

## **A Design Methodology for Trust and Value Exchanges in Business Models**

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### **Abstract**

*In this paper we introduce a design methodology for business models from two perspectives: the value web perspective and the trust perspective. The value web perspective models the creation, distribution, and consumption of economic value in a network of multiple enterprises and end-consumers. The goal of the methodology is two-fold: (1) to create a common understanding of a business model for all actors involved, and (2) to assess the potential profitability of a business model. The trust perspective describes how value webs can be expanded with trustworthy control procedures to provide for each actor sufficient confidence in each other to enable trading. We present a first outline of a formal theory to design trustworthy control procedures in the setting of the e<sup>3</sup>value methodology.*

### **1. Introduction**

e-Business development becomes more and more a *trans-disciplinary* design problem. An e-business case should have a sound value proposition, so marketing and business economics is an important discipline to take into account. On the other hand, information & communication technology (ICT) plays an enabling and critical role: most e-business cases are fully dependent on reliable information technology. Additionally, trust, e.g. enabled by inter-organizational business processes and document flows, is important to consider.

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Stakeholders representing these different disciplines view the similar design problem (how to develop a specific e-business case) from different viewpoints. It is widely accepted that these different viewpoints result, due to misunderstandings amongst stakeholders, in a lack of common understanding of the e-business case to be developed. Moreover, stakeholders often represent different enterprises. Since enterprises often do not share a common terminology, e.g. because they operate in different markets and have other cultures, common understanding an e-business case even decreases.

One of the contributions of the ICT and business process sciences is a *conceptual modeling* approach for business and ICT development. The activity of conceptual modeling refers to formally defining aspects of the physical and social world around us for the purpose of understanding and communication [Mylopoulos, 1992]. Describing an e-business case formally, may contribute to a better understanding of the case at hand, and therefore increases stakeholder's confidence in such a case.

Since there are multiple perspectives taken on an e-business case, it is important to use multiple description techniques to represent stakeholder viewpoints. A commonly made mistake in conceptual modeling is to express all perspectives by only one description formalism, leading to unclear and cluttered descriptions of the e-business case at hand, thus not contributing to a common understanding.

In this paper we introduce description techniques for two of such perspectives: the value web perspective and the trust perspective. The value web perspective models the creation, distribution, and consumption of economic value in a network of multiple enterprises and end-consumers. The goal here is two-fold: (1) to create a common understanding of a business model for all actors involved, and (2) to assess the potential profitability of a business model. It is widely acknowledged that trust between trade partners is a key to success of a business relation (see e.g. [Mayer et al. 1995], [AMR special issue, 1998]). In particular, in e-business relations where often parties do online business with each other without having any previous experience with each other, or lack detailed information about one another, trust building is a complicated aspect of the relation (see e.g. [McKnight, 2002]). The trust perspective in this paper describes how value webs can be expanded with control procedures to provide for each actor sufficient confidence in each other to enable trading. In particular, we focus on a formal analysis of the control procedures that can be used to develop a theory for designing the most appropriate control procedure for a given value web. The long-term objective of this research is to subsequently use this theory to extend the *e<sup>3</sup>value* methodology with a library of heuristic guidelines for selecting the most appropriate control procedures for a given value web.

### **Case study: Letter of Credit**

As case study we use the Letter of Credit. Banks introduced the Letter of Credit procedure in order to solve the following problem in international trade. Suppose we have a seller in Hong Kong and a buyer in the Netherlands. The agents are geographically far apart, and the goods have to be transported by a carrier from the seller to the buyer (we assume by sea). On the one hand the seller does not want to ship the goods onto the carrier's vessel (and thereby lose control over

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them) without first receiving payment from the buyer. On the other hand the buyer does not want to pay the seller (and thereby lose control over the money) before the goods have been shipped. In other words, the agents prefer a simultaneous exchange of the shipment of the goods in return for the money. To solve this deadlock situation banks introduced the letter of credit; which is an agreement that the bank of the buyer will arrange the payment for the seller as soon as the seller can prove to the bank that he shipped the goods. The bill of lading is issued by the carrier in return for the goods that he received from the seller. The *United Nations Convention on International Multimodal Transport of Goods* (CIMTG) describes this function as follows [UNCMITG, 1980]:

**Article 10** - *Evidentiary effect of the multimodal transport document*

*Except for particulars in respect of which and to the extent to which a reservation permitted under article 9 has been entered:*

- (a) *The multimodal transport document shall be prima facie evidence of the taking in charge by the multimodal transport operator of the goods as described therein; and*
- (b) *Proof to the contrary by the multimodal transport operator shall not be admissible if the multimodal transport document is issued in negotiable form and has been transferred to a third party, including a consignee, who has acted in good faith in reliance on the description of the goods therein.*

The remainder of this paper is structured as follows. Section 2 focuses on modeling value webs, whereas section 3 proposes a way to model trust. In section 4, we elaborate on relating value web modeling to trust modeling. Finally, section 5 presents future research to be done to connect value web and trust modeling more fundamentally.

