A Resource Dependence Perspective on Modelling Inter-Organisational IS Collaborations

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Abstract
This paper analyses the versatility of the Dependency Network Diagram (DND) method for modelling inter-organisational IS collaborations from a resource dependence perspective. Originally developed to facilitate the designing and optimising of structures, work processes, and supporting IT; the DND method shows signs of a potential broader usage toward managing such collaborations. Deploying a case study from the Australian electricity sector, the paper presents evidence that the DND method can partially be used for understanding dependencies but is limited for managing them. This is because the DND method – although predicated on resource dependence theory – does not fully align with the theory, limiting its versatility with respect to actively managing resource dependencies in inter-organisational IS collaborations.

Keywords: Collaboration, Dependency network diagrams, Inter-organisational networks, Modelling technique, Resource dependence theory
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Abstract
This paper analyses the versatility of the Dependency Network Diagram (DND) method for modelling inter-organisational IS collaborations from a resource dependence perspective. Originally developed to facilitate the designing and optimising of structures, work processes, and supporting IT; the DND method shows signs of a potential broader usage toward managing such collaborations. Deploying a case study from the Australian electricity sector, the paper presents evidence that the DND method can partially be used for understanding dependencies but is limited for managing them. This is because the DND method – although predicated on resource dependence theory – does not fully align with the theory, limiting its versatility with respect to actively managing resource dependencies in inter-organisational IS collaborations.

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1.0 Introduction
Over the past three decades one could witness increased research on inter-organisational IS collaborations. These collaborations involve always dependencies between collaborators; and managing such dependencies is an essential precondition for any collaboration to succeed, because it reduces uncertainty and safeguards a collaboration’s stability (Pfeffer & Salancik, 1978).

While IS research on inter-organisational IS collaboration has focused on a variety of aspects – including technological competencies acquisition (Steensma, 1996), competitive advantage creation (Johnson & Vitale, 1988), conflict avoidance (Kumar & van Dissel, 1996), understanding failures of collaboration (Kumar, van Dissel, & Bielli, 1998), implementation processes (Munkvold, 1999), the role of trust and power in collaborations (Allen, Colligan, Finnie, & Kern, 2000), organisational learning (Scott, 2000), critical success factors (Lu, Huang, & Heng, 2006), motivations to collaborate (Romano, Pick, & Roztocki, 2010), and persistence to collaborate (Rodón & Sesé, 2010) – less attention has been given to modelling a collaboration for managing its dependencies.

The most appropriate method, that supports the management of dependencies, is the Dependency Network Diagram (DND) method. Introduced by Tillquist et al. (2002), it is a representational scheme predicated on resource dependence theory (Pfeffer &
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Salancik, 1978). It has been developed to improve the understanding of, facilitate discussions on, and enable improvements in IS collaborations. The DND method complements existing modelling techniques that focus on systems development and is used to realise successful collaborations through designing and optimising structures, work processes, and supporting IT. Successful collaborations, however, are not entirely about this.

For a collaboration to be successful it needs to be stable too; i.e. uncertainty and opportunistic behaviour of individual participants need to be minimised (Pfeffer, 1992; Pfeffer & Salancik, 1978). Therefore it is indispensable to look beyond an information system to examine its goals and activities that are enabled by it (Leonardi & Bailey, 2008). Such examination facilitates a better comprehension of the rationale of forming or joining a collaboration and how to actively manage a collaboration’s dependencies to stabilise and safeguard it. It is therefore equally important to understand uncertainties in the environments, partnerships, and tasks, as it is to understand structures, work processes, and information technology (Bensaou & Venkatraman, 1996; Romano, et al., 2010). The resource dependence perspective embraces this view, and it is our intention to learn more about to what extent this view is incorporated into the DND method.

The specific purpose of the paper is therefore to analyse the versatility of the DND method for modelling inter-organisational IS collaborations from a resource dependence perspective. To that end, we review the DND method in the next section, explaining its origin and how it is used in IS research. This is followed by a case study in which we apply the DND method to examine a collaboration’s dependencies. We then discuss our findings and argue that, from a resource dependence perspective, the DND method is partially useful for understanding dependencies but limited for managing them. Concluding this paper, we explain the implications of our findings and suggest directions for future research.

