ELSEVIER

Knowledge-Based Systems xx (0000) xxx–xxx

Knowledge-Based SYSTEMS

www.elsevier.com/locate/knosys

Modelling dynamic behaviour of business organisations—extension of DEMO from a semiotic perspective

Kecheng Liu[a,*,1], Lily Sun[2], Joseph Barjis[b,3], Jan L.G. Dietz[b]

[a]*Department of Computer Science, The University of Reading, Reading, RG6 6AY, UK*
[b]*Department of Information Systems, Delft University of Technology, P.O. Box 356, 2600 AJ Delft, The Netherlands*

Received 10 March 2000; revised 12 March 2002; accepted 3 May 2002

Abstract

An organisation is by virtue an information system, in which information is used for communication and coordination of activities. This information system is built upon the organisational infrastructure and is supposed to support the business processes. To study the organisational behaviour in the form of business processes, one needs an effective modelling method to capture dynamics of business processes. In this paper we introduce the DEMO methodology for organisational modelling. An extension of the methodology has been made by incorporating a semiotic method. DEMO is a cross-disciplinary theory for describing and explaining the action of organisations. It contains several model types, each expressed in a specific diagram. They collectively provide the necessary knowledge for information systems development and business process redesign. The process model of DEMO has been discussed in detail in this paper. A need for a facility in DEMO has been identified to formulize rules and conditions for optional and conditional actions. Towards this end, a semiotic method, namely NAM has been chosen as a complement to DEMO for this purpose. After producing process model in terms of DEMO, we use NAM to capture norms (e.g. rules, regulations and conditions). The norms determine the conditions and constrains in controlling optional and conditional actions. They govern the behaviour of actors (agents), normally to decide when certain actions are performed. Norms define clearly the roles, functions, responsibilities and authorities of the actors. The extended DEMO has been applied to a real-life problem for demonstration purposes. © 2002 Published by Elsevier Science B.V.

Keywords: DEMO; Organisational semiotics; Process modelling; Norm analysis

1. Introduction

Experience shows that every modelling technique, tools and method is developed with a particular perspective of its author and is focused on some aspects of the system (or object of study). For example, DEMO is a modelling methodology mainly considering an organisation from communication perspective [1]. Organisational semiotics [2], offers a set of methods for organisational modelling. Adopting organisational semiotics, one sees an organisation as a system of information and communication. Semiotic methods, based on the fundamental observation that all organized behaviour is affected through the communication and interpretation of signs from people, enabling one to capture organisational behaviour by focusing on norms [3,4]. Combining these two approaches will lead to a more complete understanding in organisational modelling such an approach is called an integrated approach for modelling and analysis of an organisation [5].

Organisations are dynamic networks of interrelated transaction processes. When the ways of working of organisations are studied, dynamic aspects need to be considered. In this paper it is elaborated that the structure of organisations should be understood as a network of commitments. The functioning of the organisation is explained in terms of the functioning of communication between people. The commitments created through communications by the members of an organisation are considered as the backbone of the organisation. The business modelling method examined in this paper has its root in a language-action perspective. The communication-based

* Corresponding author. Tel.: +44-1189318614; fax: +44-1189751822.
E-mail addresses: k.liu@reading.ac.uk (K. Liu), l.sun@reading.ac.uk (L. Sun), j.barjis@is.twi.tudelft.nl (J. Barjis), j.l.g.dietz@is.twi.tudelft.nl (J.L.G. Dietz).
[1] www.reading.ac.uk/~sis01kl
[2] www.reading.ac.uk/~sis01ls
[3] http://is.twi.tudelft.nl/~barjis

0950-7051/02/$ - see front matter © 2002 Published by Elsevier Science B.V.
PII: S0950-7051(02)00077-1

models of business processes provide a structured overview of the business and its constituting business processes [6,7].

The approach proposed is mainly based on the business process modelling (BPM), a method of dynamic essential modelling of organisation (DEMO). DEMO is a cross-disciplinary theory, rooted in the language-action perspective [16], for describing and explaining the action of organisations, as well as for organisational (re)engineering [1]. The DEMO methodology consists of several model types, each expressed in a specific diagram, that collectively provide the necessary knowledge for information systems development and business process redesign. The core concept is the notion of the essential (business) transaction. It is the 'atomic' building block of 'molecular' structures called business processes. By means of the models it is possible to achieve a solid understanding of the types of transactions taking place in an organisation, the participants involved in these transactions, the information that is needed and created during the transactions, and the relationship between the different transaction types. One aspect that requires better improvements in DEMO is a facility to formulize rules and conditions necessary for executing optional and conditional actions. DEMO describes rules and conditions in natural language during description of business processes in an organisation. The rules can normally be programmed and handled by the computer system if they are explicit and clearly defined.

The norm analysis method (NAM) is one of the semiotic methods [4]. NAM identifies responsibilities and rules that govern human behaviour in an explicit and articulate manner. It recognizes conditions and constraints of the actions driven by their responsibilities. Therefore authors consider that to merge facilities of both methods can lead to more effective modelling of business processes.

The extended method aims to enable the analysts to model the business processes and to accommodate exceptions which have not been dealt with by other conventional methods. In achieving this, two approaches will be examined briefly, and then norms controlling optional and conditional actions will be incorporated into DEMO model. The extended method is applied in a case study of an equipment servicing company for analysis of the business processes and designing a computer support system. The effect of the result demonstrates that the method provides an effective way to model the business processes rigorously and, moreover, the business users still have the control and flexibility to handle exceptions.

The paper is structured as follows. In Section 2 we introduce DEMO methodology demonstrating its application to an insurance company. In Section 3 the NAM is briefly introduced. These two sections serve as a theoretical basis for research conducted in the following sections. In Section 4 we study an extension of DEMO process modelling with norms. Section 5 contains a case study in the service industry. In this section, based on case study, we demonstrate the application of DEMO and NAM as one extended method. Finally, Section 6 contains conclusions based on the results of this paper.

