Configuring Value Networks based on Subjective Business Values

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Abstract. Monetary profitability is an objective value essential to the sustainability of a value network. The analysis of this requirement continues to receive substantial attention by the e^3value research community thus far. However, subjective values such as privacy, security and trust might also play a key role on the configuration of a value network, especially when it is necessary to differentiate equivalent monetary value propositions. This paper describes an ontological proposition for configuring value networks based on subjective values. The ontology is aimed to be used as complement of the e^3value framework, blending concepts of Multiple Agency Theory, Enterprise Ontology, Value Modeling and Speech Acts Theory. We demonstrate our approach on a case scenario based on the Directive 2009/72/EC, which defines common rules for the liberalization of the European market of energy.

Keywords: Ontology, Subjective Values, Value Networks

1 Introduction

A value network has been initially referred to as a group of enterprises exchanging objects of economic value to satisfy the needs of a market of consumers [13]. Aiming to define formally how business actors could collaborate within a value network, Gordijn and Akkermans proposed the e^3value framework to support the modeling and profitability analysis of value networks. The fundamental principle grounding the e^3value ontology seems to be the one of "economic reciprocity", which governs how business actors sacrifice objects of economic value to obtain other ones (of equivalent value) in return. There, the difference between sacrifice and benefit is measured, as objectively as possible, as monetary profit. It is reasonable that reaching goals stated for this objective value is necessary to the economic sustainability of a value network, but not sufficient for a consumer to declare that his business need(s) will be fully satisfied with such a measure of value [2, 18]. For this case, subjective values such as assurance, privacy and trust might come into play for a consumer not only to differentiate between equivalent

monetary value propositions, but also acquire products and services the valuation of which would depend on previous experience, such as products bought online or innovative services (e.g. smart metering and medical nanotechnology).

Adopting a Design Science perspective on research [19], the research question addressed in this paper is *how a value network could be configured based on subjective values*. From an organizational perspective [6], this question is initially threefold: *What subjective values could be considered as important or even essential for consumers in a value network? How to measure these subjective values? How these values might be related to the satisfaction of a certain consumers' business need?*

To start addressing these questions from an Information Systems perspective, we propose an ontology for configuration of value networks based on subjective values. The ontology was formalized in Web Ontology Language (OWL-DL), supplemented by a set of rules defined in Semantic Web Rule Language (SWRL) [11], and blends concepts of the e^3value ontology [10], Enterprise Ontology [7], Speech Acts [15] and Value Monitoring Ontology [3].

The rest of this paper is organized as follows. In **Section 2**, we describe a case scenario that motivated our conceptual analysis of the role of subjective values on the configuration of value networks. In **Section 3**, we describe an ontology for modeling and analysis of what can be named thus far as qualitative value networks. In **Section 4**, we return to the motivating scenario to demonstrate the modeling utility of the ontology on a case scenario depicted as a value network of Smart Metering services. In **Section 5**, we provide theoretical conclusions, threats to validity and future steps of this research.

2 Observational Case Study

The case scenario presented in this section is a projection on future markets of liberalized Energy services in Europe, normalized by the Directive 2009/72/EC of the European Union [17], and described in earlier research by Silva et al. [2]. In this scenario, householders will have the option to choose not only among energy providers, but also smart metering companies that suit their needs the best. As depicted in **Fig. 1**, the case scenario was shaped as an e^3value model. The final consumer playing the Agency role of a principal is a householder represented by a market segment of Balance Responsible Parties (BRP). EU reports have revealed that one of the main issues on the adoption of smart metering solutions by the European population concerns privacy, that is, energy consumption information might be explored opportunistically [1]. Hence, householders might consider peer assessment and evaluation of the privacy provided by such an innovative service before entering into an agreement with a metering operator. This is therefore a special business case where it is not only the monetary price of the technology that matters, but also the intangible value to be experienced by the final consumer.