2.0 The DND method

2.1 Origin of the DND method

The DND method has been developed by Tillquist et al. (2002). It is a representational scheme predicated on resource dependence theory (Pfeffer & Salancik, 1978) and used for improving the understanding of, facilitating discussions
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on, and enabling improvements in IS collaborations. The DND method complements existing modelling techniques to handle situations in highly institutionalised production processes in which existing modelling strategies do not work very well.

Similar to other modelling techniques, the DND method has its origin in systems development, and particularly in the analysis and design of organisational information systems. It is used to realise successful collaboration through designing and optimising structures, work processes, and supporting IT; and it enables the essential elements governing organisational relations to be captured, communicated, and evaluated under changing conditions. For this, the DND method depicts important features of organisational relations in a diagram to help designing information systems explicitly for control and coordination of organisational activities, ensuring that information system work in an intended way within the living organisation.

Tillquist et al. (2002) operationalised six constructs of resource dependence theory (see Table 1), and introduced rules and an algorithm for constructing DNDs. By applying these, the DND method emphasises on modelling the context in which organisations operate, the activities needed to acquire critical resources, and the roles involved in the exchange relation.

Table 1. DND constructs according to Tillquist et al. (2002, p. 95)

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role</td>
<td>A <em>role</em> is the encapsulation of a set of activities and goals. Roles represent individuals, work groups, organizations, or industrial segments sharing common activities and goals.</td>
</tr>
<tr>
<td>Activity</td>
<td>An <em>activity</em> is the means or procedure for the provisioning of material or informational resources necessary to achieve a goal.</td>
</tr>
<tr>
<td>Goal</td>
<td>A <em>goal</em> is a desirable or suitable objective.</td>
</tr>
<tr>
<td>Resource</td>
<td>A <em>resource</em> is anything perceived as valuable by a role, such as information, material, capital, or access to markets.</td>
</tr>
<tr>
<td>Dependency</td>
<td>A <em>dependency</em> is the need of one role to achieve a goal through the action of another role.</td>
</tr>
<tr>
<td>Governance control</td>
<td>A <em>governance control</em> is a prescription for acceptable actions to fulfil a dependency.</td>
</tr>
</tbody>
</table>

Illustrating the usefulness of DNDs by examining changes in dependencies following the development of an automated collision-repair-estimation system in the Canadian insured-vehicle-repair industry, Tillquist et al. (2002) suggest that the DND method is not restricted to modelling pre- and post-planned change dependencies, but could also
be used to explore an existing scenario to identify where dependencies might be better managed (i.e., to identify potential change opportunities not just explore the consequences of change).

### 2.2 The DND method in IS studies

In IS research, the DND method has been acknowledged as an appropriate approach toward better understanding dependencies (Kishore, Zhang, & Ramesh, 2006; Singh & Salam, 2006) and modelling inter-organisational relationships (Madlberger & Roztocki, 2008). The DND method enhances the communication between partners (Madlberger & Roztocki, 2009) and is particularly praised for its ability to capture dependency dynamics (Dreyfus & Iyer, 2006). Based on a better understanding of dependencies, scholars suggest that the DND method can contribute toward the creation of mutual benefits (Markus, 2006) and gaining control over organisational activities (Rao, Brown, & Perkins, 2007), resulting into appropriate management strategies to manage relationships with external parties to mitigate dependencies and ensure those relationships work in an organisation’s favour (Borman, 2007).

The DND method has also been applied in various IS studies. For example, Tillquist (2004) uses examples from the supply chain management and academic settings to demonstrate the usefulness of the DND method for visualising and managing inter-organisational linkages to gain or maintain competitive advantage. Tillquist and Rodgers (2005) apply the DND method by deploying a case study of a loan department to identify and trace value-producing exchanges. Montazemi et al. (2009) apply the DND method to inform a structural approach to social network analysis, which they refine through a DND-based analysis of ubiquitous healthcare information systems (Montazemi, Pittaway, & Qahri-Saremi, 2010).

Other scholars have used the DND method to evolve into more complex forms. Dreyfus and Iyer (2008) use the DND method as a basis for developing architectural control points to conceptualise and simulate the interconnection of information systems and focusing on managing a subset of these systems. This approach has led to a spin-off method. Al-Natour and Cavusoglu (2009) suggest only minor modifications to the original DND method to use it in a different context. Illustrated by an example of an academic journal manuscript submitting system, they suggest alternations toward knowledge-based dependency diagrams to use the DND method in the knowledge management domain. Borman and Ulbrich (2011) suggest more
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substantive modifications to the original DND method. Using a case study approach that focuses on understanding dependencies, they suggest to closer align the DND method with resource dependence theory to more comprehensively capture the key aspects of dependencies.

