Extending e3tools to Assess Adoption Chain and Co-Innovation Risks

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Abstract. Digital platforms form ecosystems enabling value co-creation and creating structures of interdependence. The success of innovations in such ecosystems can largely depend on adoption chains, or on co-innovation. Theory suggests that the assessment of these ecosystem risks increases the odds of success in such cases. We present an extension to support the assessment of adoption chain and co-innovation risks using the value modelling tool e3tools. We demonstrate the implementation of ecosystem risk logics and a dashboard using examples from literature.

Keywords: Ecosystem Risk; Value Modelling; Tool; Risk Assessment

1 Problem Identification and Motivation

The ecosystems that form around digital platforms often determine their value creation and innovation [1]. A good design of a platform's business model should be explicit in how it approaches the risks that ecosystem actors deviate from envisioned roles and positions. When innovations depend on other actors, a focal firm's (i.e. platform operator) strategic approach to ecosystem risks will increase the odds of success [2]. Supporting the assessment of the risks that (1) partners cannot co-innovate, and that (2) partners do not adopt an innovation can lead to better platform designs.

One framework available for the analysis of value co-creation in ecosystems is e3value [3]. Researchers have so far discussed, further developed and extended the framework in tens of scientific papers. Within this framework, an open source software tool called e3tools [4] is available offering graphical value modelling and supporting the explorative analysis of value co-creation and ecosystem design. Among other qualities, the tool allows the modelling of interdependence structures, the simulation of value exchanges between different actors and automated net cash flow analysis. Further, e3tools supports fraud risk and revenue sensitivity analyses. However, software tool support for ecosystem risk analysis is not available [5, 6].

In this paper, we present extensions to the value modelling tool e3tools. The proposed enhancements support the assessment of co-innovation and adoption chain risks (i.e., ecosystem risks) on value models. In addition, we show how a dashboard could summarize information about the impact of these ecosystem risks and support decision making. We use theoretical examples [7] to show that the extension has the required effects.

2 Methodology

In platform ecosystems, value propositions largely depend on ecosystem partners assuming positions and roles envisioned by the platform provider. In such settings, ecosystem risk can threaten the success of innovations. Software tool support could be useful to assess ecosystem risks when designing platform value models, and could thus increase the odds of success. This work aims at contributing with an artefact using the design science research (DSR) methodology of [8] as summarized in Table 1.

Table 1. This work's DSR activities following [8] (source: own research)

Problem identification and motivation	The failure to assess adoption chain and co-innovation risks threatens the success of platforms. Assessing these ecosystem risks refers to a class of value modelling problems for assessing business risks. It is classified as a semi-quantitative risk assessment approach.
Definition of solution objectives	A value modelling tool extension is required to assess these ecosystem risks. The tool extension should enable the assessment of co-innovation and adoption chain risks based on a value model.
Design and development	A class of solution extension is designed to enable the assessment of ecosystem risks. The class of extension is instantiated in e3tools to support the assessment of co-innovation and adoption chain risks.
Demonstration	Examples from literature are used to show that the tool extension models the impact of these risks as proposed in theory.
Contribution	The main contributions are the description of a class of value modelling tool extensions for modelling ecosystem risks and an implemented extension for assessing co-innovation and adoption chain risks.

3 Definition of Solution Objectives

3.1 Representing the Logic of Ecosystem Risks

Adoption chain risks are related to the partners' willingness to undertake the activities required for a value proposition, raising questions of priorities and incentives for participation [2]. An adoption chain is the path of a product or service from scratch to the end consumer. This path is critical when the success of an innovation depends on specific ecosystem structures. Ecosystem partners only co-create if they are rewarded with an appropriate value. The extension must be able to represent the logic of minimums embedded in adoption chain risks [7]. If an actor is worse off with an innovation (i.e. the actor ha as deficit), the adoption chain should be broken.

Co-innovation risk is defined as the challenge partners face in developing the ability to undertake the new activities that underlie their planned contributions [2]. Co-innovation risks depend on the joint probability that each ecosystem partner involved will be able to deliver on their innovation commitments within a specific time frame [7]. Accordingly, the extension must be able to represent the logic of multiplications embedded in co-innovation risks [7]. The probabilities of success of all the ecosystem partners along a dependency path should be multiplied in order to estimate the chances of joint success. This requires probabilities to be propagated throughout a dependency path.