A BRP is motivated by the opportunity of balancing energy consumption, or even selling unused energy through demand-response of the smart meters. Thus, a BRP has the option to create value from smart metering assets provided as core business objects by a market segment of Metering Operators. A householder

might obtain metering accounting or auditing reports from three value paths. In the first option, the householder could possess a metering asset provided by a Metering Operator, once granted with a Metering Responsible Party (MRP) accreditation by the Transmission System Operator (TSO). In exchange, the householder allows the TSO to have access to private verifiable information of energy consumption through an Open (virtual) Monitoring Channel. This is necessary for monitoring and control of the overall state of imbalance reduction of the network by the TSO. In the second option, the householder could delegate the energy metering activity to the peers from which the energy is bought, e.g. aggregators or Distributed Energy Resources (e.g. wind turbine owners), both allowed by law to operate with MRP accreditations. The analysis of qualitative values relevant for the assessment of these options is demonstrated in **Section 4**.

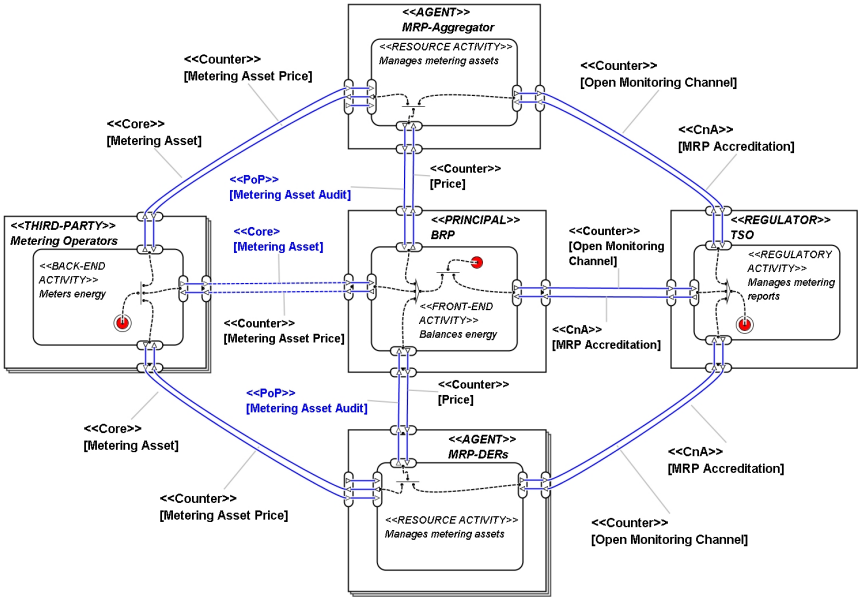

Fig. 1. Case scenario of a smart metering value network extracted from Silva et al. [2]

3 Semantic Value Network Ontology

The ontology was formalized in OWL and complemented with SWRL rules to allow semi-automatic configuration of qualitative value networks. However, the scope of this paper is limited to the demonstration of the relevance of subjective values on the configuration of a value network.

A business need is owned by a principal consumer (actor or market segment) and is the starting point of configuration of a qualitative value network. A policy may assume five organizational arrangements (or patterns) that represent

different configurations whereby a business need could be satisfied. The conceptual foundation of these patterns is described in detail by Silva et al. [2] and formalized in OWL in the ontology depicted parsimoniously in **Fig. 2**. Following the organization of the value network model, the value indicators allow for analysis of the subjective values assigned to products and services offered as value propositions to the final consumer. The value indicators not only qualify the economic effectiveness of a value proposition meeting a business need, but also the economic efficiency of a policy arrangement. Yet, value indicators do not replace the profitability analysis supported by the e^3value framework, but adds an extra layer of information to refine the selection of value propositions by the consumer.