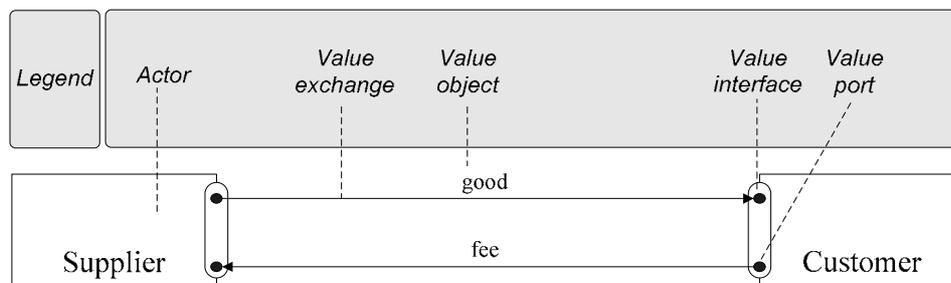
## **2. Modeling value webs**

The Letter of Credit Procedure can be viewed from multiple viewpoints. Seen from a trust perspective, the Letter of Credit Procedure contributes to increasing confidence in reliable and fair exchange of goods between actors, who do not know each other in advance. From a business value perspective, the Letter of Credit Procedure can be seen as a commercial service *itself* facilitating the sale and delivery of another good or service. If we see a value web as a set of actors exchanging things of economic value with each other, we can view the Letter of Credit Procedure as an economically valuable service in a *secondary* value web, facilitating a *primary* value web consisting of actors exchanging goods or services. This section discusses an approach called *e<sup>3</sup>value* [Gordijn 2001], to model value webs, whereas section 3 focuses on the trust perspective. The *e<sup>3</sup>value* methodology is developed to model a value web consisting of actors who create, exchange, and consume things of economic value. It has been used in various industries, e.g. the music, finance, internet service provisioning, news and energy industry [Gordijn 2002]. Moreover, elementary tool-support is available (see

<http://www.cs.vu.nl/~gordijn/research.htm>), and advanced tool support is now developed in the EC-IST funded project Obelix (see <http://obelix.e3value.com>).

### 2.1 Primary value web: Exchanging goods for a fee

Figure 1 shows a value web modeling that a supplier offers some object of value to a customer and obtains a fee in return. We keep this value web deliberately simple, to explain our formalization (section 2.2 adds trust services for the Letter of Credit procedure to this web).



**Figure 1: A supplier and a customer exchanging objects of value.**

(Note: The grey area and superimposed text are only for explanatory purposes and are not part of the  $e^3$ value modeling technique itself)

An important concept in a value web is a *value object*. Such an object is a good, a service, a fee or a combination of these, which is of *economic value* for at least one actor. An *actor* is an entity perceived by itself and its environment as an independent economic and often legal entity. The goal of an actor is to make profit (in case of an enterprise) or to increase its economic utility (in case of an end-consumer). Actors are related by *value exchanges*, which express the willingness of actors to exchange objects of economic value with each other. So, in figure 1 two actors (a supplier and a customer) are willing to exchange objects of economic value (a good and a fee) with each other.

A value web also expresses the notion of *economic reciprocity*. We assume that actors are rational acting economic entities that are only willing to offer a value object if they acquire another value object in return that represents for that actor a higher value than the one offered. To represent economic reciprocity we employ two constructs. The *value port* construct shows the willingness of actor to offer or to acquire a value object from its environment. It allows us to abstract away from internal business processes performed by an actor; a port only states *that* something is offered or requested, not *how* this is accomplished. The *value interface* construct groups value ports of an actor and states atomicity. By this, we mean that an actor is only willing to acquire or to provide a value object through a port if and only if it is willing to acquire or to provide value objects through all ports of the interface. In other words: the actor is only to exchange objects via *all* ports of its value interface, or *none* at all. This models economic reciprocity: In figure 1 it is only possible to exchange a good and a fee in combination and not separately.

### 2.2 Secondary value web: Letter of Credit



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a good, s/he gets paid. The customer obtains a Letter of Credit from an *issuing bank* and the customer should pay a fee for this.