2.3 The DND method in a broader context

In terms of the DND method, “a dependency is the need of one role to achieve a goal through the action of another role” (Tillquist, et al., 2002, p. 95). To be able to achieve these goals, a role makes use of resources that usually are unique to it and not available to another one. Such resources can include data (Levitin & Redman, 1998); hardware, software, communications, IT applications, and IT personnel (Teo & Ranganathan, 2003); or an IT capability (Bharadwaj, 2000). The dependencies revealed in a DND represent links of interaction to gain access to resources. At the same time they indicate design implication of how to integrate the different roles’ outcomes of activities into a collaborative information system. Hence a DND informs design decisions through understanding the range of dependencies, which in turn have an impact on commitments and investments in a collaboration.

One should note that, in a collaboration between separate and independent parties there can often be an imbalance in the distribution of benefits of collaboration threatening long term viability (Tapscott, Ticoll, & Lowy, 2000). In a purely internal context there can be multiple competing interests and goals (Cyert & March, 1963) that need to be accommodated. The degree of involvement and entwinement sought may also vary. Moss Kanter (1994) suggests that cooperative arrangements range along a continuum from weak and distant to strong and close. Kumar and van Dissel (1996) and Thompson (1967) both sought to define different types of partnership based on the level of integration between partners.

To be able to assess risks related to a collaboration, a DND should inform about a collaboration’s stability. Stability of a collaboration is an important feature, captured in resource dependence theory (Pfeffer & Salancik, 1978) and related to the understanding of uncertainties in the environments, partnerships, and tasks. Given that the DND method is predicated on resource dependence theory, it is our intention to learn more about to what extent this view is incorporated into the DND method; and we intend to address this question by analysing the versatility of the DND method for
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modelling inter-organisational IS collaborations from a resource dependence perspective, using a case study from the Australian electricity sector.

3.0 A case study from the Australian electricity sector

3.1 The collaboration

Influenced by new-public-management ideas, the Australian electricity sector underwent partial de-regulation in the 1990s, resulting into competitive segments in which existing organisations had to re-position themselves and new actors entered the market. At present, the electricity market is structured such that network provision is regulated; retail on the other hand is contestable.

Business and residence customers usually receive their electricity through a combination of a distribution network operator (infrastructure for delivering electricity) and retailer (the actual electricity). Customers thus have two separate components to their electricity charges: the first relating to network supply (i.e., a connection or access fee) and the second to the use of electricity. Because of geographical circumstances and limited interconnections between distribution electricity, networks markets are still highly regional; and in many cases a given geographical area will be serviced by a single network operator.

EnergyCo is a large Australian electricity network operator and retailer. The business is split into two main divisions, largely operating at arm’s length from one another: (1) the Network Division (ND), which is responsible for building and maintaining EnergyCo’s electricity distribution network and physically connecting businesses and residences to it; and (2) the Retail Division (RD), which manages the actual supply of electricity. EnergyCo has 1.6 million network customers and 1.4 million retail customers with approximately 1 million in common.

In the past, EnergyCo’s customers were billed for their consumption by the two divisions individually. To avoid sending two bills to most of the customers, making energy bills easier to understand, and to enhance the customer experience, EnergyCo established a collaboration for billing and communicating with its customers. The collaboration is expected to contribute to cost reductions and quality improvements in the contact with customers and revolves around a Shared Services Provider (SSP) that has been established at EnergyCo.
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The SSP is principally responsible for managing billing and inbound call centre services. The ND and RD are required to use the SSP by management fiat, and the SSP aims at providing cost-effective services, which is expressed by the goal to reduce the SSP’s cost by five per cent per annum. The SSP uses administrative IT systems, namely EnergyCo’s corporation-wide enterprise resource planning (ERP) system, to provide most of its services. The services are delivered, using a combination of internal and external resources. The latter, provided by a Fulfilment Company (FC), which is primarily responsible for services relating to the physical dispatch of bills.

