A Dyadic Model of Interorganizational Systems (IOS) Adoption Maturity

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Abstract

Interorganizational Systems (IOS) adoption requires cooperation and collaboration between trading partners and, therefore, is reliant on the nature of their relationships. There has been some research that investigates relationships and how organizations progress from one level to the next level of adoption. However, these studies do not adequately justify the exclusion of other variables and are not theoretically based. This research extends the Kurnia and Johnston (2000) process model of IOS adoption by incorporating the notion of IOS adoption maturity and also modifies it from a supply chain to a dyadic level so better evaluations of progression can be performed. With this model, the dynamics of IOS adoption maturity can be better examined empirically.

Introduction

Interorganizational systems (IOS) are automated information systems, such as Electronic Data Interchange (EDI) and Collaborative Planning, Forecasting and Replenishment (CPFR), which are shared by two or more companies [1]. IOS offer trading organizations substantial benefits such as reduced inventory costs, elimination of redundant handling of data entries, improved scheduling, processing and distribution of goods and improved information accuracy, to name a few [2, 3]. IOS have become a strategic weapon for some organizations to obtain competitive advantage and have shifted competition from single firms competing individually to supply chains competing against other supply chains [4, 5].

Despite these benefits, many companies face difficulties in adopting these systems because such implementations are highly reliant on trading partners' existing relationships which often are not favorable [6]. IOS adoption requires credible commitment of participating firms to work collaboratively to achieve common objectives and goals. Because of the inherent complexity in IOS adoption, there have been many attempts the literature to study various aspects of IOS adoption by organisations in [9, 28, 51]. Some studies (see for example, [7-10]) indicate that unfavourable relationships often exist among trading partners, which makes IOS adoption difficult.

Realizing the importance of relationships in IOS adoption, there have been an increasing number of studies investigating Interorganizational (IO) relationships. For example, some studies examine IO relationship factors or aspects that contribute to adoption failures or success [8, 11, 12], while others classify relationship types based on relationship intimacy and IOS types based on integration and then match levels of relationship intimacy with the levels of IOS integration[13, 14]. More recently, researchers not only examine the interaction between relationship types and IOS types but also investigate how organizations move from lower levels to higher levels of intimacy of relationship and integration of IOS types[7].

While there are some studies that shed light on how organizations can move or progress from a less sophisticated to a more sophisticated IOS based on relationships, it is difficult to base an empirical investigation on this work. This is because these studies are not theoretically strong and do not include, or justify the exclusion of, other factors such as organizational capabilities to investigate maturity or progression of IOS adoption.

Kurnia and Johnston [15] in their study of IOS adoption using Efficient Consumer Response (ECR) as an example present a process model of IOS adoption that includes a set of factors and also considers the role of time in IOS adoption. Their model has the potential to complement other studies that examine IOS adoption maturity. Their process model suggests that through dynamic interactions among industry/supply chain players, organizations modify their capabilities and technology vision in the course of adoption of a particular IOS. The model suggests broadening the scope of study to include both an individual organization and its inter-organizational environment (supply chain and/or industry).

The Kurnia and Johnston process model could be extended to include the notion of progression because IOS adoption maturity is intended to take place over time. However, it would pose a challenge for empirical research since the model proposes the inclusion of an organization and its inter-organisational environment as the unit of

analysis, which is practically difficult to achieve. Therefore, in this paper, we modify the Kurnia and Johnston model by reducing its scope from a supply chain to a pair of organizations (dyadic level) and also refine the model to incorporate the idea of maturity of IOS adoption. We will show that during the course of IOS adoption, organizational capabilities and the nature of technologies can improve over time through better relationships between the two organizations. This, in turn, will result in the ability of the two organizations to adopt a more sophisticated IOS, which will further improve the relationships. Then we argue that overtime, this IOS adoption progression phenomena occurs because of the reciprocal influences between the nature of trading partner relationship and the IOS adopted. Based on our model, we finally outline a number of propositions to be tested for further empirical studies.

In the next section, we present a summary of the Kurnia and Johnston [15] study and highlight its limitations. We then discuss a dyadic model of IOS adoption maturity. Next we justify the exclusion of some factors identified in previous studies. Finally, we propose two propositions in relation to our model and conclude the paper.