2. Demo methodology

DEMO is a theory about organisations, based on an integrated set of ideas that are collectively called the OER paradigm (see Fig. 1). One of these assumptions is that, for the purpose of redesign and reengineering the business processes of an organisation, one needs to have an understanding of its 'construction' and 'action'. So, instead of applying the common black-box model, DEMO applies a white-box model to understand organisations [9]. Another assumption is that organisations belong to the category of social systems, meaning that the active elements are social individuals or subjects that behave according to assigned authority and corresponding responsibility against a common background of social norms and values. Yet another assumption is that information systems belong (only) to the category of rational systems, meaning that they do not make decisions, but only calculations, and in doing so only support decision making [10].

The subject in an organisation performs two kinds of action: objective actions and intersubjective actions. By executing *objective actions*, the members of an organisation fulfil the mission of the organisation. The nature of an objective action can be material or immaterial. By executing *intersubjective actions*, subjects enter into and comply with commitments. In doing so, they initiate and coordinate the execution of objective actions. In order to abstract from the particular subject/person that performs an action and to concentrate on the functional or organisational role of the subject in performing that action, the notion of *actor* is

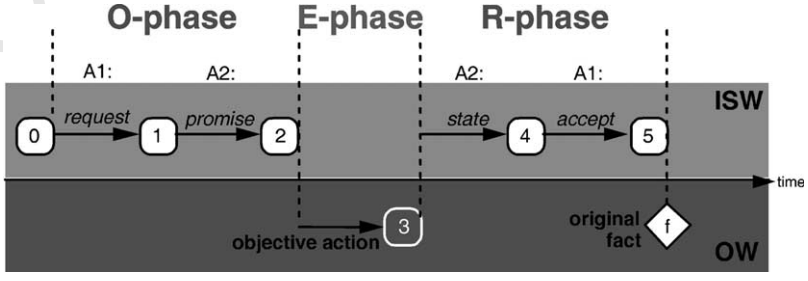

Fig. 1. The business transaction.

introduced. The role of actor can be fulfilled by a number of subjects (concurrently as well as collectively), and a subject may fulfil concurrently a number of actor roles.

In correspondence with the distinction between objective and intersubjective actions, DEMO distinguishes between two worlds in which each of these kinds of actions have effect: the *object world* and the *intersubject world*, respectively. The effect of every action is a state transition.

Objective actions and their related intersubjective actions appear to occur in a particular pattern, called the (business) *transaction*, as exhibited in Fig. 1. It consists of three phases: the order phase or O-phase, the execution phase or E-phase, and the result phase or R-phase. A transaction is carried through by two actors. The one who starts the transaction and eventually completes it, is called the *initiator* (A1 in Fig. 1), the other one, who actually performs the objective action, is called the *executor* (A2 in Fig. 1).

The order phase is an actagenic conversation, and the result phase is a factagenic conversation [1]. Both conversations consist of communicative (therefore intersubjective) actions, having an effect on transition in the intersubject world (ISW). These actions are executed alternately by the initiator and the executor of the transaction. In between the two conversations, the objective action is executed, by the executor of the transaction. The effect of this action is a transition in the object world (OW).

2.1. DEMO modelling

The DEMO methodology comprises five types of models, together describing the essential model of an organisation. One of them is the business process model (BPM). A BPM shows all identified (essential) transaction types, as well as the causal and conditional relationships between them.

2.2. Business process modelling

The BPM aims at providing a full specification of the time aspects of business transactions. The BPM is a standard element in the DEMO analysis of an organisation.

In the BPM two types of time relationships are specified: *causal relationships* and *conditional relationships*. We speak about a causal relationship between two business transactions if one transaction causes the start of the other transaction. A causal relationship can also be *optional*. This means that the start of a new business transaction is dependent on some condition. A conditional relationship between business transactions is defined as that the completion of one transaction forms the condition for the initiation or the completion of another transaction. Like the optional causal relationship a conditional relationship can also be optional.

2.3. The business process diagram

The business process diagram is the graphical representation that is used to represent the DEMO BPM. The diagram is based on the transaction types and results Table 1 and provides symbols for all the possible process aspects that were specified in the transaction result table. This means that transaction phases, and their causal and conditional relationships are represented in the business process diagram.

The business process diagram represents the BPM in a full or a compact notation. In full notation all individual transaction phases are drawn while in the compact notation transaction phases are compressed into one symbol as much as possible. This business transaction symbol in the business process diagram is a disc with a bold line identified with the transaction number.

The three constituting transaction phases may be compressed into one business transaction symbol:

1. If there are no business transactions initiated during the transaction phases and;
2. If the completion of the Order-phase or Execution-phase are not conditions for initiation or the completion of other business transaction phases.

In order to visualize the above described BPM and its diagram, we take an example of an insurance company. We study business process in this company when one applies for insurance policy. All identified business transactions of

Table 1
Transaction results

Transaction type		Transaction result	
T1	Requesting_policy _delivery	F1	Insurance policy ⟨IP⟩ delivery is handled
T2	Filling_form	F2	Insurance application form ⟨IF⟩ is filled
T3	Rejecting_form	F3	Insurance application form ⟨IF⟩ is rejected
T4	Assessing_form	F4	Insurance application form ⟨IF⟩ is assessed
T5	Accepting_form_proviso	F5	Insurance application form ⟨IF⟩ is accepted with proviso
T6	Rejecting_incomplete_form	F6	All criteria are not met application form ⟨IF⟩ is rejected
T7	Accepting_form	F7	Insurance application form ⟨IF⟩ is accepted
T8	Handling_policy_delivery	F8	Insurance policy ⟨IP⟩ is delivered
T9	Issuing_policy	F9	Insurance policy ⟨IP⟩ is issued
T10	Issuing_invoice	F10	Invoice concerning insurance policy ⟨IP⟩ is issued

applying for insurance policy are represented in Table 1. Accordingly, Fig. 2 shows an example of a business process diagram of applying for an insurance policy.

