

A methodology to quantify failure for risk-based decision support system in Digital Business Ecosystems

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Abstract

In digital business ecosystem architecture it is rational for the trusting agent to analyse the possible risk according to its demand before interacting with a probable trusted agent. Doing so would assist the trusting agent in its decision process and would also give the trusting agent a hint of the direction in which the interaction might head. The possible risk in an interaction is a combination of the probability of failure and the possible consequences of failure of an interaction. In this paper, we propose a methodology by which the trusting agent determines the probability of failure in interacting with a probable trusted agent. The determined probability of failure by the trusting agent is according to the specific demand of its future interaction with the probable trusted agent.

Keywords: Criteria, FailureLevel, Trusting agent, Trusted agent.

1. Introduction

The development of the internet has provided users with numerous mechanisms for conducting or facilitating e-commerce interactions [1]. The terms 'trusting agent' and 'trusted agent' define the two agents participating in an interaction. The former refers to the instigator of the interaction while the latter refers to the agent accepting the request. In other words, this is the agent with whom the trusting agent interacts with to achieve its desired outcomes. The significance of the trusting agent to analyse the possible risk before initiating an interaction with a probable trusted agent is substantial. The trusting agent, by analysing the possible risk beforehand, could gain an idea of whether it will achieve its desired outcomes from the interaction or not. Based on this, it can safeguard its resources.

Risk analysis is important in the study of behaviour in e-commerce because there is a whole body of literature based in rational economics that argues that the decision to buy is based on the risk-adjusted cost-benefit analysis [2]. Thus, it commands a central role in any discussion of e-commerce that is related to a transaction. The need to distinguish between the likelihood and magnitude of risk is important as they represent different concepts. For example, the likelihood of selling an item on the web decreases as the cost of the product increases and vice versa. The likelihood of a negative outcome might be the same in both transactions but the magnitude of loss will be greater in the higher cost transaction. Risk plays a central role in deciding whether to proceed with a transaction or not. It can broadly be defined as an attribute of decision making that reflects the variance of its possible outcomes. The Australian and New Zealand Standard on Risk Management, AS/NZS 4360:2004, states that Risk Identification is the heart of Risk Management [3]. Therefore the trusting agent, by identifying and analysing the possible risk beforehand in interacting with a probable trusted agent, can make an informed decision of whether to interact with that particular agent or not. Alternatively it can choose an agent to interact with from the set of probable trusted agents.

Digital Business Ecosystems is a new concept that is emerging worldwide as an innovative approach to support the adoption and development of information and communication technologies. Digital ecosystems transcend the traditional rigorously defined collaborative environments from centralized or distributed or hybrid models into an open, flexible, domain clustered, and demand-driven interactive environment. A digital ecosystem is a new-networked architecture and collaborative environment that addresses the weakness of client-server, peer-to-peer, grid and web services. It is a self-organizing digital infrastructure aimed at creating a digital environment for networked organizations that supports the cooperation, knowledge sharing, development of open and adaptive technologies and the evolutionary business models [4-6]. It can also be defined as a system which is loosely coupled, agent-based collaborative environment where every specie is proactive and responsive and acts for its own benefit or profit. A business ecosystem is the network of buyers, suppliers and makers of related products or services plus the socio-economic environment. An agent in a Digital Ecosystem can be a client and a server at the same time. They may offer their service to others as a server and request help as a client. The communication and collaboration is through swarm intelligence. Unlike traditional environments, digital ecosystems are self-organizing systems which can form different architectural models through swarm intelligence. A demand driven business ecosystem interaction implies that the trusting agent wants to achieve certain desired outcomes in its future interaction and in order to achieve that it should select a trusted agent who can fulfil its demand. In doing that, it is possible the trusting agent has to decide and choose a trusted agent to interact with among a set of probable trusted agents. The trusting agent can analyse the possible risk according to its demand and can ease the decision making process of which agent to interact with. The possible risk in an interaction is a combination of:

- The probability of failure in achieving the outcome; and
- The possible consequences of failure.

As a step towards analysing the possible risk in an interaction beforehand, in this paper, we propose and develop a methodology by which the trusting agent can determine the probability of failure in interacting with a probable trusted agent to achieve its demand. This paper is organised in seven sections. In section 2, we discuss the definitions of Risk defined in the literature and highlight the need to analyze the possible Risk before initiating an interaction. In section 3, we propose the methodology of determining the probability of failure of an interaction. From section 4 to section 6 we explain the proposed methodology with an example and finally in section 7, we conclude the paper.

