Revisiting Dependency Network Diagrams: A Conceptual Extension

Completed Research Paper

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ABSTRACT

In this paper we propose an extension to the Dependency Network Diagram (DND) technique. We revisit the DND technique to discuss its ability to facilitate the strategic management of cross-organizational ICT-resource collaborations, which are increasingly paramount to achieving sustained competitive advantage. Predicated on resource dependence theory, we operationalize the constructs of power and secondary dependency, and propose their integration into the original DND technique. New rules, together with an updated algorithm for how to construct an extended DND, are introduced. We propose that the extension of the DND technique adds to clearer visualizing, understanding, and communicating dependencies in ICT-resource collaborations, and ultimately facilities their strategic management. We point out potential benefits of applying the extended DND technique and provide directions for empirically validating the extension in future research.

Keywords

Collaboration, strategic alliance, ICT resource, dependence, strategic management.

INTRODUCTION

Organizations increasingly form or join collaborations to access ICT resources paramount to achieving sustained competitive advantage. Collaborations, here being defined as arrangements in which two or more organizational entities unite to pursue a set of agreed-upon goals (cf. Yoshino and Rangan, 1995), are invariably accompanied by dependencies between collaborators; a dependency being the need of one organizational entity to achieve a goal through the action of another one (Tillquist, King and Woo, 2002). These dependencies need to be managed effectively to, for example, create value for the collaborators (Dyer and Singh, 1998), mitigate the risk of opportunistic behavior, and safeguard stable relationships (Oliver, 1990; Pfeffer, 1992; Pfeffer and Salancik, 1978). Those who seek to manage such collaborations need to accurately comprehend their organization's collaborative environment and dependencies (Pfeffer and Salancik, 1978).

Diagrammatic approaches facilitate greatly the understanding, systematic analysis, and visualization of dependencies in easy-to-communicate ways. They are in vogue not only because they are more suitable to comprehend complex contexts than are sentential representations (Larkin and Simon, 1987), but also because they facilitate effective communication between various stakeholders (Siau and Tan, 2005).

The Dependency Network Diagram (DND) technique in particular is suitable to analyze a collaboration's dependencies because it images the context in which organizations operate, the activities needed to acquire critical resources, and the roles involved in exchange relations (Tillquist et al., 2002). Originally used in the information systems development domain to better understand the dynamics of organizational and institutional life in inter-organizational collaborations (Tillquist, 2004; Tillquist et al., 2002), the DND technique has later successfully been used in the wider organizational domain to image the contexts of pure intra-organizational collaborations (Tillquist and Rodgers, 2005) as well as collaborations including both inter and intra-organizational dimensions (Ulbrich and Borman, 2012). Although the technique lacks some strategic aspects it has also been recognized for supporting the identification of value-generating activities within collaborations and the complementary activities required from collaborators (Tillquist and Rodgers, 2005).

Complementary activities here refer to utilizing resources that are not internally available (cf. Ireland, Hitt and Vaidyanath, 2002). Following Barney (1991), such resources might include physical capital resources (such as IT hardware and software), human capital resources (such as IT personnel, skills and problem-solving abilities), or organizational capital resources (such as routines and procedures). Gaining access to such resources allows to, for example, share risks with others, reduce costs, and improve the quality of goods and services. Hence, forming or joining a collaboration is a strategic option to secure access to resources paramount to achieving sustained competitive advantage. Because of this strategic importance, collaborators

seek stable long-term arrangements; long-term here not referring to any specific period of time, but rather to the intention of the partners that the collaboration is not going to be a transient one (Tsang, 1998).

The DND technique is a promising approach for analyzing and imaging an ICT-resource collaboration's context. It is, however, limited with respect to supporting the strategic dimension of effectively managing collaborations. To overcome this limitation, this paper proposes an extension of the established DND technique by including two additional constructs and rules on how to clearly visualize the extent and symmetry of dependencies. Together with an updated construction algorithm, the extended DND technique furthers drawing inferences on dependencies and how to actively managing ICT-resource collaborations. This allows the established DND technique to expand from the traditional information systems development into the strategic management domain, furthering a better understanding of ICT-resource collaborations and ultimately their strategic management.