A transaction phase is represented by a disk/circle, and identified by the transaction type (e.g. T2) and the phase kind (e.g. E). There is also a compact notation for transaction types, namely a disk with a bold line (e.g. T3). The point of initiation of a transaction type is represented by a small disk. If such a point lies within a transaction phase, the phase symbol is extracted (c.f. T1/E, T2/E, T4/E and T8/E). A plain line with an arrowhead represents a *causal* relationship between two phases or between an initiation point and a phase. Its meaning is either of the next two cases. If the other side of the arrow is connected to a phase symbol, it means that the phase at the arrow side is started on completion of that phase (e.g. T2/E is started on completion of T2/O). If the other side is connected to an initiation point, it means that the phase is started from this point. There are two possibilities: the initiation is external (e.g. T1), or the initiation is during a phase (e.g. T3 is initiated during T2/E). Initiations may be exclusive-or, meaning that only one of the two (or three) transactions can be initiated (e.g. T3 and T4 have an exclusive-or relations; also T5, T6 and T7 have an exclusive-or relations). Initiations may be concurrent, meaning that both transactions will be initiated at one time (e.g. T9 and T10). Initiations may be optional, meaning that they do not necessarily take place always, but that there is some condition (e.g. T8). A dotted line with an arrowhead represents a *conditional* relationship. If the arrow points to a phase symbol, its meaning is that this phase can only be completed after the phase at the other side of the arrow is completed. If the arrow points to an initiation point, its meaning is that the phase connected to this point, can only be initiated after the phase at the other side of the arrow is completed (e.g. T2/R and T8/O). There may also be conjunctions of such conditions (e.g. the completions of T9/R and T10/R are conjointly the condition for completing T8/E).

In Fig. 2, there are several optional transactions where business rules are applied in the process of approval of an insurance policy. The rules can normally be programmed and handled by the computer system if they are explicit and clearly defined. For example, from the diagram, when *Requesting insurance policy*transaction T1/O is invoked, it will cause *Take form and fill* transaction T2/O. When *Take form and fill* transaction T2 is invoked, it will cause one of the following actions if the control condition pre-attached to them is true:

If the insurance application form is not filled completely, *then* reject the form (T3).
If the insurance application form is filled completely, *then* assess the form (T4).

Continually, if the *Assess form* action is invoked, it will trigger (cause) one of the following actions if the control condition pre-attached to them is true:

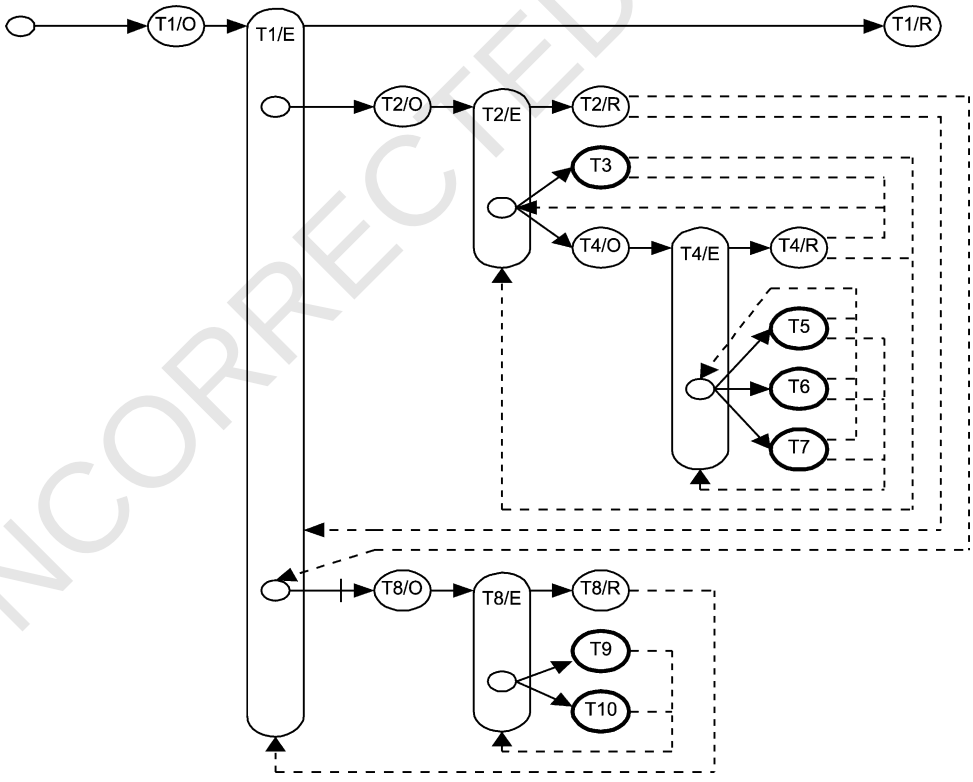

Fig. 2. Business process diagram of Issuing.

If one of the criteria is not met,
then accept the assessed form with proviso (T5).
If all criteria are not met,
then reject the assessed form (T6).
If all criteria are met,
then accept the assessed form (T7).

If the *Form accepted* event occurs, actions like *Issue policy* (T9) and *Issue invoice* (T10) will be invoked concurrently. If the following conditions are true, the *Delivery* action will be activated.

If the invoice is issued *and* policy is issued,
then deliver the policy documents.
If the form accepted with proviso is issued,
then deliver the policy documents T1/R.

