Combining visualisation techniques to understand cooperation in inter-organisational systems

María Laura Ponisio\textsuperscript{1}, Klaas Sikkel\textsuperscript{1}, Lourens Riemens\textsuperscript{2}, and Pascal van Eck\textsuperscript{1}

\textsuperscript{1} Department of Computer Science, University of Twente
P.O. Box 217, 7500 AE Enschede, The Netherlands
m.l.ponisio, k.sikkel, p.vaneck@utwente.nl

\textsuperscript{2} Dutch Tax and Customs Administration
Apeldoorn, The Netherlands
l.j.riemens@belastingdienst.nl

ABSTRACT.

Purpose To present an approach to support understanding of inter-organisational systems.

Design/methodology/approach The approach combines two types of graphical snapshots of relevant properties of each organisation, based on concrete data. The first type of snapshot provides a bird’s eye view of the network that enables matching partners to form groups based on similarity. The second type of snapshot can be used to compare and contrast the information technology (IT) portfolio of partners to assess to which extent each portfolio is ready to meet the needs of the inter-organisational system. The approach has been applied in a case study that analysed e-customs, a large distributed system that connects the customs organisations of a number of member states of the European Union. We have validated our approach by showing the results to experts in the e-customs project, who confirmed our findings.

Findings An approach based on quantifiable and non-quantifiable data that combines two visualisation techniques. The graphical snapshots obtained by applying our approach showed similarities and differences between countries that indicate opportunities and challenges in IT integration.

Practical implications The approach provides a semi-automatic method to understand inter-organisational systems. If in need of successful cooperation in groups within an inter-organisational network, our approach will help the expert to ask the right questions.

Value Understanding of inter-organisational systems is necessary, as cooperation in inter-organisational networks usually requires considerable up-front investments in IT specific for this cooperation.

KEYWORDS: inter-organisational systems, alliance formation, radar charts, landscape maps

PAPER TYPE: Research paper
1 Introduction

More and more organisations work jointly to perform increasingly complex tasks. Rather than providing services in an isolated way, organisations construct inter-organisational systems in which flows of information support joint value-creating processes of the organisations. These inter-organisational systems demand cooperation between participating organisations. Understanding how tighter cooperation can be fostered should facilitate making correct investment decisions.

Current approaches to analysing inter-organisational cooperation focus on common patterns of cooperation. Weill and Vitale (2001) identify a number of e-business models according to the principle employed to create value. For instance, one of their models is the online auction, where the principle is price finding via an auction mechanism. However, history has shown that not every instance of such a model is successful: Covisint, a very prominent online auction set up by the Big Three USA car manufacturers turned out to be a costly failure. Recent research (Gerst and Bunduchi, 2005) has shown that in this particular network (of car manufacturers and their suppliers), the introduction of this particular form of cooperation generated a shift in power that was too much for the network to accept. What we learn from this is that we not only need general principles, but also an approach that enables us, given a particular, concrete network of organisations, to identify a priori which partners have the most potential for successful cooperation. In this paper, we present such an approach, which is based on the combination of two visualisation techniques.

If the objective is to group partners for collaboration, then we need a better understanding of potential opportunities and problems on cooperation; which in turn calls for an analysis of similarities and matches between organisations. An approach that we advocate is to capture in graphical snapshots relevant properties of selected dimensions of the organisations. The first phases of our approach use quantifiable characteristics to find such similarities and matches between organisations, as we prefer to use explicit numerical data rather than non-quantifiable characteristics. Quantifiable characteristics have the advantage that they can be used together with automatic methods to reverse engineer the “big picture” in large networks. However, next to quantifiable characteristics, also non-quantifiable characteristics are relevant to analyse collaboration. Therefore, in our approach we include a visualisation technique based on non-quantifiable data.

As a running example to illustrate this approach, we use E-CUSTOMS, a case study about customs in the European Union. This example is particularly interesting because it is not a commercial business network but a governmental network, demanding a more complex analysis of similarities and matches between organisations. Goals are more fluid, political benefits are intangible, and the dynamics of inter-organisational cooperation are harder to capture.
This paper extends work reported earlier (Ponisio et al., 2007) with the inclusion of a complementing visualisation technique to enrich our approach together with an extension of the case study that includes the new visualisation, data and relevant analysis.

Our approach proved to help domain experts in reasoning about the network and detecting potentially good partners for cooperation. Comparing quantifiable characteristics proved to be helpful to understand the context, e.g., spotting potential obstacles for collaboration that suggest to not include an organisation in the collaboration attempt. From a broader perspective, results seem to suggest the conjecture that it is wise to start with projects that include a small number of participant organisations (e.g., making cooperating pairs rather than involving every organisation in a given endeavour at once).

The presentation of our findings is structured as follows. Section 2 discusses related work and relevant problems of cooperation in inter-organisational systems. Section 3 presents our approach in a nutshell. Section 4 presents E-CUSTOMS, a case study that we use as a running example to show how our approach helps us to reason about opportunities for cooperation. In Section 5, we present the results of applying our approach to the E-CUSTOMS case study. Section 6 presents a discussion on the implications of our work. In Section 7 we describe our insights for future work before concluding in Section 8.

2 Cooperation in inter-organisational systems

In this section we define the concept of inter-organisational system in the context of this work, we define the problem addressed in this paper (selecting partners for alliance formation) and we elaborate on challenges encountered by inter-organisational networks in this context.

