specification” will be useful within RBO in the future as well.

“Planned Process” and “Processual Entity” and “History” are additional terms that will be vital in building out RBO, as occurrents.

Import of IAO did provide a few challenges. Since Protégé was used and OntoFox was not, Protégé was prevented from running reasoners due to the complexities of the relationships present in IAO. This is a technical issue and will be resolved by integrating OntoFox for import of various ontologies.

**Related, Unused Ontologies**

Of interest but not included within RBO at this time were several other financial ontologies.


Unfortunately, this ontology seems to be defunct at this time. Attempts to contact its administrators have gone unanswered.

**Finance Ontology:** [http://www.fadyart.com/ontologies/documentation/finance/index.html](http://www.fadyart.com/ontologies/documentation/finance/index.html)

This ontology contains many similar terms that are found in FIBO. Since FIBO was larger and had additional terms like organization, I chose FIBO instead of the Finance Ontology as a better fit for RBO.

**Organization Ontology:** [http://www.cs.umd.edu/projects/plus/SHOE/onts/org1.0.html](http://www.cs.umd.edu/projects/plus/SHOE/onts/org1.0.html)

This ontology could be relevant to the organizational units of a bank, but it seems that it focuses more on physical products than the organization component of FIBO. This ontology was also not based on BFO, so the organization components of FIBO were a better fit.

REA is not a stand-alone ontology, but the link above is a discussion of adding Resources, Events, and Agents modules to FIBO. This will be useful, when integrated with FIBO, in order to detail process-related terms in RBO.


The IFIKR ontology relates specifically to finance terms in the Islamic culture. While some finance terms would apply to international banking, many would not apply to RBO, and so this ontology was not imported. At some future time, it would make sense to connect with this ontology in some manner. Additionally, the website for this ontology uses a novel interactive display to map ontology terms, and this type of display could be helpful for a dynamic method of viewing ontologies outside of Protégé.

![Islamic Finance Ontology Map](image)

**Figure 1:** IFIKR interactive display
Retail Banking Ontology

In this section, details regarding several key RBO terms and relationships will be described. The scope of RBO wound up growing much larger, in a very short timeframe, than was originally anticipated, so not every term can be discussed in a paper of concise form.

Bank Account Entities and Processes

The most difficult entity to classify and define was the “bank account,” since it relates to measures of money and value, resides as related data in computer systems, and also has related roles and artifacts (such as “check,” “bank debit card”). The data relating to a bank account can be duplicated, but the all-encompassing entity does not itself seem to be an information artifact. As such, I chose to classify this entity as a generically dependent continuant, but not as an information artifact.

Figure 2: Bank account relationships

\[\text{('is owned by' some 'legal person')}\]
\[\text{and ('is constrained by' some 'bank product specification')}\]
\[\text{and ('is issued by' some 'bank organization')}\]
\[\text{and ('participates in at some time' some 'bank process')}\]
\[\text{and (is_specified_output_of some 'account opening process')}\]
Information Artifact Classes

There are many types of information artifacts associated with banks, bank accounts, and bank processes.

A few have been defined so far in RBO, one such being “product specification” – each account has a product specification that determines how the account is built along with features and limitations, and has associated marketing and branding information. This specification is what is “sold” – example “Totally Free Checking”. When a customer agrees to open a new account for this product, the bank uses the “product specification” to build the bank account.

![Figure 3: Information artifact hierarchy](image)

![Figure 4: Bank card information artifacts](image)
Object & Object Aggregate Classes

“Legal person,” an entity from FIBO, is a key reused term. Since a person can own a bank account, as well as a person’s estate after their death, “legal person” was used to define the “bank account holder” role as the link between a person and a bank account.

“Organization” is a subclass of the “object aggregate” class, since it is a group of objects with some sort of function linking them together. “Bank organization” was interesting to define as it has two facets – the actual object aggregate formed of the people, systems, processes, etc., within a bank, as well as the legal person that represents the bank organization in legal actions.
Figure 7: Bank organization

Figure 8: Bank organization relationships
Qualities, Roles & Functions
Some of the terms that are categorized as qualities apply to continuants, and others to occurrents. For example, “bank account type” is a quality of a particular bank account instance, whereas the quality “bank method of communication” is meant to describe the type of communication that is used in a particular bank process.

The naming conventions used in the current version of RBO require refinement, as “bank account type” having a subclass “bank account type deposit” is confusing, and could be interpreted as a “type of a type.” Instead, the purpose here is to say that a “bank account type” can be “deposit” or “loan.”
Likewise, roles can be divided into roles that are borne by objects to indicate a relationship, as well as roles meant to indicate a relationship between a process or event and an entity.

For example, one bank account instance may hold the “bank transaction source role” in a bank transaction process, while another may hold the “bank transaction destination role.”

However, a “bank account holder role” is held by a legal person to indicate their relationship with a bank account instance, as well as the bank that issued the bank account.

Figure 11: Role hierarchy

Figure 12: Bank employee roles

Figure 13: Transaction roles
Functions within the Retail Banking Ontology can apply to continuants and are realized by occurrent processes. For example, a “deposit money function” can be held by a bank teller as well as an automated teller machine.

Figure 14: Function hierarchy

Figure 15: Transfer money functions
Assessment and Conclusion

As a class project, the Retail Banking Ontology had a large scope. This wasn’t anticipated, but rather grew as discussions about the nature of retail banking products brought entities to light. Technical issues relating to importing FIBO and IAO prevented use of Protégé reasoner functionality to check inferred relationships, which was a disappointment.

Despite these challenges, the Retail Banking Ontology seems to fill an empty, though specific, niche in the realm of finance ontologies. Due to the market opportunities and pressures that current technology and regulatory trends are placing upon certain types of retail banks, I believe RBO can be expanded and used in several capacities.

While it is not certain that many banks will collaborate at the outset, the potential of organizational improvement and aid to communication seems to merit further discussion and research. This ontology will be published in the near future, and work to start collaboration with other related ontologies will follow.

Comments are welcome and can be directed to laurenmadar@gmail.com, and I wish to thank Dr. Barry Smith and Ron Rudnicki for their guidance for this project.