The Kurnia and Johnston IOS adoption models

Based on the taxonomy of Markus and Robey [16], Kurnia and Johnston [15] classify IOS studies according to the factor approach and process approach. This classification is useful not only because it highlights the theoretical inadequacies of the factor approach but also shows the importance of expanding the unit of analysis and the role of time in studying IOS adoption. The factors based studies assume that IOS adoption is determined by a number of predicting variables identified at a particular point of time. These studies examine (a) the nature of technology, (b) characteristics of the organization, and (c) some conditions in the environment of the adopting organization in order to predict adoption.

The first group of factor studies that have investigated "the nature of technology" has relied on Roger's [17] innovation theory as a foundation [18-20]. The individual factors include relative advantage, trialability, ease of use [2, 19, 21], and perceived risk [18]. These studies argue that the more favourable the perceived characteristics of the nature of technology, the more likely the organizations are to adopt (or intent to adopt) the technology. The second factor group, "characteristics of the organization", includes top management support, availability of the technological infrastructure, size, and structure. These factors have been commonly regarded to predict adoption (or intent to adopt) [2, 22, 23]. The last factor group suggests that certain conditions that exist in the external environment of the focal organization may affect the decision to adopt an IOS [2, 24, 25]. These factors include industry concentration [24, 25], power [26] and competitiveness [23].

The factor based studies (refer to figure 1) adopt a firm-centric perspective, which views organizations as victims of their environment and do not account adequately for the fact that the action of firms changes their conditions over time [15].
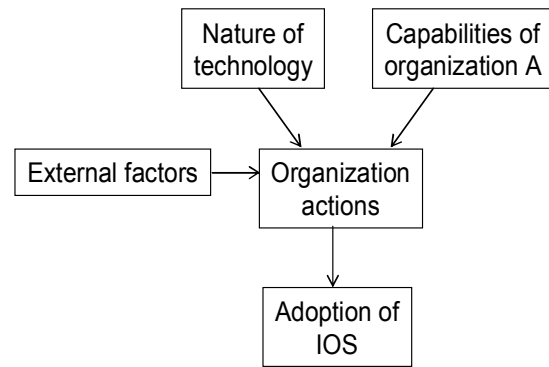

Figure 1. A typical factor model (Kurnia and Johnston, 2000)

On the other hand, the processual approach posits that the factors alone are insufficient to explain adoption without understanding the processes which are undertaken by the adopting organizations [15]. The Kurnia and Johnston process model represents a transition from the factor approach and is based on empirical evidence from the Australian grocery industry. They argue that the complex interaction between supply chain members in the process of adopting the IOS occurs over time and it is necessary to include the industry players as part of the unit of analysis. Thus, because the industry organizations are viewed as part of the internal environment, they are not completely victims of their environment as they are able to change their conditions over time.

As illustrated in figure 2, the Kurnia and Johnston process model proposes the existence of two-way causal links among actions of organizations, inter organizational environment (supply chain structure), nature of technology, and capability of the organizations. External factors are beyond the control of the organization and include unpredicted demand, declining competitiveness and the political environment. They argue that the actions of the focal firm is not only influenced by the nature of technology, capability of organizations and environment factors but also modified by mutual interactions of the focal firm with its supply chain structure. The supply chain structure consists of the players, power relations, economic relations, communication relations, trust, and partnerships [27]. This approach provides a better understanding of the way organizations adopt an IOS by investigating their industry structure, capturing the changes of technology and the role of organization in the process (for example, [28]). While the Kurnia and Johnston IOS process model has advantages, it is unsuitable to use for empirical investigation because the model suggests the inclusion of all the industry players as part of the unit of analysis which is in practice difficult to

achieve and the complexity involved may create barriers to the interpretations of the findings.
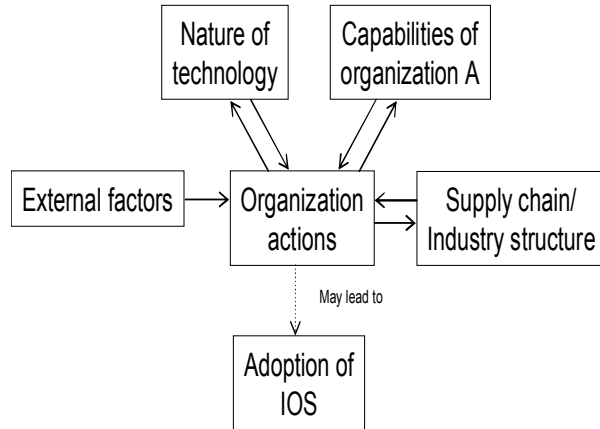

Figure 2. IOS adoption process model (Kurnia and Johnston, 2000)

We propose to create a new model by incorporating the notion of IOS progression and reducing the scope of the Kurnia and Johnston process model from a supply chain level to a dyadic level. The dyadic level is justifiable because: (a) our main objective is to conduct future case studies that investigate the maturity concept in IOS adoption, and by reducing the scope to a dyadic level we believe that we will be better able to show how pairs of organisations move from one level of IOS adoption to the next level, (b) adoption decision is a fundamental activity between two organizations in a supply chain or a network [8], and (c) focusing on the dyadic level permits researchers to advance further and faster [29] in understanding complex IOS adoption phenomena.

