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A Mechanism-based Explanation of the Institutionalization of Semantic Technologies in the Financial Industry

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Abstract. This paper explains how the financial industry is solving its data, risk management, and associated vocabulary problems using semantic technologies. The paper is the first to examine this phenomenon and to identify the social and institutional mechanisms being applied to socially construct a standard common vocabulary using ontology-based models. This standardized ontology-based common vocabulary will underpin the design of next generation of semantically-enabled information systems (IS) for the financial industry. The mechanisms that are helping institutionalize this common vocabulary are identified using a longitudinal case study, whose embedded units of analysis focus on central agents of change—the Enterprise Data Management Council and the Object Management Group. All this has important implications for society, as it is intended that semantically-enabled IS will, for example, provide stakeholders, such as regulators, with better transparency over systemic risks to national and international financial systems, thereby mitigating or avoiding future financial crises.

Keywords: Institutional Theory · Social mechanisms · Institutional mechanisms · Semantic technology ·Web Ontology Language · OWL · Financial Industry Business Ontology

1 Introduction

Forty four years ago, Wall St. had to close its doors on Wednesday each week to do paperwork—such was the volume of paper-based data produced in conducting business in the stock market alone [1]. The financial industry faces similar difficulties today; but instead of manual systems that produce paper, it is computer-based information systems that generate big data. While the volume of data being processed has grown, so too has number of information systems. Our unpublished research found that CitiGroup Inc. alone has over 70,000 computer-based information systems supporting its business operations globally, many of which are similar and replicating the same tasks in different geographical locations. Even small financial services organizations typically possess between 5-12 poorly-integrated information systems. Thus, organizations both large and small face significant data management problems [2], the

adfa, p. 1, 2011.
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solutions to which involve addressing the root cause—the so called 'vocabulary problem' [3].

The financial industry responded to the above problem by institutionalizing a 'common vocabulary', enabled by semantic technologies, to manage better not only the mountains of data, but also financial risk, and to enable comprehensive compliance reporting [2] [4]. Semantic technologies, such as OWL-based ontologies, provide the ability for organizations to consolidate, integrate and federate both structured data in legacy database silos and also the increasing volume of unstructured data that is now being generated electronically [5]. Inter alia, the benefits then identified were to: (1) Identify patterns and insights in data; (2) Integrate heterogeneous data; and (3) Optimize enterprise search and navigation. Thus, semantic technologies are argued to enable improved data processing and management, in addition to search, visualization, and information exchange for organizations in the financial industry [5, 6].

This paper operates from an IS perspective and applies a mechanism-based conceptual framework to study the institutional initiatives that are producing novel approaches to data and risk management using semantic technologies, for the purpose of modelling, federating, and integrating diverse operational and risks data in and across financial services organizations. The remainder of this paper is structured as follows. The second major section presents the theoretical background, the objective of which is present a mechanism-based conceptual framework to help explain institutional change. The third section describes the research method. The fourth section applies the aforementioned framework in our case study of the institutionalization of semantic technologies in the financial industry. The final section then offers some concluding thoughts.

2 Theoretical Background

Institutional theory explains how the regulative, normative, and cultural-cognitive influences shape societal and organizational fields and organizations [7]. In an IS context, researchers maintain that institutional theory can explain "how regulative processes, normative systems, and cultural frameworks shape the design and use of technical systems" [8, p. 153]. Theories developed from the conceptual framework offered by intuitional theory usually explain how regulative, normative, or cultural-cognitive forces shape institutional environments and organizational fields, while influencing organizational structures and processes. At a macro-level such outcomes result from, and can be explained by, the action of coercive, normative and mimetic (cultural-cognitive) mechanisms [7, 9]. However, a range of other mechanisms, operating at different levels, are at play. Take, for example, that actors apply mechanisms in an institutional environment to influence the formation and structure of organizational fields: such actors include governments, industry associations, dominant organizations, and social movements. An organizational field is typically defined as consisting of organizations with similar business, commercial, or public service interests: also included are suppliers of services, resources, and/or products, customers and consumers, government agencies, and other stakeholders [7, 9]. These actors also

apply endogenous mechanisms to shape and influence structure and process in and across the field [10].

2.1 Social, Institutional and Organizational Mechanisms

A social, institutional or organizational mechanism may be a structure or a process [11], it may be observable or unobservable, and/or it may be formal or substantive in nature [12]. According to Hedström [13, p. 25], mechanisms describe "a constellation of entities and activities that are organized such that they regularly bring about a particular type of outcome." We adopt Gross' [12] conceptualization of mechanisms as consisting of a configurations of actors, their habits of cognition and action, related resources, and the responses they make when faced with problem situations. Researchers have identified a range of social, institutional or organizational mechanisms that operate at macro- meso- and micro-levels to explain social phenomena [cf. 12, 13, 14, 15]. Micro-level mechanisms employed by individual actors translate into social and organizational mechanisms that operate at meso- and macro-levels [10] [16]. According to Elster [16, p. 42] "atomic" mechanisms are "elementary psychological reactions that cannot be reduced to other mechanisms at the same level." Such atomic mechanisms might form the "building blocks in more complex 'molecular' mechanisms" [16, p. 43], whether micro-level individual, meso-level or macro-level. Hedström's [13] Desires (D), Beliefs (B) and Opportunities (O) or DBO theory describes three fundamental atomic mechanisms that shape individual and collective Action (A). Institutional theorists broadly categorize meso- and macro-level mechanisms as coercive, normative or mimetic [9, 10]. Hedström and Swedberg [11] posit three categories of social mechanisms: situational mechanisms are macro-or meso-level social, institutional or organizational structures and processes that shape desires and beliefs; micro-level action-formation mechanisms link desires, beliefs, and opportunities with resultant actions; and transformational mechanisms explain individual and collective action as a cascade/network/constellation of individual mechanisms, leading from micro- to meso- to macro-level. Finally, it is important to note that mechanisms operate in tandem, in cascade and/or in combination with each other to bring about observed outcomes [10] [13].