UNDERSTANDING DEPENDENCIES

As mentioned before, a collaboration between two or more organizational entities invariably is accompanied by dependencies that need to be managed effectively. To better understand such dependencies, the following subsections review dependencies through three complementary lenses. First, dependencies are regarded as part of a collaboration to access resources vital to an organization's survival. This perspective is followed by viewing dependencies as part of a theory, particularly resource dependence theory. Finally, dependencies are accounted for as being part of diagrammatic approaches with a specific focus on the established DND technique to analyze, visualize, and communicate dependencies. Together these three subsections lay the theoretical foundation for later in this paper proposing an extension of the DND technique.

Dependencies as Part of a Collaboration

A dependency as part of a collaboration exists when a focal organization depends upon the action of another organizational entity within the collaboration to acquire and maintain resources vital to the focal organization's survival (Pfeffer and Salancik, 1978). Such resources might include ICT resources, which usually are "hardware, software, communications, IT applications, and IT personnel" (Teo and Ranganathan, 2003, p. 231).

Scholars such as Penrose (1959), Wernerfelt (1984), or Barney (1991) have repeatedly argued that the ability to acquire and maintain resources enables organizations to gain sustained competitive advantage. The focus here has been predominately on domination, i.e., owning or controlling resources by the focal organization. To hinder other organizations from competing with the focal organization, Barney in particular suggests that resources need to be heterogeneous and not easy to imitate to contribute to an organization's sustained competitive advantage. This view is widely confirmed in the information systems domain through various studies demonstrating that utilizing resources typically correlates with positive performance when they are unique to an organization (Doherty and Terry, 2009; Leidner, Preston and Chen, 2010; Mahoney and Pandian, 1992).

ICT resources, however, are increasingly perceived as a commodity, i.e., ICT resources possessed by one organization are easily available to its competitors. This poses increasingly the question of how to achieve positive performance through domination; and for quite a while ICT infrastructure, for example, has now been perceived as no longer contributing to sustained competitive advantage (Mata, Fuerst and Barney, 1995; Powell and Dent-Micallef, 1997; Ray, Barney and Muhanna, 2004; Ray, Muhanna and Barney, 2007). In fact, recent research suggests that ICT can even become a cost disadvantage (Carr, 2003). Consequently, some organizations experience the contribution of ICT resources as source of competitive parity (Mata et al., 1995) and as being rather marginal to sustain competitive advantage (Clemons and Row, 1991).

Being increasingly homogenous, ICT resources alone cannot contribute to competitive advantage. Instead they need to facilitate or contribute to services that allow an organization to outperform others (Powell and Dent-Micallef, 1997). Thus, ICT resources complement business and human resources to improve organizational performance (Teo and Ranganathan, 2003). Such integration of ICT with other resources produces value (Benjamin and Levinson, 1993; Powell and Dent-Micallef, 1997; Ravinchandran and Lertwongsatien, 2005); and a clear strategy is needed to integrate these resources to produce value, leverage ICT resources, and—ultimately—achieve sustained competitive advantage (Bharadwaj, 2000; Venkatraman, 1997).

The ICT resources needed, however, might not always be available in-house, could be of poor quality, or complement existing ones. Then, organizations can enter into relationships with one another to gain access to specific resources (Oliver, 1990), i.e., they form or join a strategic collaboration. Such collaborations may include third-party outsourcing, application-service provision, and shared services. All of them have in common that they create dependencies among its participants (March and Simon, 1958).

Dependence on others always involves some measure of uncertainty. For example, it has been acknowledged that as one participant can never be completely sure of what the other will do, it is important to avoid conflicts that can jeopardize a collaboration (Kumar and van Dissel, 1996). Opportunistic behavior of participants in a collaboration, for example, should therefore be repressed as early as possible. Governance controls have been pointed out to help detecting or preventing such behavior (Kartseva, Hulstijn, Gordijn and Tan, 2010). Furthermore, the aspects of value creation (Dyer and Singh, 1998) and value appropriation in the collaboration (Adegbesan and Higgins, 2010) plays a central role for the focal organization in determining whether it will be beneficial to be part of a collaboration. Thus, dependencies as part of a collaboration need to be fully understood to be managed effectively.

