Journal of Theoretical and Applied Electronic Commerce Research
ISSN 0718–1876 Electronic Version
VOL 3 / ISSUE 1 / APRIL 2008 / 71-80

This paper is available online at
www.jtaer.com

Business IT Alignment and technology adoption; The case of RFID in the logistics domain

Lidwien van de Wijngaert[1], Johan Versendaal[2] and René Matla[3]

[1] Utrecht University, Department of Information and Computing Sciences, L.vandeWijngaert@cs.uu.nl
[2] Utrecht University, Department of Information and Computing Sciences, J.Versendaal@cs.uu.nl
[3] Royal Dutch Airlines, Amsterdam, Rene.Matla@klm.com

Received 1 August 2007; received in revised form 7 January 2008; accepted 18 February 2008

Abstract

Radio Frequency Identification (RFID) is increasingly applied in the logistics domain. As with other emerging technologies it is complex whether, when and how an organization should invest in RFID. In this paper the decision to adopt RFID in the logistic domain is explored. The authors take a business/IT-alignment approach and investigate the relation between business/IT-alignment principles and preference for RFID applications. A comparison of thirteen organizations that operate one or more warehouses shows that managers and decision makers in companies are not necessarily in sync with the business/IT-alignment principle which implies to further mature in the areas/domains that are least developed. Organizations were more prone to invest in business/IT areas that are already well developed. We conclude that other factors influence decisions to apply this type of new technology. Yet, the framework offers the opportunity to analyze and prepare a technology decision; it provides insight in and arguments for possible RFID adoption.

Key words: Business/IT-Alignment, Logistics, Maturity, RFID

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1 Introduction

1.1 New technology of Radio Frequency Identification

Radio Frequency Identification (RFID) is an upcoming wireless technology that enables items to be identified through radio waves. Typically, RFID can be described as a reader communicating with a tag, holding information in a microchip. An object or good is equipped with the tag and a reader can identify the object.

After a rather turbulent period in which RFID's possibilities have been promising, [5] states that the technology is over its hype, and into the 'trough of disillusionment'. RFID applications in asset management and tagging of cases however are application fields that are hitting the 'slope of enlightment'. This means they are becoming more and more popular and companies are finding ways to make sound business cases out of these applications [14]. Still a lot of challenges have to be overcome in areas like technology, standards, costs, ROI etc. before RFID can become a widespread technology [11], [27].

According to [9] there are two important drivers that motivate companies to start experimenting with RFID applications. The first driver is the mandate by some major channel masters and procurement agencies that foresee operational efficiencies when applying RFID. This mandate is a clear example of buyer power through great volumes as identified by Porter in his five-forces model [17]. Examples are Wal-Mart and the US Department of Defense; they demand that their preferred suppliers comply with their RFID application. In practice this means that crates and pallets are tagged with RFID chips so they can be traced through the supply chain. The second driver for RFID diffusion is the collection of immediate benefits that can be gained from implementing the technology. Companies try to gain competitive advantage by being a first-adopter. They use RFID to innovate their business and to gain strategic leverage. Research question and outline

As with many new technological innovations, companies may not be ready to take full benefit from RFID's possible advantages. From a Business/IT-Alignment (BITA) perspective, the introduction of new technology in an organization may unbalance business and IT, bringing them out of sync; [25] argue that continuous strategic alignment is needed. [10] identify four basic concepts in BITA: 1) business strategy, 2) organizational infrastructure (both related to the business domain), and 3) IT strategy and 4) IT infrastructure and processes (both related to the IT domain). Their assertion is that in an organization all four concepts should have the same level of maturity in order to realize value from IT investments. Another much cited scholar on this topic is Porter [18] who argues that business and Internet strategies should coincide. Also [26] and [8] argue that IT innovation should come in careful consideration with the business processes.