2.2 The Role of Mechanisms in Institutional Theory

Institutional theory has as its subject "the formal and informal rules, monitoring and enforcement mechanisms, and systems of meaning that define the context within which individuals, corporations, labor unions, nation-states, and other organizations operate and interact with each other" [10, p. 1]. Scott [7, p. 35] argues that "regulatory processes involve the capacity to establish rules, inspect another's conformity to them, and as necessary, manipulate sanctions – rewards or punishments – in an attempt to influence future behavior. These processes may operate through diffuse, informal mechanisms, involving folkways such as shaming or shunning activities, or they may be highly formalized and assigned to specific answers, such as the police or the courts." Thus the coercive mechanisms that underpin institutional change may, for

examples, be instituted and employed by governments, dominant organizations, and social movements and operate through governance or power systems—their origins may also be within an organization, however. Normative mechanisms typically draw upon values and norms that "introduce a prescriptive, evaluative, and obligatory dimension" to organization life in a field [7, p. 37]. Values indicate what is preferred or desirable, while norms specify the means by which what is desirable should be achieved. In an organizational field, normative mechanisms typically originate in and are applied by professional and standards bodies, non-government organizations (NGOs), consulting organizations, professional bodies, academic institutions and publications etc. Cultural-cognitive or mimetic mechanisms operate with reference to symbolic systems, cultural rules, and shared perceptions and understandings. Cultural-cognitive mechanisms emanate from societal actors, NGOs, social movements, community groups, investors, and other stakeholders. Di Maggio and Powell [9] argue that over time organizations in a field tend to become homogenous in terms of both their processes and structures—this they term isomorphism. Competitive isomorphism arises from market forces in an organizational field, while institutional isomorphism arises out of coercive, normative, and mimetic mechanisms that underpin political and organizational legitimacy in the field [7] [9].

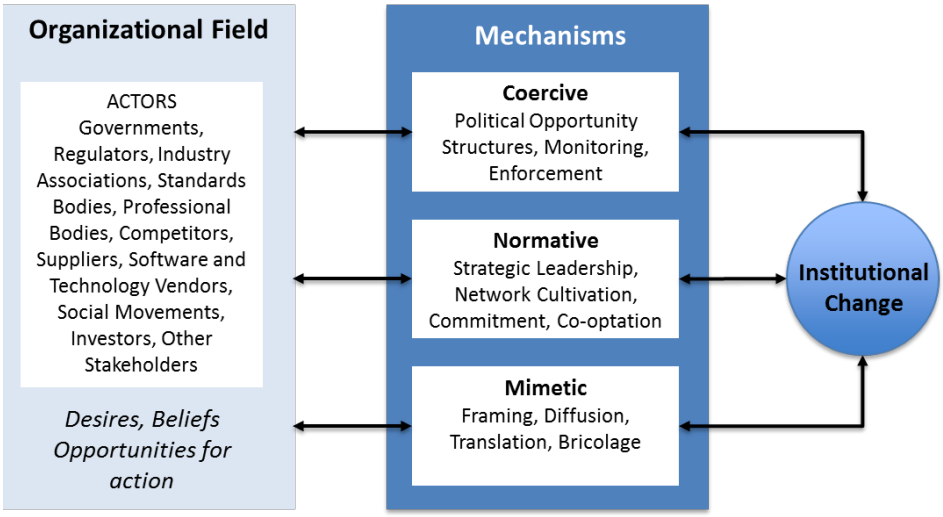

Fig. 1. Mechanisms Underpinning Institutional Change

Campbell [10] [14] employs both macro- and meso-level social and institutional mechanisms to help explain institutional change in a variety of research contexts, whether it is mechanisms involved in shaping organizational reproduction, or change due to globalization, or collective action in organizations and social movements in organizational fields. These mechanisms are: (a) Framing, which involves the use of metaphors and symbols which influence how issues are perceived and which inform social action in the context of socially constructed realities; (b) Diffusion, which refers to the dissemination of concepts, social structures, and practices, mainly through

social networks; (c) Translation, which refers to how diffused concepts and ideas are transformed for application in new social contexts; (d) Bricolage, which involves the recombination of concepts, practices, etc. from other social contexts to produce new forms of social activity; (e) Network cultivation, which involves creating social and institutional movements and associations; (f) Strategic leadership (or institutional entrepreneurship), in which social actors decide on which, direction a social, institutional or organizational entity should take; and (g) Political Opportunity Structures, include regulations, laws, governance policies, and informal unwritten rules. Campbell [10] also makes reference to 'monitoring and enforcement mechanisms'. Our previous research indicates that these are important sub-categories of coercive mechanisms in that they are required to provide full explanations of institutional processes and change.

Figure 1 places the mechanisms described above into a conceptual framework which posits that such mechanisms operate at different levels to bring about the institutional change observed in organizational fields. The upcoming case study section applies this conceptual framework to explain how the organizational field of the financial industry is being shaped by exogenous and endogenous mechanisms with the objective of instituting a common vocabulary using semantic technologies. The next section describes the research design and method through which this research objective was met.