2.1 Defining inter-organisational systems

We define an inter-organisational system as a network of organisations which jointly support value-creating processes. Information flows between the participating organisations, and the goal of the system is some result of that flow of information. Henceforth we refer to such a system simply as a network of organisations. Each organisation in the network uses a set of information systems (i.e., computer hardware, application software, datasets and possibly manual procedures) to process the information flows mentioned. This set of information systems (the IT portfolio of the organisation) includes both organisation-specific information systems as well as general IT infrastructure components (e.g., email servers).
2.2 Alliance formation in networks

Organisations participating in a network need to address problems related to mutual cooperation within this network. In particular, organisations can form alliances with other organisations in the network, which requires them to solve a number of problems (Gulati, 1998), e.g., how to select partners, and how to govern the alliance. The problem addressed in the present paper is the partner selection problem: How to decide which participants in the network are the most suitable alliance partners? In the context of this work we do not question that the network should be formed (the network was formed for external reasons e.g., political reasons). Rather, we aim to identify opportunities for cooperation among organisations belonging to the network by forming alliances.

Better understanding of characteristics of potential partners, their similarities and differences should help stakeholders to improve detecting potential problems and opportunities for collaboration. Currently, such understanding is based solely on the experience of stakeholders, and fashioned from particular ad-hoc tools available to the stakeholders such as text documents, tables and graphs. In short, it depends on the discipline and creativity of the people, rather than being systematic.

In the organizational research literature, alliance formation has been explained from several angles. Eisenhardt and Schoonhoven (1996) and Das and Teng (2000) approach alliance formation in terms of resource dependence: organizations form alliances as one means to acquire resources that they need, but cannot acquire in another way. Results in this area of research generally take the form of correlations of quantities aggregated for a particular industry or market-segment. For example, Eisenhardt and Schoonhoven found that the rate of alliance formation increases with the number of competitors in a market. Another approach to alliance formation is the study of research and development partnerships (Rosenkopf et al., 2001; Hagedoorn, 2002; Belderbos et al., 2004). Here, alliance formation is viewed as a way to “[obtain] access to and control of technical and strategic knowledge as well as opportunities to increase visibility as legitimate actors and potential partners in the technological community.” (Rosenkopf et al., 2001, p. 750). Again, results usually take the form of correlations between quantities aggregated at the level of a particular industry or market segment. For example, Rosenkopf et al. show that participation in technical committees (e.g., of a standards organization such as the International Telecommunications Union) correlates with alliance formation.

Aggregated correlations help to understand how the phenomenon of alliance formation is related to other phenomena, such as competition or participation in technical committees. However, for managerial decision making, this is not enough: a manager needs to decide precisely which members of the network are suitable partners to form an alliance with. Our paper therefore aims to develop understanding at the level of individual network participants.
2.3 Challenges presented by inter-organisational networks

In this section we elaborate on challenges and opportunities presented by planning cooperation in networks as they are reported in related work. In the rest of this paper, we analyse the utility and scope of our approach from the perspective of these challenges.

1. Characterisation of participants when planning the network

Inter-organisational coordination needs the alignment of multiple perspectives, i.e., strategic goals, value propositions, processes and information systems, across participating organisations. Figure 1 depicts an inter-organisational alignment framework (Derzsi and Gordijn, 2006) that stresses the possible alignment issues in networked business settings. But is it realistic to expect the alignment of every perspective? If only some of these perspectives could be aligned, then which ones would they (in a real system) be?

Moreover, we observe that much of the discussion in practice while planning a business network is about information systems and levels above them such as strategic goals. But this model lacks a concrete description of specific properties of attributes to study when planning the network. In particular it lacks descriptors to characterize participants in the network, which are needed to compare participants. Comparing participants is a way to spot differences among them, as participants may run their organisations in different manners. Differences between participants indicate spots of possible problems even before the network starts.

Fig. 1. Inter-organisational alignment framework (Derzsi and Gordijn, 2006) indicating multiple perspectives to align.

2. Distribution of power

If power relations are unbalanced in a network of power-dependency relations, there are mechanisms to restore the balance. For instance, the weaker actor may withdraw his interest in the relationship, or two weak
actors may form a coalition against a stronger actor. Balancing alterations change the power relationship, tending to reduce power advantage (Emerson, 1962). Given the permanent tensions of imbalance in the power relations these changes happen continuously, and the relation moves then toward a temporary state of balance.

Previous work derived a theory of power relations that explains the possible balancing operations (Emerson, 1962) and recognised the importance of addressing power relationships to coordinate inter-organisational networks (Evermann, 2006). However, understanding the distribution of power is not straightforward. Working out efficient plans for collaboration includes determining which aspects are to count. If power is concentrated in some actors, which perspective will be used to detect them? Which operational definitions will connect generalising concepts from theory with concrete features of a specific system?

Our problem and the perspective of analysis chosen in this paper suggest to seek better understanding of opportunities and challenges for cooperation rather than to focus on determining who are the most powerful players per se and the impacts of power-dependence in corporate or conventional network (as, e.g., by Cook (1977)). We add distributing of power as a challenge because understanding the distribution of power might highlight dimensions to take into account when selecting partners to cooperate with, improving thus our understanding at the time to make a decision.

3. **Opportunistic behaviour**

Traditionally, opportunistic behaviour refers to the way an economic agent operates, characterised by exploiting a certain advantage for its benefit and in detriment of other participants of an agreement (Williamson, 1975).