The depiction of the sequence of transactions of the business processes has shown the usefulness of the business process diagrams. In addition, the diagrams can describe complex behaviour and parallel activities, which is highly desirable in IS modelling. However, the diagrams do not facilitate situations where decisions are made solely on human judgement. This concerns mainly optional transactions or exclusive-or transactions, for example T3 and T4, which are exclusive-or transactions. These decisions are called for by the unexpected situations and occur on an ad hoc basis, and are therefore impossible to be automatically handled by computer systems without human intervention. These kinds of situations, which cannot be dealt with computer system as they are difficult to anticipate and specify in advance, are called exceptions [11]. To handle these rules, an extension of the modelling technique by incorporating Norm Analysis [12] is suggested so as to accommodate the exceptional situations.

3. Norm analysis

A norm is more like a field of force that makes members of a society tend to behave or think in a certain way. It defines responsibilities and authorities for each member, and establishes regularities of behaviour. As [13] explains: 'Norm' has several partial synonyms which are good English. 'Pattern', 'standard', 'type' are such words. So are 'regulation', 'rule', and 'law'. In an organisation, norms reflect regularities in the behaviour of members allowing them to co-ordinate their actions. Norms can be formal and informal, and they cover broader areas in an organisation than the rules and regulations. The analysis of norms provides a means for one to expect and predict behaviour, so as to collaborate with others in performing co-ordinated actions. It also recognizes the central role and ultimate responsibility of an individual actor, and provides a mechanism for specifying such responsibility.

There are five types of norm that influence certain aspects of human behaviour [14]. They are *perceptual norms, cognitive norms, evaluative norms, behavioural norms and denotative norms*. The *perceptual norms* deal with how people receive signals from the environment via their senses through media such as light, sound and taste. The *cognitive norms* enable one to incorporate the beliefs and knowledge of a culture, to interpret what is perceived, and to gain an understanding based on existing knowledge. The *evaluative norms* help explain why people have certain beliefs, values and objectives. The *behavioural norms* govern people's behaviour within regular patterns. Finally the *denotative norms* direct the choices of signs for signifying such choices are culture-dependent, e.g. the choice of a colour to signify happiness or sadness.

The perceptual norms reside in a business organisation's culture convention practice, and they generally assist in forming other kinds of norms. The perceptual norms will direct in selecting the relevant words which people use to describe their percepts. From here the cognitive norms will address the structures and cause-and-effect relationships. Their consequences will be the interpretation of the forms and functions of the structure that will affect the beliefs and knowledge. The evaluative norms evolve the reasoning and the finding of intentions. They enable discussion and are disposed in favour or against something in value terms. The behavioural norms will reflect the processes and regulations cited in the organisation. They help to articulate business rules and regulations such as *must*, *may*, and *must not* behave in certain ways. The denotative norms guide the use of terms and language in communication. This type of norm is normally consistent with the perceptual norms.

Of all the norms discussed, particular attention is given to the behavioural norms since they are expressed as business rules and have direct impacts on business actions. Three fundamental deontic operators-permitted, obliged and prohibited equivalent to 'may', 'must' and 'must not'—have been implemented in a few systems that distinguish actual facts and normative behaviour. Typically, this type of norm consists of the following components:

whenever ⟨condition⟩
if ⟨state⟩
then ⟨an actor⟩
is ⟨"permitted"/"prohibited"/"obliged"⟩
to do ⟨action⟩.

The condition describes a matching situation where the norm is to be applied, and sometimes further specified with a state-clause (this clause is optional). The actor-clause specifies the responsible actor for the action. The actor can be a staff member, or a customer, or a computer system if the right of decision-making is delegated to it. As for the next clause, it quantifies a deontic state and usually expresses in one of the three operators—*permitted*, *forbidden* and *obliged*. For the next clause, it defines

the consequence of the norm. The consequence possibly leads to an action or to the generation of information for others to act.

Using the insurance policy example, some norms controlling the process are identified:

whenever insurance application form is not complete
then the customer
is prohibited
to buy an insurance policy.

whenever the sum assured exceed 1,000,000
if the income is above 10,000
then the customer
is permitted
to buy an insurance policy.

whenever the customer exceeds the agreed weight
then the insurance actor
is obliged
to charge a tariff.

The norms describe the responsibilities and obligations. They are fundamentally different from the causal–effect relationship, which normally states that if the conditions are met, certain events will happen or actions will be taken. The conditions and consequences in these logical expressions are always bound, with no room for human discretion. Therefore, the norms reflect better how people behave in a business context, and are more suitable for modelling organisations and business objects.

4. Extension of business processes modelling with norms

The extension is carried out by incorporating norms into the business process diagram. In the diagram, each control condition is labelled as [*N#*] where # is the number for identification. The labels are then elaborated in the norm specifications to indicate the *condition*, the *actor* and *action* to be undertaken. Fig. 3 depicts the extended business process for applying insurance policy, and Textbox 1 shows a list of norms for the control conditions of the business process. Phases in curly brackets are comments to help a reader to refer to the business process diagram in the corresponding figures.

On the list, the norms define business rules that are imposed on the particular process. For example, from the list in Textbox 1, Norm N1 reflects the straightforward rules that have to be followed after the *Take form and fill* action has been invoked. In addition, the norms allow exceptions to be specified in it. For example, Norm N2 includes both the business rules and an exception that will be triggered (caused) when the *Access form* action has been invoked. The exception identified here is that a customer applies for insurance for a sum that exceeds the maximum allowable amount in a certain condition (c.f. N1 and N2 in Textbox 1).