3 Research Method

An exploratory/explanatory, longitudinal case study design was chosen for the study [17]. The case study design permitted the development of a mechanism-based theory of institutional change in the financial industry by applying previously identified mechanisms associated with institutional change [10] [14] with empirical insights gathered from a case study of this organizational field in the United States and Europe. Two embedded units of analysis were purposively selected—the Enterprise Data Management Council (EDM Council) and the Object Management Group (OMG). The first is an industry association whose members are drawn from the financial industry and related sectors. The second is an international software industry standards consortium. The exploratory aspect of this study is important, as this topic is novel and has not previously been the subject of research in the social sciences. The explanatory dimension arises as we seek to illustrate the combination of mechanisms that are instituting change in this important industry sector, which, more than any, impacts on the daily lives of individuals globally. Participant observation was chosen as the primary research technique as the process of institutional change in organizational fields is often "obscured from the view of outsiders" [18, p. 12]. Participant observation of, and data gathering from, social actors in the embedded units of analysis occurred at OMG technical meetings, industry conferences, and through a series weekly and monthly teleconferences and webinars, with the EDM Council, the Open Financial Data Group (OFDG), the OMG's Financial Domain Task Force (FDTF), the OMG's and Smart Regulation Initiative, and related meetings with key informants from the

EDM Council on FIBO. Each of the on-site or teleconference meetings lasted from between 1-1.5 hours each. A research team of 5 actively participated in the data gathering activities and took field notes of their observations, formal and informal discussions. Data gathering began in March 2012 and continues into and throughout 2013. This gave a total of over 350 hours of direct data gathering. Also as members of the OMG and the EDM Council, the research team had unrestricted access to all relevant documentation. Detailed field notes were taken throughout the research process and these were reflexively analyzed and recorded by the researchers. A wealth of documentary evidence was also gathered. While observation was the primary data source, supplemental and confirmatory information was acquired through documents and formal and informal conversations during meetings. Data analysis involved the use of the Campbell's [10, 14] coercive, normative and cultural-cognitive/mimetic mechanisms as 'seed' or a priori categories for coding, constant comparative analysis and rigorous coding procedures [19].

4 Case Study: The Institutionalization of Semantic Technologies in the Financial Industry

The business need for a common vocabulary and semantic technologies in the financial industry was first comprehensively articulated at the Demystifying Financial Services Semantics Conference on March 13, 2012 in New York. This event was viewed as a critical incident [19] in our study of the institutionalization of a common vocabulary and related semantic technologies in the financial industry and is therefore of particular relevance to this case study. First, however, we explain the ongoing development of this common vocabulary/semantic technologies and their institutionalization by focusing on the agents of change—the Enterprise Data Management (EDM) Council and Object Management Group (OMG)—and the critical incidents that marked the changes in the institutionalization process. The second section focuses on the critical incident of note, the Demystifying Financial Services Semantics Conference. The third section focuses on the development of the semantic technologies and common vocabulary around which the institutional change in the financial industry revolves.

4.1 Strategic Leadership and the Enterprise Data Management Council

The Enterprise Data Management (EDM) Council was founded in 2005 by IBM, SunGard, and GoldenSource. The council was established to provide solutions to data-related problems in the financial industry. The Council is governed by a board of 24 members. The council currently presents its program of work in four categories; standards, industry best practices, industry relations and business networking. It structures on-going activities around six projects: FIBO Standard, Legal Entity ID, Data Management Maturity, Benchmarking, Data Quality and Regulation. Such programs resulted in its establishment as an industry leader in enterprise data management in the financial industry and beyond. In the following, we describe how the EDM Coun-

cil leveraged its strategic leadership position towards institutionalizing semantic technologies across the financial industry in general and the ongoing development and application of its semantics repository in particular.

From the outset, network cultivation operated to secure the participation and sponsorship of leading organizational actors in the field, Bank of America, Citigroup, Deutsche Bank, UBS. In 2006, the EDM Council conducted over 60 interviews with different field actors to read the "EDM pulse and define core priorities"; here, they identified the lack of enterprise-wide EDM and the dangers of short sighted project-oriented EDM. In 2007, the council published (diffused) a series of reports on EDM case studies (Mellon Financial, JPMorgan Chase, Daiwa Securities, SMBC Europe, HBOS, Barings Asset Management, M&G Investments, etc.) identifying major issues, success stories and current best practices. In April 2007, the council proceeded to frame the lessons learned in an EDM scoreboard. This scoreboard provides a common framework for evaluating the issues associated with EDM. It used the mechanisms of translation and bricolage to build on the framework presented by CitiGroup's Chief Data Officer to the Financial Information Management (FIMA) conference in 2007. Furthermore, continuing its efforts to establish EDM as a business priority, and itself in a strategic leadership position, the EDM Council diffused its findings through an important report on July 6th 2007 and subsequently briefed the Department of Defense on the benefits and challenges of EDM.

The EDM Council relied again on network cultivation to take leadership on a new topic: Entity Identification, which is recognized as a shared need by organisational actors. Capitalising on its strategic leadership, the council briefed, upon invitation, the US Securities & Exchange Commission (SEC) on the status of legal entity identification and data attribute tagging on January 18th 2008. Later on, the council acting as "global facilitator, neutral and trusted" brought together, using network cultivation, 22 financial industry members, 10 software vendors, regulators and standards bodies, such as the SEC, FSA, CESR, and BaFIN, to frame and diffuse Business Entity Identification as testified in the EDM Council February 2008 report to its members. Also in 2008, the EDM Council leveraged its strategic leadership position to diffuse novel concepts such as Business Semantics and the Web Ontology Language (OWL).