Dependencies as Part of a Theory

Resource dependence theory (Pfeffer and Salancik, 1978) provides a theoretical foundation for understanding and managing dependencies within organizational systems. It accounts for the rational organizational adaptation to external changes in a business environment (Pfeffer and Salancik, 1978; Ulrich and Barney, 1984). Resource dependence theory proposes that an organization lacking resources essential to its survival will seek to establish relationships with—that is, be dependent upon—others in order to obtain such resources.

Collaboration is one strategy for establishing relationships of this kind (Harrigan and Newman, 1990; Pfeffer and Salancik, 1978). Collaborations, however, not only allow organizations to gain access to resources, but also bear some risks. For example, within in a collaboration there is always the possibility of one partner capturing a disproportionate share of the benefits, thereby destabilizing the collaboration (Inkpen and Beamish, 1997; Tapscott, Lowy and Ticoll, 2000). To mitigate this risk, organizations seek mechanisms to manage their resource collaboration. One way, for example, is to formalize agreements that ensure continuing access to needed resources. Another is to place ones organization in a stronger negotiation position.

Regardless of the chosen approach, key for managing such collaboration is to identify, understand, and communicate essential dependencies. Research on dependencies in collaboration has done so from various angles, including, for example, network theory (Gulati, 1995), agency theory (Kumar and Seth, 1998), and a resource-based view (Murray, Kotabe and Zhou, 2005). Modeling resource dependencies is another promising avenue. Modeling is an activity that focuses on formally describing the most important aspects of a physical or social phenomenon (Giaglis, 2001; Mylopoulos, 1992), usually resulting in some kind of diagram or conceptual model that facilitates the discussion of a specific phenomenon and its interrelated components.

Approaches for modeling dependencies in the information systems domain include, amongst others, e3control (Kartseva et al., 2010), Role Activity Diagrams (Ould, 1995), the MLxMC framework (Rukanova, van Stijn, Henriksen, Baida and Tan, 2009), Metagraphs (Basu and Blanning, 2000), E^2ML (Botturi, 2006), Resource Flow Graph Analysis (Wyner, 2011), the i* framework (Yu, 1995), and the DND technique (Tillquist et al., 2002). Notwithstanding that these approaches are predominantly aligned with the systems development literature, Al-Natour and Cavusoglu (2009) have compared some of them for modeling dependencies from an organizational perspective and find that the DND technique is the only one that both explicitly represents dependencies and governance controls—both essential to managing a collaboration. This positions the DND technique as a valuable tool for identifying, understanding, and communicating essential dependencies in a collaboration. The DND technique, furthermore, is clearly grounded in resource dependence theory, providing a comprehensive representational scheme for understanding the dependencies within organizational systems (Al-Natour and Cavusoglu, 2009).

Dependencies as Part of the DND Technique

The DND technique (Tillquist et al., 2002) is a representational scheme for analyzing information technology and organizational dependency. It complements existing modeling techniques and is designed for highly institutionalized production processes in which existing modeling strategies do not work very well. Similar to other modeling techniques, the DND technique has its origin in information systems development, in particular the analysis and design of organizational information systems. It enables the essential elements governing organizational relations to be captured, communicated, and evaluated under changing conditions. The DND technique depicts important features of organizational relations in a diagram to help design information systems explicitly for control and coordination of organizational activities.

Tillquist et al. (2002) have introduced four rules and a construction algorithm for DNDs (for details see their 2002 article). By applying these, the DND technique emphasizes modeling the context in which organizations operate, the activities needed to acquire critical resources, and the roles involved in exchange relations. The DND technique is grounded in resource dependence theory (Pfeffer and Salancik, 1978), which has allowed Tillquist et al. (2002) to operationalize some essential constructs of this theory, namely; activity, resource, role, goal, dependency, and governance control (Table 1).