The e3value modelling element AND is needed in case the partners need to work together to realise a service which satisfies the customer need [9]. The OR element is needed if an actor can decide which offer he will choose, for example, if two actors provide the same product and the actor takes the one with the better conditions [9]. The AND and OR elements also have two different variants of how they are used in a model. A fork is used when a path is split into several paths. After a fork, the following paths are dependent on this one element. A join is used when several paths merge into one. A path is dependent on the previous incoming connections [9]. Accordingly, modifications to four different variants are needed: the OR-join, OR-fork, AND-join and the AND-fork.

3.2 Dashboard

Dashboards are useful to manage growing complexity [10], which characterizes digital platform ecosystems [11]. Dashboards can be used to analyse current states and possible future scenarios as well as support the managers in decision making [10]. Charts and colours are helpful to explain factual connections much faster and to highlight essential facts [12]. A dashboard should provide an overview of the most important aspects of an ecosystem that are required to assess and manage ecosystem risks. It should also provide an insight into ecosystem risk-related dynamics of the ecosystem, which are essential to realize a value proposition.

Risks need to be ranked and prioritized in order to identify areas for immediate improvement and, thus, focus best efforts on dealing with threatening risks [13]. A risk level matrix [13] could enable a quick overview of the risk in each value exchange. The columns in the risk level matrix describe the percentage of the probability. The rows classify the impact of a value exchange.

4 Design and Development

To enable the analysis of ecosystem risks, we first modified the value exchanges. e3tools already supports formulas for value exchanges, actors and value activities. To enable risk modelling, it was essential to add the values Probability and Impact to the property Formula. We integrated the formulas into every value exchange. The value Probability describes the probability that a value offering is successfully realized.

To enable joint probabilities, it is necessary to propagate the probability of each value offering through a dependency path up to a boundary element. To allow this, we made changes to the Traverse function. The function Traverse is initiated by the function Enhance, which searches for every element after a start stimulus and forwards it to the function Traverse where it traverses through a dependency path. Traverse always takes the next element, checks its type and decides which steps are necessary to get the next element. If it gets the next element, it recalls itself and repeats the same steps as before until every boundary is reached. The elements must be forwarded through the path to allow each probability on the path to be multiplied with the probability of the next value exchange. The function traverse forwards to the next element the current probability in the graph until all end stimuli are reached.

To add a probability, we need to verify if the OR join was visited before because the the node´s default probability is 1. If we do not distinguish between the first and later visits, it is impossible to know why the likelihood of the node is 1. It could either be an unvisited node, or a visited node where every incoming path had a probability of 1. The OR join always saves the highest possible probability. Once all incoming paths have been considered, the current probability of the node is requested. This probability is then forwarded to an outgoing path.

In the case of the AND join, it is not necessary to check if the node was already visited because the node has a probability of 1 and the first incoming path will only be multiplied by it. Therefore, this multiplication does not sophisticate our result. Contrary to the OR-join, all incoming paths are included for the probability calculation. This probability is then forwarded to the outgoing path. There is no difference between an AND or OR node when forwarding the probability of the fork. The difference shows up at the following elements or at the end of the path, where the cumulative probability is calculated. Only at this point one option could turn out as the better one.

We implemented a risk level matrix following [13] to enable a quick overview of the probability of each value exchange. The columns denote the probability while the rows classify the impact of the value exchange. It is either a benefit or a threat. The legend shows the occurring risk level. A value exchange could either be "High profitable", "Profitable", "Negligible", "Unacceptable" or "Critical". The risk levels "Unacceptable" or "Critical" should be avoided.

5 Artefact Description and Demonstration

In order to demonstrate that the implemented extension artefact successfully allows the assessment of ecosystem risks, we modelled two examples from literature [7] as well as two synthetic examples. For both examples from the literature, we generated e3value models of the situations presented in two chapters of the work to test the logics implemented. The synthetic examples were value models designed ad-hoc to test if the risks are propagated through dependency paths and to test if the changes to the OR element are performed as designed.