In the context of a network of organisations, participating organisations take advantage of their strengths for their own interest (Moulaert and Cabaret, 2006). An economic agent holding information can deliberately make use of the asymmetric information advantage for its benefit and in detriment of other participants of a contract.

Previous research identified opportunism as a critical transactional factor steering activities between business or governmental organisations (Williamson, 1993). It suggested to solve this problem by understanding the complex interactions between the agents and by advising each participating organisation to give and receive credible commitments. Moreover, interaction between individual goals and the group goal, as both evolve, raises the question whose objectives the network is to promote, a question that in turn opens the door to the need to distinguish opportunism from behaviour instrumental to the concretisation of the network goal (Samuels, 1977).

4. **Development process evaluation**
Development processes in inter-organisational networks are complex and risky, in general lacking the means to measure sustainable gain. In some cases they have a political benefit as driver of the evaluation. Political benefits are intangible and not measurable in euros. Therefore, evaluating processes in inter-organisational networks becomes a key skill with yet unclear descriptive concepts.

Maturity models can be used to evaluate and improve processes. In the area of collaborative work, examples of maturity models are the interoperability maturity model (Clark and Jones, 1999), the supply chain management maturity model (Lockamy III and McCormack, 2004), and the maturity framework for managing distributed development (Ramasubbu et al., 2005). However, existing maturity models do not sufficiently address inter-governmental networks and practice shows that descriptive concepts that are more expressive for inter-governmental networks are still missing. We need to extend existing models with concepts specific for inter-governmental networks.

All in all, networks are complex structures with multiple perspectives to coordinate. To manage them, we must first understand them. Participating organisations need guidelines on the practice of selecting peers to collaborate with. Governing organisations need guidelines to balance the common purpose of the network against opportunistic behaviour. To the best of our understanding, cooperating organisations lack a general approach to detect problems up-front and to describe hands-on approaches at a theoretical level.

3 Exploiting properties and visualisation to understand cooperation

In the previous section, we have seen that planning cooperation in a network is about understanding. Moreover, we have seen that understanding the network can be approached from a number of perspectives (characterising participating organisations, understanding distribution of power, detecting opportunistic behaviour, and evaluating development processes). Understanding and prioritising these perspectives forms the basis of our approach, of which we give an account in this section.

3.1 Comparing participating organisations

In order to understand how tighter cooperation can be fostered, we have to find a way to compare characteristics of participating organisations. That would give us understanding of some dimension of the network. For instance, if we could compare the degree of IT development of the involved organisations, we could capture the current power relations—in the technology dimension—of a given network.
We conjecture that having a graphical snapshot of relevant properties of the organisations contributes to the assessment of how well partners fit together. In this paper we do so by gathering quantitative data about important aspects of the network, and visualising them via radar charts (Henderson-Sellers, 1996).

In practice, participants in the network may be characterised from a number of perspectives (e.g., degree of IT development and maturity of processes). In turn, each perspective highlights a number of features to characterise participating organisations (e.g., degree of standardisation, amount of transactions). Every single feature might be important. Our approach does not suggest which kind of features to analyse, requiring only to have access to data on some quantifiable features. There could be many features that are interesting, but which to choose depends on the problem at hand. Moreover, domain knowledge is needed for insight and the expert should determine which feature to use according to her experience and the context. ¹

By now we have all the key elements of the research method used in the first part of our work. Figure 2 gives an account of how they fit together.

Fig. 2. Putting together quantifiable descriptors to characterise participants of inter-organisational networks.

3.2 Understanding existing IT portfolios

After understanding how tighter cooperation can be fostered, and having found potential partners for close collaboration, we can start analysing existing IT portfolios of the organisations involved in detail. The goal of

¹ For example, the Dutch Tax and Customs Administration made a questionnaire to get insight about customs of some countries. They identified four profiles which could be seen as high level characteristics. And within these profiles, more detailed questions revealing corresponding characteristics. For the domain of customs, this gave them a good understanding of the customs of each analysed country.
this is to assess how much each partner needs to change to meet the needs of the network. We do not assume
that potential partners need to have identical portfolios, and thus the goal is not to determine how much each
partner must change to reach a situation where IT portfolios are identical. However, for close collaboration,
parts of the portfolio may need to change, and this has to be determined.

For instance, if A and B are organisations planning to collaborate closely, then systems of A and B must
match before collaboration can take place. In other words, to collaborate closely, information systems of A and
B must have already reached a certain maturity level and A and B must be willing to invest in their systems.
Moreover, if A is mature enough to manage electronic transactions, but B cannot, the process of A transacting
with B will not run as smoothly as if B were able to process electronic transactions.

This leads us to reason that planning cooperation requires decisions made by domain experts e.g., can A’s
systems be adapted on time to interface with the systems of B? We propose to use landscape maps (van der
Sanden and Sturm, 2000; van der Torre et al., 2006) to understand the existing infrastructure perspective.
Landscape maps are tabular representations that can be used to visualize the architecture of an information
system infrastructure. In our approach landscape maps have the role of giving an overview of the IT portfolio
of a given organisation. This view is detailed enough to help experts to reason about the system, for instance
about how transition to a close collaboration situation would be. Figure 3 shows an example of a landscape
map and we present (parts of) two landscape maps in detail in Section 4.7.