Therefore, using the theoretical concepts of Kurnia and Johnston, we propose a dyadic IOS adoption maturity model that retains the richness of their model while making empirical research into IOS adoption progression more feasible.

A dyadic model of IOS adoption maturity

The dyadic model is based on the concept that an IOS adoption is reliant on two organizations agreeing to use an IOS. Therefore, instead of studying one focal organization and its arbitrary trading partners, we look at two particular organisations: organization (A) and its trading partner (B). As shown in the figure 3, organizations A and B have their own capabilities, their own perceptions of the nature of technology and their own actions. The part of the industry structure consisting of the dyad is now viewed as consisting of two elements: (a) relationships between the two organizations, and (b) other relationships within the rest of the supply chain players which are now viewed as external factors. The perceptions of organizations A and B of the nature of technology (arrows b) and their capabilities (arrows h) may enable or inhibit

organizations' actions to use the IOS (arrows f) and alter the dyadic relationship (arrows c). The two organization's actions may also modify their perceptions (arrows a) and improve their capabilities (arrows g) through various interactions with each other (their relationships, external environment and IOS sophistication). The dyadic relationship (arrows d) and external environment (arrows p) also mediates organization actions to use the IOS (arrows f). IOS sophistication also affects the two organizations' dyadic relationships mediated by organization actions (arrows c) because of routinized structured communication facilitated by the IOS sophistication [30]. The new constructs of the simplified dyadic model are explained below.
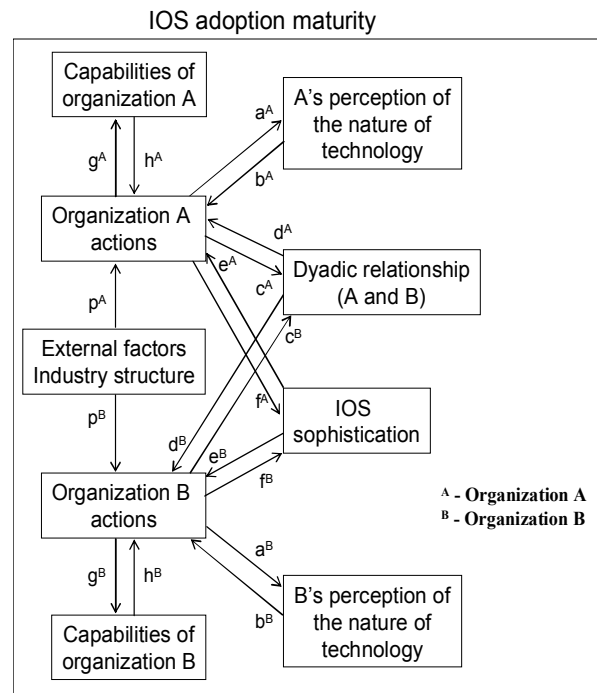

Figure 3. A dyadic IOS adoption maturity model

Dyadic relationships

The nature of Dyadic relationships is defined in terms of some common relational variables [31, 32] identified from the Interorganizational (IO) relationship and IOS literature. The three defining relational variables that are the most frequently cited and investigated in the literature include trust, goal congruence and dependence. They are explained below:

1. Trust

Interpersonal relationship and negotiation theory includes trust as a predictor of improved relations between organizations [33]. From a relationship theory perspective, [34] trust is defined as "the firms' belief that another company will perform actions that will result in positive outcomes for the firm, as well as not taking unexpected actions that would result in negative outcomes for the

firm" (p. 45). The importance of Interorganizational trust has also been emphasized in the IOS adoption literature [8, 11, 12, 35, 36]. Trust determines the reliability of partners, their competence and their openness [12].