To be able to bill customers the SSC is dependent upon data provided by other information systems such as meter readings. These systems are usually located within the ND or RD. Corporate Services (CS), which is responsible for EnergyCo’s information systems strategy, generally prescribes which systems to use in the corporation.

3.2 Data capture

To understand and analyse the collaboration, interviews were conducted with senior executives of EnergyCo in the ND, RD, and SSP to capture the shared services context being modelled from a range of perspectives. An interview was also conducted with a general manager of the FC.

A semi-structured protocol was followed to introduce a focus and consistency but also allow unanticipated areas to be further explored. As such it is in line with the methodology presented by Eisenhardt (1989). Interviews were between one and two hours in duration and were audio recorded and transcribed. Interviews were also supplemented by a review of publicly available and interviewee-provided documentation to enhance the ability to triangulate data.

Data were coded in terms of the dependency dimensions, primarily relating to the coverage and classification of the dependency, the goal of the relationship, and its governance. This is an approach in accordance with the recommendations of Yin (1981) who suggests organising data “around the substantial topics of the case study” (p. 60).

3.3 Dependency network diagram

Figure 1 depicts the collaboration’s DND of the billing part.
The ND provides network access to its customers for which it needs to be correctly compensated. Because billing has been moved to the SSP, the ND cannot bill its customers directly. Instead it provides data to the SSP for billing purposes. This data is the critical resource in the relationship between the ND and the SSP because the SSP depends upon this information to bill ND’s customers. For example, SSP needs to know the number of days in the billing period a customer is connected to the network. The dependency is modelled:

**1. Billing information (SSP → ND)**

The SSP depends upon the ND for **billing information** to **cost-effectively bill ND’s customers**. The ND must provide **error-free data** to get correctly compensated for its **services**. The applicable criterion for **billing information** is a **service level agreement (SLA)**.

Similar to the ND, the RD needs to be compensated for electricity provided to its customers. Since billing has been moved to the SSP, the RD provides the SSP with accurate meter readings to receive compensation for electricity use. The dependency is modelled:
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(2) Billing information (SSP → RD)
The SSP depends upon the RD for billing information to cost-effectively bill RD’s customers. The RD must provide meter readings to get correctly compensated for its services. The applicable criterion for billing information is a SLA.

The SSP is heavily dependent upon information technology for the delivery of its services; but it does not have responsibility for all aspects of that technology. The SSP is the designated owner for the operation of EnergyCo’s ERP system. However CS determines strategy-related issues; such as which ERP to use, the architecture chosen, what functionality; and is responsible for the operation of several other IT systems that integrate or interact with the ERP system. The split was determined by management fiat. The SSP has no input into the strategy-making process and simply has to work with what they are given. The dependency is modelled:

(3) IT systems (SSP → CS)
The SSP depends upon CS for IT systems to deliver its services (i.e., all of SSP’s activities). CS must decide which IT systems the SSP may use to align with the corporate IS strategy and the SSP must use these to comply with the corporate IS strategy. The application criterion for IT systems is management fiat.

When it comes to printing and dispatching bills, the SSP does not have the necessary resources to perform this service in-house. Instead, the SSP relies on the FC. The SSP compiles a single billing file, which it transfers to the FC. The FC then prints and mails the paper bills to customers overnight. A commercial contract specifies the terms and conditions, and thus governs, the relationship. The dependency is modelled:

(4) Billing (SSP → FC)
The SSP depends upon the FC for billing. The SSP needs to combine bills and provide a single billing file to allow the FC to print and dispatch bills, hence generating revenues. The application criterion is a commercial contract.

Table 2 shows the actual links between dependencies, activities, and goals. Dependent activities are those performed by the role one depends upon whereas internal activities are performed by the dependent. Similar, source goal are the dependent’s goals whereas destination goals are the goals of the role one depends upon.
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Table 2. Links between dependencies, activities, and goals in the collaboration

<table>
<thead>
<tr>
<th>Dependency</th>
<th>Dependent activity</th>
<th>Internal activity</th>
<th>Source goal</th>
<th>Destination goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3) IT systems</td>
<td>A1. Decide which IT systems the SSP may use</td>
<td>(Use ERP system for activities A1, A2, and A3.)</td>
<td>G2. Comply with the corporate IS strategy</td>
<td>G1. Align with the corporate IS strategy</td>
</tr>
</tbody>
</table>

4.0 Discussion

Applying the DND method to the case study from the Australian electricity sector, demonstrates how the DND – based on robust theoretical underpinnings predicated on resource dependence theory – facilitates the comprehensive representation of dependencies in an inter-organisational IS collaboration.