Fig. 3. Landscape map of one organisation in the network.
Landscape maps have been made popular in The Netherlands by a well-known textbook on information systems planning (van der Sanden and Sturm, 2000). Landscape maps are introduced as a visualisation tool for shaping the organizational architecture (van der Sanden and Sturm, 2000, p. 318). They are also used, as in our approach, to visualize the allocation of business functions to software applications per case: which applications support which systems for which cases. The paper of van der Torre et al. (2006) is the only recent scientific report on landscape maps that we are aware of. In this paper, van der Torre et al. present algorithms for automatic generation of landscape maps from a repository, as well as algorithms for updating the repository contents by manipulating these landscape maps (a problem that is analogous to the problem of view updating in relational database systems). Landscape maps can be traced back to Martin (1989), who in the Information Engineering approach frequently uses two-dimensional tabular representations of information systems to determine clusters of functionality.

3.3 Our approach step-by-step

In the previous sections we have proposed to exploit radar charts and landscape maps to compare organisations. In a first phase, putting together quantifiable descriptors helps experts to characterise participants of inter-organisational networks, to compare them by getting the big picture. After selecting candidates for cooperation, landscape maps provide detailed pictures of IT portfolios (such as needed unification of internal systems to facilitate interfacing with foreign applications), which in turn helps experts to foresee changes required to meet the needs of the network. We have now all the elements of our approach and to describe it explicitly, we present the following step-by-step structure:

1. Identifying potential partners.
2. Identifying common goals / problems.
3. Defining comparable characteristics.
5. Making radar charts to compare.
6. Grouping partners with similar characteristics.
7. Planning transition through an overview of a partner’s IT portfolio.

4 The E-CUSTOMS case study

This section gives an account of the application of our approach in E-CUSTOMS (our case study). It shows how our approach can be useful to find key coordination issues in a concrete inter-organisational network; which in turn helps the expert to understand and analyse potential cooperation between its organisations.
The European Commission aims to improve ensuring safety of the external borders of the European Union, and facilitating trade. Therefore, it has established a network of all its member states. As a result, customs organisations of 27 member states of the European Union have to act as if they form one virtual customs. The network has been in place for many years, but all the new demands make it necessary to cooperate in order to fulfil these demands. Recognising a lack of information required to find opportunities for collaboration, the Dutch Tax and Customs Administration conducted between January 2005 and October 2005 a study that compared current organisational context, business processes, systems and future ambitions of ten members states. That study is called “Benchmarking Customs IT Architecture”. The benchmarking study provided the data needed to analyse opportunities for cooperation. With the experience and data gathered in this study, customs experts produced a report suggesting guidelines to foster the cooperation. However, the analysis of ‘with whom to cooperate’ was performed on an ad hoc basis.

The example provided useful data, as it showed the customs-networking profiles of each country. Customs belonging to the sample revealed their profiles by answering questions about their organisation, transaction, technology, and processes-and-systems. Each of these profiles contained information on staff size, transaction volumes, number of inspections, IT architecture (in the form of landscape maps), ambitions and best practices among others. Moreover, the final report provided a source of valuable guidelines against which to compare the results that we obtained with our approach.

In the following sections we explain our running example and the application of our approach on that example. In the case study, we applied our approach to the data provided by “Benchmarking Customs IT Architecture” and we reasoned about potential cooperations, their opportunities and challenges. We derived then our conclusions independently from the conclusions obtained by custom experts. At a later step, we compared our conclusions regarding opportunities for cooperation with those of customs experts. We observed that the conclusions derived from using our approach matched the conclusions of the customs experts who performed the benchmarking.

### 4.1 Identifying potential partners

The potential partners are the customs organisations of all 27 EU member states. In the case study, we limit this to the 10 countries covered in the report.

### 4.2 Identifying common goals / problems

The long-term goal is to obtain unified e-customs throughout the EU. It should “make custom clearance more efficient, reduce administrative burdens, combat fraud, organised crime and terrorism, serve fiscal interests,
protect intellectual property and cultural heritage, increase the safety of goods and the security of international
trade, enhance health and environmental protection and allow for a seamless flow of data between export and
import countries.”, as stated in the strategic plan of the European Commission. The problem is that this is easier
said than done. There is no way a new network can accomplish everything at once, so the issue is to identify
first steps towards these lofty aims that have a reasonable chance of being successfully implemented.

4.3 Defining comparable characteristics

There are several dimensions of the network that could be analysed (such as organisation, technology, or pro-
cesses). We chose to analyse transaction volumes and organisation because these dimensions count with simple
metrics and data available from the benchmarking. Number of import declarations, number of inspections, staff
size and population are all quantifiable descriptors. Moreover, they match with the role of the network of en-
suring safety of the external borders of the European Union and to facilitate trade. Finally, import volumes and
controls say something about customs activity and structure: customs with higher volumes must put in place
procedures and information technology to support importing large quantities; e.g., procedures and information
technology to increase the speed of importing.  

There is no guarantee that only quantifiable characteristics are sufficient to solve a problem. However, in the
E-CUSTOMS case study these characteristics seem to help in planning collaboration as transaction volumes and
staff size are useful indicators to determine partner organisations for collaboration. Two member states with
similar contexts and the same transaction volumes show opportunities for cooperation, since solutions for the
same range of volumes facilitate the match. A system for 10,000 declarations is totally different from a system
for 10,000,000 declarations.

Our approach characterises participants according to quantifiable descriptors. We do not ask if a participant
should be added to the network because the network has been formed already. Rather, we address the question
of which participant to study in detail. This depends on the specific network that is being analysed and on the
available data. These participants could be chosen randomly, or after careful study of the available population.
Moreover, the expert could choose to select all participants of the network for visualisation. For E-CUSTOMS
we chose the participants that had data in the benchmarking case study.