2. Dependence (Power)

Organizations are limited in their ability to obtain or produce all resources making them dependent on their partners and others in the environment to acquire resources [37]. Dependency is an important characteristic of a relationship [34] and influences party's degree of long-term orientation [38]. The nature of dependency is closely related to the issue of power, which has been commonly investigated in IOS adoption [8, 11, 12, 26]. In a dyadic relationship, power relation imbalance exists when one of the organizations is more powerful in terms of resources such as facilities, manpower and sales. In such a relation, the powerful party can easily influence the less powerful party to abide by its terms and conditions and force it to adopt the system. When there is a balanced power relationship and one of the parties is unwilling to implement the IOS, the initiating organization may implement the system with the reluctant organizations' rivals. This may put competitive pressure on the unwilling organization and force it to implement the system. In the literature, this type of pressure is commonly referred to as mimetic pressure [54]. More specifically, mimetic pressure occurs when an organization is forced to change its action over time in order to become similar to its rivals [54]. Teo et al [20] found empirical evidence of a link between organizations' IOS adoption decisions and mimetic pressure.

3. Goal Congruence

Goal congruence refers to alignment of the goals of different components of an organization [39]. In a dyadic or supply chain context, goal congruence is achieved when firm's goals coincide with the goals of their trading partners. Goal congruence is regarded as a key component in establishing successful trading partners' relationships [40, 41]. IOS studies also recognize the importance of congruence in establishing partnerships by considering alignment of organizational cultures and size [42], goal compatibility [43, 44], and IT compatibility [45-47]. In this study, we define goal congruence as the extent to which the goals of two trading partners are aligned with each other.

The level of dyadic relationship is based on the degrees of trust, dependency and goal congruence. In other words, the higher the degrees of trust, goal congruence and dependence, the higher the intimacy level of the dyadic relationship of the two organizations.

IOS sophistication

In the Kurnia and Johnston model, the outcome construct is called "IOS adoption", which implies that the IOS system may or may not be used. As such, this definition will not serve the purpose of this study because maturity of IOS adoption is based on prior experiences from using the IOS. Therefore in this study, we rename this construct to "IOS sophistication" which refers to the actual use of the system and not intention to use. To define the level of IOS sophistication, we apply the accumulated number of functions of the IOS and the level of organizational involvement as measurement variables, as explained below.

1. Accumulated number of functions embraced by the IOS

This variable assesses the type of processes or functions that a particular IOS integrates or facilitates between two or more trading organizations. The number of functions of the system shows the extent of integration or sophistication of the system [44, 48]. In this study, we use accumulated number of functions of the IOS as one indicator of its sophistication. As two organizations progress from one level of sophistication to the next, the number of functions accumulates from the lower level to the higher level because more sophisticated IOS general depend on the existence more basic (for example transactional) IOS. Therefore, we can differentiate between different types of IOS by examining their accumulated number of functions.

2. Level of organizational involvement

We define organizational involvement as the extent to which senior hierarchical management functions (operational, tactical, and strategic) are involved in the day to day functioning of the IOS. In other words, the higher (deeper) the organizational involvement required by the system, the more sophisticated the system employed.

The more functions and organizational involvement in IOS adoption, the more sophisticated is the IOS.

A dyadic IOS adoption maturity model with time and performance dimensions

The dyadic IOS adoption model in figure 3 depicts that over time, two organizations would adopt a particular IOS (arrow f in figure 3) that is compatible with their capabilities, perception of the IOS, dyadic relationships and some external factors (arrows b, d, h and p in figure 3). The IOS adopted (arrow e in figure 3) will then improve their own performance and in turn lead to advancements in their capabilities, perception of the IOS and dyadic relationships (arrows a, c, and g). These modifications will enable them to progress to adoption of a more sophisticated IOS. Thus, the different types of IOSs adopted over time are a result of the various causal relationships that emerge from the interactions of the two organizations' actions over time.

To further illustrate the IOS adoption progression/maturity suggested in figure 3 model, we explicitly show the time and performance dimensions involved in the model in figure 4a. The IOS sophistication

at different time intervals (t1, t2 and t3) is an outcome of the influence of all the variables, their perceptions, capabilities, dyadic relationships, initial IOS use and some external factors. The model is also driven by performance, which is the result of using the IOS and is regarded as a key factor for organizations to adopt an IOS [3, 49, 50]. In simple terms, organizations would not progress to the next level of adoption maturity, if the current systems did not provide the expected benefits.