The DND shown in Figure 1, for example, visualises the collaboration’s various roles and how they are linked together. Activities and goals for each role are clearly identified, and resource dependencies between these roles are captured. The DND captures the collaboration’s essentials and, hence, facilitates a better understanding of the collaboration.

However, we notice before that it is equally important to understand structures, work processes, and information technology, as it is to understand uncertainties in the environments, partnerships, and tasks (Bensaou & Venkatraman, 1996; Romano, Pick, & Roztocki, 2010). The latter is well captured in resource dependence theory (Pfeffer & Salancik, 1978), its central proposition being that an organisation’s survival is influenced by its surrounding social, political, and task environment; and hinges on its ability to manage the procurement of critical resources from that environment.
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Access to these resources is secured, for example, through acquisition or collaboration (Pfeffer & Salancik, 1978). When collaborating, resources are not internally controlled. To secure the flow of needed resources, organisations try to restructure their dependencies (Cyert & March, 1963). From a managerial perspective, it is crucial to understand emerging and existing dependencies, because it is here a collaboration is actively managed.

Pfeffer and Salancik (1978) argue that for any specific resource the degree of dependence is a function of:

- The importance of the resource to the survival of the organisation,
- the extent to which the resource is controlled by another, and
- the extent to which there are alternative sources of supply.

In terms of the importance of a resource, EnergyCo, for example, could not survive if the billing and distribution resources were not available to it. Without these resources, EnergyCo would not be able to bill its customer. Consequently the corporation would not be able to generate revenues – unless, of course, they could replace the missing resources. For EnergyCo it is therefore central to understand how important particular resources are. The DND, however, cannot visualise how important the billing and distribution resources are to EnergyCo. It cannot be captured because this particular aspect of resource dependence theory has not been operationalised in the DND method when developed by Tillquist et al. (2002).

Because of EnergyCo.’s commitment to collaborate with the FC, the billing and distribution resources are not controlled by EnergyCo’s divisions anymore. The FC controls these resources. A commercial contract is used as governance control to regulate access to the resource. This aspect of resource dependence is captured in the DND through explicating existing governance controls. This is possible because of Tillquist et al.’s (2002) operationalisation of governance control.

In terms of alternative sources of supply, EnergyCo needs to know how easy it is to replace the FC in the collaboration. If the FC, for example, does not make available its billing and distribution resources, EnergyCo needs to access these resources elsewhere. In the case of the particular collaboration, this is easy to accomplish for EnergyCo. The services provided by the FC are rather generic. It is not specifically difficult to provide these services and they are also easy to replicate. Many possible suppliers are already in the market and consequently alternative sources of supply are plenty. This important information, however, is not captured in the DND because in
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the DND method alternative sources of supply has not been operationalised by Tillquist et al. (2002).

From resource dependence theory (Pfeffer & Salancik, 1978) it is known that the three above-mentioned aspects are central in understanding and managing resource dependencies. The DND method, which is built upon resource dependence theory, however, is limited in visualising these aspects. This is because its original purpose has been to facilitate the designing and optimising of structures, work processes, and supporting IT. The lacking managerial focus has led to a method that can only partly visualise a collaboration’s essentials. Therefore, the understanding it can facilitate is somewhat limited.

When it comes to managing resource dependencies, the DND method cannot be used in its original form. Based on the six constructs that were operationalised, the method cannot be used to capture essential aspects of a resource dependency. In particular, the lack of visualising the importance and alternative sources of resources are limiting the DND method’s versatility, making it less useful for managing resource dependencies.

5.0 Conclusion

In this paper we have analysed the versatility of the DND method for modelling inter-organisational IS collaborations from a resource dependence perspective. Deploying a case study from the Australian electricity sector, we have presented evidence that the DND method is partially useful for understanding dependencies. The lack of visualising the importance and alternative sources of resources, however, limits the DND method’s versatility, making it less useful for managing resource dependencies.

For further research, we suggest to build upon the DND method’s positive qualities and research whether it can be extended to fully integrate a resource dependence perspective. This has the potential of making the DND method available for actively managing dependencies in inter-organisational IS collaborations.

References

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