However, it remains unclear what a particular organization can specifically do with RFID in order to gain tangible benefits of the investment. In our research we adopt the concept of BITA and intend to further operationalize and detail it for the logistics domain. We investigate whether our detailed and operationalized logistics BITA framework aids in justifying the adoption of a specific RFID application. Our associated research question is:

To what degree can we use a business/IT-alignment framework to explain preferences for RFID-applications?

The scientific relevance of this research lies in the development and testing of a BITA-framework in the logistics domain. We will obtain insight into the degree to which the ideas with regard to alignment will hold in the context of specifically warehouse management. The practical relevance of this research lies in the possibility for organizations to derive which RFID-applications can be relevant in their specific situation. Rather than simply looking at the possibilities that RFID have to offer, this research takes the organizational readiness (in terms of maturity) for an RFID application into account.

In the next section we construct the logistics BITA framework and provide associated propositions. Section 3 describes our validation of the framework in detail, followed by an analysis of the validation results at thirteen organizations in section 4. We end this paper with conclusions and some suggestions for further research.

2 An alignment framework for the logistics domain

In making a tangible and logistics specific alignment framework we: 1) further drill-down business domains from [25] into four dimensions, 2) include maturity levels for each of the dimensions.

2.1 Business dimensions

[24] and also [20] considered the business domain of [10] as too abstract and developed extensions to the strategic alignment model. The business domain can be drilled down into four dimensions: 1) strategy & policy, 2) monitoring & control, 3) organization & processes, and 4) people & culture. [20] showed the usefulness of this particular division through an empirical study of 265 Dutch housing corporations for identifying approaches for business improvement.

Also in specific domains like the procurement function this division has been proven useful [2]. With the identification of four business dimensions and the separate IT dimension, optimal BITA now entails the balancing and equal alignment of all business and IT dimensions.

2.2 Logistics maturity

In IT system development, a known maturity assessment model is the Capability Maturity Model [15]. Likewise, on the topic of logistics maturity and logistics evolution some research has been performed. Examples are [13], [4] and [16]. Taking this research we define logistics evolution or maturity (towards logistics integration) in terms of progressing along physical boundaries. These physical boundaries act as differentiators between different maturity phases. The different phases can be defined accordingly:

- Pre-Supply chain; The lowest level of maturity; often the state of a starting organization.
- Functional orientation; An organization starts to improve its logistic functions; improving merely at an operational and functional level (within departmental boundaries).
- Internally Integrated; The organizations starts to improve its logistics by aligning different functions and organizational entities.
- Externally Integrated; The focal point shifts to customers and suppliers, optimizing across the borders of the company becomes the key issue.
- Value Chain Integrated; The company integrates with the full supply chain. The most important property of this level is the end-consumer driven integration from start to end of the value chain.

The five phases provide a representation of the borders and maturity phases within a firm. BITA is now defined as the degree to which the maturity levels of the different business and IT dimensions are equally high. It also implies that companies should invest in their 'weakest' business/IT dimensions.

2.3 The Business/IT-alignment framework for logistics

Table 1: BITA framework for the logistics domain

Maturity Dimension	**Pre-Supply Chain**	**Functional Orientation**	**Internally Integrated**	**Externally Integrated**	**Value Chain Integrated**
Strategy and Policy	Logistics only at the basic level.	Unsegmented supply base with no formal supply chain partners.	Segmented supply base and organized core suppliers.	Discussions with trading partners on how to attract customers.	Strategy formulation based on a full view of the value chain.
Monitoring and Control	No authority outside the shipping area. Little to no authority outside the shipping area.	Monitoring of performance of processes across a limited lateral span of control taking a range of improvement actions.	High level of formal control over a greater lateral span of related logistic functions.	Monitoring of 1st-tier chain partners.	Value chain monitoring & control. Real-Time inventory.
Organizatio n and processes	Logistics defined as shipping.	Logistics defined as shipping and warehousing.	Logistics defined as shipping warehousing and customer service functions.	Just In Time production /delivery, Vendor Managed Inventory.	Automated connections between organizations.
People and Culture	Clerical style logistics.	Run by 'military style' logisticians.	Run by (Chief) Logistics Officer.	Awareness of the importance of external linkages.	Value Chain awareness.
Information Technology	Notepad, Word.	Barcodes, basic Order Management.	Warehouse Management System, Enterprise Resource Planning	Electronic Data Interchange, Customer Relationship Management, Supply Chain Management.	EPCglobal network. See: www.epcglobal. org.