The model in figure 4a illustrates how the variables mediate organizations' actions to adopt an IOS (arrows b, d, f, h, and p). Over time, and due to better performance experienced by the two organizations as a result of IOS use (arrow e), improvement can also be expected in their current dyadic relationship, their perceptions of nature of technology and their capabilities (arrows a, c and g). This, in turn, mediates organizations' actions to implement a more sophisticated IOS (arrow f) than before. This results in the next level of IOS adoption maturity. For example, at time t1, the actions of the two organizations are influenced by their perceptions of the nature of technology, their relationships and their capabilities to adopt and implement a particular IOS system such as an EDI (arrows b, d, f, h, and p). Through the interactions of the two organizations and because of their current IOS use (arrow e), they may modify their perceptions of the nature of technology, their relationships and their capabilities mediated by organizations' actions (arrows a, c, and g) to enable them to implement a more sophisticated IOS at time t2, which may be a CPFR system. Such a system is characterised by more functions and organizational involvement compared to the EDI system at time t1. With a more sophisticated IOS like CPFR, the two organizations will further improve their relationships which may in turn result in better capabilities and perceptions of the technology. This will enable them to progress to implementing a more sophisticated IOS than CPFR and so on. This process will continue till the two organizations reach the highest level of IOS sophistication which is at time tn.

Simplifying the dyadic IOS adoption maturity model

Thus far, we have argued that for two organizations to move from one level of IOS sophistication to the next (IOS adoption maturity t1 to t2), their perceptions of the nature of technology, their capabilities, their dyadic relationship and their IOS experiences are modified through the two organizations' actions. However, there is a problem of including all these variables in an empirical investigation of progression of IOS, because some of the variables overlap with each other when the two organizations progress from time t1 to t2. The interactions between dyadic relationship and IOS sophistication of the two organizations indirectly capture their perceptions of the nature of technology, their capabilities and some aspects of industry structure. As explained earlier, the level of dyadic relationship of the two organizations is defined by the degrees of trust, dependence and common goals. These three variables affect perceptions of the nature of technology. For instance, when one of the organizations shows its intentions to adopt the next IOS, their perceptions of the nature of technology is shaped by their dyadic relationship, which is characterised by some level of trust [11, 12, 50, 51], dependence [8] and goal congruence [7]. In addition, the last two defining variables, goal congruence and dependency, relate to partners capabilities. For example, partners would not likely be dependent on each other if they were not capable, and they would not likely to have compatible goals, if some degree of common goal was not present. In such a case, parties may be pressured by their partners to have the required IT capabilities [52] to facilitate the IOS sophistication or they may look for other partners.

Furthermore, as explained earlier, unwilling organizations are also pressured to implement the IOS out of competitive necessity [20]. They tend to imitate their equal rivals to maintain their social status in the industry and particularly with their partners. This mimetic pressure is related to industry structure. Therefore, by investigating the dependence variable, we also examine some aspects of the two organizations' industry structure.

Also, the initial use of IOS affects the two organizations' perceptions of the nature of technology and their capabilities for further adoption. For example, the adopted IOS creates the infrastructure for subsequent IOS implementations [7, 53]. When the two organizations adopt an IOS, they are aware of each others internal IT infrastructure [45, 46], and they also create the initial joint capabilities such as training, defined roles and the existing IOS infrastructure [7] for further implementations. Thus, this suggests that the various interactions among the variables in the model shown in figure 4a can be well captured and represented entirely by the two new constructs in the model (dyadic relationship and IOS sophistication), and with two-way interactions between these over time. This simplification is summarized in figure 4b.

The model in figure 4b, illustrates that progression of IOS adoption can be adequately explained in terms of the interactions between dyadic relationship and IOS sophistication over time. Thus, we black box other variables because all the complex interactions between the two organizations involving their own capabilities, their perceptions of technologies and some aspects of the external factors, can be summarized in the two-way causal links between dyadic relationship and IOS sophistication (arrows a, b, c, d , e, f, g and h). During IOS adoption maturity at time tn, the dyadic relationship results in the highest level of IOS sophistication and no further progression takes place.