First, as shown in Figure 1, we modelled an adoption chain where an innovation needs to pass through two intermediaries before reaching the end customer [7]. In this example, the innovation is highly profitable for the innovator (surplus of +4), creates high margins and low handling costs for the distributor (surplus of +3), higher up-front costs, retraining and after-sales service issues, despite slightly higher margins for the retailer (a deficit of –1), and very high value for the end customer (surplus of +5). The net system surplus created by innovation 11 (4 + 3 – 1 + 5).

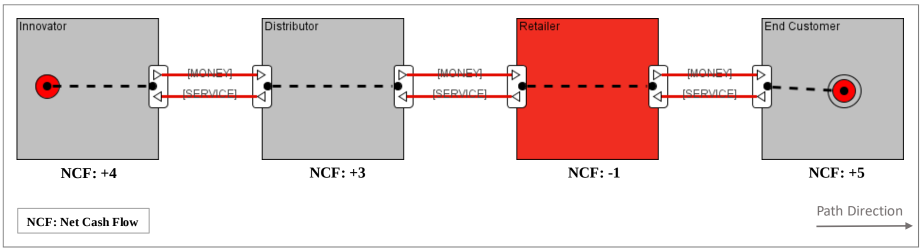

Fig. 1. Adoption chain risk example (Source: example based on [7], created with extended e3tools).

Then, as shown in Figure 2, we modelled a co-innovation risk where complementors (or supplier) have an eight-in-ten chance of succeeding independently [7]. In this example, the chance that they will all jointly succeed at the end of the year is the product of their independent probabilities (0.85 × 0.85 × 0.85 × 0.85). We include the probability and impact of each value exchange as well as the joint or cumulative probability at each step of the dependency path.

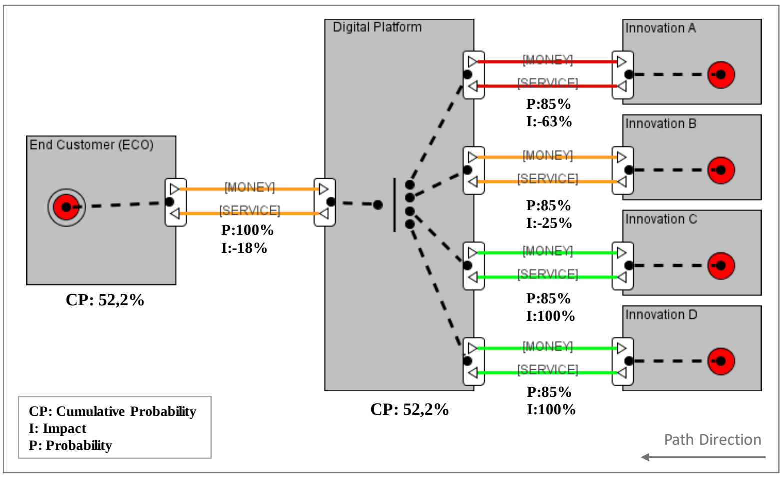

Fig. 2. Co-innovation risk example (source: example based on [7], created with extended e3tools).

To test the propagation of risk, we used a synthetic example were a path starts at an Innovator and ends at an End Customer. The example is shown in Figure 3. The joint probability that the value proposition will be materialized for the "End Customer" is

0.432 (0.8 × 0.6 × 0.9). The calculation considers every value exchange throughout the path. Accordingly, to calculate the probability of 0.48 for the actor "Retailer" the extended function traverse multiplies 0.8 × 0.6 of the two previous value exchanges.

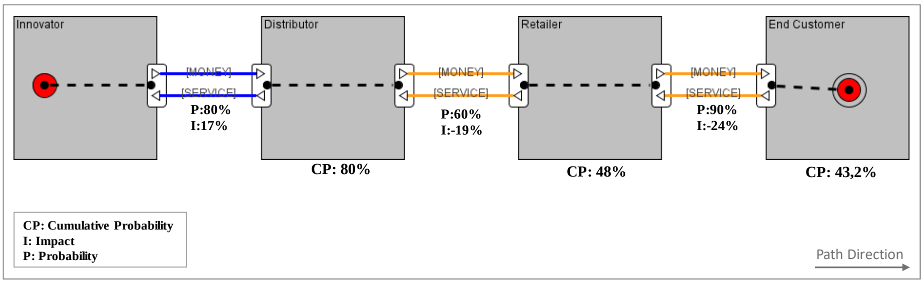

Fig. 3. Co-innovation risk example to test risk propagation (source: own example, created with extended e3tools).