4.2 The Emergence of Semantic Technologies as a Solution to EDM Problems

The financial industry faces data integration problems that are unique in nature [2]. Business processes and transactions span multiple functions and sophisticated supply chains, with several trading entities and with data being exchanged in a range of formats and message protocols. Add to this a multiplicity of systems involved in risk and compliance management, general ledger and reporting and so on. The major problem here is that the same data is defined differently across systems, with divergent data models and database schemes—this is a classical 'vocabulary problem' (Furnas 1987). It was with this in mind that the EDM Council decided to commission a semantics model and repository for Security terms and definitions to help begin to address the aforementioned problems with multiple meanings of data stored in heterogeneous databases. This would then be extended into other areas. Thus, the EDM

Council recognized that the major problem facing the industry was not, necessarily, the huge volumes of data, but the different meanings attributed to the real world objects and data entities that represent them both within and across a multiplicity of organizational information systems. Hence, in order to begin to manage the mountains of data effectively, it was recognized that the first task would be to provide a common vocabulary for the industry globally—a semantic approach was therefore adopted in order to arrive at unambiguous concept and relationship definitions for all financial industry data. Bennett (2011, p. 440) reports that what was needed was "a resource in which there was one entry per meaningful concept, with a written definition that could be agreed by business domain experts, and any number of synonyms for that term. This would provide the needed common point of reference for message and database integration across the supply chain." To achieve this goal a pilot implementation was conducted to model terms used in trading and analysis of derivative-based mortgage and asset-backed securities. Here the EDM Council again leveraged it strategic leadership position and engaged in network cultivation to have IBM Research, the European Central Bank, US regulatory agencies, several financial institutions and risk analytics vendors participate in finding a solution—or at least a viable proof of concept (PoC). The goal of this initiative was to prove, from a regulatory perspective, the relevance of semantic technologies. This proof of concept was demonstrated (diffused) to several major financial institutions on Wall Street in September 2008, as the financial system unraveled due the very problems that the proof of concept was meant to solve.

This endogenous critical incident had the EDM Council advance the development of the Financial Industry Business Ontology (FIBO). This ontology is currently being proposed as an industry standard through the Object Management Group (OMG), one of the software industry's influential standards body. The OMG has been shaping the Software industry since 1989 with standards like the predominant Unified Modeling Language (UML) for creating, inter alia, visual models of object-oriented systems. The OMG task forces produce "enterprise integration standards" for different technologies used in several domains such as manufacturing, healthcare, government and finance. Between the EDM Council and the OMG, the nascent FIBO standard is being used to both frame the meaning of common financial concepts in a knowledge model (i.e. the common vocabulary) and diffuse this model as an OMG standard specification. The institutional actors which is playing a pivotal role in applying these mechanisms is the Financial Domain Task Force (FDTF), which is a sub-group of the OMG; FDTF members share the same desires and beliefs regarding the role and application of semantic technologies. The FDTF mission is to "promote the notion that Data and its Semantics are the DNA of financial services". It brings together industry practitioners (banking, securities, funds, compliance, etc.), technologists and academics to collaborate on a series of projects focusing on interoperability between financial information systems. The co-optation of the OMG provided the EDM Council with the opportunity to use, within the OMG-FDTF, a combination of framing, translation and bricolage mechanisms on technologies developed for the semantic web (RDF, RDFS, OWL2, Graphs, Common and Description Logic) and on OMG legacy standard specifications such as the Unified Modeling Language (UML), and on more recent ones

such as the Semantics of Business Vocabulary and Business Rules (SBVR, OMG's Business Natural Language specification), to develop semantic repositories and a family of ontologies. In this context, the OMG is also using co-optation mechanisms to have semantic modeling experts from a range of other disciplines and industry sectors to participate in this venture. Members of other OMG Task Forces (TF), Special Interest Groups (SIG) and Working Groups (WG) were invited to the FDTF. The latter partnered with 8 different OMG sub-groups such as the Ontology SIG, Business Modeling and Integration TF (managing SBVR) and the Regulatory Compliance SIG. Members of those sub-groups are active on a set of projects and use cases framing the need for a "common vocabulary" like FIBO and translating its implementation possibilities. The FDTF also partnered with several non-OMG groups to leverage domain expertise (CFTC, OFR, BIAN), co-opt legacy industry standards (ISO, FIX, XBRL), ensure future co-optation of FIBO, and expand its diffusion network. The joint, OMG-Data Transparency Coalition (DTC), SMART Regulation initiative clearly illustrates how this co-optation benefits from network cultivation, framing, translation and diffusion to promote data standards and semantic technologies. Figure 2 helps illustrate the role of mechanisms in shaping institutional structures and processes—that is in bringing about the FTDF and the adoption and diffusion of UML and SBVR standards in the expression of the common vocabulary.

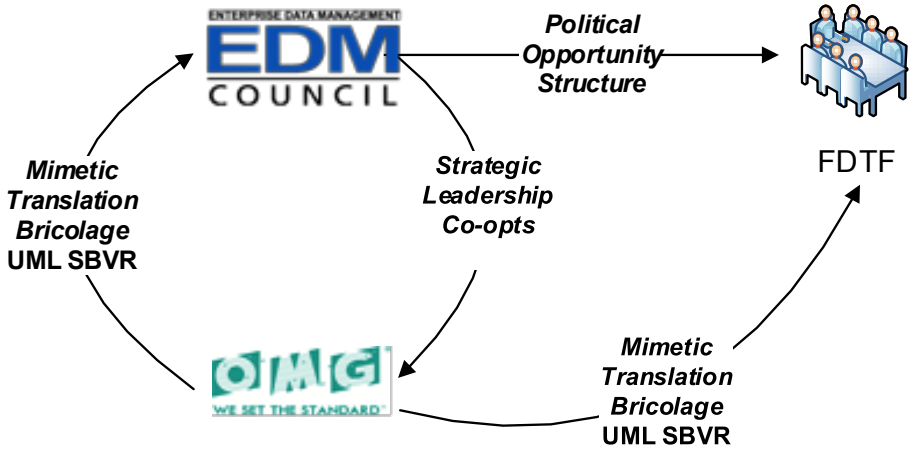

Fig. 2. An Example of the role of mechanisms in shaping institutional structure and process