The characteristics to be visualised are a subset of data related to the import process; which is related to the
problem to solve. The concrete data that we use to describe each customs organisation are:

\footnote{We do not include geographical situation (e.g., having borders or not with countries that do not belong to the Euro-
  pean Union) because every member state with an international airport has an external border with non-European-Union
countries.}
- **Import declarations**, which is defined as the total number of import declaration form files in one year received by the analysed country.

- **Import inspections**, which is defined as the total number of declared forms that are physically inspected against the imported goods.

- **Staff size**, which is defined as the total number of employees in Full Time Equivalents (FTE).

- **Ratio of control** is defined as the ratio of import inspections over the import declarations.

- **Declarations per 1000 inhabitants** is defined as the import declarations divided by the number of inhabitants in units of 50 \(^3\).

### 4.4 Collecting information

The data for the descriptors identified above are taken from the study “Benchmarking Customs IT Architecture”.

### 4.5 Making radar charts to compare

Before we can compare the customs of each country with one another, the data have to be normalised in some way. We normalise the numbers by computing the percentage of each descriptor in the total of the sample. The figures for one analysed country are as follows:

- **% import declarations** is defined as the percentage of import declarations in the (total import declarations) of all countries in the sample.

- **% import inspections in the network** is defined as the percentage of import inspections in the (total import inspections of) all countries of the sample.

- **% staff size** is defined as the percentage of staff size in all countries.

- **% ratio of control** is defined as above, not needing further normalisation.

- **Import declarations per 50 inhabitants** rather than 1000 inhabitants so as to fit the scale.

Normalisation in percentages allow us to compare customs profiles. Table 1 presents the normalised data describing customs of each country.

In the previous section, we defined the descriptors for a country. In this section we use our running example to illustrate how the shapes of the diagrams capture in a graphical snapshot the relative importance of the features depicted.

\(^3\)inhabitants are the estimated population for 2006.
We can visualise features of one country by means of radar charts (Henderson-Sellers, 1996). Figure 4 gives a visualisation of the first row of Table 1 (data for Country A) and its radar chart. The chart presents the concrete information to describe the profile of each customs: its axes represent the percentage in import declarations, percentage of import inspections, percentage of staff size, ratio of control, and number of declarations per 50 inhabitants, of Country A.

The axes shown in Figure 4 have a scale from zero to 50. They describe the customs of one country. 50 is a pragmatic upper limit because the highest figure is around 43.

The radar charts of the 10 countries that participated in the study are shown in Figure 5. The grouping that we make in Section 4.6 is also represented in Figure 5.

<table>
<thead>
<tr>
<th>Country</th>
<th>Import declarations (%)</th>
<th>Import inspections (%)</th>
<th>Staff size (%)</th>
<th>Ratio of control</th>
<th>Imp. Decl. per 50 inhabitants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country A</td>
<td>24.12</td>
<td>41.15</td>
<td>30.87</td>
<td>11.73</td>
<td>6.67</td>
</tr>
<tr>
<td>Country B</td>
<td>40.50</td>
<td>31.21</td>
<td>20.85</td>
<td>0.05</td>
<td>15.22</td>
</tr>
<tr>
<td>Country C</td>
<td>9.66</td>
<td>2.27</td>
<td>16.22</td>
<td>0.02</td>
<td>3.43</td>
</tr>
<tr>
<td>Country D</td>
<td>1.43</td>
<td>12.94</td>
<td>11.88</td>
<td>0.62</td>
<td>0.85</td>
</tr>
<tr>
<td>Country E</td>
<td>6.32</td>
<td>5.63</td>
<td>8.17</td>
<td>0.06</td>
<td>2.44</td>
</tr>
<tr>
<td>Country F</td>
<td>5.05</td>
<td>3.67</td>
<td>4.38</td>
<td>0.05</td>
<td>6.94</td>
</tr>
<tr>
<td>Country G</td>
<td>5.50</td>
<td>1.03</td>
<td>2.86</td>
<td>0.01</td>
<td>2.78</td>
</tr>
<tr>
<td>Country H</td>
<td>5.82</td>
<td>0.04</td>
<td>1.95</td>
<td>0.00</td>
<td>14.51</td>
</tr>
<tr>
<td>Country I</td>
<td>1.19</td>
<td>1.46</td>
<td>0.42</td>
<td>0.08</td>
<td>4.54</td>
</tr>
<tr>
<td>Country J</td>
<td>0.36</td>
<td>0.54</td>
<td>2.15</td>
<td>0.10</td>
<td>2.29</td>
</tr>
</tbody>
</table>

**Fig. 4.** A chart showing our characterisation of Country A participant of the network.
Fig. 5. Ten countries belonging to E-CUSTOMS grouped by their working styles.
4.6 Grouping partners with similar characteristics

Figure 5 shows the different working styles of ten sample customs organisations of countries in their dealings with imports, inspections and staff. The graphical snapshot facilitates spotting usual and unusual combinations of features. Countries are grouped based on similarity in the transaction dimension and each group represents a pattern to be considered at the time of planning cooperation.

**Group P** (*Big Importers*) consists of countries having large numbers of import declaration forms, inspecting a comparatively high percentage and having large amounts of staff.

**Group Q** covers countries with middle values. Those are the so-called "normal" countries, some with more import declarations than the others regarding population. In this kind of groups, the first analysis puts organisations in the same box. A second analysis allows the expert to derive more detailed information about the group members.