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

Table 1. DND Constructs According to Tillquist et al. (2002, p. 95)

The DND technique aims at ensuring that information systems work in the way intended within an organization. Tillquist et al. (2002) illustrate the use of the DND technique by examining changes in dependencies following the development of an automated collision-repair estimation system in the Canadian insured vehicle repair industry. They suggest that the approach is not restricted to modeling pre and post-planned change dependencies but also can be used to explore an existing scenario to identify where dependencies might be better managed—i.e., to identify potential change opportunities, not just the consequences of change. This is in line with identifying options for actions to manage resource dependencies as suggested by Pfeffer and Salancik (1978).

Since its publication, the DND technique has been applied in various information systems-related domains. To mention a few, Tillquist (2004), for instance, uses examples from the supply chain management and academic settings to demonstrate the usefulness of the DND technique for visualizing and managing interorganizational linkages to gain or maintain competitive advantage. Tillquist and Rodgers (2005) apply the DND technique by deploying a case study of a loan department to identify and trace value-producing exchanges. And Montazemi et al. (2009) apply the DND technique to inform a structural approach to social network analysis, later refined through a DND-based analysis of ubiquitous healthcare information systems (Montazemi, Pittaway and Qahri-Saremi, 2010).

In information systems research, the DND technique has been acknowledged as an appropriate approach for better understanding dependencies (Kishore, Zhang and Ramesh, 2006; Singh and Salam, 2006) and modeling interorganizational relationships (Madlberger and Roztocki, 2008). The DND technique enhances the communication between stakeholders (Madlberger and Roztocki, 2009) and is particularly praised for its ability to capture dependency dynamics (Dreyfus and Iyer, 2006). Based on a better understanding of dependencies, scholars suggest that the DND technique can contribute toward the creation of mutual benefits (Markus, 2006) and gaining better control over organizational activities (Rao, Brown and Perkins, 2007). The result is more appropriate management strategies for managing relationships with external parties, mitigating dependencies, and ensuring those relationships work in an organization's favor (Borman, 2007). On the whole these studies have proven the DND technique being an adequate approach in capturing actions and governance controls—both of which can contribute to reduce uncertainty, hence, contribute to more stable collaborations.

While the DND technique has been recognized for its positive qualities, it has also been criticized, for example, for being limited in capturing a fine grained view of dependencies (Wyner, 2011) and for not capturing the essentials necessary for managing such collaborations (Ulbrich and Borman, 2012). Tillquist et al. (2002), for example, have not operationalized integral constructs of resource dependence theory such as power and secondary dependencies. This, for example, limits the ability of DNDs for counterbalancing asymmetric dependencies to exercise power or control over another organizational entity or its resources (cf., Oliver, 1990). In addition, it limits the ability of DNDs to capture and understand dependencies upon roles beyond the focal collaboration's boundaries. The DND technique has therefore been criticized by one of its originators for not being capable to facilitate a comprehensive understanding of the context in which it is used (cf., Woo, 2011), which is because secondary dependencies that could contribute to such a holistic view were not considered in the original DND technique. The integral constructs of power and secondary dependencies, thus, are not captured and understood through the use of current DNDs. Such understanding, however, is essential for effectively managing a collaboration.

In consequence, neglecting power and secondary dependencies in the established DND technique has limited its usefulness from a strategic management perspective. As a step to overcome this limitation, this paper proposes an extension of the DND technique by including two additional constructs and rules on how to clearly visualize the symmetry and extend of dependencies.

PROPOSED EXTENSION

The extended DND technique is a method to capture, understand, and communicate dependencies that are part of a collaboration to gain access to resources. Applying the extended DND technique facilitates the strategic management of such collaborations because the symmetry and extend of dependencies emerge clearly visible. For this to happen, the original six constructs derived from resource dependence theory (Table 1) are extended by the two constructs of power and secondary dependency derived from the same theory, which are operationalized by constructing the following definitions:

- *Power* is control over a resource.
- A *secondary dependency* is the need of one role to achieve a goal beyond the scope of the focal collaboration through the action of another role.