The business and IT dimensions and the logistic maturity levels result in the logistics based BITA framework. It is presented in Table 1. This framework provides a way to measure the maturity of a firm in the logistic domain in the different dimensions. The characteristics and descriptions of most of the business dimensions related framework cells were derived from literature [13], [4], [16]). Concerning the characteristics for the IT dimension we used [23], [19] and [21], as well as [5], a technology trend watch report. Note that all characteristics are indicative, we do not intend to be complete.

2.4 RFID applications

As the aim of the research was to evaluate the choices for certain RFID applications, we identified possible RFID applications in the logistics domain. These applications were derived from current trends and possibilities with respect to RFID, e.g. [5]. We distinguish two specific types of applications: warehouse specific (receiving, intelligent picking, shipping, replenishment and Returnable Transport Items (RTIs)), and non-warehouse specific (Electronic Product Code Global network (EPCGlobal network), Vendor Managed Inventory (VMI) and Supply Chain Management (SCM)). The warehouse specific applications can be directly linked to operational processes in the warehouse [1]. The EPCGlobal network originates from the EPC organization, which in turn originates from GS1-US and the Uniform Code Council (cf. http://www.uc-council.org/). EPCGlobal is a powerful driver in RFID adoption through the EPCGlobal network, and promises to implement an infrastructure able to create full visibility of RFID tags throughout the supply chain. Both VMI and SCM are concepts already present but more effective in combination with RFID.

To be able to evaluate these applications with the help of our framework we apply further dispersion. Roughly there are applications that are directly related to a certain process. There are also applications that are more strategic in nature, and their implementation will go beyond the warehouse environment in most cases. In particular, the applications were grouped by properties that can be matched against the BITA dimensions (see Table 2). Strategic concepts are applications that are closely related to a firm's strategy and can affect or are being affected by firm strategy. Therefore, in a proposition, we relate the strategic concepts to the BITA dimension Strategy and Policy. Process-oriented solutions have strong ties with operational processes, and will therefore (propositionally) be related to the BITA dimension Organization and Processes. Some solutions improve the tracking and tracing abilities of the organization. Tracking and tracing influences the capabilities related to Monitoring and Control. The value chain integration enablers are applications that enable a firm to integrate with other value chain partners, propositionally relating to overall maturity across all BITA dimensions. The General RFID Investment Score will be propositionally related to the maturity of the IT dimension.

Table 2: Application grouping

Application groups Applications	Strategic Concepts	Process Oriented Solutions	Tracking and Tracing	Value Chain Integration Enablers	General interest in RFID
Receiving		x			x
Intelligent Picking		x			x
Shipping		x			x
Replenishment		x			x
Returnable Transport Items (RTI's)			x		x
EPC Global Network	x		x	x	x
Vendor Managed Inventory (VMI)	x				x
Supply Chain Management (SCM)	x			x	x

2.5 The Research framework revisited and definition of propositions

Now that we have provided detailed information with regard to the maturity and alignment model in the logistic domain as well as with regard to RFID applications, we can describe the propositions related to it.

Proposition 1: If a firm has a low score on the Strategy and Policy dimension compared to the other dimensions, its priority is to invest in a strategic concept (like SCM or VMI).

When a firm is on a low level regarding Strategy and Policy the incentive (from a BITA perspective) is to invest in strategy in order to improve the maturity in this dimension. The implementation of strategic concepts is a way to improve the score in the Strategy and Policy dimension.

