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ARTICULATION OF INFORMATION REQUIREMENTS IN E-BUSINESS SYSTEMS

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Abstract

E-business is a relatively new area where the theory, methods and technologies can bring in a great deal of benefit to the whole enterprise. The study of information requirements for e-business systems reveals that the level of detail, granularity, format of presentation, and broad range of information type are required for the applications. The provision of relevant information will affect how e-business systems can efficiently support the business processes to achieve the business goal. This is particularly important for firms to sustain in the dynamic marketplace. This paper presents an approach for determining information requirements for e-business systems (DIRES) that allows the user to describe the core business processes, which determine adding value for business growth into a business activity space, by prompting possible patterns of activity dimensions. It further aids a configuration of information requirements into an information space, which captures the information required for the described the business operation. A case study has been used to demonstrate the use of the set of techniques of DIRES.

Keywords: E-business systems, information requirements, activity space, information space, requirements articulation

Introduction

Electronic business (e-business) is emerging as one of the most exciting research areas in our era. E-business systems are dynamic networks of interrelated IT systems that enable the conduct of business between two or more parties electronically. It offers an innovative and promising way for companies to trade and cooperate in the ever-changing market. When designing an e-business system, it is essential to understand the business operations and capture the information requirements for the various users of the system. Due to the nature of e-business systems, they perform functionality to serve buyers, suppliers, business trading partners as well as internal employees of the firm. To develop such kind of systems, there are some issues on information provision that need to be addressed. This has raised two primary concerns. Firstly, there is a need to ensure the provision of appropriate information on one hand to help customers in making purchase decisions. On the other hand the firm can be supported to collaborate with suppliers and business partners. The second concern is to consider the issues at the management level, which are related to the provision of the most appropriate information to the management with regard to formulating vision and mission, setting goals and objectives for the direction, forming polices and rules for the organisation to maintain customer relationships and manage supply chains. E-business systems, therefore, involve numerous stakeholders for different objectives and requirements. Customers must trust that the systems would not provide the wrong information and that the actions of the systems made on their behalf will not contrast their intentions. This becomes a real challenge for determining the right information requirements based upon which the e-business systems can be designed and developed to encapsulate the notion of trust. To this end, the Determining Information Requirements of E-business Systems (DIRES) method is introduce in this paper.

The DIRES method bases its work on Liu (2000), Chong and Liu (2000; 2001), Sun et al. (1999) and Sun and Liu (2001). This paper aims to introduce DIRES with its set of techniques that enables users and developers to determine information requirements for design of e-business systems from a methodological perspective. Following an explanation of basic concepts in DIRES, a set
of constituting techniques is presented. The method is applied to a case study in freight transportation to demonstrate its use. Finally discussions and conclusions are drawn.

The DIRES Method

The DIRES method aims to enable users to articulate business operations and configure information requirements in an interactive fashion. It facilitates users during a business domain analysis to specify business processes by describing the business terms, and derive the information requirements based on business knowledge and rules captured in the system (Liu and Ong, 1999). There are three important concepts, ontology, activity space and information space, in the DIRES method (Sun et al., 2000). An ontology of the business domain is presented in a chart that delineates the business terms and the core business processes (Chong and Liu 2000; 2001). These business processes can be further decomposed into a number of business activities, which possess information elements. The principal purpose of the ontology chart is to describe common e-business processes (Jones et al., 2000). These business processes can be decomposed to form activity space and information space, will then determine information requirements for systems design (see Figure 1).

In an e-business context, managers and customers usually require information to make decisions for different purposes, for example, a manager may wish to access the performance on sales in certain locations, customers may request information on certain types of product/service for purchase, and the firm needs to plan production by getting enough supply. In order to design an efficient e-business system to serve these purposes, the business operation can be conceptualised in a sequential business process and they can be represented in activity spaces, which consist of a set of dimensions equivalent to these business terms in the process. The information required to the activity space can be organised in the information space. A mapping between these two spaces will determine the information requirements for the system (Sun and Liu, 2001).

DIRES Architecture

DIRES provides a mechanism for systems developers to start an analysis from a problem statement, which may be vague, and gradually move on to acquire more concrete knowledge of the business operation by using a set of techniques. This analysis can be carried out at two major phases: domain analysis and modelling, and configuring information space.

Domain Analysis and Modelling

Domain analysis and modelling (Figure 2) involves process analysis, agency structuring, role/activity analysis and information analysis. The process analysis focuses on the business process aspects at the enterprise level. Agency structuring, conducted
at the same time as the process analysis for their interdependency, identifies human actors (i.e. agents), their roles and responsibilities within the organisational structure. Role/activity analysis further identifies activities involved by each role. Finally, information analysis determines the information requirements for each role and activity.