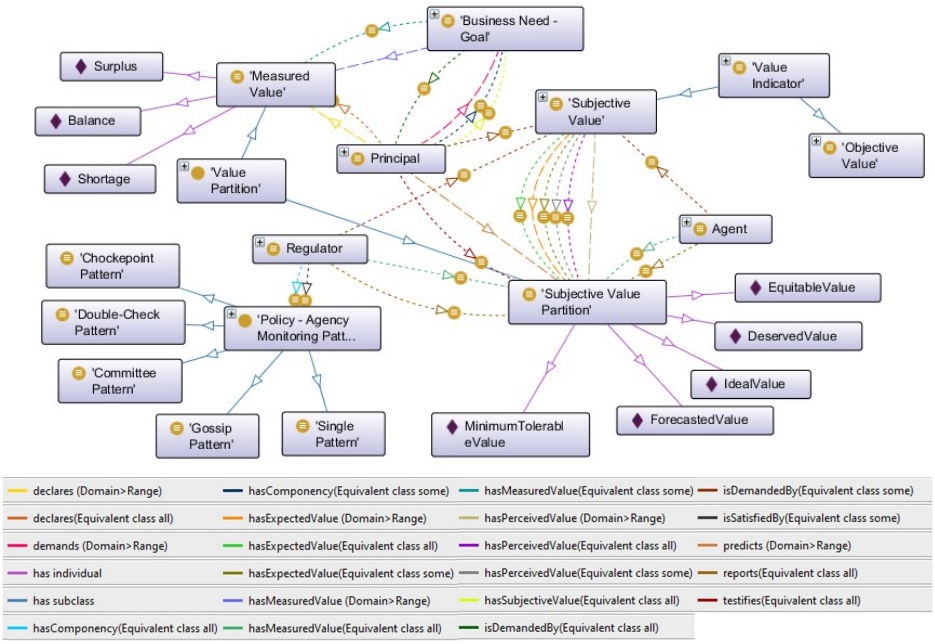

Fig. 2. SVNO full viewpoint

3.1 Business need

In e^3value, the notion of a business need is reified as a value object desired by the consumer. Here, this notion is extended by separating the identity of a core business object (i.e. a product or service category) from its value, which can be *objective* (e.g. quantity, quality, time and location) or *subjective* (e.g. privacy, reliability or trust). In e^3value, a core business object meets a consumer's need when its investment is lower than its sacrifice, which is measured by quantifying the monetary resources paid in exchange for the core product or service provided by the network.

From our best knowledge, objective values such as *quality*, *time* and *location* are not taken into consideration in an e^3value profitability analysis. Despite the importance of these values, we take the e^3value *quantitative* approach as sufficient for objective valuation of core business objects and move our discussion into the role of subjective values on classifying value propositions of equivalent objective values. Accordingly, a business need is demanded by a consumer acting as an Agency *principal* of the network, and is satisfied not only by a core business value object, but also by the value indicator assigned to this object. There are two subclasses of value indicator: objective value and subjective value. Different from objective values, subjective values are perceptual, and the assessment of which involves at least two Agency parties and depends on individual experience. The difference between the perception of two Agency parties on the same value assigned to a value object is a *measured value*, which has three value partitions: *value surplus*, *value balance* and *value shortage* [16]. The logic underpinning subjective value measurement is detailed further in this section. Moreover, the principal has also a *business rationale*, e.g. a *business weakness*, *threat* or *opportunity* (the only rationale treated in this paper). A business need is represented as a defined class in the ontology, as depicted in **Fig. 3**.

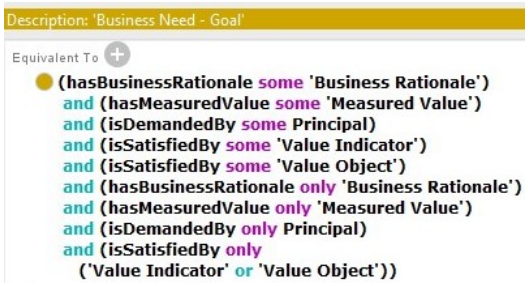

Fig. 3. Description logic representation of the class *business need*

3.2 Policy

A policy is defined here as an organizational *pattern* of actors, activities and objects connected by speech acts and inspired by the NIST metamodel of Role-Based Access Control (RBAC) [8]. Preventive monitoring is intrinsic to Multiple Agency, and the ontology formalizes five Agency monitoring patterns for value networks, described in detail in Silva et al. [2]. The patterns are named as *single*, *double-check*, *chokepoint*, *committee* and *gossip*, and comprise different strategies whereby the principal might evaluate products and services offered by the network. The pattern described in detail here is the committee pattern, due to its completeness on covering the case scenario. The ontology defines four actor roles (i.e. principal, third-party, regulator and agent), four value activity roles (i.e. front-end, back-end, resource and regulatory) and four value object roles (i.e. core business, proof-of-performance, certification or accreditation and counter-object). Actor roles are connected to activity roles by relationships of *authority*,

competence and *responsibility*, inspired by the Enterprise Ontology [7]. Activities roles are connected to object roles by speech acts, (some of them adapted by Enterprise Ontology as production acts) such as *produce*, *consume*, *grant*, *transfer*, *bundle* and *distribute*. The formalization of the committee pattern is depicted in **Fig. 4**.