The two additional constructs are included in the diagrammatic representation of a collaboration. Their visualization in an extended DND is discussed by constructing representational rules in the following subsections.

The Power Rule

Power in a collaboration is control over resources (Pfeffer, 1992; Ulrich and Barney, 1984). When such resource is needed by a focal role to accomplish a particular goal and it is not available within it, it becomes dependent upon another role to provide the resource necessary through one or more activities (Tillquist et al., 2002). How this reliance is perceived from the focal role's point of view depends on how control over a resource is distributed among collaborators.

With regard to control, Pfeffer and Salancik (1978) point out that asymmetric control—i.e., power distribution—exists when the exchange is not equally important to both roles. In other words, the role which the focal role depends upon has full control over the resource and, hence, exercises control over the focal organization (Todeva and Knoke, 2005). This is usually the case when it is difficult for the focal role to find an easy replacement for the resource-providing role but not vice versa.

In contrast, when there are alternative sources available from which a needed activity or resource can be obtained, Blau (1964) argues that in this situation the distribution of power is symmetrical. In resource dependence theory, it is referred to as a dependency that is characterized by virtually equal bargaining power between two roles (Pfeffer and Salancik, 1978).

The focal role favors dependencies that are characterized by symmetric power distribution because the supply of a resource can be assumed as being stable and ample, which, according to Pfeffer and Salancik (1978), has a positive impact on a collaboration's stability because it lessens the risk for exploitation.

When power symmetry does not exist, one alternative is attempting to gain sole control over the necessary resource (Pfeffer and Salancik, 1978). This alternative, however, lies outside the scope of the paper, as it does not involve collaboration. Within the collaborative scope, the focal organization instead strives normally for stability mechanisms to safeguard balanced power distribution (Borys and Jemison, 1989). The focal role, for example, can attempt to reduce other roles' power over them by increasing their own power over others (Hillman, Withers and Collins, 2009). This could be done, for example, through the strategic alternative of utilizing collective bargaining power (Oliver, 1990) through which, for example, the net power in a collaboration is balanced through corresponding asymmetries for other resources.

As a consequence, strategic decisions on stability mechanisms to safeguard balanced power distribution depend upon one's full understanding of the power distribution of each dependency in a collaboration as well as the dependencies as a whole. When a diagrammatic approach such as the DND technique is applied to facilitate this kind of understanding, the technique thus needs to visualize whether dependencies are characterized by asymmetrical or symmetrical power distribution. To visualize this, we propose:

Rule 5: The power rule.[1] The power rule specifies how power is visualized. When power is distributed predominately symmetrically, the dependency between two roles is labeled with an "S" for symmetric or an "A" for asymmetric power distribution.

[1] The power rule is introduced as a fifth rule because the original DND technique consists of four rules that continue to exist. It is deemed more useful to continue sequential enumeration to allow a clear reference to a rule in question.

Figure 1a) shows how a symmetric dependency is drawn in an extended DND. The dependency reads: Role i depends upon Role j to achieve a goal through the action of role j, where role j controls the resources necessary for the action and the power distribution is predominately symmetric.

Figure 1b) shows how an asymmetric dependency is drawn in an extended DND. The dependency reads: Role i depends upon Role j to achieve a goal through the action of role j, where role j controls the resources necessary for the action and the power distribution is predominately asymmetric.

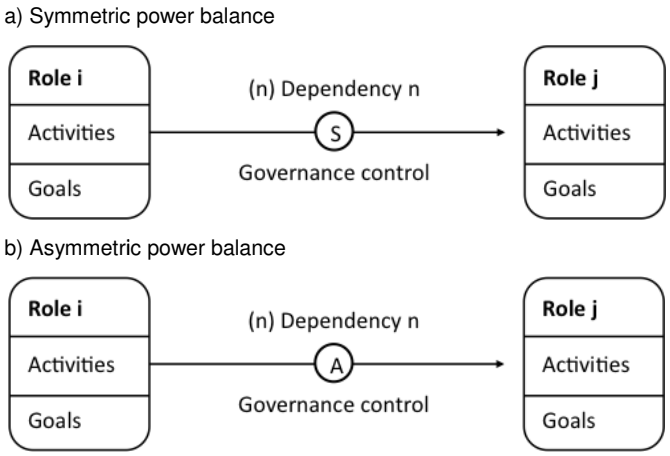

Figure 1. The Power Rule

Visualizing the power distribution in an extended DND, it is suggested, advances the understanding of strategic options to work toward stable long-term collaborations.