Figure 4 shows the synthetic example used to test the modified OR-join. If the path from Comp. 1 is the first path, it will be saved in the node with 0.6. When the next connection from Comp. 2 with 0.5 appears at the node, the highest probability is determined. Since 0.6 is the higher probability, the following path will be calculated with this probability, because it is the better option. Afterwards, it requests the outgoing connection element and forwards the new probability along the path. With the better option, the value proposition would be materialized with a probability of 0.48. Otherwise, the probability would be 0.4.

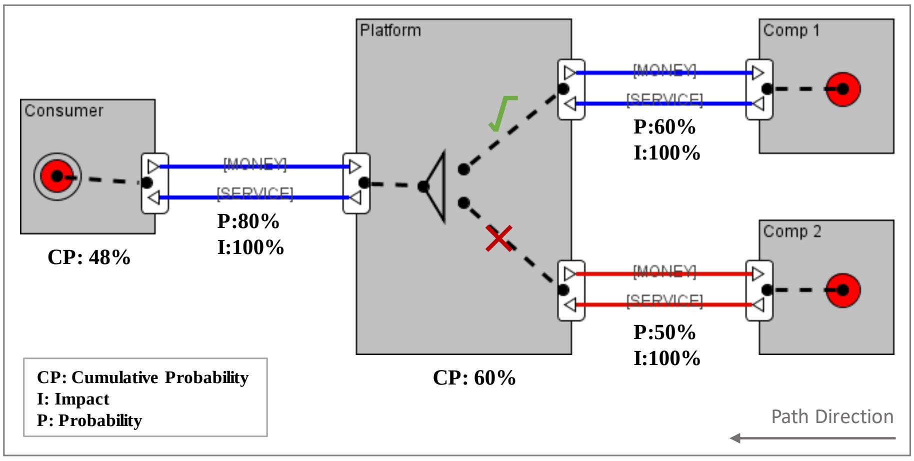

Fig. 4. OR join example (Source: own example, created with extended e3tools. Numbers added manually for better understanding.)

To test the dashboard (Figure 5) , we used the previous co-innovation risk example shown in Figure 2. The component Results is an extension of the already existing Profitability Table. This panel presents the profitability table and the profitability table after showing the impact of the probabilities which are connected to the actors. The digital platform has a negative result when considering the joint probability. The reason for this is the redistribution of income and loss. The digital platform is connected to the innovations with 0.85 and connected to the end customer with a 0.52 probability of success. So relatively more will be deducted from the profit. This leads to a negative result for the digital platform. The joint probability of the complementors leads to such a low probability of success. The next column shows the possibility to redistribute income to compensate the negative result of the digital platform. The actor with the highest result compensates the highest percentage of the offset value. The column Comp. shows the shares of the compensated amount of every actor. The last column indicates the adjusted results, after the compensation of the values. Now, every actor has a positive result (except the end customer, which is not considered), which ensures the realisation of the value proposition.