2. Related Work

In this section we will discuss about the existing work in the literature related to Risk in an interaction. In the literature Risk has been defined in different ways by different researchers. To summarize some of those definitions, March and Shapira [7] define Risk more by the magnitude of the value of the outcome rather than by taking its likelihood. This paradigm of Risk is more common in business transactions. Luhmann [8] defines Risk in a transaction where the possible damage might be more than the advantage sought. This type of perception is more common in finance and investments where the expected returns are high. Mayer, Davis and Schoorman [9] conclude that Risk is present in the transaction only if the negative outcome outweighs the positive outcome at the end of the transaction. In contrast to this definition, Rousseau et al [10] measure Risk as the potential negative consequence and probability of failure. Sztompka [11] defines Risk as the probability of the loss of the resources invested. Grazioli and Wang [12] views Risk as the consumers' perception of the uncertainty and adverse consequences of engaging in an activity. Cheung and Lee [13] define Risk as having two dimensions; one related to the uncertainty or probability of loss notion and the other related to a consequence of the importance of the notion of loss. Jarvenpaa et al [14] define Risk in Information Systems by using items reflecting its likelihood such as too much uncertainty, how to characterize a decision to proceed with a transaction.

The above mentioned definitions of Risk though have been defined in different context but they all emphasize on the probability of failure and the possible loss in an interaction. This loss varies according to the context in which it is being discussed. In the context of a financial e-interaction the possible loss is to the resources of the trusting agent involved in the interaction.

There is still confusion in the relationship between Trust and Risk. As Mayer et al [9] suggest 'it is unclear whether Risk is an antecedent to trust'. It is a well known fact that Risk & Trust are dependent on each other, but it is still unclear whether Risk is an antecedent to Trust or an outcome of Trust. Different arguments can be given to this. It can be said that in an interaction Risk creates an opportunity for Trust which leads to Risk taking. In this case Risk is an antecedent to Trust. But it can also be said that when the interaction is done based on the level of Trust, then there is a low amount of Risk in it. In this case Risk is an outcome of Trust. Risk can also provide a moderating relationship between Trust and the behaviour of the Peer in an interaction. For example the effect of Trust on the behaviour is different when the level of Risk is low and different when the Risk is high. Similarly Risk can have a mediating relationship on Trust. For example the existence of Trust reduces the perception of Risk which in turn improves the behaviour in the interaction and willingness to engage in the interaction.

It is important to comprehend the difference between Trust and Risk as they are two different terms that express different concepts, but they complement each other [15]. Risk evaluation involves the trusting agent to determine beforehand the probability of failure and the subsequent possible consequences of failure to its resources in interacting with the probable trusted agent. On the other hand trust evaluation measures the belief that the trusting agent has in a probable trusted agent in attaining its desired outcomes if it interacts with it. The trust evaluation is done by the trusting agent either by considering its own experience or by considering the other agents recommendations but this does not take into account the amount of resources invested in the interaction. A lot of work has been done in the literature to determine and evaluate the trust in an interaction [21-30]. We will not be discussing it here as our aim in this paper is not trust evaluation, where as it is to determine one aspect towards risk evaluation, namely determining the probability of failure of the interaction. As mentioned before the inclusion of Risk in the study of behaviour of e-commerce transaction is important because there is a large volume of literature based in rational economics that argues that the decision to proceed with the transaction is based on the Risk adjusted cost benefit analysis and analyzing Risk in the transaction is really important with the widespread use and incursion of the Internet in our day to day life, particularly with the advent of business and e-commerce transactions in digital business ecosystem domain.

Through the above discussion, it is evident that Risk measurement, prediction and management is indeed needed before initiating an e-commerce interaction in a digital business ecosystem domain. We need a Risk management tool which complies with Australian and New Zealand Standard on Risk Management AS/NZS 4360:2004 and that helps in analyzing and evaluating the risk. In order to achieve that, we defined risk in the context of e-commerce transactions conducted in digital business ecosystem domain as 'the likelihood that the trusted agent might not act as expected according to the trusting agent's expectations in a given context and at a particular time once the interaction begins, resulting in the loss of dollars and the resources involved in the interaction'. Context represents the high level nature of the trusting agent's interaction with the trusted agent [16]. It can be decomposed into several detail aspects called as the criteria. Criteria is defined as the demand or the set of factors which show specifically what the trusting agent wants in its interaction with the trusted agent in the particular context.

In order to ascertain the possible risk in an interaction, the probability of failure and the possible consequences of failure of an interaction must be quantified. To quantify and represent semantically the probability of failure of an interaction, we define the term 'FailureLevel' and the 'Failure scale'. 'FailureLevel' (FL) is defined as the numerical value that is assigned by the trusting agent to the trusted agent after interacting with it, which shows the level of failure of the interaction on the Failure scale. The Failure scale as shown in Figure 1 has 7 different probable levels of failure that could be present in the interaction, with level 0 representing the highest level of failure and level 5 representing the lowest level of failure.