The secondary dependency rule

A secondary dependency is the need of one role to achieve a goal through the action of another role with the goal clearly outside the scope of the focal collaboration. This situation is not uncommon, meaning that, for example, Role i can collaborate with Role j on various aspects that are perceived as different collaborations—probably managed through different governance controls and possibly also including other roles than those of the focal collaboration.

Pfeffer and Salancik (1978) describe this situation as a web of relationships and dependencies in which the focal role can be tangled. They acknowledge that dependencies that lie outside the scope of the focal collaboration still can have immense impact on strategic decisions on how to establish stable long-term collaborations. Lomi and Pattison (2006) have built on the idea of tangled relationships and point out that one dependency cannot be understood without the other, especially as it can impact on power distribution in a collaboration and consequently on a collaboration's stability.

Pfeffer and Salancik (1978), Walker et al. (1997), and Heintz (2002) and others therefore repeatedly argue that studying the structure of a collaboration requires an analysis of the network as a whole. This means that all dependencies should be considered in a model that represent a collaboration. For example, when one participant in a collaboration has a previous commitment to share resources with one another, this is perceived as a dependency that lies outside the scope of the focal collaboration—or in other words a secondary dependency (Castejón, Bræk and von Bochmann, 2007). Lu and Cai (2001) note that such dependencies can influence decisions on the focal collaboration and thereby impacting the modalities for resource sharing.

Despite the more recent attempts to express the importance of secondary dependencies, Pfeffer and Salancik's (1978, p. 64) original explanation still captures this situation superbly: "actions in other parts of the interconnected system, while largely invisible, can have impact on the organization's immediate exchanges." Following this reasoning, all dependencies—independent of occurring inside or outside the scope of the focal collaboration—are potentially important. One therefore needs to be able to evaluate the importance of secondary dependencies in relation to the focal collaboration.

The original DND technique, however, focuses only on dependencies isolated within a specific collaboration (see Rule 4, the dependency rule, Tillquist et al., 2002). DNDs hence only focus on primary dependencies, making it impossible to analyze all

relevant relationships in a collaboration. As a consequence, an interpretation of a DND might lead to initiating changes to a direct dependency without understanding how this change might impact on a secondary dependency and perhaps lead to unwanted results in a role's other collaboration. It therefore appears natural to consider both primary[2] and secondary dependencies before making strategic decisions on how to design the collaboration to ensure a stable long-term one. To facilitate this diagrammatically, secondary dependencies need to be incorporated in the DND technique. We therefore propose:

Rule 6: The secondary dependency rule. The rule specifies how a secondary dependency is visualized. When a secondary dependency exists between two roles—and both roles are part of the focal collaboration too—the dependency is visualized through dashed arrows.

Figure 2 shows how a secondary dependency is imaged in an extended DND. The diagram reads: Role i depends on Role j to achieve a goal through the action of role j, where the goal is situated outside the focal collaboration.

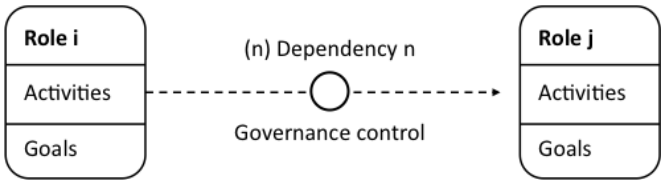

Figure 2. The Secondary Dependency Rule

Visualizing secondary dependencies in an extended DND, it is suggested, advances the understanding of strategic options to work toward stable long-term collaborations.