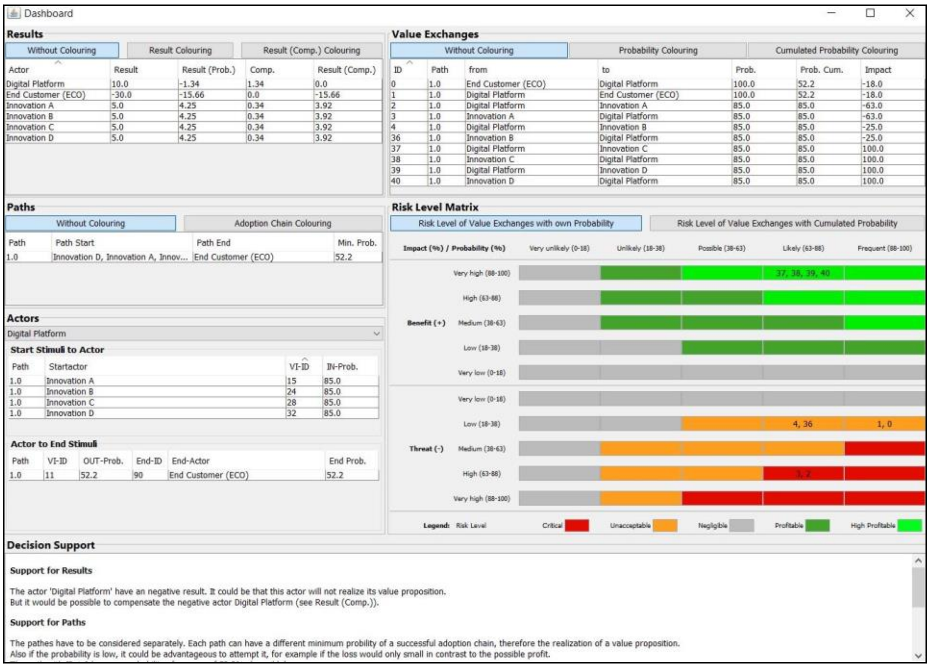

Fig. 5. Dashboard (Source: own implementation)

The component Paths shows the available paths in the value model. This example shows only one path. Further paths would be listed successively. The buttons above are useful to colour each path according to the minimum probability of each path. The used colours to colourize the value exchanges of each path are red (0 – 0.33), orange (0.33 – 0.66) and green (0.66 – 1). In the component Actors, the list field allows the selection of one actor to show which paths are arriving at it from the start point with which incoming probability. The component Value Exchanges shows which actors are connected and the direction of the path including probability and cumulated joint probability of each value exchange. The last column shows the impact of the value exchange, thus, how beneficial or detrimental it is when this particular value exchange takes place or not. The buttons enable the colouring of the value exchanges in the value model. The button With Probability Colouring colours the value exchanges according to the specified probability and impact. The button "With Cumulated Probability Colouring" colours the value exchanges according to the cumulated joint probability and the entered impact. The colouring follows the risk level matrix component, which assigns the probability and impact to a specific risk level. The numbers in the matrix represent the IDs of each value exchange. The buttons above the risk level matrix allow to show the value exchanges with the entered probability or with the cumulated joint probability. Therefore, it is possible to see which connections are critical from the beginning or only critical because of the joint probability of all actors which occur before the relationship. The Decision Support component was created using a policy and points to uncertain actors or paths, or to how a value proposition could be realized through compensation in case a partner has a deficit.

6 Discussion

The tool extension to analyse adoption chain and co-innovation risks presented in this work enables tool support for the assessment of and decision making regarding these risks. The extension artefact supports the analysis of ecosystem risks as proposed in theory [2, 7]. Our approach relies on concepts, elements, functions and other functionalities of e3tools [4] which we could extend to implement tool support for the analyses described in the literature [7]. Further, we present a dashboard that presents rich information for decision makers at a glance. Our work evidences the applicability and extensibility of the value modelling framework e3value [3], while showing some tool-based ecosystem risk analyses.

As mentioned above, value modelling tools available, such as e3tools, already support some analyses of certain business risks. However, the logics of ecosystem risks differ substantially from the implementations available. The logic of adoption chain risks follows a logic of minimums (instead of surplus) while the logic of co-innovation risks follows a logic of multiplication (instead of averages) [7]. Our extension artefact provides novel tool functionalities grounded in theory to assess ecosystem risks, and support decision making regarding distribution of income. This can enable the design of better ecosystem or alignment strategies, which in turn can lead to better platform ecosystem designs.

In this work we only dealt with co-innovation an adoption chain risks. Further ecosystem risks, especially those specific to digital platform ecosystems, may follow other logics than the ones discussed and implemented here. Further ecosystem risks were not part of the scope of this work. We hope that other researchers can extend the proposed class of tool extension and the instantiated artefact to enable tool-based analyses of further ecosystem risks. We demonstrated the utility of the tool based on examples. This means that an empirical evaluation is still needed to evidence the utility of the tool.

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