Proposition 2: If a firm has a low score on Processes and Organization compared to the other dimensions, its priority is to invest in process-oriented solutions.

Proposition 3: If a firm has a low score on Monitoring and Control compared to the other dimensions, its priority is to invest in solutions that improve Tracking & Tracing.

Proposition 4: If a firm has a high overall alignment score it will likely invest in RFID technologies that enable integration with value chain partners than firms with a low alignment score.

Alignment is a combination of maturity and the degree to which dimension maturity values are assessed equally high. When further improving, the focus of a firm should be on external parties and integrating with them.

Propositions 1 to 3 directly relate to the basic principle of the BITA framework: invest in the 'weakest' dimension to become better aligned. Proposition 4 reflects overall alignment. Proposition 5 takes a different angle than BITA, in order to check whether non-BITA aspects influence the decision to start implementing RFID. Being 'IT-sensitive', when further improving the IT, a company is likely to consider or further implement RFID.

Proposition 5: When a firm has a high score on Information Technology, it is more willing to invest in RFID.

Using these normative propositions we can now describe our research design. The basic idea of the design is to establish the maturity of organizations by interviewing (top)managers from the logistics department in terms of the BITA-framework (represented by the vertical arrow on the left hand side of Figure 1). Likewise we establish to what degree organizations are interested in specific RFID applications (represented by the upper horizontal arrow in Figure 1).

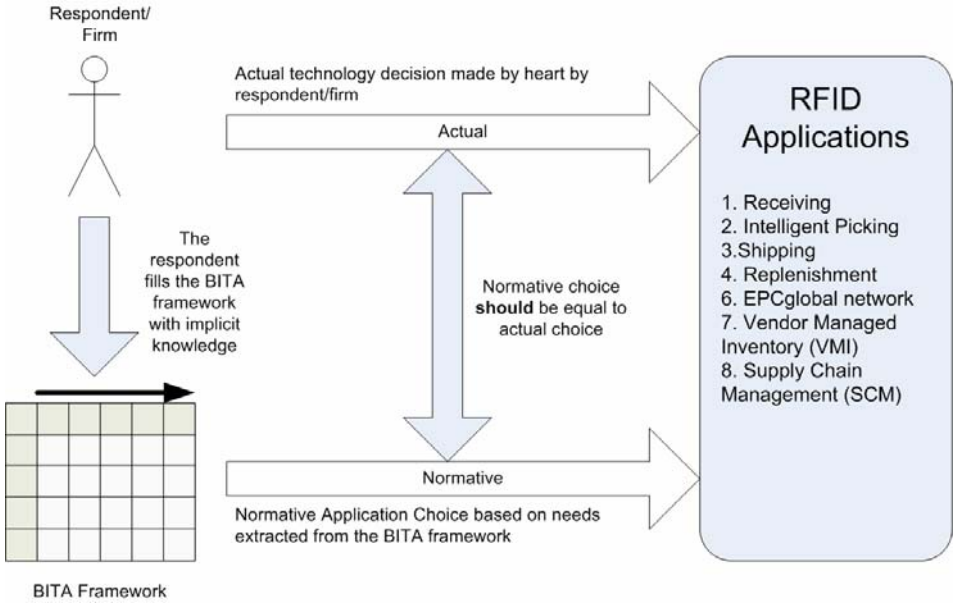

Figure 1: Research model in detail

Now that we have determined a normative technology strategy (depicted by the five propositions as well as the lower horizontal arrow in Figure 1) we can compare them to the actual choice(s) made by the firm (upper horizontal arrow). This comparison is depicted by the vertical arrow in the middle of Figure 1. In the next section we describe how we applied our design and checked the propositions in thirteen cases.