This phase produces the following deliverables:

- **Ontology chart** is produced from the process analysis. The ontology chart represents the business domain by capturing the business processes, business terms and jargons and their meanings. In addition, the chart identifies the many useful concepts such as the responsible agents, their roles and their ontological dependency relationships.

- **Business norms** are examined and captured from the ontology chart. They represent a more thorough understanding of the business processes identified in the ontology chart, based on which the decomposition of the business processes can be carried out.

- **Agency models** are created based on the process analysis and analysis of agent structure (i.e. agency structuring). This conceptual model is a refinement of the ontology chart that identifies agents, their roles and relationships.

- **Business Activity repository** is a collection of business activities related to the e-business processes. This repository is the result from the role/activity analysis, which examines agents in each role and their involvement in the activities. This repository contains all the possible activities across the different processes. It will be used to facilitate an articulation procedure in the second phase.

- **Information category repository** resulting from the information analysis that takes input from the agency models. This repository defines the categories (i.e. types) of information (rather than information content itself). Each category can later on form an information dimension in an information space.

### Configuring Information Space

The phase of configuring information space (Figure 3) carries out two analyses: **articulation of activity space** and **configuration of information space**. The articulation of activity space takes input from the agency model and the business activity repository. The user will have opportunities to interact during this procedure and to customise the selected activities and specify the granularity of the activities for constituting the dimensions of the activity space. The activity space is composed of several dimensions, each of which is represented by a business term. For example, an order process consists of a number of activities, such as make a **sales contract** (including quote, tax, customer details, product and quantity), **delivery address and date**, **inventory status**, **amend order**, and **cancel order**. These activities normally follow the norms for governing the behaviour and their sequence. In order to execute these activities, certain kinds of information are required, e.g. customer details, product, quote, delivery details, inventory status and payment terms.

The configuration of information space maps an activity space, with the input from the information category repository, onto an information space. The information space is formed by a number of information dimensions. Each dimension corresponds to a category of information. For example, the category of information on purchase contract can be one dimension, which can be tuned at any level of granularity: normal contract or special contract. The procedure of configuring information space is complex, because there is normally a number of choices of granularity available in each dimension which may all be relevant to the business

![Figure 3. Configuring Information Space](image-url)
process, but to varying extents. In such cases, the user can interact during the procedure to determine, e.g. temporal and spatial granularity, any additional dimensions, and chronicle coverage.

Applying DIRES in Freight Transport

To illustrate the techniques in DIRES, a case study is adopted from Roadway Express, a large American freight transport company. Internationally, this company has an extensive business network to run its operations in over 70 countries in six continents via the Internet system. The network operates on a multiple mode of transportation by air, rail, and water. Within North America, the two types of transport, over-the-road operation between cities and local pickup and delivery, constitute the major operations. Satellite terminals are spread around major cities where there are breakbulks. The satellite terminals collect goods from customers and bring them to the breakbulks. The goods are then sorted and consolidated at the breakbulks for the linehaul transportation to another city.

Analyzing the Business Processes

Within the operation of Products and Services, the freight transportation is the key process, around which all other business functions are built. Therefore understanding and capturing this process is essential in modelling the core business domain. Based on an analysis of the entire business domain, the area of Products and Services is analysed and represented in an ontology chart in Figure 4. The details of the various steps in constructing the ontology chart are excluded in this paper (for details see Liu, 2000; Chong and Liu, 2000; Barjis and Chong, 2001). The agents are grouped according to their ontological dependency relationships and the types of responsibility. It is interpreted as follows. The ontology chart is read from the left to the right. Entities that are on the right are dependent on the existence of the entities on their left to exist. Any entities whose existence is dependent on the existence of other entities is known as the dependant (e.g. sends), while the parent entity of the dependant is known as the antecedent (e.g. sender). In this chart, the entities in circles are usually the companies or agents that are responsible for performing some activities. The roles of the agents at different point in time can be identified from the semi-circles. Nodes that represent verbs reflect the potential activities that the agents can perform. The activity “request” leads to the existence of the activity “generates” if the action “request” is completed. Therefore, a dotted line with an “@” sign is used to indicate that the completion of the activity “request” activity the action “generates”.