Typically, the issuing bank is in the same country as the customer, but has no branch in the supplier's country. Therefore, the issuing bank needs to involve a *corresponding bank*, which is physically closely related to the supplier. This corresponding bank ensures that the supplier will be paid as soon as the supplier has shipped the good. Consequently, the corresponding bank needs to be informed on the actual shipment of a good. This is done by an additional actor, the *carrier*. The carrier is offering a shipping service to the supplier, for which the supplier pays. It is the carrier, as a party trusted by the corresponding bank, who issues a Bill of Lading, which proves that he received the goods from the seller. The carrier gives this Bill of Lading to the seller. As soon as this Bill of Lading is presented by the seller to the corresponding bank, then the bank pays the fee for the good to the supplier. Hence, this is a kind of secured pre-payment arrangement for the seller.

The dependency path shows that the exchanges via value interfaces #4 and #5 are unconditionally related. So, if values are exchanged between supplier and customer, the supplier must also exchange values with a carrier for shipping these goods. In other words, the supplier cannot obtain his fee for a good (interface #4), without actually shipping the good (#5). This conforms to the Letter of Credit procedure: a supplier gets paid by the corresponding bank if and only if the supplier can show a Bill of Lading, which the supplier can only obtain if he shipped the good.

Note that the value model only shows *who* is offering *what* to *whom* and expects *what* in return. It does not say anything about the *physical* flow of value objects. From a physical perspective, money flows from a customer to an issuing bank, then to a corresponding bank, which finally pays the money to a supplier. Process modeling techniques like Petri nets or UML activity diagrams are suitable to express this, but it is not the goal of the *e<sup>3</sup>value* technique. In contrast, its goal is to clarify which objects of value are offered, and the reciprocal objects requested.

Also note that the Letter of Credit service only secures the interest of the supplier that he obtains payment for a delivered good, but that there is no control mechanism in place yet that guarantees the customer that s/he will receive the ordered good, or receives a refund in case of a lost good (e.g. a shipment insurance). Such an additional service is needed to ensure that value exchanges between supplier and consumer are indeed atomic, but is not part of this paper.

### **3. Modeling trust in control procedures**

Whereas the forementioned value model presents the Bill of Lading/Letter of Credit procedure as a commercial service, we also need to understand how this procedure actually works. In addition to that, an important way to create trust in a control mechanism is to understand how it works, and how the controls protect you against opportunistic behavior of a trading partner in a commercial

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transaction (see e.g. [Das and Teng, 1998]). In this section we formalize what it means to understand a control procedure for trust. This is based on earlier work that was introduced in [Tan & Thoen, 2000] and [Tan & Thoen, 2002].

According to Article 10 of the CIMTG the Bill of Lading as shipment document *reliably indicates* that the goods have been shipped in international trade procedures. Note that this article has a normative element. Whether the Bill of Lading is evidence does not depend so much on whether a person is psychologically convinced by it, but the law simply stipulates that everybody involved in a letter of credit procedure should consider this document as sufficient evidence. We use the conditional operator  $\Rightarrow_P$ , which denotes ‘reliably indicates’, to formalize the following so-called evidence rule:

$$\text{BoL} \Rightarrow_P \text{Shipped} \quad (\text{Evidence Rule}) \quad (1)$$

This is read as ‘In the context of procedure P, the Bill of Lading reliably indicates that the goods were shipped’. We assume that the conditional  $\Rightarrow_P$  has the following axioms as defined in [Jones and Sergot, 1996]

$$(A \Rightarrow_P B) \wedge (A \Rightarrow_P C) \rightarrow (A \Rightarrow_P (B \wedge C)) \quad (2)$$

$$((A \Rightarrow_P B) \wedge (C \Rightarrow_P B)) \rightarrow ((A \vee C) \Rightarrow_P B) \quad (3)$$

and the following inference rules

$$\text{If } \vdash A \leftrightarrow B, \text{ then } \vdash (C \Rightarrow_P A) \leftrightarrow (C \Rightarrow_P B) \quad (4)$$

$$\text{If } \vdash A \leftrightarrow B, \text{ then } \vdash (A \Rightarrow_P C) \leftrightarrow (B \Rightarrow_P C) \quad (5)$$

Note that the modus ponens inference rule does not hold for  $\Rightarrow_P$ , hence it is much weaker than material implication. The evidence relation is not a causal relation. Just as smoke does not cause fire, the bill of lading does not cause shipment.