3 Validation design

To empirically validate the propositions we performed 13 case studies, using pen and paper questionnaires to gather data. The organizations were selected using the customer base of a Dutch software vendor of warehouse systems. This vendor delivers software solutions for retailers, logistic service providers and manufacturers. The respondents that answered the questionnaire were all managers in the logistics domain, capable of making decisions with regard to the adoption of new (RFID) technologies. The organizations that were included in the research represent a wide variety. Table 3 provides an overview of the main characteristics of the organizations in the sample.

The questionnaire consisted of two parts. The first part related to items for assessing the maturity level of framework dimensions and the second part consisted of scenarios in which applications of RFID were presented. With regard to the maturity, several items were formulated with regard to each of the dimensions. The respondents were asked to state to what degree an item was applicable to the organization on a seven point scale. Earlier related work on measuring maturity for the same framework dimensions (in a procurement business function context, see [3]) encouraged to assume that scales can be used to measure maturity. The reliability of these constructs was tested

using Cronbach's Alpha. The alpha's are considered satisfactory with all but one scores above .70 being adequate and all scores above .80 being good. Scores lower than 0.70 should be considered with care [7]. See Table 4 (left part) for the reliability scores of the constructs that make up the BITA dimensions. We observe that all constructs are (at least) satisfactory. Consequently we computed the average score for questions related to a particular BITA dimension.

Table 3. Characteristics of respondents

Branch	Operation	Clients	Suppliers	Warehouses	Employees	Order
Automotive	Logistics	20	50	8	450	100000
Transport	Logistics	80	50	3	75	80000
Transport	Logistics	250	200	3	60	70000
Retail	Production	100	150	2	300	5000
Metal	Production	500	150	1	500	25000
Bicycles	Production	1500	150	4	500	400000
Retail	Retail	300	4000	1	550	40000000
Food	Retail	1700	350	1	150	130000
Food	Retail	100000	300	5	600	100000
Food	Retail	500	600	6	12000	500000
Home shopping	Retail	not provided	3000	3	1000	not provided
Retail	Retail	130	500	1	2400	12000
Toys	Retail	700	3900	1	180	13000000

As for the definition of alignment we include the different scores on the individual maturity dimensions, and the degree to which the scores on the different maturity dimensions are in sync with each other. These two building blocks of alignment have been successfully applied in related research dealing with the operationalization of alignment for specifically the procurement business function and the marketing and sales business function in organizations [2],[3],[12]. As for the value of the different maturity scores 1) we take the mean value of the individual maturity dimensions: the higher the mean value, the higher the overall alignment value. Regarding the degree of synchronization of the individual maturity scores 2) we operationalize this by taking the difference between the highest maturity dimension score, and the lowest maturity dimension score: the higher the value of this difference, the lower the overall alignment. The resulting alignment formula is now defined as:

Alignment = ((Σ maturity)/5) * (1/max-min))

The second part of the questionnaire consisted of a number of scenarios that described possible applications of RFID in the warehouse. The first scenario for example related to automatic receiving:

Verifying incoming shipments can take a considerable amount of time within warehousing. It is a labor-intensive process to match invoices with received products. When containers are equipped with RFID they can be linked to their load. When a container or pallet is unloaded the warehouse management system can match it directly with invoices. Shipments can be checked rapidly and with lower labor effort. The shipment is processed by the warehouse management system after which it will enter the storing process.

The other scenarios are related to Intelligent Order-Picking, Shipping, Replenishment, Tracking Returnable Transport Items (RTIs), EPCglobal, RFID and VMI, and RFID and SCM. For each scenario we asked to respond to two items: 'This solution is interesting to our firm' and 'Our firm is interested in buying this solution'. Respondents were asked to state to what degree they agree with both items on a seven point scale.