Fig. 4. Description logic definition of the *committee monitoring pattern*

3.3 Value indicators

Subjective values are normally used by consumers when evaluating a product or service before acquisition. Without experience on the use of the product or service, it is also common that consumers consider other peers' evaluation on subjective values of the desired commodity. Such a practice is not recent, and therefore should not be exclusively associated with the current trend of e-Commerce solutions. However, subjective values are shaped not only by individual and private productive acts of experience, but also by social communication, which is closely related to the reputation of a commodity and its respective provider. From a Speech Acts perspective, it is possible to argue that subjective values might assume different roles, depending on who is making a (subjective) value proposition to whom.

Taking this perspective into a value network organized with Multiple Agency roles, the final consumer acting as a principal receives value propositions of core business objects produced by back-end activities of competence of third-parties, and transformed (i.e. bundled, distributed, granted or transferred) into value-added commodities by agents and regulatory parties. Considering that suppliers acting as third-parties are prone to communicate biased evaluations on their own products or services, it is assumed here that their evaluation on corresponding products or services shall not be fully taken into consideration by a rational consumer. Thence, the social construction of a business value in this case will involve the consumer acting as a principal, agents and regulators.

For the principal, what is relevant is the expectation of value to be created using the product or service produced by third-parties. In this sense, the principal initially *predicts* his *expected value* for the commodity to be acquired. Nonetheless, for the agent and regulators, whose evaluation will be considered by the

principal on acquiring the commodity, and who somehow experienced or sensed the value of the commodity, the subjective value will have the role of *perceived value*. While a regulator *testifies* his perceived value of the commodity by verification or witnessing, an agent *reports* own perception on the same commodity through business transformation. The description logics definition for subjective value and corresponding value scales (or partitions) are depicted in **Fig. 5-a** and **Fig. 5-b**, respectively. The SWRL rules for assignment of expected and perceived values are summarized in **Table 1**.

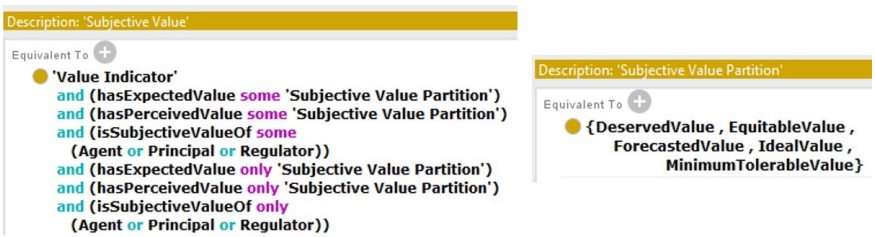

Fig. 5. a) Description logic definition of subjective value; **b)** subjective value partition

Table 1. SWRL rules for assignment of expected value and perceived value

Agency-role value viewpoint	**SWRL rule for value assignment**

Value expected by the principal	`svn:Principal(?p)^svn:hasSubjectiveValue(?p,?s)^`
	`svn:SubjectiveValue(?s)^svn:predicts(?p,?svp)^`
	`svn:SubjectiveValuePartition(?svp)`
	`→ svn:hasExpectedValue(?s,?svp)`

Value perceived by the agent	`svn:Agent(?p)^svn:hasSubjectiveValue(?p,?s)^`
	`svn:SubjectiveValue(?s)^`
	`svn:testifies/reports(?p,?svp)^`
	`svn:SubjectiveValuePartition(?svp)`
	`→ svn:hasPerceivedValue(?s, ?svp)`

Value perceived by the Regulator	`svn:Regulator(?p)^svn:hasSubjectiveValue(?p,?s) ^`
	`svn:SubjectiveValue(?s)^`
	`svn:testifies/reports(?p, ?svp)^`
	`svn:SubjectiveValuePartition(?svp)`
	`→ svn:hasPerceivedValue(?s, ?svp)`

Subjective value is a class defined as an enumerated set of partitions adapted from the SERVQUAL model to express measures for expected value or perceived

value, as depicted in **Fig. 5-b**. Accordingly, the value partitions comprise: ideal value, forecasted value, equitable value, deserved value and minimum tolerable value [14]. The difference between expected value (*predicted by* the principal) and perceived value (*testified by* at least one regulator and *reported by* at least one agent) is assessed qualitatively as measured value. The logic underpinning the qualitative assessment is formalized in SWRL rules summarized in **Table 2**.