We described the evidence rule and the procedure in an objective manner, i.e. in terms of objective facts such as ‘BoL’ and ‘Shipped’. For the actual execution of the procedure, however, the mental states of the agents involved are equally important. If one of the agents does not believe the facts, or something went wrong, e.g. an agent did not receive the Bill of Lading, then the procedure does not work. Hence, we cannot simply use objective facts like ‘BoL’ and ‘Shipped’ for modeling the mental states of the agents, but we have to use subjective beliefs about such facts to model the mental state of the agents. To model these belief states of agents, we use epistemic operators such as  $B_i\phi$ , which denotes that agent  $i$  believes  $\phi$ , and  $K_i\phi$ , which denotes that agent  $i$  knows  $\phi$ . If agent  $b$  believes the Bill of Lading, then we represent this by the formula  $B_b\text{BoL}$ . This belief depends on the agent’s belief that the document is not forged, i.e., that the document comes from a trustworthy source. Similarly,  $B_b\text{Shipped}$  means that the agent  $b$  believes that shipment of the goods took place. The  $K_i$  and  $B_i$  operators have the usual axioms and inference rules (see [Fagin et al., 1995]).

$K_i$  Axioms:

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- a)  $K_i(\varphi \rightarrow \psi) \rightarrow (K_i\varphi \rightarrow K_i\psi)$  (K axiom for  $K_i$ )
  - b)  $K_i\varphi \rightarrow \varphi$  (T Axiom)
  - c)  $K_i\varphi \rightarrow K_iK_i\varphi$
  - d)  $\neg K_i\varphi \rightarrow K_i\neg K_i\varphi$

$B_i$  Axioms:

- a)  $B_i(\varphi \rightarrow \psi) \rightarrow (B_i\varphi \rightarrow B_i\psi)$  (K axiom for  $B_i$ )
- b)  $B_i\varphi \rightarrow \neg B_i\neg\varphi$
- c)  $B_i\varphi \rightarrow B_iB_i\varphi$
- d)  $\neg B_i\varphi \rightarrow B_i\neg B_i\varphi$

and the following inference rules:

- a) if  $\varphi$  and  $\varphi \rightarrow \psi$ , then  $\psi$
- b) if  $\vdash \varphi$ , then  $\vdash K_i\varphi$  and  $\vdash B_i\varphi$  (Necessitation rules)

We model the fact that an agent understands the evidence rule of the procedure with the following formula.

$$K_i(B_iBoL \Rightarrow_P B_iShipped) \quad (\text{Epistemic Evidence Rule}) \quad (6)$$

This formula says that agent  $i$  knows that, if he believes the Bill of Lading, then according to the procedure  $P$  he has a good reason to believe that the goods are shipped. Note the importance of the procedural setting here. Agent  $i$  knows that by law he is supposed to consider the bill of lading as sufficient evidence for shipment. We use here the knowledge operator, because procedures or legal texts are non-empirical information (like the rules of a game, or mathematics). In other words, these are not empirical data about which you can make incorrect observations. You either know this or not, but there is nothing in between, while you can get misleading information about empirical facts such as a bill of lading or shipment. Hence, we use the  $B_i$  operator to represent the belief in these facts.

It is a general principle in most legal systems that its norm subjects are supposed to know the norms. This can be represented by an obligation for the norm subjects to ‘ought to know’. The norm in Article 10 expresses that everybody who uses the letter of credit procedure *ought to know* that the Bill of Lading reliably indicates that the goods were shipped is formalized as, which can be formalized as follows.

$$O_iK_i(B_iBoL \Rightarrow_P B_iShipped), \text{ for all agents } i \quad (\text{Obligatory Knowledge of the Evidence Rule}) \quad (7)$$

Where the deontic operator  $O_i$  is the standard deontic logic (SDL) operator, and  $O_i p$  means that  $p$  is obliged. We have the usual SDL axioms and inference rules (see e.g. [Meyer and Wieringa, 1993]).

$O_i$  Axioms:

- a)  $O_i(\varphi \rightarrow \psi) \rightarrow (O_i\varphi \rightarrow O_i\psi)$  (K axiom for  $O_i$ )
- b)  $O_i\varphi \rightarrow \neg O_i\neg\varphi$

and the following inference rules:

- a) if  $\varphi$  and  $\varphi \rightarrow \psi$ , then  $\psi$
- b) if  $\vdash \varphi$ , then  $\vdash O_i\varphi$  (Necessitation rule)

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The idea of rule (7) is that an agent cannot use the argument that he did not know rule (6) as justification for violating an obligation. In other words, if agent  $i$  has received the Bill of Lading but did not pay for the goods on time, then agent  $i$  cannot justify his violation of the obligation to pay for the goods by saying that he did not know that the goods have been already shipped. Agent  $i$  ought to have known that receiving the Bill of Lading reliably indicates that the goods were shipped.