**Group R** (*Small Importers*) consists of countries with small numbers in every depicted feature; i.e., receiving much less import declarations, inspecting less and having less staff. Countries in Group R (Country I and Country J) are the two countries in the sample with smallest population size; which could explain the small role played in the dimension depicted by the radar charts.

Identifying different and similar approaches is done according to a combination of criteria. In grouping countries, both size (i.e., value on every chart axis) and the pattern that those values form (i.e., the combination of values on every axis) are equally important to detect opportunities for collaboration or to exclude potentially difficult collaborations. There are no strict threshold values that determine whether two countries are different or similar because at this stage of the analyses customs experts are exploring data and opportunities. Exploratory search for patterns requires a degree of flexibility during the search, instead of strict rules. Visualisation suits it by revealing patterns that experts did (not) expect, opposing to preconceived ideas of how the grouping should be.

For instance, consider Country B and Country E. Customs organisations of these countries have similar patterns, but the values of Country B are in general much larger than those of Country E. This does not mean that these two countries *have* to belong to the same group, or different ones, according to a strict rule. Instead, their similarity according to one criterion (shape) and difference according to another (size) favours useful discussion: Do Country A and Country B have automatic procedures to process such large volumes of import declarations? Does Country E have them? Does Country C (the statistical outlier with regard to staff size) have it? How significant is automatisation for the kind of collaboration aspired?

Figure 6 presents an example of countries taking different approaches regarding imports. In the left half we see two countries with *different* approaches and in the right half we see two countries with *similar* approaches.
Country C and Country D appear on the left of Figure 6. Comparing their radar charts we see that they assign different importance to inspections. Country D inspects more than Country C even though the amount of import declarations that it receives is significantly lower. Nevertheless, Country C is a statistical outlier with respect to staff level. This configuration (less inspections but more staff), suggests a potential obstacle in the collaboration between Country C and Country D, since their approach to handling import transactions is very different.

Country E and Country F have similar approaches dealing with imports. Figure 6 shows that inspections on imports and the staff employed are similar and correspond to the volume of their import declarations. This situation indicates that priorities of each customs are compatible, which facilitates collaboration.

### 4.7 Planning transition through an overview of a partner’s IT portfolio

After getting a snapshot of the whole inter-organisational network, we need a thorough understanding of the IT infrastructure supporting each organisation. To obtain that understanding we propose to visualise in detail the IT portfolio of organisations that are candidates to closer cooperation by means of landscape maps.

In landscape maps, the information systems that comprise an organisation’s IT portfolio are clustered according to two dimensions, which can be chosen arbitrarily. In our case study, the horizontal dimension of the landscape maps consists of process categories, while the vertical axis consists of information systems (IS) functions in the top half of the figure and data areas in the bottom half. As can be seen in Figure 3 in Section 3.2, the Application X1 system covers three functions (‘risk selection’, ‘levying’ and ‘revenue collection’) for a large number of process categories (e.g., ‘import’ as well as ‘export’; see the second and third column in the ‘cargo and post arrival’ section in the upper-left hand corner). The Application X1 system also manages five data areas (‘Declarations’, ‘Reconciliation’, ‘Payments’, ‘Accounts’, and ‘Licenses/guarantees’) across all
but three process categories. Most information systems in Figure 3 have a horizontal orientation: integration is per function across process categories (‘functional silos’), not per process across functions (process-oriented information systems).

Figure 7 depicts the landscape maps of Country E and Country F, zooming in on the area of cargo and post arrival processes. For reasons of space, only the magnified parts are readable (the labels on the axes are the same as in Figure 3). In this example we observe that Country F possibly has to redesign and rebuild some information systems to meet the needs of the network. For instance, suppose that close cooperation with a partner requires redesign of the risk selection function (see leftmost column) across all processes for cargo and post arrivals, integrating electronic data interchange. In that case, the landscape map of Country F indicates that this change affects multiple information systems, while for Country E it only affects one (Application X1). Whether this is really the case, and whether this is a significant obstacle to closer cooperation, is a question that only domain experts can answer. Our point is that landscape maps help experts to identify the right questions.

![landscape of country E's IT portfolio](image1)
![landscape of country F's IT portfolio](image2)

**Fig. 7. Landscape maps of Country E and Country F.**

Comparing the two landscapes we see that the IT portfolio of Country F is much more diversified than the portfolio of Country E. Moreover, Figure 7 helps experts to point at the system changes that need to be implemented to adapt both countries for cooperation. For instance, Country F could unify the systems used for processing cargo and post arrival of goods. Indeed, off-the-record sources of information revealed that Country F aspires to have old legacy procedures (for cargo and post arrival) integrated and that Country F is currently implementing upgrades toward that goal.
5 Results

The visualisation in the E-CUSTOMS case study was based on data in the report “Benchmarking Customs IT Architecture”, without knowledge of the conclusions drawn from these data. The grouping as shown in Figure 5 was inspired by radar charts (made by non-experts in customs), and in fact without deep knowledge about customs. These results were discussed with customs experts who had participated in the original benchmarking study. The experts found the reasoning leading to the potential cooperation was surprisingly correct, and the proposed grouping matched their insight. Together with non-quantifiable characteristics, the approach was good to understand the context, having the potential to help experts on reasoning about planning collaboration.