Table 2. SWRL rules for assignment of measured value

Partition of measured value	**SWRL rule for measured value assignment**
Value surplus	svn:Principal(?p)^svn:demands(?p, ?bn)^ svn:BusinessNeed(?bn)^ svn:hasSubjectiveValue(?p, ?sv)^ svn:hasExpectedValue(?sv, svn:EquitableValue)^ svn:hasPerceivedValue(?sv, svn:IdealValue) → svn:hasMeasuredValue(?bn, svn:Surplus)
Value balance	svn:Principal(?p)^svn:demands(?p, ?bn)^ svn:BusinessNeed(?bn)^ svn:hasSubjectiveValue(?p, ?sv)^ svn:hasExpectedValue(?sv, svn:EquitableValue)^ svn:hasPerceivedValue(?sv, svn:EquitableValue) → svn:hasMeasuredValue(?bn, svn:balance)
Value shortage	svn:Principal(?p)^svn:demands(?p, ?bn)^ svn:BusinessNeed(?bn)^ svn:hasSubjectiveValue(?p, ?sv)^ svn:hasExpectedValue(?sv, svn:EquitableValue)^ svn:hasPerceivedValue(?sv, svn:DeservedValue) → svn:hasMeasuredValue(?bn, svn:shortage)

4 Demonstration: A Case Scenario in Smart Metering

We now return to the case scenario introduced in **Section 2**. The problem of this case is how a householder could analyze value propositions of smart metering services based on qualitative values that this technology might return. Earlier research conducted by the European Commission has uncovered privacy as a key value expected by the European population to be offered by smart metering operators. As smart metering assets are becoming more intelligent and innovative, the acceptance of this technology by European householders shall depend, among many other factors not covered in this paper, on progressive peer evaluation of subjective values such as privacy to be created using this technology. This evaluation can be supported by e-Government channels providing transparent accounting of infrastructure services to the population [4].

Hence, to decide which metering operator to choose, a householder might take into consideration some evaluation provided by agents that used the technology. After declaring a business need of a smart metering service and predicting a subjective value to be created by its use, a householder has the option to select one among many policies whereby the desired commodity could be acquired. The Agency monitoring patterns proposed by Silva et al. [2] can be used for this purpose. For brevity, our demonstration will be resumed to the *committee pattern*.

Once the policy pattern is selected, the next step is to evaluate its internal subjective value propositions for the smart metering asset as a core business object. In this case scenario, the BRP's business need could be satisfied by the metering asset prospected to offer the best level of *privacy*, as a subjective value of relevance. This prospection has been referred in this paper as *measured value*, which is defined by the difference between the principal's *expected value* of the core business object and the agents *perceived value* of the same object, based on previous experience or use. Let it be supposed that:

(1) the market segment of Metering Operators acting as third-parties has three individuals for analysis;
(2) the BRP *predicts* an expected value for the metering asset as *equitable*;
(3) the MRP-Aggregator *reports* a perceived value as *forecasted*; and
(4) some MRP-DER *reports* a perceived value as *equitable*;

Then, the rules for definition of the measured value taking the BRP's perspective as dominant apply as summarized in **Table 3**. Accordingly, it is possible to notice that the metering asset provided by the *Metering Operator 1* is prospected to generate *value surplus* as a measured value on the BRP's side.