The last issue that we have to address is the *shared knowledge* aspect of trust. The letter of credit procedure is only trustworthy for the seller if he knows about all the other parties involved, e.g. the buyer, the buyer's bank etc, that they will accept the bill of lading as proof of shipment. In other words, the seller has to know that the evidence rule is obligatory knowledge for all the other parties. We model this by the following formula

$$K_i(O_j(K_j(B_jBoL \Rightarrow_P B_jShipped))) \text{ for all agents } j \neq i \quad (9)$$

The understanding of the procedure is modeled by the fact that the rules 6, 7 and 9 are part of the agent's mental state. In other words,  $B_iBoL$  by itself only models that the agent believes the written content of the Bill of Lading. *Understanding* the complete functionality of the Bill of Lading requires a lot more. The agent has to know (1) all the consequences and functions of the Bill of Lading, and (2) the agent has to know what he and other agents are supposed to know about these consequences. In particular, this shared knowledge is essential for trust creation between the agents of a trading community.

#### 4. **Value modeling and trust modeling**

In [Bons et al., 1997] and [Lee and Bons, 1996] a set of auditing principles is introduced for trustworthy trade procedures in international trade. The problem in international trade is that you often have very little information about your potential trade partner. The underlying idea is that if trade procedures are compliant with these auditing principles, then these procedures create enough trust for people to trade. An example of such an auditing principle is the following:

*If Role 1 cannot witness the performance of a counter-activity, another Role 3 should testify the completion of Role 2's activity if the agent playing Role 2 is not trusted by the agent playing Role 1. This document must be received by Role 1 before the execution of its primary activity, and the agent playing Role 3 should be trusted by the agent playing Role 1.*

This general principle can be applied to the earlier example of the seller in Hong Kong and the buyer in the Netherlands. The first condition, that the buyer (Role 1) cannot witness the shipment of the goods, holds. And the second condition that the seller (Role 2) is not trusted by the buyer (Role 1), holds as well. (We said that the buyer does not want to pay before shipment of the goods). The solution that the general auditing principle prescribes is the introduction of a third agent (Role

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3) that testifies (using a document) that the goods have been shipped. The buyer (Role 1) should have received this document before the seller is paid.

This general principle, therefore, imposes a constraint on the letter of credit procedure we described in the previous section. The corresponding bank will only accept the Bill of Lading when it is issued by an independent third party, i.e. the carrier has to issue it and not the seller. Hence, we only have that  $B_iBoL$  is true, if the Bill of Lading was issued by an independent trusted third party. In other words, Article 10 only makes sense if the CIMTG complies with this auditing principle, which is indeed the case.

This auditing principle can be analyzed with the formal concepts that we introduced in section 3. More importantly, this formalization provides a basis to develop a theory that can be used to explain how control procedures create trust. This theory can then be used to design for a particular primary value web the control procedure which is most adequate to create trust for a specific agent. For example, from the perspective of the buyer the letter of credit creates no trust about the actual delivery of the goods by the carrier. Other control procedures could be used to secure the interests of the buyer. For example, an insurance at least secures the financial risks of the buyer (who already pre-paid the goods in the letter of credit situation!) in case the goods are damaged by the carrier. Hence, the formal analysis can be used to develop a theory to design the most appropriate secondary control value web to secure the interests of a specific agent in the primary value.

## 5. Conclusions

Value models and trust models are two perspectives on an e-business case. A value model shows which actors are involved and which objects of economic value are exchanged between these actors. The  $e^3value$  methodology assumes that these exchanges always occur, or none at all. In other words, there are no actors who are committing a fraud, or other mishaps which may result in failed exchanges of value.

Consequently, to put an e-business idea into practice, mechanisms need to be in place which ensure that committed exchanges of value actually occur. In general, such mechanisms will be based on trustworthy control procedures. Two interesting observations were made about these control procedures. First, trust-increasing procedures themselves can be seen as viable commercial value-added services with a corresponding value model. We called such value models secondary, because they facilitate the exchange of values in another, primary, value model. Relating a secondary value model to enhance trust to a primary value model goes via the value exchanges of this primary model; these are the exchanges which need to be secured by trust-services. Second, a theory is needed about trust procedures and how to design them for specific value models. Just as the design methodology requires principles for the design of the primary value models, it also requires control specific principles for the design of the secondary trust services value models. Here we made a first attempt to develop such a theory for the design of the secondary trust services value models.

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In future research we plan to further develop the formal theory about auditing principles for trust building for designing the most appropriate control procedure to extend a given value web. The long-term objective is to use this theory to extend the e3value methodology with a library of heuristic guidelines for selecting the most appropriate control procedures for a given value web.

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