4.3 The EDM Council and Political Opportunity Structure Mechanisms

In order to further its aims, the EDM Council is actively engaging in creating political opportunity structure mechanisms with US regulators to legitimize [7] the use of semantic technologies in the financial industry. Take, for example the evidence provided to the US SEC and the Commodity Futures Trading Commission by Michael Atkin, Managing Director, of the EDM Council, in 2010. The SEC/CFTC study "explores whether the collection, reporting, and management of risk exposures can be

aided by the computer-readable descriptions - a common dictionary with standardized, electronic "spelling" for each aspect of a derivative." The aim of the SEC here is to enhance greater understanding of risk by both regulatory and financial industry actors. We reproduce part of the introductory statement by the EDM Council, which indicates the power of semantic technologies for GRC–related data management in the financial industry:

"To summarize, complete, accurate and consistent data is relevant at three distinct levels: facts about contracts, facts about positions and holdings within a financial institution, and facts about the wider system. Tagging each of these kinds of terms semantically with reference to contract, party, market events and the mathematics of cash flow would ensure accuracy and consistency across different data sources and different reporting mechanisms."

Hence, in collaborating with the SEC and Commodity Futures Trading Commission, the EDM Council is shaping future political opportunity structure mechanisms by framing the solution to the problem in semantic terms to legitimize its position on the use of semantic technologies in the sector. Its submission proved influential, as the report cited in the above footnote indicates. Other initiatives aimed at creating or influencing political opportunity structure mechanisms are that the Managing Director of the EDM Council (along with several member organizations of the council) sits on the Office of Financial Research's (OFR) Financial Research Advisory Committee. He is also the Chair of the FRAC Data and Technology Subcommittee, a member of the Financial Stability Board's LEI Private Sector Participatory Group; a member of the financial industry's LEI Steering Committee within GFMA, a member of the CFTC's Data Standardization Subcommittee; sits on the Board of Advisors for the Data Transparency Coalition, and is a member of both ISO TC68/SC4 and ANSI/X9D. This is also evidence of the use it is making of network cultivation and diffusion mechanisms at various levels and to a variety of audiences.

4.4 A Critical Incident in the Institutionalization of Semantic Technologies for the Financial Industry

The stated objective of the Demystifying Financial Services Semantics Conference was to help conference participants "better understand the role of semantics in meeting both business processing and regulatory oversight objectives". This conference was convened by the Enterprise Data Management Council (EDM Council) and the Object Management Group (OMG), with the OMG being responsible for the conference organization (i.e. the two embedded units of analysis). In setting the stage, the OMG pointed out the financial industry is characterized by organizations who use "common business terms that have different meanings, common meanings that use different terms and vague definitions that don't capture critical nuances." In an organizational field where transactional data is captured in real-time by complex processes/workflows and stored in and across heterogeneous systems in different formats, where governance policies, risk management and compliance reporting on business processes and transaction outcomes is becoming increasingly difficult in the face of ever increasing and more complex and onerous regulations, then the "precision of

data matters." This introduces a huge issue for data management, integration, and analytics, to say nothing of risk assessment and analysis. The purpose of this conference was to highlight the business value and role of semantics and semantic technologies for the financial industry. Semantic technologies in the financial industry will be used to capture business and regulatory terms, their definitions and meanings, the relationships that exist between them, and business and other rules that govern their application, and the contexts in which they are applied. The conference's importance in bringing institutional change to the financial industry cannot be understated, as will be now explained.

It is clear from our analysis that the objective of the EDM Council and the OMG in jointly convening and hosting this conference was to widen and deepen the interest in the adoption and implementation of semantic technologies, specifically the Financial Industry Business Ontology (FIBO) across the organizational field to solve the regulatory and data management problems described herein. The structure of this one day event, which was attended by several hundred members of the financial industry, US regulators, and IT vendor organizations, focused on panel discussions of several general themes: The business case for data semantics in financial services, the need for a business natural language (BNL) for financial services (based on the OMG's Semantics of Business Vocabulary and Business Rules, SBVR standard), regulatory reporting using XBRL, and the implications of semantic models for the challenges posed by big data. The conference included two formal presentations on FIBO, the first was a brief overview of this family of ontologies, the second focused on the operational application of FIBO using a proof of concept on over the counter (OTC) derivatives. This was followed by a panel that shared perspectives on semantic metadata provided by FIBO, a critical view of the capabilities of such semantic technologies, and the future application of FIBO. Primary actors from across the organizational field participated in the remaining panels and in the debates that ensued on the topics discussed.

As indicated earlier, DBO theory posits that desires, beliefs and opportunities for action are three fundamental atomic mechanisms that shape individual action. Actors employ molecular, meso-, or macro-level mechanisms to alter the desires and beliefs of others [13]. Viewed from this paper's conceptual framework, actors on the conference stage employed a combination of strategic leadership, framing, network cultivation and diffusion mechanisms to alter the desires and beliefs of, and present opportunities for action to, attendees from the financial industry. The panels and breakout networking are clearly general network cultivation and diffusion mechanisms; however, in framing the central issues, Mike Atkin, managing Director of the EDM Council stated:

"First, it's about the development of a common vocabulary so we can deal with the requirements for the precision of contracts that drive all of our activities. It is also a common vocabulary that is required for us to do analytics in a complex and interconnected industry. The second thing is about combining the precision of that language with business tools, straightforward definitions of how things work together and the power of computers to do inferences and to do analysis and to make connections."