Besides handling the business rules and exceptions, the norm provides a degree of flexibility that allows the analysts to introduce additional exceptions that may have been discovered in the later stage of analysis. For example, the customers below 18 years of age are normally required a consent form signed by their parents or guardians. Such a situation may occur where the application form is filled completely and a verbal consent from the parents has been

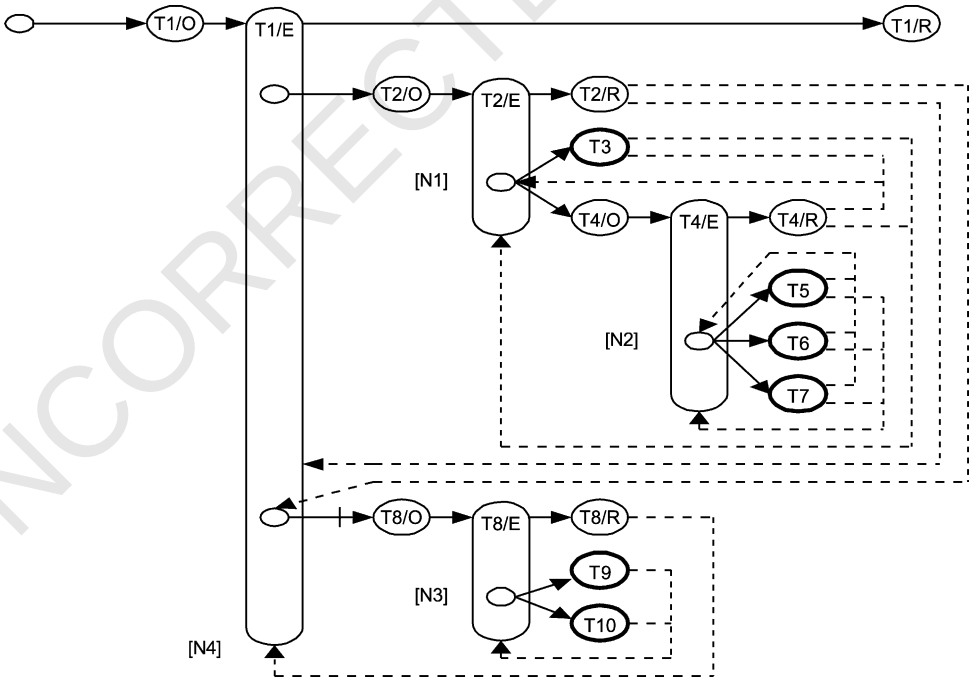

Fig. 3. Business process diagram of the Insurance Organisation.

Norm **N1**:
whenever the insurance application form
is not complete
then the insurance actor on the counter
is obliged
to reject the application form.
whenever the insurance application form
is complete
then the insurance actor in the office
is obliged
to assess the application form.

Norm **N2**:
whenever all criteria are not met
then the customer
is prohibited
to buy an insurance policy. {reject the form}

whenever the sum insured exceeds 1,000,000
if the income is above 10,000
then the customer
is permitted
to buy an insurance policy. {accept the form}

whenever the customer exceeds agreed weight
then the insurance actor
is obliged
to charge a tariff. {accept with proviso}

Textbox 1. Norm specification for the Insurance Organisation.

acquired. To handle this exceptional situation, the analyst adds an additional norm into Norm N1 as shown in Textbox 2. Note that the action prompted by the norm to hold the application, as an exception is detected. Rather than processing the form automatically, it calls a claim officer to deal with the case using his or her experience, or with consultation with a supervisor. The examples show that the norms specify the rules of an action in a specific manner since it includes the condition, the state and the actions with specified deontic states. Moreover, exceptional situations are able to handled and elaborated in the model. This establishment increases the understanding of the business processes. On the other hand, as with other approaches, this modelling approach has its drawbacks. One lies in where there are a lot of exceptions to handle, and then it becomes tedious to look into every possible exception. Another problem is there may occur a circumstance where some of the exceptions conflict with each other to a certain degree. To reduce these problems, it is appropriate to involve the manager to delimit the number

Norm **N1**:
: (same as Norm N1 in Textbox 1)
:
(insert additional norms)
whenever the customer is below 18 years of age
if the parents have verbally consented
then the insurance agent in the office
is permitted
to hold the application form
Norm **N2**:…
:

Textbox 2. Additional Norm for Norm *N*1.

of exceptions to be handled, and to set aside those exceptions if a conflict occurs.

With the extension of the business process diagram with the Norm Analysis, the business rules are rigorously specified, and exceptions can be handled and modelled. The following is a discussion of a case study in which the modelling approach is applied.

5. Case study—the service company

In this section we demonstrate application of developed method, which compresses DEMO and semiotic methods, to the Service Company. During study of this company there were specified three separate business processes. These three separate business processes are studied in the following subsections.

5.1. The service company description

The Service Company (the case documents originated by Ref. [15] is a subsidiary of an international organisation which is a leading manufacturer of construction plant equipment. The primary business of the Service Company is to provide service support to plant equipment in the construction industry. Other functions of the company include undertaking pre-delivery inspections of all new equipment before the new owners take them over; repair service for customers; undertaking warranty and servicing of equipment sold; damage assessment for insurance purpose; and providing specialist service like designing and modifying specific machinery to meet the customer's requirements.

Recently, there has been a plan for restructuring the subsidiaries of the organisation. The responsibilities of the service manager at one branch (the Service Company) will be extended to manage the service departments of all branches, under the new title of 'regional service director', replacing the service managers at these branches. The strategy here is to breach the geographical boundaries of all the branches. In the restructuring plan, two systems are addressed and they are the *call log system* and the *staff skill system*. The intention is to maximize the utilization of the complete asset base across the geographical branches so as to provide the best possible service to customers.