Table 4: Cronbach's Alpha for framework dimensions and interest in applications

Dimension	Cronbach's α
Strategy & Policy	.72
Monitoring & Control	.72
Organization & Control	.88
People & Culture	.84
Information Technology	.89

Applications Groups	Cronbach's α
Strategic Concepts	.86
Process Oriented	.90
Tracking & Tracing	.91
Value Chain Integration solutions	.90
RFID Investment score	.68

Not only did we use reliability analysis to check the consistency of the BITA dimensions, we also checked the reliability for the interest in the Application Groups. The first question measures general interest, and the second question measures buying intention: together they measure the profound interest in the particular RFID-application groups. The alpha's found for the applications in each group are presented in Table 4 (right part). The alphas are mostly satisfactory except for the alpha for the general interest in RFID investment, which is considerably lower than the other alphas. This can be explained as a consequence of the fact that the diversity is greater across all applications as opposed to application groups. Although an alpha of .68 is not as high as the others, we consider it

as acceptable. Consequently, we computed the average score for questions related to a particular RFID-application group.

4 Results and analysis

In this section we will first provide descriptive statistics with regard to alignment, maturity and preferences for RFID applications. Next we will look into the propositions of Section 2.5.

From Figure 2 we can conclude that most of the 13 organizations in our sample have high scores with regard to maturity. There may be several explanations for this. One possible cause is the fact that these particular customers of the warehouse management system vendor have thought thoroughly before or when implementing their warehouse management system. The alignment scores are determined using the formula for alignment in section 3. As for the degree of alignment, there are some differences. Especially regarding Information Technology, several companies are behind. As a result the value for aligned maturity also differs.