Table 3. Qualitative value prediction of Metering Operator's service based on evaluation provided by delegated agents

Third-Party (Metering Operator)	**Agent (MRP-DER)**	**Agent (MRP-Aggregator)**
Metering Operator 1	svn:hasSubjectiveValue (svn:BRP, svn:Privacy)^ svn:hasExpectedValue (svn:Privacy, **svn:EquitableValue**)^ svn:hasPerceivedValue (svn:Privacy, **svn:ForecastedValue**) → svn:hasMeasuredValue (svn:SmartMetering, **svn:Surplus**)	svn:hasSubjectiveValue (svn:BRP, svn:Privacy)^ svn:hasExpectedValue (svn:Privacy, **svn:EquitableValue**)^ svn:hasPerceivedValue (svn:Privacy, **svn:IdealValue**) → svn:hasMeasuredValue (svn:SmartMetering, **svn:Surplus**)

Metering Operator 2	svn:hasSubjectiveValue (svn:BRP, svn:Privacy)^ svn:hasExpectedValue (svn:Privacy, **svn:EquitableValue**)^ svn:hasPerceivedValue (svn:Privacy, **svn:EquitableValue**) → svn:hasMeasuredValue (svn:SmartMetering, **svn:Balance**)	svn:hasSubjectiveValue (svn:BRP, svn:Privacy)^ svn:hasExpectedValue (svn:Privacy, **svn:EquitableValue**)^ svn:hasPerceivedValue (svn:Privacy, **svn:DeservedValue**) → svn:hasMeasuredValue (svn:SmartMetering, **svn:Shortage**)
Metering Operator 3	svn:hasSubjectiveValue (svn:BRP, svn:Privacy)^ svn:hasExpectedValue (svn:Privacy, **svn:EquitableValue**)^ svn:hasPerceivedValue (svn:Privacy, **svn:DeservedValue**) → svn:hasMeasuredValue (svn:SmartMetering, **svn:Shortage**)	svn:hasSubjectiveValue (svn:BRP, svn:Privacy)^ svn:hasExpectedValue (svn:Privacy, **svn:EquitableValue**)^ svn:hasPerceivedValue (svn:Privacy, **svn:DeservedValue**) → svn:hasMeasuredValue (svn:SmartMetering, **svn:Shortage**)

5 Conclusions and Future Research

In this paper, we have addressed the research question of how a value network could be configured based on subjective values. We recognize that meeting a consumers' need with value objects exchanged by a reciprocate monetary price is necessary, but insufficient to state that the need will be fulfilled. The ontology proposed here defines a business need as a composition of a desired value object (i.e. a product or service category) and its value components (i.e. objective or subjective values). For objective value assessment, we recommend the use of the e^3value mechanism of profitability analysis to verify the objective values of quantity and quality (e.g. monetary price) assigned to value propositions. For subjective value assessment, we assume that values such as privacy, security and trust are perceptual and dependent on social communication. Accordingly, the ontology includes five Agency monitoring patterns of Silva et al. [2] to indicate the provenance of the value propositions that will possibly satisfy a consumer's business need. For simplicity, only one pattern is demonstrated in this paper. Moreover, the ontology is complemented by a set of SWRL rules to support semi-automated classification and selection of value propositions based on the need of value surplus on the consumer's side.

Gómez-Pérez [9] proposes a framework for ontology evaluation, which comprises three phases: (1) verification of correctness, consistency and completeness; (2) validation via theoretical demonstration, prototyping or case study applica-

tion; and (3) evaluation of community acceptance, modeling utility and usability. The correctness and consistency of the ontology has been checked by using OWL2 and a SRWL plugin for Protégé [12]. Completeness has been verified according to an Ontology Requirements Specification Document (ORSD) not described in this paper. For validation, we have been using observational case studies in digital music clearance [10], energy imbalance reduction [3], and customs control [5] for research problem exploration and technology evaluation. Thus far, the ontology has not yet been applied in interventional case studies or submitted to users' evaluation and surveying, which comprise the current threats to validity of this research.

For future work, this research will follow three directions. First, a more precise characterization of subjective business values demands philosophical grounding. Business values should not be misinterpreted as soft goals (as defined in Requirements Engineering) or Non-Functional Requirements (NFR) analysis. It is necessary to investigate the role of subjective value analysis for the overall sustainability of value networks. Second, it is necessary to design a mechanism for integrity check of transactions that compose a value network, also taking subjective values into consideration. For a while, our analysis is driven by a Service Dominant Logic, focused on a single consumer's business need. However, it is relevant to resolve two or more business needs covered by a same value network. Third, the logic of qualitative assessment proposed here will be revisited based on related research in gossip algorithms and evaluation of products and services provided by e-Commerce platforms.

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