Semantics of Failure Level	Probability of Failure	FailureLevels	Star Rating
Unknown		- 1	Not Displayed
Total Failure	91 - 100 % Probability of Failure	0	Not Displayed
Extremely High	71 - 90 % Probability of Failure	1	From  to 
Largely High	51 - 70 % Probability of Failure	2	From  to 
High	26 - 50 % Probability of Failure	3	From  to 
Significantly Low	11- 25 % Probability of Failure	4	From  to 
Extremely Low	0 - 10 % Probability of Failure	5	From  to 

Figure 1 showing the Failure scale

The trusting agent assigns a FailureLevel to the trusted agent after interacting with it by assessing the level of un-commitment in the trusted agent's actual behaviour in the interaction as compared to the expected behaviour. In other terms, this is the in-capability of the trusted agent to complete the interaction according to the expected behaviour. *Expected behaviour* is defined as that behaviour which the trusted agent was supposed to commit to in completing the interaction [16]. This expected behaviour is defined by the trusting agent before starting its interaction with the trusted agent and is according to the criteria of its interaction. The actual behaviour is the commitment that the trusted agent showed or behaved in the interaction. Hence, the FailureLevel that the trusting agent assigns to the trusted agent after the interaction is by assessing the un-committed behaviour of the trusted agent according to the criteria of its interaction. The methodology by which the trusting agent sets the criteria and later assesses and assigns a FailureLevel to the trusted agent after interacting with it, depending on the level of its un-committed behaviour in the interaction is defined in Hussain, Chang, Hussain and Dillon [17].

By utilising this methodology, the trusting agent assigns a failure level to the trusted agent after completing its interaction with it. For risk analysis before initiating an interaction, a trusting agent has to determine the probability of failure and the possible consequences of failure before starting an interaction with the probable trusted agent. The determined probability of failure of the interaction by the trusting agent should be strictly according to the criteria of its future interaction with the probable trusted agent. Further, it is likely that the trusting agent, before initiating an interaction, might have to select an agent to interact with from a set of possible trusted agents. If the trusting agent does not have an interaction history with any of the possible trusted agents in the context of its future interaction then it is difficult for it to decide which particular agent to interact with. One way by which the trusting agent can ease its decision making process is by determining the possible level of risk beforehand. To achieve that, in this paper, we propose a methodology of determining the probability of failure (FailureLevel) of an interaction beforehand as a step towards risk analysis of an interaction.

In the next sections, we define the process by which the trusting agent can determine the FailureLevel in interacting with a probable trusted agent before initiating an interaction with it.

3. Determining the FailureLevel of an Interaction

The FailureLevel of an interaction is the extent to which the trusting agent ascertains that it might not achieve its desired outcomes in interacting with a probable trusted agent. The trusting agent can determine the FailureLevel in interacting with a probable trusted agent beforehand, by analysing the trusted agent's in-capability to complete the interaction according to the expected behaviour of its future interaction. By considering the expected behaviour, the trusting agent is analysing the FailureLevel in interacting with a probable trusted agent according to the criteria of its future interaction. The possible interaction of the trusting agent with the probable trusted agent is in the future state of time. Hence, for risk analysis, the trusting agent has to determine the FailureLevel in interacting with the probable trusted agent in the future. In order to achieve that, we propose that the trusting agent analyse the FailureLevel in interacting with a probable trusted agent in two stages. They are:

1. Pre-interaction start time phase
2. Post-interaction start time phase

Pre-interaction start time phase refers to the period of time before the trusting agent starts its interaction with the probable trusted agent, whereas *Post-interaction start time phase* is the period of time after the trusting agent starts and interacts with the probable trusted agent. The trusting agent has to determine the FailureLevel in interacting with a probable trusted agent in that future state of time, i.e. in the post-interaction start time phase. In order for the trusting agent to determine the FailureLevel in interacting with a probable trusted agent in the post-interaction start time phase, it should know its FailureLevel according to the specific context and criteria as that of its future interaction, in the pre-interaction start time phase. Based on the FailureLevel achieved for the probable trusted agent in the pre-interaction start time phase, the trusting agent can predict the FailureLevel of the probable trusted agent in the post-interaction start time phase.

We will explain the process of determining the FailureLevel in interacting with a probable trusted agent in each time phase in the next sub-sections.

3.1 Determining the FailureLevel in Pre-Interaction Start Time Phase

The trusting agent can determine the FailureLevel in interacting with a probable trusted agent in the pre-interaction start time phase either:

- a) By considering its past interaction history with the probable trusted agent in the same context and criteria as that of its future interaction with it; or
- b) By soliciting recommendations from other agents and determining the in-capability of the trusted agent to complete the interaction according to the criteria of its future interaction with it.

If the trusting agent has a past interaction history with a probable trusted agent in the same context and criteria as that of its future interaction, then it can determine the FailureLevel of the probable trusted agent in the pre-interaction start time phase by analysing those past interactions. As mentioned in the literature, risk varies according to the time and context of the interaction. Hence, if the trusting agent's past interactions with the probable trusted agent were long ago as compared to its future interaction or if they are in a different context as compared to its future interaction, then those past interactions cannot be utilised to determine the FailureLevel of the probable trusted agent. In such a case, the trusting agent has to solicit for recommendations to determine the FailureLevel of the particular trusted agent in the pre-interaction start time phase. As mentioned by Carter and Ghorbani, reputation can be relied on in the event of total ignorance [18]. But the reputation of a probable trusted agent shows its capability to complete the interaction. In order for the trusting agent to