The *call log system* maintains information about the customer, machine and the type of problem. It addresses the business requirements in providing a wide range of flexible services to the customer and maintaining high standards in keeping with the company image. The aims of the system are to improve customer service and customer relations, which relate to the business requirements, to increase the customer base, sales and the number of long-term contracts. The *staff skill system* maintains information regarding the allocation of experienced and available engineers from across the branches of the company. It supports the business requirement to maintain a sufficient level of trained engineers in

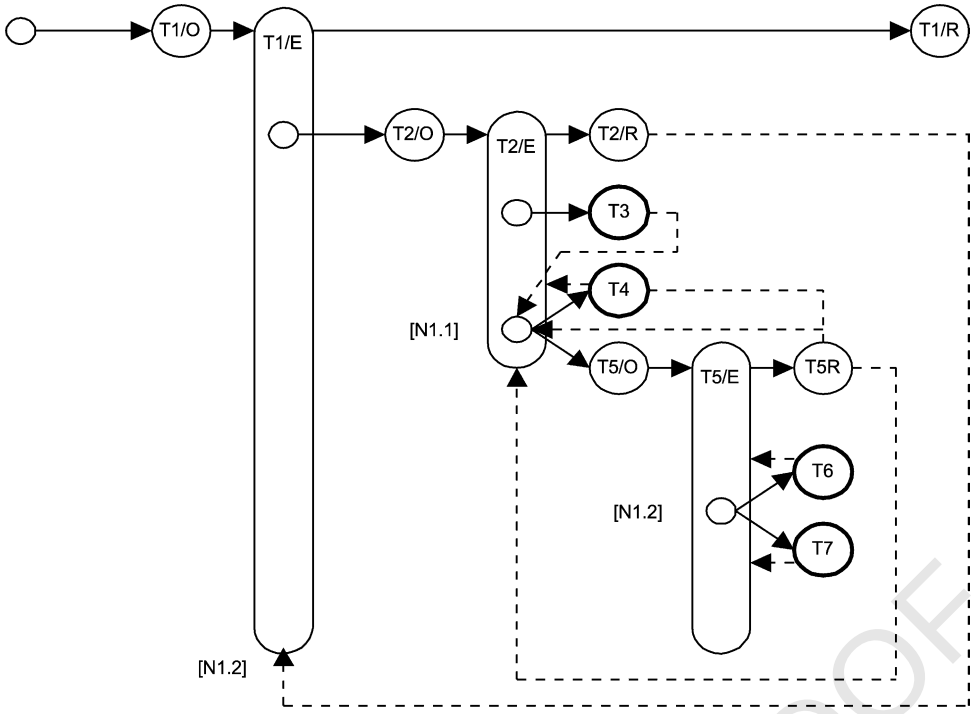

Fig. 4. Business process diagram for Handling Machinery Delivery.

order to provide a responsive and flexible service to the customers. The system aims to assist in balancing customer needs against the skilled resources available to improve customer service and thus assist in increasing the customer base, increasing sales and increasing the number of long-term contracts. This requires the system to be responsive to customer needs.

In correspondence to the restructuring plan for the Service Company, the extended modelling approach is applied to produce the business process diagrams and identify norms. The diagrams provides a stepping stone to designing the call log system and the staff skill system.

5.2. Handling machinery delivery

The business process diagrams show precisely the sequence of transactions and the control conditions of the three processes—carrying out a pre-delivery inspection (PDI); handling the repair service request; and updating staff skill. In each diagram, each control condition is labelled as [*N*#] where # is the number for identification. The corresponding norms are acquired by studying business processes and are represented in the textbox.

Fig. 4 shows the business process of carrying out pre-delivery inspection. All identified business transactions of the pre-delivery inspection are represented in Table 2. When a *Machinery delivery* is requested a *PDI Requested* action will be invoked. After this action the *Undertake PDI* action will be invoked and it triggers the norm [*N*1.1]. This may lead to *Return Machinery* action or *Machinery accepted* event which depends on the control condition pre-attached to them. For the Machinery accepted event, the norm [*N*1.2] will trigger *Prepare Insurance* action and *Prepare Warranty* action concurrently. Whenever *Insurance prepared* event and *Warranty prepared* event occur, the norm [*N*1.3] will be invoked and it will activate the *Delivery* action (see Textbox 3a).

5.3. Handling repair service request

Fig. 5 shows the business process of handling repair service requests. All identified business transactions of the handling repair service requests are represented in Table 3. When a *Services Requested* event occurs, the *Create*

Table 2
Transaction results

Transaction type		Transaction result	
T1	Requesting_machinery _delivery	F1	Machinery ⟨M⟩ is delivered
T2	Requesting_PDI	F2	PDI of machinery ⟨M⟩ is conducted
T3	Undertaking_PDI	F3	PDI of machinery ⟨M⟩ is undertaken
T4	Returning_machinery	F4	Machinery ⟨M⟩ is returned
T5	Handing_delivery	F5	Machinery ⟨M⟩ is handled
T6	Preparing_insurance	F6	Insurance for machinery ⟨M⟩ is prepared
T7	Preparing_warranty	F7	Warranty for machinery ⟨M⟩ is prepared

Norm **N1.1**:
whenever the requirements of the pre-delivery inspection is accepted
then the engineer
is permitted
to deliver machinery to the customer and pass the machinery details to admin staff.
whenever the requirements of the pre-delivery inspection are not accepted
then the engineer
is obliged
to return the machinery to the headquarters.

Norm **N1.2**:
whenever the machinery pre-delivery inspection is accepted
then the admin staff
is obliged
to prepare insurance details and the machinery warranty for the customer company.

Norm **N1.3**:
whenever the machinery insurance and machinery warranty are produced
then the admin staff
is obliged
to deliver them to the customer company.

Textbox 3a. Norm specification for Handling Pre-Delivery Inspection.

Customer action will start the sequence of transactions for the Call Log System. The Call Log System is one of the proposed systems for the restructuring plan.

The *Create Customer* action will trigger the *Create New Customer Details* action or the *Update Customer Details* action that depends on the norm [*N*2.1] pre-attached to them (see Textbox 3b). Nevertheless, both actions will trigger the *Create Log Call* action. The *Create Log Call* action will trigger the *Evaluate Log Problem* action that will invoke the norm [*N*2.2] subsequently. When the norm [*N*2.2] is incurred, the *Allocate Engineer* action and the *Check Service Contract* action will invoke concurrently.