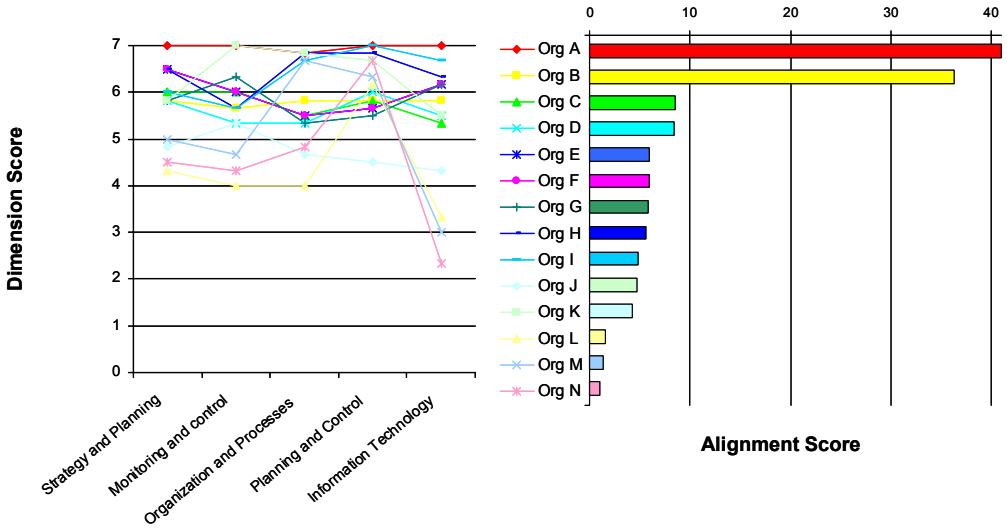

Figure 2: Maturity and alignment

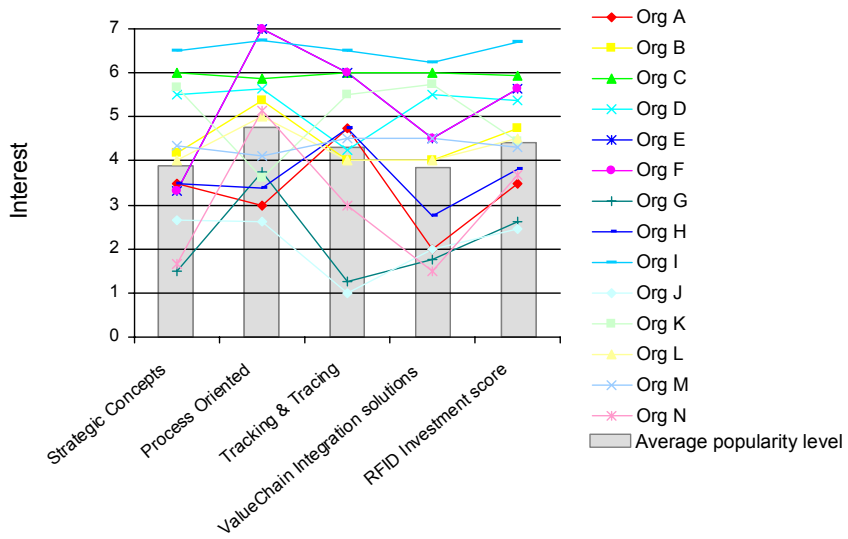

Figure 3: Bar chart describing the mean interest for each application group

Figure 3 illustrates the results with regard to interest in RFID applications. In general firms show interest in applying RFID in receiving, order picking, shipping and RTIs. In particular, shipping is popular. The reason for this could be

that it is relatively easy to implement RFID in combination with RTIs; it also allows for increased precision and service.

Using the bars in Figure 3, we conclude that overall the RFID-applications that are directly related to the warehouse processes are most popular. This could be interpreted as an internal functional focus. The more 'strategic' or firm boundary surpassing applications are less popular. The increased complexity of these applications is a possible reason for this. We do however see relatively high variation of popularity of the different application groups between the individual organizations.

The results concerning the propositions are analyzed by means of the scatter plots in Figure 4. The figure depicts a composite plot for each of the application groups. The independent score (on the X-axis) represents the scores in the business IT/alignment framework. The dependent scores (on the Y-axis) are the actual technology decisions scores (= application group values).