The other members of the panel repeatedly used the phrase 'common vocabulary'. In order to help diffuse this message, Atkin stated that the conference was going to employ 'Use Cases' that illustrated the power of semantics good and that illustrated "the challenges of adopting these things into real environments and what we have to do to overcome them." After a short introduction, he then put a question to John Bottega, Chief Data Officer, Bank of America. The mechanism of strategic leadership operates at several levels; at the macro-level the EDM Council is, as indicated, leading the field in endeavoring to solve enduring problems using semantic technologies; at a micro-level, individuals such as John Bottega in his capacity as Chief Data Officer are changing the beliefs and desires of organizational actors, while also providing them with opportunities for action. In explaining his position Bottega stated the "Chief Data Officer is still relatively new, its position in a firm is being recognized now as important, more from the perspective – and this is probably more linked to the meaning of Data linked to technology – the Chief Data Officer does not replace the Chief Technology Officer, or the CIO." He went on to explain that Bank of America's:

"focus is on concepts and meaning [in solving] one of the key business problems we face every day; In large institutions in Finance, multiple areas of a Bank or Financial Institution will perform transactions and activities with common data. That data, although it may start out in 5, 6, 10, 12 different areas funnels its way into the bank's core control function where we have to look at risk, we have to look at regulatory requirements and reporting…there is an opportunity now to start bringing meaning to that data, minimize those transformations, minimize the cost of doing that aggregation and actually get a result in analytics that makes sense".

Eric Chacon, Global Head of Business Data Management at CitiGroup, New York echoed and elaborated on the points made by Bank of America's CDO. Again the theme of a need for a common vocabulary emerged. He stated that the most challenging problem is "how do we get everyone to speak a common vocabulary?" In order to put the common vocabulary issue into contact, the panel pointed out that the financial industry funds and finances the economy and creates and trades complex financial instruments. Chacon stated that "the challenge has always been that business experts have to translate what is in their head's to a technologist to substantiate that into a system, and that has not traditionally worked that well. There is the lost in translation type of activity that goes on, and what often happens is that the business people are so involved working with a client and making the trade, that that responsibility gets delegated to the technologists, now there is another layer of lost in translation as the technologists try to do this." According to Chacon the problems arise because there is no common vocabulary. Both he and the Bank of America CDO argued that semantics can provide "a language that both parties speak." Of course agreeing on what that common vocabulary is needs to be resolved—that, he indicated, was the purpose of the conference. Referring to CitiGroup, he stated that:

"We have to come to agreement within the firm on what do we mean by terms like 'contract', 'transaction', 'customer', 'product'. Those foundational terms and everything underneath them are used ubiquitously but they are used in different ways by different silos. We have conservatively speaking, hundreds of silos within Citigroup.

We have silos around product lines, silos within markets and countries, we have arbitrary management, barriers; we also have regulatory imposed barriers. "

CitiGroup's solution was to develop a set of semantically defined, data standards that Chacon stated was "essentially an ontology, although we don't usually describe it with that term." CitiGroup are using a data dictionary and an underlying model that defines the business language, naturally, formally and completely. As with Bank of America, CitiGroup are not doing "a massive integration or a large scale gate linkage or data analysis; that would be overwhelming…we're starting in small areas, we're building." In this scheme of things, we subsequently learned through engagement with CitiGroup, that its Chief Data Officer was promoting SBVR as a platform for the emergent common vocabulary that would help bridge the 'silos' mentioned above.

Joseph Bugajski, Managing SVP at Gartner Inc., and former VISA's Chief Data Officer, broadened the debate and highlighted the need for such a common vocabulary across the organizational field to help solve the problems of the "perfect spaghetti pot" of data that had been created by the growth of heterogeneous data silos within and across financial services organizations. He pointed out that "every single financial institution maintains bilateral agreements with almost every other major financial institution and with many, many minor financial institutions; and inside Financial Institutions, each one of which can have its own set of goals on how those relationships are maintained etc." Building on observations by Mike Atkins and John Bottega that retail and investment banks face huge 'reconciliation' problems with internal data, the transactions that take place between banks and other financial institutions require additional data reconciliation, Bugajski estimated that over "40% of total costs that goes into maintaining interfaces between systems and between companies" could be reduced by half. He opined that "that's just the beginning, better communications means better information therefore for our clients. It means better information for use in investment; it means better information for use in risk management. So all along the way we see improvements, so the rising tide that rises all ships in this case are the ontologies".

In order to look at other areas of the organizational field that might benefit, Mike Atkins asked Con Crowley Director of Standards, Office of Financial Research at the US Treasury for his thoughts on how a common vocabulary could help regulators manage better systemic risk. The Director of Standards stated that "the same silos that you're dealing with internally, regulators are dealing with on an industry-wide basis. So the ability to aggregate that information, to be able to improve the quality, the ability to compare the data, will get you better systemic analysis. The review of systemic risk across the industry is critically dependent on the quality of data that is received and the ability to view it in a common vocabulary so you can compare that data." CitiGroup's Global Head of Business Data Management pointed out that this work had already commenced, specifically with complex instruments such as derivatives and swaps: "Right now reporting our swaps and derivatives trades, there are a lot of attributes that describe those instruments that we've had trouble defining the meaning of. Semantics is going to give us an opportunity to bring technology and business to the table and agree upon those terms and again reduce that lost in translation and transformation that governs regulators." Thus, the role that was socially constructed

(framing) for semantic technologies is not limited to data management, but ultimately one of managing systemic risk in order to avoid future financial crises.

To further reinforce their message the EDM Council had scheduled two presentations from vendors of semantic technologies; however, the most influential use case of the application of common vocabulary- based semantic technologies was that provided by Dennis Wisnosky, then Chief Technology Officer and Chief Architect, Business Mission Area, U.S. Department of Defense.