The *Allocate Engineer* action will trigger the *Record Action Report* action that subsequently triggers the norm [*N*2.3]. When the norm [*N*2.3] incurs, the *Allocate Engineer* action or the *Log Problem Solved* event will be invoked which depend on the pre-attached condition. When the *Log Problem Solved* event incurs, the norm [*N*2.4] will trigger the *Produce Action Report* action and the *Update Machine History* action simultaneously. Finally, when the *Action Report produced* event and *Machine History updated* event occur, the norm [*N*2.5] will invoke and activate the *Update Log Call Report* action.

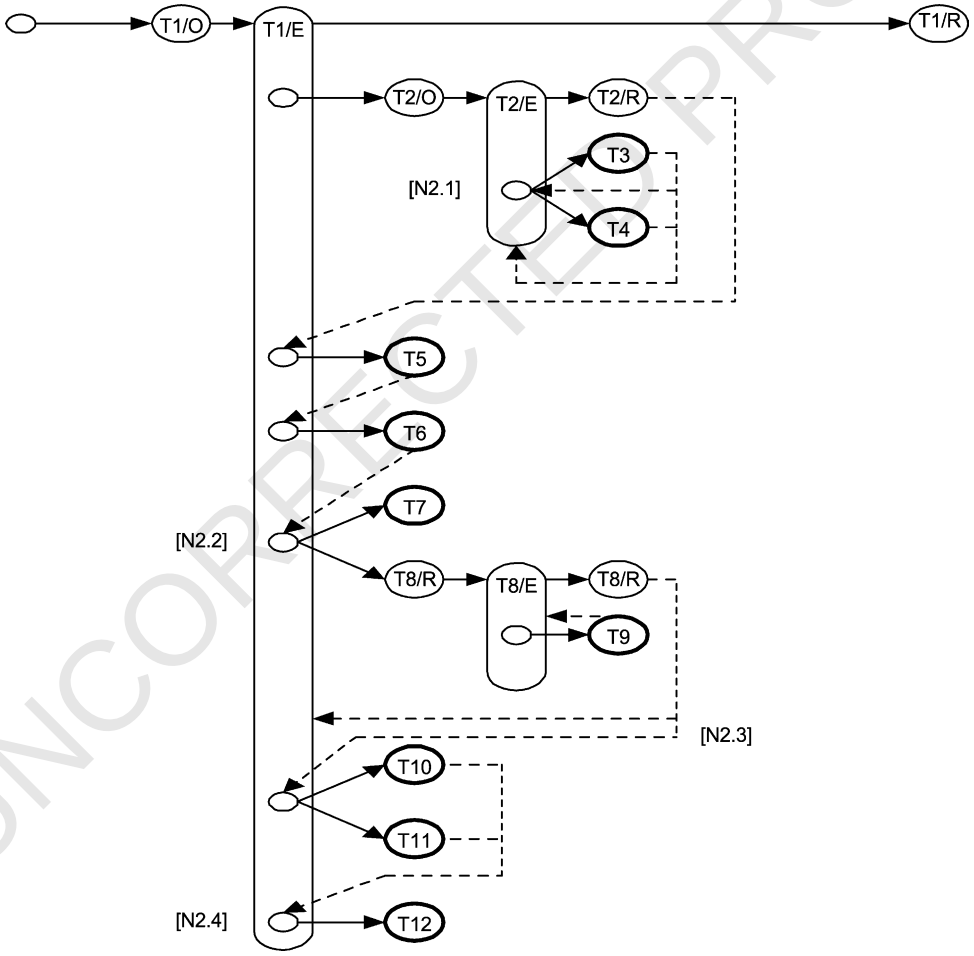

Fig. 5. Business process diagram for Handling Repair Service Request.

Table 3
Transaction results

Transaction type		Transaction result	
T1	Requesting_repair_service	F1	Repair service ⟨S⟩ is conducted
T2	Creating_customer	F2	Customer details ⟨C⟩ are created
T3	Creating_new-customer	F3	New customer details ⟨C⟩ are created
T4	Updating_details	F4	Customer details ⟨C⟩ are updated
T5	Creating_log_call	F5	Log call ⟨L⟩ is created
T6	Evaluating_log_problem	F6	Log problem ⟨L⟩ is evaluated
T7	Checking_service_agreement	F7	Service agreement ⟨SA⟩ is checked
T8	Allocating_engineer	F8	Engineer is allocated ⟨E⟩ to solve problem
T9	Recording_action_report	F9	Action report ⟨R⟩ is recorded
T10	Updating_machine_history	F10	Machine history ⟨H⟩ is updated
T11	Producing-action_report	F11	Action report ⟨R⟩ is produced
T12	Updating_log_call_report	F12	Log call ⟨L⟩ report is updated

5.4. Updating staff skill

Fig. 6 shows the business process diagram for updating staff skill for all engineers who have attended the course arranged by the parent company. All identified business transactions of the updating staff skill for all engineers are represented in Table 4. The diagram shows the sequence of transactions for the Staff Skill System, which is another proposed system for the restructuring plan.

When the *Update Staff Skill Requested* event occurs, the *Create Engineer Details* action will invoke and subsequently triggers the norm [*N*3.1], as described in Textbox 3c. The norm [*N*3.1] triggers the *Update Engineer Detail* action and the *Create Course Entry* action concurrently. The *Create Course Entry* action triggers the *Update Course Entry* action that subsequently triggers the *Update Experience* action. When the *Experience updated* event and *Engineer Details updated* event occur, the norm [*N*3.2] will invoke that will trigger the *Update Staff Skill Record* action subsequently.

6. Conclusions

The purpose of this joint research, which was reported in the introduction and abstract to this paper, is an elaboration of the integrated modelling approach that invoke organisation study from various angles. DEMO provides reach tools for graphical representation and formalization of information systems and business process in an organisation. NAM is focused in formalization of business rules and exceptions providing a bridge from natural language to programming language. Developed in the base of this

Norm **N2.1**:
whenever the customer's details are not found in the customer records
then the admin staff
is obliged
to create a new record for the customer's detail.

whenever the customer's details are found in the customer records
then the admin staff
is obliged
to maintain updated details in the customer records.