![Ontology Chart of Roadway Express](image-url)
Some features of the ontology chart are worth noting. Firstly, one contribution of the ontology chart is that it provides an understanding of which agents are responsible for the activity. This is important in an e-business deal, since it is important for the company to fulfil any obligations that are incurred on them after being involved in some activity. Customers will definitely take their business elsewhere if obligations or promises are not kept. Secondly, one has to realise that the existence of an activity must be within the existence of its antecedent. Once its antecedent ceases to exist, the lifetime of the activity will also come to an end. For example, no activity ‘pays’ should take place when there are no customers. This understanding can be translated into implementation to ensure the integrity of the system. Thirdly, the ontological dependency relationship between different entities map to the concept of inheritance in object oriented concepts. For example, sender and receiver are two instances of customer and they inherit the characteristics of the customer.

<table>
<thead>
<tr>
<th>Table 1. Business Norms of Roadway Express</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>request</strong></td>
</tr>
<tr>
<td>BN1 IF sender is requesting a quotation</td>
</tr>
<tr>
<td>THEN sender is obliged to state one of the delivery methods that is required (Guaranteed day, Metro service, Government transportation services, Exhibit transportation services, Managed returns, International services, Time-critical, Precision delivery or Freezables program).</td>
</tr>
<tr>
<td><strong>enters</strong></td>
</tr>
<tr>
<td>BN2 IF sender wishes to enter the pick up details</td>
</tr>
<tr>
<td>THEN sender is obliged to state their contact information, pickup location, shipment destination and shipment information.</td>
</tr>
<tr>
<td>BN3 IF sender has entered pick up details</td>
</tr>
<tr>
<td>THEN sender is permitted to check the cost of a freight move, shipment’s location, proof of delivery or other shipment related information.</td>
</tr>
<tr>
<td><strong>pays</strong></td>
</tr>
<tr>
<td>BN4 IF sender has sent freight</td>
</tr>
<tr>
<td>THEN sender is obliged to make payment to Roadway Express.</td>
</tr>
<tr>
<td>BN5 IF sender is making payment to Roadway Express</td>
</tr>
<tr>
<td>THEN sender is obliged to settle the payment with sender satellite terminal.</td>
</tr>
<tr>
<td><strong>generates</strong></td>
</tr>
<tr>
<td>BN6 IF E.Z Rating is responding to customer’s request</td>
</tr>
<tr>
<td>THEN E.Z. Rating is obliged to generate a quote of charge to the customer.</td>
</tr>
<tr>
<td><strong>Checks</strong></td>
</tr>
<tr>
<td>BN7 IF sender is using the tracking system</td>
</tr>
<tr>
<td>THEN sender is permitted to check the PRO-Number request, bill of lading request, P.O. request and booking number request.</td>
</tr>
<tr>
<td><strong>Claims</strong></td>
</tr>
<tr>
<td>BN8 IF the delivered good is lost or damaged,</td>
</tr>
<tr>
<td>THEN the sender, receiver, or a third party is permitted to submit a claim form.</td>
</tr>
<tr>
<td>BN9 IF a claim form is submitted</td>
</tr>
<tr>
<td>THEN claimant is obliged to present a statement describing the goods lost or damaged and how the amount of the claim was determined, a copy of the bill of lading or Roadway freight bill, a copy of an inspection report if one was performed, and a copy of the vendor’s original invoice or other document to establish the value of the goods.</td>
</tr>
<tr>
<td>BN10 IF the good is received for more than nine months,</td>
</tr>
<tr>
<td>THEN the claimant is forbidden to submit a claim form.</td>
</tr>
<tr>
<td>BN11 IF claimant wishes to view the status of a claim,</td>
</tr>
<tr>
<td>THEN the sender, receiver, or a third party is obliged to submit a PRO-number or claim number.</td>
</tr>
</tbody>
</table>
The ontology chart describes the responsible agent for each business process and their ontological relationships. However, each of the business processes involves a highly complex norm-governed set of activities. In order to understand gain a thorough detail, the business norms of Roadway Express are examined and expressed in Table 1. For reason of brevity, the business norms shown in Table 1 are not exhaustive. Due to the scope of this paper, the specification of business norms have been limited to natural language (English) though they can also be specified using a formal language known as LEGOL (Jones et al., 1979; Stamper, 1980), a language for specifying business norms. Based on the ontology chart and the understanding of the business norms, an interaction model, which captures the detailed business processes of the freight transportation can be derived. In the interaction model, it presents the sequence of the procedures from an enquiry from a sender customer, to the transit of the freight, and to the delivery of the goods to a receiving customer with all messages flow among them.