The proposed dyadic IOS adoption maturity model

In this section, we explicitly show the two-way causal relationship between the dyadic relationship and IOS
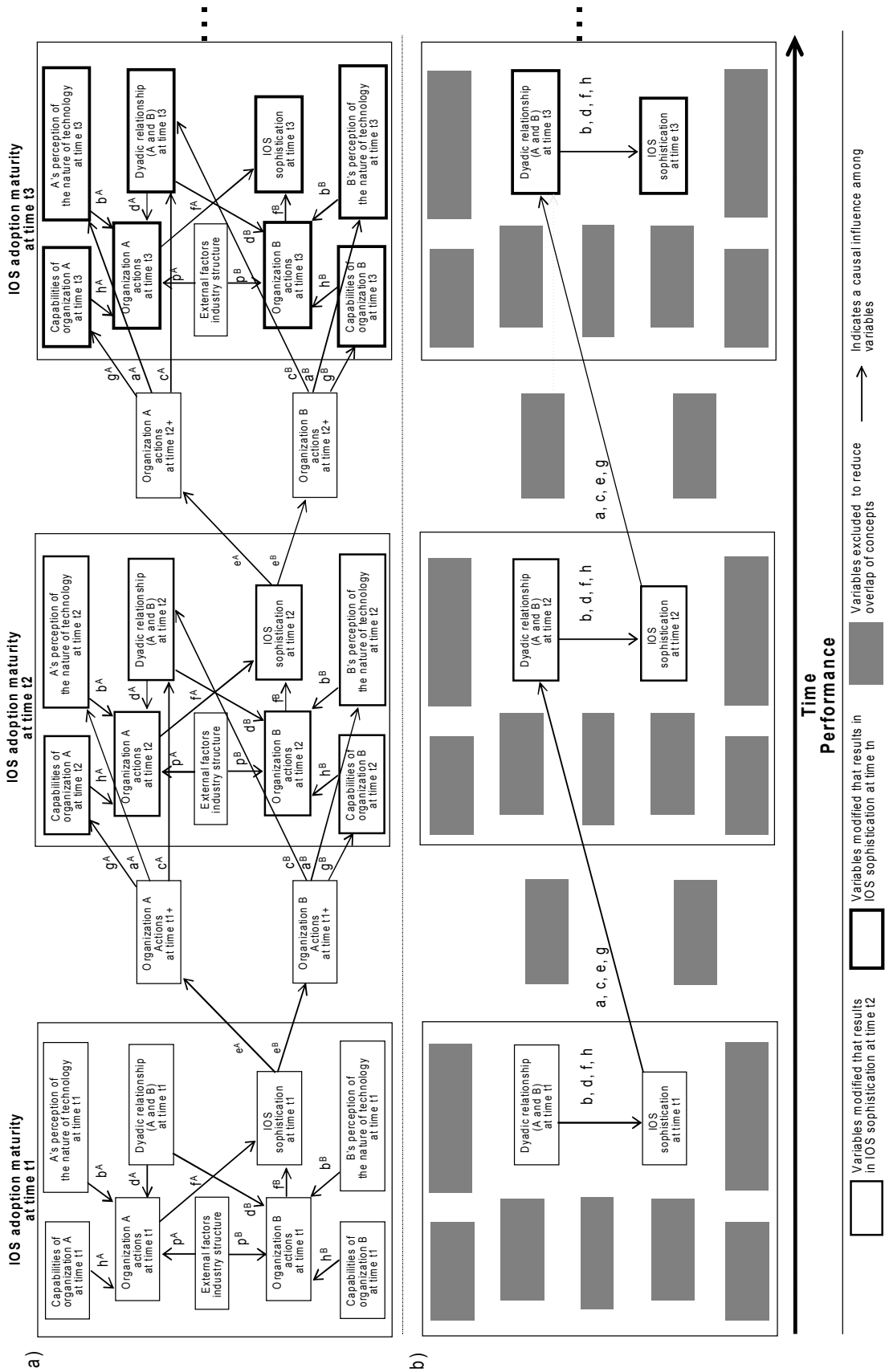
Figure 4. Transition from a) IOS adoption model with overlapping variables to b) IOS adoption maturity model that reduces overlap of variables along time and performance dimensions
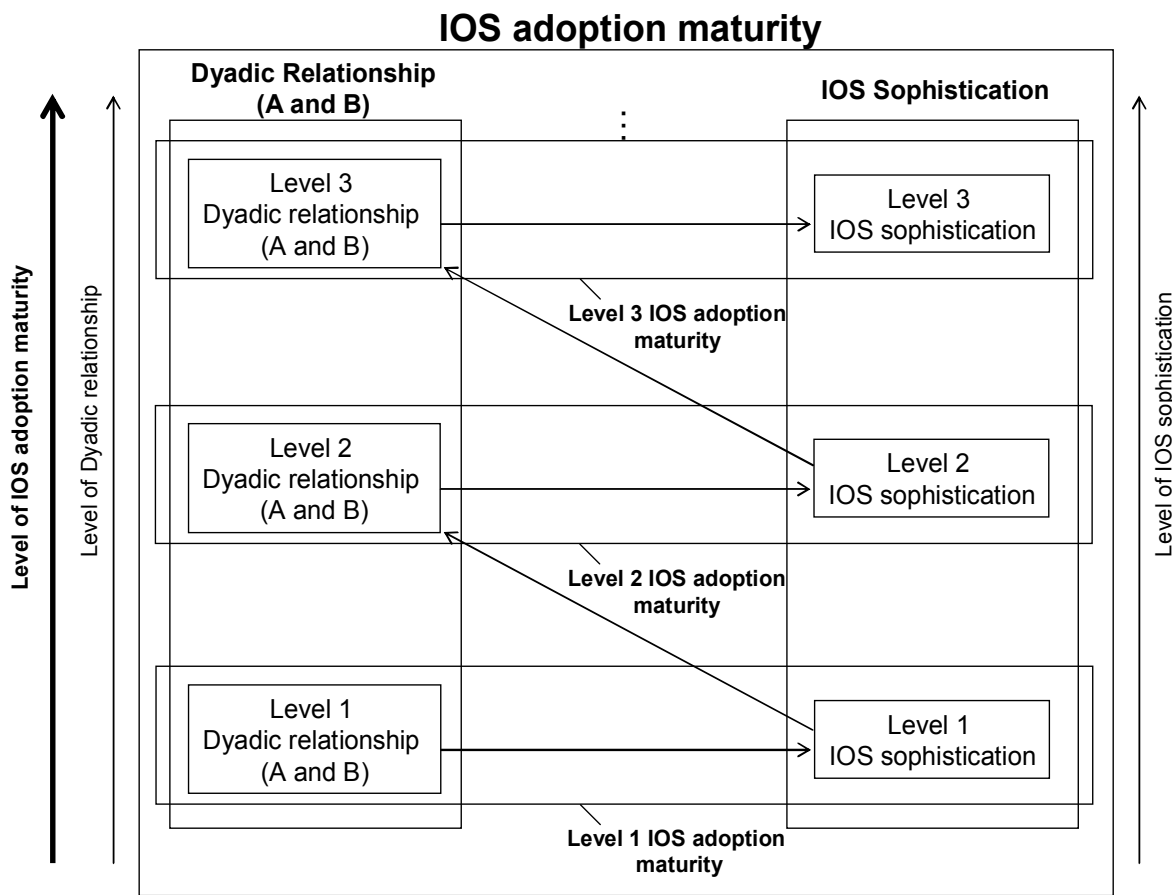
IOS adoption maturity