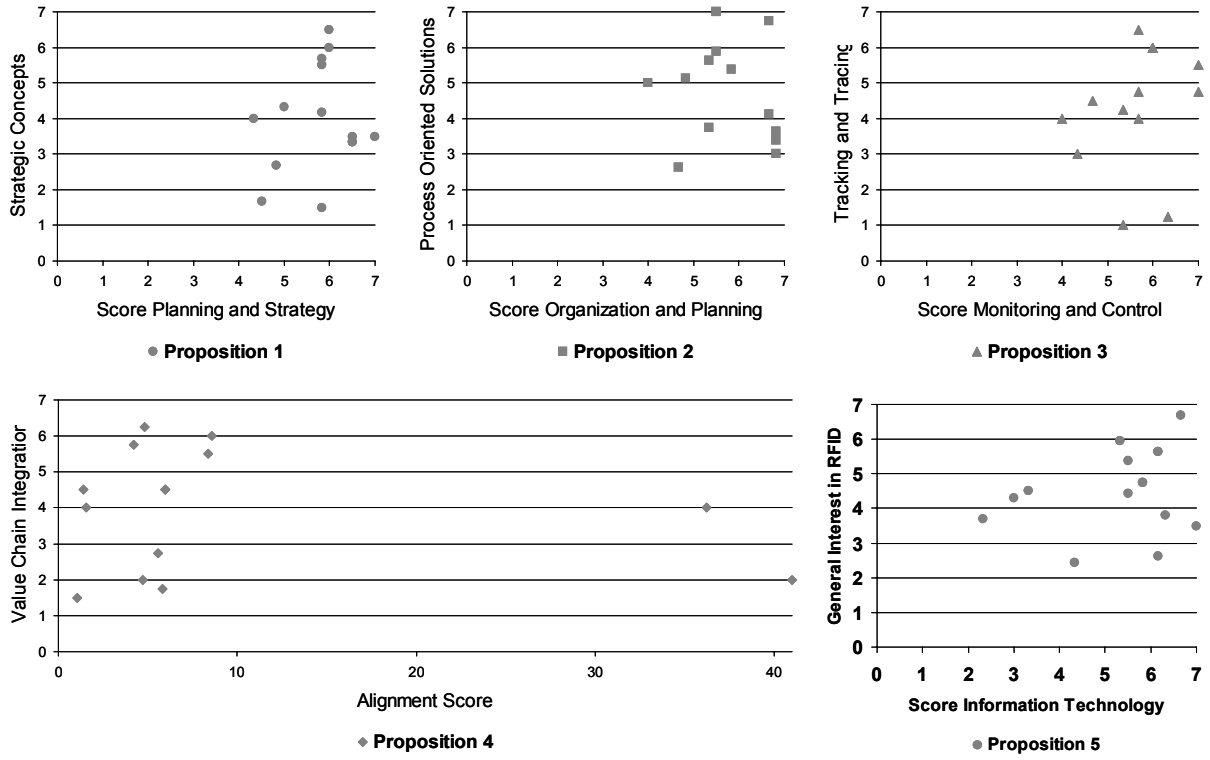

Figure 4: Scatter plots of application groups vs. maturity and alignment scores

Interpreting and analyzing the results of the thirteen cases depicted in Figure 4, we conclude that there is some support for the propositions formulated earlier in this paper:

Proposition 1: This proposition is not supported based on the data we have. The proposition assumes a negative relation between the strategic concepts type of RFID-applications and the Strategy and Policy business dimension. However, the data indicates that low scores on the Strategy and Policy dimension do not show a trend towards a willingness to invest in strategic concept type of RFID-applications.

Proposition 2: We found support for the second proposition: lower scores on the Organization and Planning business dimension seem to relate to higher scores for applications related to Process Oriented solutions.

Proposition 3: The data does not support a negative relation between Tracking & Tracing applications and Monitoring and Control. Comparable to the first proposition there seems to be a slight positive relation.

Proposition 4: On a general level the proposition that there is a positive relation between the degree of alignment and a general interest in RFID application cannot be confirmed. When we do not take the two organizations with highest alignment scores we see a positive trend between level of alignment and an interest in RFID applications. Consequently, we should reflect upon the

question whether maturity as a concept can be used to explain interest in new technologies, whether maturity can be measured through scales and how we operationalize alignment.

Proposition 5: Proposition 5 assumes a positive relation between the score in IT and the willingness to invest in RFID. The respondents' data indeed indicates a likewise trend.

Some, but not all propositions based on the BITA framework, are supported. From this we conclude that other factors play a role in adoption of new technology as well.

5 Conclusions

As a new technology, a useful application strategy for RFID is hard to determine. In this paper we investigated whether our developed BITA framework for logistics is a useful instrument. The construction of the framework was based on BITA literature as well as on literature on the maturity of logistics and warehousing, and on RFID specifically.

The validation of our framework at thirteen companies indicates that the weakest BITA dimension is not necessarily the focus of existing and future RFID investment approaches. We know that the sample size implies limitations of research and applying the propositions to additional case organizations will provide more detailed conclusions. For now we conclude that besides alignment other factors also influence the choice of new technology adoption, as indicated by proposition 5: companies having a high IT awareness and installed base, have willingness to invest in IT. Although, in the light of alignment research this is a strange result, it does seem to be in line with earlier research on decision making (e.g. [22] and [6]) which states that decision making is not always as rational as one would like it to be. Further research should therefore focus not only alignment, but also other factors that may influence investments in RFID.

Nevertheless the BITA framework for the logistic domain is a supplement to the already existing BITA frameworks. It offers the possibility to benchmark the logistics operations of firms and detect possible shortcomings from a BITA perspective. It can also estimate the readiness of a firm in starting with supply-chain integration for which RFID can be a good enabler.

Concerning technology adoption we think that the framework offers possibilities in analyzing technology decisions and helping managers guide them in these decisions. The ability of the framework to make implicit knowledge within the firm more explicit makes it a suitable tool for this purpose.

Acknowledgments

We would like to acknowledge the anonymous reviewers and guest editors who helped us in improving this paper.

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