Agency Structure in the Company

The targeting user group that the DIRES method is intended to help includes customers, suppliers, the employees (i.e. drivers and staff at satellite terminals and distribution breakbulks), and the operation managers, because they are most likely to require information to perform business functions. Therefore identification of the roles and responsibilities of these users is important in determining the information requirements. To this end, the ontology chart and the business norms provide the point of departure in conducting such an analysis. As can be seen from the ontology chart, the employee is the generic type of agent who has responsibilities for handling products and services at different levels. The managers are concerned with planning of products and services and monitoring of the quality. The drivers follow the plans and instructions to pickup and deliver freight to all customers, including individual, business and government. They also deal with bill of lading, but not damage claims as the receiver must report damage or shortages through other channels. The above information can be represented in the agency model.

Building the Business Activity Repository

A business activity repository is the container, which collects the activities decomposed from the business processes identified from the ontology chart. They are treated as business objects, which encapsulate the business rules and information required. The advantage of creating this repository is that the activities can be selected in the flexible manner to constitute an activity space. The available activities can also be reused and customised according to the business change in its operations. The role/activity analysis together with the business norms provides a description of the freight operations and leads to create a business activity repository. Building a business activity repository takes three steps:

Step 1: Decomposition of business activity
The base techniques are inspired by the concept of activity theory developed by Bodker (1991). Each individual activity can be conducted by a set of actions, in which users want to achieve a certain purpose. In the example of ordering, an “ordering” activity can be achieved by carrying out the set of action: getting quote, assessing quotes, placing an order, followed possibly by e-Tracking. In order to realise these actions, a series of corresponding operations are required that need resources, including tools, materials, and information. For the action of getting quotes, it can be executed by accessing to the online Rating and Routing tool to get quote based on shipment location and shipment characteristics. The outcome of this step is the sets of decomposed activities into actions, plus the sets of operations associated with the actions.

Step 2: Generalisation of activity patterns
The activity patterns can be generalised as:

$$A = \bigcup_{i=1}^{n} C_i$$

and

$$C = \bigcup_{j=1}^{m} P_j \cap C_i$$

An A may consist of n sets of action, and a C may include m sets of operation. One P must belong to the action(s). In the example of “ordering,” the actions are defined as $C_1 =$ getting quote, $C_2 =$ assessing quote, $C_3 =$ placing an order, and $C_4 =$ e-Tracking. Subsequently, the operations are $P_1 =$ shipment location, $P_2 =$ shipment characteristics, $P_3 =$ consignee contact, $P_4 =$ order quantity, $P_5 =$ payment terms, $P_6 =$ e-mail, $P_7 =$ type of request, $P_8 =$ special request. So $A = \{C_1, C_2, C_3, C_4\}; C_1 = \{P_1, P_2, P_3\}; C_3 = \{P_1, P_3, P_4, P_5\}; C_4 = \{P_6, P_7\}$. This activity space A contains the business terms, which will be used to find matched information.
dimensions to form an information space. This way of representing activities, actions and operations provide flexibility that allows the business practice changes being incorporated easily. The presentation of activity, action, and operation applies to each business process for representation of the activity tuples, and the collection of these tuples will be stored in the business activity repository.

**Step3: Extraction of business terms based on the business norms**

Once the terms have been identified in the activity tuples, an extraction of terms into a standardised definition is carried out in this step. A list of definition of the terms is produced in a dictionary, which provides reference of the terms to the business norms in table 1. For instance, BN2 in Table 1 can be listed as the following definition.

```
BN2
IF sender wishes to enter the pick up details
THEN sender is obliged to state their contact information, pickup location, shipment destination and shipment information.
```

The terms in the dictionary can be altered and extended as the domain operation or business norm changes, in order to understand new and re-defined terms. The activity tuples and definitions of the terms constitute the business activity repository.

**Information Analysis**

The main task for this stage is to generate patterns of information space. These patterns will be the candidates for determination of the information space. With reference to the ontology chart and agency model (Figure 2), the candidate dimensions are identified to form patterns of information space. A pattern can serve information required to the activities that share a common information dimensions but at possibly different granularity. The patterns of information space and all information dimensions are stored in an information category repository.

**Information Category Repository**

The information category repository for the freight transport contains a collection of information dimensions with which the patterns of information space for the freight transport are tailored. One pattern of information space, e.g. information space pattern for delivery, is constituted as shown in Figure 5. The information space pattern for delivery is represented in the central box, and it contains the dimensions of Consignee, Driver, Products & Services, Bill of Lading, and Cargo Claims. The Output in this pattern can be pre-processed into total cost and receipt. These generated information dimensions are useful for producing reports on the freight operation and market forecasting. There can be more information space patterns made according to the different types of the business activities and the different intentions on performing the actions and operations within the activity.