Figure 5. The dyadic IOS adoption maturity model explicitly showing the causal relationship between dyadic relationship and IOS sophistication along an IOS adoption maturity dimension

sophistication derived from the model in figure 4b and present a set of propositions for future work. We simplify our dyadic IOS adoption model by summarizing the various interactions among actions of organizations, capability of organizations, perception of technologies and the external factors in the two-way causal links between the dyadic relationship and IOS sophistication constructs In this way, our final model (figure 5) is based on dyadic level variables. In addition, in this section we focus on the progression in maturity of IOS rather than events over time as represented by the model in figure 4b. Therefore, we transition from a model that includes organizational level concepts developing along a time dimension to a model that is based on dyadic level variables, which develop along an IOS adoption maturity dimension.

The model depicted in figure 5 has three main constructs: dyadic relationship, IOS sophistication and IOS adoption maturity. As explained earlier, the dyadic relationship is qualified in terms of level of dyadic relationship (intimacy) that is based on the degrees of trust, goal congruence and dependence, and the IOS sophistication is qualified in terms of level of sophistication, which is composed of the accumulated number of functions and organizational involvement in the IOS use. We define the level of IOS adoption maturity

as the highest level to which the dyad has progressed in *both* dyadic relationship and IOS sophistication.

In addition, Figure 5 illustrates how trading partners progress from one level of IOS adoption maturity to the next level. For instance, IOS adoption maturity at level 1 is achieved when dyadic relationship reaches level 1 (level 1 dyadic relationship) and the IOS sophistication reaches level 1 (level 1 IOS sophistication). Therefore, to achieve a particular level of IOS adoption maturity, a particular level of dyadic relationship and a particular level of IOS sophistication must be achieved first.