In the particular case of the case study, most of the chosen properties (percentage of import declarations, percentage of import inspections, percentage of staff size, and ratio of control) made sense to the experts. The exception was the property called number of declarations per 1000 inhabitants, that experts found original. To the contrary, the experts themselves would have added the number of traders doing import declarations and volume of transit (goods passing through the country on their way to another country that imports them), as countries with high volumes of transit need advanced logistics. Our charts do not include them because that data was not available to us for every country in the sample, and therefore we cannot make any claim as to what these extra measures would have revealed in our analysis. However, we do believe that, provided that data is available, our approach is flexible enough to incorporate more measures into the analysis by adding an extra axis in each radar chart displaying that information.

All in all, reflecting on the potential of the approach applied to general situations, experts could relate to this approach, finding it useful to detect opportunities of collaboration with potential synergetic partners. Moreover, landscape maps fit in our approach, helping experts to analyse how realistic the planned or desired collaboration is. Hence the case study gives circumstantial evidence that this visualisation technique can be used together with non-quantifiable characteristics to detect potential partners for cooperation based on similarity.

5.1 Validity of the case study

Construct validity (do the metrics measure what we want to measure) deserves some questioning. Because all customs organisations in the European Union have their own way of defining and measuring things, it is hard to get truly comparable data (though the benchmarking provided high quality harvested data).\(^4\) There are several other properties that could be of interest, e.g. degree of IT architecture development, process maturity level and

\(^4\) Private communication revealed that the benchmarking and its data proved to be extremely useful to support customs experts in their reasoning about countries, their customs and IT.
areas with greater aspiration for development; but there are no hard data for this. We decided that it is best to restrict ourselves only to those properties that could be objectively quantified.

*Internal validity* (does the method lead to the right conclusions in this case study), nevertheless, has been established as high by the customs experts. Experts agreed with the grouping as shown in Figure 5. The bigger picture enhanced with non-quantifiable characteristics has the potential to help in reasoning to plan cooperation. It also showed that harvesting comparable characteristics (quantifiable as well as non-quantifiable) is needed to identify collaboration partners.

*External validity* (can it be generalized to other cases) is something we cannot prove, but the result of this case study is encouraging at the very least. Visualisation by means of radar charts has been successfully used in a number of different domains (e.g., understanding modularity of large object-oriented software systems (Ponisio, 2006)) and it did work convincingly in this case study. According to the experts, the application of our approach (together with non-quantifiable characteristics) to the case study forms a “kind of reverse engineering” process. Hence with some confidence we conjecture that it is a useful technique for spotting similarities and differences that could support or obstruct IT effectiveness in networked cooperation.

6 Discussion

6.1 Analysing the scalability of our approach

Scalability of our approach can be analysed from different perspectives such as its potential to capture a snapshot of what is happening in a large network, loss of details, capability to communicate non-quantifiable characteristics and capability to visualise more complex diagrams (e.g., adding more axes to each diagram).

We conjecture that our approach can support visualisation of large networks. Once the expert has decided which characteristics to visualise and harvested the data, the remaining tasks are mechanical, while radar charts specially favour the detection of repeated visual characteristics (i.e., visual patterns).

Small figures in the data result in small pictures in the diagrams; which become hard to read. In particular cases, when the snapshot and the circumstances reveal challenges or opportunities for collaboration, the expert can always scale the diagrams that she needs to analyse in detail. In general, to have a few markedly smaller radar charts is simply indicating a group of members of the network with the property of being smaller. This may encourage the expert to take some action. For example, the expert can decide to exclude them from plans of collaborating with “bigger” organisations or to analyse them in detail in a second instance. In theory, radar charts can have as many axes as needed. In practice, however, the number of axes is limited since the human eye has a limit to capture details (Ware, 2000).
Landscape maps are used in the Dutch tax administration and other large and medium-sized organisations in The Netherlands to visualise IT portfolios of substantial size, which we think shows that they scale to situations that are relevant for practice. The landscape map of the entire customs domain fits (in a readable way) on a sheet of A3 paper and can be created and maintained with commonly available tools. Landscape maps are supported by the ArchiMate framework (Lankhorst, 2005) for architecture modelling and its tools (van der Torre et al., 2006). We have found landscape maps to be useful to map IT portfolios, but in the context of this paper we cannot make any claim about whether landscape maps could be used to map other aspects of an organisation. However, we do believe that landscape maps are potentially useful in other cases because they are scalable and general enough to describe a large variety of mappings. Van der Sanden and Sturm (2000) use landscape maps both for business process modelling as well as for modelling the IT portfolio that supports these processes.

6.2 Generalisation to other networks

Based on the results of our case study, we allow ourselves to conjecture that the key to cooperation seems to be using a wide spectrum of characteristics to search for opportunities for collaboration and then to execute small projects in small groups. Small projects are easier to manage, and smaller organisational groups inside the business network increase interoperability. Running smaller projects first rather than trying to do everything at once makes sense, since smaller projects have, for instance, the advantage of capturing cultural differences without increasing risk. As a counter-argument to this conjecture, we mention the role of the European Commission, not really as a participant in the network, but as a body that defines legislation and implementation provisions that are mandatory for all participants. Not all networks have that type of actor involved.

6.3 Exploiting visualisation to plan cooperation

We have observed that planning cooperation requires thorough understanding of complex interactions and is performed today in an ad-hoc way depending on creativity and communication skills of the team of experts. In practice experts use some of the available tools such as landscape maps (van der Torre et al., 2006). Visualisation techniques have been successfully used to understand complex systems because they help to uncover hidden patterns (Tufte, 1990, 1997). These patterns may complement the view that experts working on the system have in mind, suggesting points of interest for a second analysis.