The U.S. Department of Defense had significant problems implementing its Defense Integrated Military Human Resources System (DIMHRS) to get its personnel data in order by consolidating personnel records. The failed DIMHRS platform cost the U.S. taxpayer $850 million. Dennis Wisnosky disclosed how the Department of Defense leveraged semantic technologies such as RDF, OWL, and SPARQL with Business Process Model and Notation (BPMN) to deliver an enterprise-wide HR system for the DoD based on its Business Enterprise Architecture (BEA). Using a semantic approach, the DoD was able to solve legacy HR data integration and problems. Now the DoD employs a 'Model-Data-Implement' semantic technology pattern to design and deploy the semantic version of its HR system in up to 90 days. Prior to this it had taken over 11 years to develop the monolithic HR system at the aforementioned cost of $850 million. He demonstrated the capabilities of the system which could now perform complex ad-hoc queries using the reasoning power of ontologies. For example, Mr. Wisnosky stated that "after the earthquake in Haiti, we wanted to find out how many service members there were who spoke Creole or Haitian French, who could be deployed in 24 hours and had at least 12 months' service time remaining." These examples and others like them impressed the delegates at the conference, as the follow up questions illustrated. There was evidence across attendees that their DBO about the relevance of semantic technologies was reinforced by this use case. It also impressed the EDM Council.

In a statement released on February 14th 2013, the EDM Council announced that it had appointed "Dennis E. Wisnosky to lead the standards implementation process for the Council's Financial Industry Business Ontology (FIBO) suite of standards. In this role, Wisnosky will provide technical strategy and operational guidance to help the Council finalize and implement FIBO standards. Wisnosky brings extensive experience with enterprise architecture, ontology development and semantic deployment and is poised to help the Council address the political and technical realities associated with the FIBO standard." In commenting on his new role, Wisnosky argued that for data management purposes, records of securities share many similarities with military personnel records. Semantic technologies could determine with great accuracy relevant parties of interest in a particular transaction, right back to the entity that first issued a loan that forms one asset in a mortgage-based security.

In terms of this study's theoretical perspective, the strategic leadership provided by the US government, and the innovations they made in implementing semantic solutions—through a combination of translation and bricolage of W3C and OMG standards and the DoD's BEA—are being used by the EDM Council to influence the DBO of council members and others across the organizational field. The object of diffusing these concepts is stimulating mimetic responses across the financial industry.

4.5 The What and How of the Financial Industry Business Ontology

Up until now, we have explained why and how semantic technologies are being institutionalized across the financial industry. We now explain briefly what it is that this industry desires and believes in respect of the proposed common vocabulary and its expression using semantic repositories and related modeling techniques. The Financial Industry Business Ontology (FIBO) aims to "bridge the language gap between business and technology". It captures business meanings (rather than a being a mere data dictionary or a taxonomy) in business language for business people. It also provides definitions and explanations with no technical representations or new languages to learn (EDM Council, Head of Semantics, Mike Bennett). The main components of FIBO are: (i) a Business Conceptual Ontology, (ii) a web-accessible business presentation layer, (iii) a set of operational ontologies, and (iv) the FIBO Object Management Group Specifications. The FIBO Business Conceptual Ontology (FIBO-BCO) is a family of ontologies that describe the major concepts (Things) relevant to financial services and what type of conceptual abstractions they derive from (i.e. facts about those Things). It describes common definitions and illustrates how they relate to each other. FIBO-BCO revolves around two main elements: (i) Financial and Entity concepts and (ii) a Basic Business Ontology. The Financial and Entity concepts are grounded in commitments, obligations, transactions, legal contracts etc. The Basic Business Ontology captures the "most primitive of each concept abstracted and maintained in a formal semantic structure". The EDM Council aims to align its Basic Business Ontology with formal industry-led semantics where available. FIBO covers the following subject areas: (1) FIBO-Foundations (Global Terms and modelling framework); (2) Business Entities; (3) Tradable Securities; (4) Derivatives; (5) Loans; (6) Pricing/Market Data; (7) Corporate Events and Actions and (8) Payments.

The web-accessible business presentation layer is the EDM Council Semantics Repository. It presents FIBO-BCO, alongside its RDF/OWL representation, in a business readable format that avoids technical representations or the need to learn new languages. The EDM Council uses (i) "boxes and lines" in OMG UML-like diagrams to present the modelled business concepts and their relationships, and (ii) tabular spreadsheets to capture the definitions in natural language. The focus on accessibility for business people remains a major concern for the EDM Council, who tries to avoid technical representations or the need to learn new languages. Following the same rationale, the council recently expressed its intention to leverage OMG's Business Natural Language specification Semantic of Business Vocabulary and Rules (SBVR) to present FIBO's knowledge model in the form of a business vocabulary.

Several operational ontologies could be derived from FIBO-BCO. An operational ontology is often a subset of the BCO. It is oriented towards solving a given business problem or task. Technically, a FIBO Operational Ontology is described in a machine readable language thus rendering automatic algorithmic reasoning (inferencing in particular) possible. It contains concepts and their attributes, relationships between concepts and axioms governing business activities related to those concepts. A team headed by David Newman - Strategic Planning Manager, Vice President Enterprise Architecture, Wells Fargo Bank is building an operational ontology for Business Enti-

ties, with a use case of LEI (Legal Entity Identifier) data processing. This project falls under Operational FIBO for OTC Derivatives Proof of Concept (PoC). The PoC's main objective is to demonstrate to the financial industry and the regulatory community how FIBO can help achieve data standardization, integration, linkage and automatic classification in securities firms and investment banks.