As shown by the arrows in figure 5, the level of IOS sophistication depends on the level of dyadic relationship and the level of dyadic relationship is also influenced by the level of IOS sophistication. In particular, a certain level of dyadic relationship is a prerequisite to adoption of an IOS at the level of sophistication that is in line with the level of dyadic relationship. The adoption of IOS at a particular level of sophistication, in turn, affects the level of dyadic relationship positively, leading to the achievement of the next level of dyadic relationship, which again facilitates the adoption of an IOS at a higher level of sophistication and so on. Thus, with the model, we can illustrate how two organizations progress from one level to a higher level of IOS adoption maturity.

Based on the above discussion, we postulate the following two propositions:

Proposition 1: *The levels of dyadic relationship affect the levels of IOS sophistication and the levels of IOS sophistication affects the levels of dyadic relationship*

Proposition 2: *To progress from one level of IOS adoption maturity to the next, a pair of organizations level of dyadic relationship and their IOS sophistication has to increase positively*

We now illustrate the propositions with a hypothetical example. A level 1 dyadic relationship may be characterized by reliability based trust, moderate goal congruence and some degree of dependency. This could result in an IOS sophistication that may be an EDI type of system. This level of IOS sophistication is characterized by its ability *to automate the process of exchange of business documents* such as invoice, purchase order, purchase order change, sales etc. This system *involves participants from the lower organizational levels*. To progress to the next level of IOS adoption maturity, their experiences from the use of the EDI system improves their dyadic relationship at level 2. The dyadic relationship at this level may be characterized by *an improvement in their trust, goals and parties are more dependent on each other*. Level 2 dyadic relationship again facilitates the adoption of an IOS with a higher level of sophistication. The IOS sophistication at level 2 could be adoption and use of a CPFR system. In terms of the type of functions embraced, such a system is characterized by *synchronizing the trading organizations planning functions and helps the development of promotion and sales forecasts*, while also *provides replenishment plans and facilitates distribution of products based on joint demands*. In terms of the level of organizational involvement, such a system *requires involvement of persons such as category managers, logistic planners, demand forecasting managers and key account managers* [50]. This system requires involvement of personnel *not only at the floor level but also at the middle level such as the logistics manager, logistics planning manager and so on*, who are involved with the distribution and logistic functions. Depending on their performance from IOS use and their dyadic relationships, level 2 or level 1 could be the highest level of IOS adoption maturity that the two organizations can achieve. In such a case, there may be no further progression.

Conclusion

In this paper, we modify the Kurnia and Johnston [15] IOS adoption process model by reducing its scope to a dyadic level and also extend it by introducing the concept of progression of IOS adoption. We introduced and defined three new constructs; "dyadic relationship", "IOS sophistication" and "IOS adoption maturity". By defining

the IOS sophistication construct, we can differentiate between different types of IOS, which can serve as a measuring tool for future IOS studies. This is an essential step because most IOS adoption studies assume that IOS technologies are one general type of system and do not highlight the distinctive characteristics of different systems. For example, IOS studies that have investigated EDI systems, often assume that the same results apply to other types of IOS. Moreover, by distinguishing different IOS systems and assessing the link with the previous adoption of a less sophisticated IOS, we can also better understand and investigate IOS adoption maturity that evolves over time.

In addition, reducing the scope of the Kurnia and Johnston model has many practical research benefits: (a) we are better able to understand the notion of IOS adoption maturity because we focus research on the interaction of two organizations compared to the whole supply chain or industry, (b) we can justify that the two way causal effect of the dyadic relationship and IOS sophistication captures the concept of IOS progression, and (c) by investigating these two constructs (dyadic relationship and IOS sophistication), we can prevent or reduce the overlap of variables (such as capabilities of parties) which would create problems in empirical research, especially if the dyadic relationship construct is not clearly defined (for instance, [15]). Furthermore, in testing the propositions, the complex interactions behind the two way causal link between dyadic relationship and IOS use will also be examined indirectly to enrich the understanding of how relationships and IOS sophistication progresses over time. Moreover, researchers can adopt the dyadic relationship and IOS sophistication defining variables to categorise relationships into types, which can then match the IOS types.

Practitioners can also benefit from the model. The IOS sophistication should not be treated as single dependent variable, and practitioners should not base their implementation decisions on a single time assessment, but rather on a continuous evaluation process which is also related to performance measures. Hence, continuous assessment of their relationship and IOS sophistication should be done in different points of time to identify patterns and see if they are able to reach the maturity adoption level required. This can help practitioners form new, or evaluate existing, strategies to facilitate future IOS use.

Future research is needed to operationalize the new variables and empirically validate the model of this study. We are in the process of testing the two propositions of the model with dyadic pairs of organizations using case studies.

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