Updated DND Construction Algorithm

As part of the original DND technique Tillquist et al. (2002) have supplied a construction algorithm that—when applied correctly—will result in a schematic representation of the collaboration analyzed from a focal role's perspective. The algorithm prescribes how to apply the DND technique's four rules and how to depict roles, goals, activities, dependencies, and governance controls. For an in-depth description on the *scope rule, activities rule, goals rule,* and *dependency rule* as well as the construction algorithm's use we refer to Tillquist et al.'s (2002) original paper.

The extension of the DND technique at this stage requires the integration of the two proposed rules into the original construction algorithm. To that end, Table 2 contrasts the original construction algorithm with the updated one, explaining when and how to apply the new rules in constructing a DND. For clarity, changes in the updated algorithm are emphasized.

The addition of two new steps to update the construction algorithm does not change the basic logic and explanation behind the algorithm with regard to the original DND technique. Therefore, no additional attention is given to further explain the updated algorithm in this paper.

FUTURE RESEARCH

For future research it is proposed to empirically test the usefulness of the proposed extension. A practice-oriented approach could be applied to investigate how applicable the extension is in practice and how much it contributes to better understanding ICT-resource collaborations. It might also be worthwhile to test whether the increased complexity of an extended DND positively contributes to better understanding ICT-resource collaborations. Such an approach would also allow to further operationalize the two additional constructs based on practical experience. Input from such research could make a valuable contribution toward further discussing the value of the extended DND technique.

[2] Primary dependencies are those referred to in Rule 4 in the original DND technique. For consistency with the original DND technique, primary dependencies are hereafter referred to as just dependencies.

Original construction algorithm	*Updated construction algorithm*
1. Identify an initial event that triggers the need to accomplish a goal	1. Identify an initial event that triggers the need to accomplish a goal
2. Identify and depict the role that need to accomplish the goal arising from this initial event	2. Identify and depict the role that need to accomplish the goal arising from this initial event
3. Identify and depict all the activities needed to accomplish the goal using the activities rule	3. Identify and depict all the activities needed to accomplish the goal using the activities rule
4. For each activity not performed internally by the role, construct a dependency to another role using the dependency rule	4. For each activity not performed internally by the role, construct a dependency to another role using the dependency rule
	5. For the newly identified dependency, depict the power symmetry using the power rule
5. For the newly identified role: a. depict the activity required by the dependent role b. identify the goal(s) that compels the role to perform the dependent activity using the goal rule c. repeat steps 3 through 5 for each goal identified for the newly created role	*6.* For the newly identified role: a. depict the activity required by the dependent role b. identify the goal(s) that compels the role to perform the dependent activity using the goal rule c. repeat steps 3 through *6* for each goal identified for the newly created role
6. Repeat steps 1 through 5 for any additional initial events	*7.* Repeat steps 1 through *6* for any additional initial events
	8. For each role, identify and depict secondary dependencies using the secondary scope rule

Table 2. Original and Updated Construction Algorithm for the DND Technique

CONCLUSION

In this paper we have proposed an extension of the established DND technique. We have revisited the DND technique to discuss its ability to facilitate the strategic management of cross-organizational ICT-resource collaborations. The argument put forward is that, in order to clearer understand and manage dependencies in ICT-resource collaborations, it is necessary to embrace a strategic dimension when visualizing those dependencies. Resource dependence theory provides the theoretical ground for the proposed extension, from which we have operationalized the constructs of power and secondary dependency. We have proposed the integration of the two constructs into the original DND technique, and introduced new rules together with an updated algorithm for how to construct an extended DND. We have argued that the extension of the DND technique contributes to clearer visualizing, understanding, and communicating dependencies in ICT-resource collaborations, and ultimately facilities their strategic management. We propose to empirically test the usefulness of the proposed extension in future research.

ACKNOWLEDGMENTS

We presented some early ideas on evolving the existing Dependency Network Diagrams technique at the HICSS (Borman and Ulbrich, 2011) and UKAIS (Ulbrich and Borman, 2012) conferences. We thank track chairs, reviewers, and participants for their constructive and encouraging comments.

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