In regard to the how of constructing a common vocabulary, Subject Matter Experts (SMEs) play a central role in building FIBO. The financial services professionals and software engineers from the members of the EDM Council and the OMG insure that FIBO-BCO sections "represent a full and factual view of the world as seen by the business". When the EDM Council drafts a section of FIBO, it is presented to SMEs for validation. The purpose of this validation is to ensure that the modelled section is "True" so that it captures the business reality. The review process can take two forms: (1) individual reviews, where an SME reviews offline a section of FIBO and reverts to the EDM Council with comments and suggested changes or (2) group teleconferences, where a community of SMEs joins a weekly teleconference by the EDM Council on which a section of FIBO is deeply discussed. The authors and this paper and their co-researchers are participating in these activities, as indicated, to contribute to the development of two family members to the FIBO ontology. It is through this iterative process that the EDM Council, its members, and other stakeholders are socially constructing a common vocabulary for the financial industry.

5 Conclusions

This paper offers an explanation of the why and how the financial industry is rethinking the design and integration of financial information systems, to say nothing of the way it views data. The CIOs, CTOs and CDOs in industry now realize that data is all about meaning, and, accordingly, that they need a common vocabulary to describe that meaning—to humans and to machines. This is a field level phenomenon which involves the institutionalization of new micro-level desires, beliefs and opportunities for action (DBO) [13] among financial services and IT professionals through the application of meso- and macro-level mechanisms. These DBO relate to the need for a common vocabulary and the use of semantic technologies to manage financial and GRC data across multiple silos in, across, and between organizations and on to government departments and regulators.

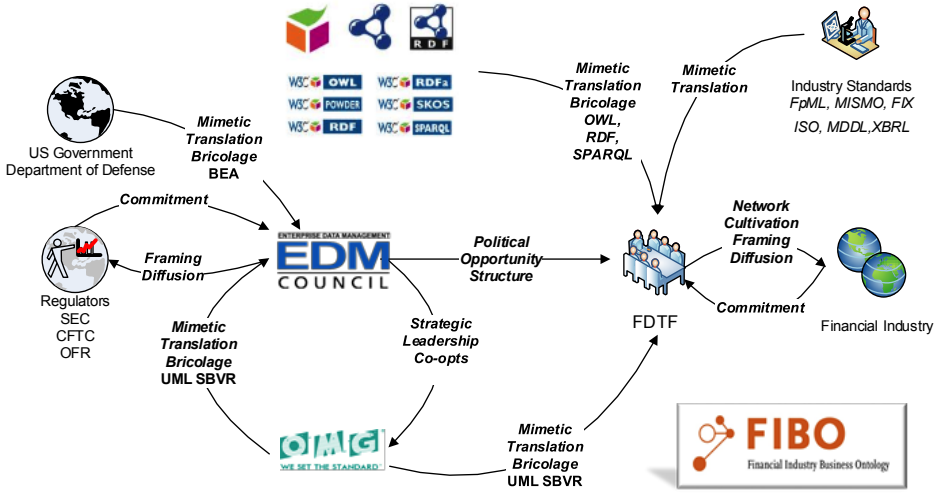

Fig. 3. Institutional Actors, Mechanisms and the Institutionalization of FIBO

We have adduced the benefits of such vocabulary-based technologies and provided an example of one—the Financial Industry Business Ontology (FIBO)—which is about to become an industry standard. As indicated, FIBO is being developed incrementally by subject matter experts from across the financial industry under the sponsorship of the Enterprise Data Management (EDM) Council and with the assistance of the industry standards body the Object Management Group (OMG) and its Financial Domain Task Force (FDTF). Figure 3 builds on Figure 2, and the forgoing empirical findings, to illustrate how mechanisms are shaping the development and institutionalization of FIBO.

The powerful and influential EDM Council, which is not widely known outside of this organizational field, has, over the past 8 years, used a combination of macro- and meso-level mechanisms to achieve its objectives in relation to enterprise data management. This paper extends the conventional conception of coercive, normative, and mimetic mechanisms previously used to explain IS-related phenomena, with meso-level mechanisms (i.e. political opportunity structure, strategic leadership, network cultivation, framing, diffusion, translation, and bricolage mechanisms) used to explain field-level phenomena such as the institutionalization of semantic technologies. The paper also bridges these situational mechanisms to micro-level DBO mechanisms, which are used to inform action (action-formation mechanisms) and transform (transformational mechanisms) social and institutional contexts [13]. It is outside the scope and length of this paper to explain the latter in detail; however, we have observed translation and bricolage mechanisms in operation as social actors adopted semantic web technologies such as OWL, and adapted design standards such as UML and SBVR, to create the aforementioned common vocabulary, which is represented in FIBO (see Figure 3). We have also observed senior financial services executives commit, because of changes to their desires and beliefs due to the EDM Council's

framing and diffusion mechanisms, to the use of semantic technologies to manage risk and compliance for securities trading in one US-based Fortune 100 organization.

We argue that the EDM Council and the OMG have achieved the semi-institutionalization [21] of sematic technologies in the organizational field of the financial industry. Thought leaders in this industry expect that the adoption of standards such as FIBO will bring profound changes to the design and development of IS, as traditional data management approaches give way to semantic modelling, and radical innovation around semantic technologies leads to a new generation of semantically-enabled IS. Such radical innovations will permit organizations across the industry to bring added value to, and enhance the delivery of, financial services. On the other hand, regulators such as the SEC argue that the institutionalization of a common vocabulary and related semantic technologies will permit them to better assess systemic risks across the financial industry and to detect a potential financial crisis in the early stages, thereby avoiding catastrophes like the global economic meltdown that occurred in 2008.

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