We have found that this visualisation technique has the potential to help experts in understanding inter-organisational networks if the experts can obtain reliable data and identify relevant measures. We cannot make any claim about whether our method would improve understanding in inter-organisational networks where
organisations are not cooperating. However we do believe it would improve understanding because it is systematic, it reveals patterns that might surprise the experts and the patterns are supported by quantifiable data.

6.4 Our approach and its support to challenges in cooperation

In this section we review the relevant problems of cooperation in inter-organisational networks discussed in Section 2.

1. Characterisation of participants when planning the network. Figure 5 and Figure 7 are examples of graphical snapshots characterising participants of a network. Being traditionally useful for identifying strengths and weaknesses, radar charts help experts to compare characteristics of the members of the network. Comparing quantifiable characteristics is useful to understand the context and it may also be a means to exclude countries. Therefore, the pictures support expert understanding of the context of collaborations and to focus (in a second step) on details of the more promising collaboration partners. Our case study provided circumstantial evidence that useful characterisation of the participants is possible provided that the characterisation is used in combination with non-quantifiable characteristics, of which our use of landscape maps is an example.

2. Distribution of power. Apart from the detection of big, normal and smaller players in a determined dimension, our approach does not provide significant insight about distribution of power. For instance, a participant with small values depicted in the radar chart may be extremely powerful in other characteristics that are not depicted in that diagram. Representation of the distribution of power depends on the problem, on the depicted quantifiable characteristics, and on non-quantifiable characteristics.

3. Opportunistic behaviour. Using our approach we could not find cases of opportunistic behaviour. This seems to be specific for this case study. Our results show that our approach facilitates understanding of the complex interactions between participants in a network, and therefore we expect that our approach supports spotting possibilities for opportunistic behaviour when they are present.

4. Development process evaluation. E-CUSTOMS revealed qualities of the network or properties of the network that facilitate understanding and management of collaboration. Examples of these properties are “presence of big importers” (or big actors in general terms), “presence of small importers” (or small actors), and “presence of markedly different partners”. We conjecture that our approach (facilitating to spot existing properties) can be a valuable help to derive more precise maturity models for business networks. Together with non-quantifiable characteristics, it could be used as a kind of reverse engineering tool, deriving properties in a semi-automatic way rather than via interviews with experts on development process
evaluation and focus sessions (which are the usual way to develop such models). Our case study seems to indicate circumstantial evidence of that potential in our approach.

7 Future work

Our approach depends heavily on the specific knowledge of the expert that is planning collaboration. For instance, there might be valid reasons for choosing not to visualise a characteristic (e.g., the characteristic depends on another characteristic that is already in the radar chart) that only experts can identify. Therefore, future work would be on the one hand to find more ways to combine our approach with non-quantifiable characteristics, and on the other hand to find guidelines that help to prioritise characteristics used to compare members of the network according to their relevance. In a sense, the problem is like that of capturing requirements: at the time of planning collaboration, there are a number of explicit and tacit requirements that experts have to prioritise.

Future work should as well follow the line of analysing, in depth, more case studies. Such an analysis should reveal novel properties of such networks. We also conjecture that such properties would help preventing problems in business networks and would help to extend existing maturity models.

8 Conclusion

In this paper, we present a systematic approach to understand opportunities and problems in cooperation in an inter-organisational network. Understanding how tighter cooperation between organisations belonging to an inter-organisational network can be fostered should be able to help, for instance, in planning collaboration between them; which in turn would help in making correct investment decisions around the network’s goal.

The approach that we advocate in this paper is to capture in graphical snapshots relevant properties of the organisations in a network. These graphical snapshots indicate similarities (and differences) between organisations. These similarities are used to determine which organisation matches with which other organisations. The starting point in our approach are quantifiable characteristics to find such similarities and matches, i.e., we base our approach on explicit numerical data (rather than on characteristics that are hard to quantify). In this way, our approach supports traditional methods of analysis that are based on non-quantifiable data, which are also needed for a thorough understanding of a network. To assess how much change is needed in the IT portfolio of each partner, we visualise the IT portfolio using landscape maps.

The approach has been tried out in a case study that serves as a running example in this paper. The case study analyses E-Customs, a network consisting of customs organisations of member states of the European Union. Recently, new demands have appeared forcing member states to search for partners to collaborate in
joint systems development efforts to achieve the network goal. But how to choose such partners in such a complex network with multiple dimensions as this inter-governmental network?

In the application of our approach to E-CUSTOMS, we have analysed member states in a transactional and an organisational dimension (i.e., acknowledging only their dealings with imports, inspections, staff and population). Jointly, these dimensions are characterised by five features. These features are diagrammatically represented to form the graphical snapshot with which we compared customs organisations to describe opportunities for cooperation. In particular we could find patterns in working styles of the countries and group them accordingly (e.g., small importers and big importers). We could spot markedly different working styles such as lots of controls and lots of staff. Landscape maps helped to visualise differences and similarities in the IT portfolios of selected countries. Our approach supported the expert in reasoning about opportunities for collaboration and making the right questions. We have validated our approach by showing the results to experts in the E-CUSTOMS project, who confirmed our findings.

ACKNOWLEDGEMENTS

We gratefully acknowledge the anonymous reviewers for pointing out better ways to explain the usefulness of our approach. We gratefully acknowledge the financial support of the Dutch Jacquard program for the project “QuadREAD”.

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