![Figure 5. A Pattern of Information Space of Delivery](image-url)

The process of integrating the business activities and the business norms into the information space patterns is a complex and continuous process. The Evolving Process Model for Information Space Patterns is shown in Figure 6. The model includes the following stages:

1. Identification of business norms
2. Identification of business activities
3. Identification of business norms and activities
4. Identification of business norms and activities and their relationships
5. Identification of business norms, activities, and their relationships and their integration into the information space patterns

```
BN2
IF sender wishes to enter the pick up details
THEN sender is obliged to state their contact information, pickup location, shipment destination and shipment information.
```

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![Figure 5. A Pattern of Information Space of Delivery](image-url)
**Articulation of Activity Space**

Information requirements are not always easy to specify especially when the e-business system is complex and requires information related to many issues for various users. The articulation process can assist users to identify the business processes in a more articulated way therefore the information requirements can be elicited. There are two main sub-procedures involved as Facilitation and Confirmation, which enable the user to interact in the articulation procedure, as shown in Figure 3.

The Facilitation aids users in articulating activity spaces by providing the business knowledge and norms. When a business process is clearly identified, it can be directly converted into a generic tuple. There is no need for facilitation. But sometimes users may wish to change the granularity in a generic tuple, the facilitation is then required for the user to do so (Sun and Liu, 2001). In the facilitation process, there are no fixed patterns which users must follow. Users have the control over the articulation, not the system. So the interaction can be carried on or stopped at any detailed articulation level when the user is satisfied. The Confirmation provides users the opportunity to clarify whether the actions and operations are defined correctly, before the system finalises an activity space. This is again an option unless it is necessary to prompt to users. The confirmation is useful especially for complex business processes. It may happen that an irrelevant term has been chosen in $C_n$, wrong level of granularity for $P_m$ or the terms have been selected wrongly by a mistake. It is important in this case that the user is able to adjust the result of understanding; in order to make sure that the activity space represents the intention.

**Configuration of Information Space**

Following up the basic concepts of DIRES, one can see that the activity space and the information space are two interrelated spaces. A business process can be presented by a set of activity space, which possess information dimensions described by the business terms in $P_m$. These terms are the basic items relating to information dimensions. Each information dimension is linked to information stored in various data sources (e.g., ERP, a data warehouse and a public domain database on the net). In order to retrieve the information required by the activity space, the corresponding information space must be accessed. The configuration procedure starts with taking the activity space from the business activity repository and the information space pattern from the information category repository and then run through several steps to match the information space with the activity space.

If no directly matching pattern is found, the configuration identifies the information dimensions and selects them from the information category repository. Once this set of dimensions is collected, the matching process cannot be started before they are put into a pattern. A tailoring process takes place to organise the dimensions in the pattern. This tailoring is not always a straightforward process. It may involve an interaction with users, especially when there is ambiguity in selecting a dimension. The users therefore can clarify with the process to ensure that the information dimensions in the pattern are the right ones. Finally, these confirmed dimensions are formed into the pattern and the next round of matching starts. The configuration is completed when the information space is successfully constituted. As the mapping result, the information space for the generic tuple of $A_{ordering}$ is configured (Figure 6). Within this information space, information provided satisfies the user’s original requirements.

However, the matching process may not be always wholly successful. In such case, the configuration facility will allow the user to select relevant information dimensions manually from the information category repository, and further tailor them into the appropriate pattern of information space.
Discussion and Conclusions

The DIRES approach enables interactive articulation of information requirements for e-business. It allows the designer to start the analysis from a vague problem statement and subsequently moving on to capture more concrete information requirements of the proposed e-business system. The understanding of the business processes and related business norms allows analysts to further decompose the business processes into business activities, actions and operations. Furthermore, the specific meanings of the business terms can be defined by examining the business norms. An output of this analysis is described in the activity spaces. These activity spaces can only present how actions are executed and what resources are required. They cannot be used to retrieve information from data sources. There is therefore a need to have information spaces, which are constituted by a set of dimensions associated with entities in database’s terms (e.g. consignee, and Products&Services), or sometimes an attribute (e.g. receiver’s address, quote, and shipment time). A space may be equivalent to the database tables or aggregation of several tables. Based on the information space, it is possible that high level query languages, such as SQL, XML and the like use their data binding methods to form an executable query statement for information retrieval. The use of information space also provides significant potential to cope with business change. When new information requirements are derived from new business needs, a corresponding information space can be flexibly constructed by configuring the basic information dimensions.

Future work includes the incorporation of object-oriented modelling methods to represent an activity space. The actions in the activity space can then encapsulate the operations as well as business norms in a logic form. In such way the configuration procedure will become more robotic.

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