Norm **N2.2**:
whenever the log problem is evaluated
then the admin staff
is obliged
to check the service agreement and allocate an engineer to solve the problem.

Norm **N2.3**:
whenever the action report shows that the problem is unsolved
then the admin staff
is obliged
to re-allocate another engineer to solve the problem.
whenever the action report shows that the problem is solved
then the admin staff
is permitted
to close the log problem and compile the action report.

Norm **N2.4**:
whenever the action report is compiled
then the admin staff
is obliged
to produce the action report and update the machine history in the customer records.

Norm **N2.5**:
whenever the action report is produced and the machine history is updated
then the admin staff
is obliged
to close the log call and update the report.

Textbox 3b. Norm specification for Handling Repair Service Request.

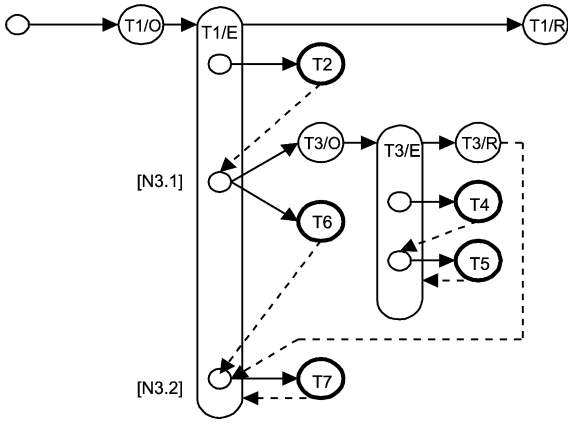

Fig. 6. Business process diagram for Updating Staff Skill.

Table 4
Transaction results

Transaction type		Transaction result	
T1	Requesting_update_staff_skill	F1	Staff skill ⟨S⟩ is updated
T2	Creating_engineer_details	F2	Engineer details ⟨D⟩ are created
T3	Creating_course_entry	F3	Course entry ⟨CE⟩ is created
T4	Updating_course_entry	F4	Course entry ⟨CE⟩ is updated
T5	Updating_experience	F5	Experience ⟨E⟩ is updated
T6	Updating_engineer_details	F6	Engineer details ⟨D⟩ are updated
T7	Updating_staff_skill_record	F7	Staff skill record ⟨M⟩ is updated

Norm **N3.1**:
whenever the engineer's details are created
then the admin staff
is permitted
to update the engineer's details in the staff records and create a course entry

Norm **N3.2**:
whenever the engineer's details and experience are updated
then the admin staff
is obliged
to update the staff skill record

Textbox 3c. Norm specification for Updating Staff Skill.

approach models provide a structured overview of the business and its constituting business processes. While constructing IS models, business rules are also identified. A business rule is a shorthand language for expressing business knowledge that include condition and constraint. However, in many cases they are not expressed rigorously in the model. Henceforth, an approach of capturing the business rules rigorously and at the same time dealing with exceptions has been developed. The approach is constructed by extending the BPM with Norm Analysis.

The strength of this modelling approach results from the two base methods, both of which are sound and well tested. The DEMO is a rigorous approach that provides a solid understanding of the types of transactions that take place in an organisation, the participants involved in these transactions, the information that is needed and created while carrying through the transactions, and the relationship between the different transaction types. Norm Analysis enables one to specify business rules, which is necessary in systems design. The specification of norms allows recognition of human responsibilities and obligations and yet the ultimate power of decision-making in exceptional cases. The extended method of DEMO with Norm Analysis leads to a powerful modelling approach for information systems analysis and design in general and business processes in an organisation in particular.

7. Uncited references

[8]. [17]. [18]. [19]. [20].

References

[1] V.E.v. Reijswoud, J.L.G. Dietz, DEMO Modelling Handbook, Delft University of Technology, Delft, 1998.
[2] R.K. Stamper, Organisational semiotics, in: J. Mingers, F. Stowell (Eds.), Information Systems: An Emerging Discipline, McGraw-Hill, London, 1997, pp. 267–283.
[3] K. Liu, A. Alderson, Z. Qureshi, Requirements recovery of legacy systems by analysing and modelling behaviour, to appear in the International Conference on Software Maintenance, Oxford, 1999.
[4] K. Liu, Semiotics in Information Systems Engineering, Cambridge University Press, Cambridge, 2000, forthcoming.
[5] J. Barjis, J.L.G. Dietz, Business Process Modelling and Analysis Using GERT Networks, Proceedings of the First International Conference on Enterprise Information Systems (Setubal, Portugal, March 27–30, 1999), vol. 2, 1999, pp. 748–756.
[6] V.E.v. Reijswoud, The structure of business communication—theory, model and application, PhD Thesis, Delft University, Delft, 1996.
[7] V.E.v. Reijswoud, J.B.F. Mulder, Speech act based communication and information modelling with DEMO, Australian Journal of Information Systems 6 (1) (1998) 89–102.
[8] J.L.G. Dietz, Introductie tot DEMO, Samsom BedrijfsInformatie BV, Alphen aan den Rijn, 1996.
[9] J.L.G. Dietz, Modelling Business Processes for the Purpose of Redesign, Proceedings of IFIP TC8 Open Conference on BPR, Amsterdam, 1994.
[10] J.L.G. Dietz, J.B.F. Mulder, Organisational Transformation Requires Constructional Knowledge Of Business Systems, Proceedings of HICCS 98, IEEE Press, New York, 1998.
[11] K. Liu, T. Ong, A modelling approach for handling business rules and exceptions, The Computer Journal 42 (3) (1999).
[12] K. Liu, L. Sun, A. Dix, M. Narasipuram, Norm based agency for designing collaborative information systems, Information Systems Journal 11 (2001) 229–247.
[13] v.G.H. Wright, Norms and Action—a Logical Inquiry, Routledge and Kegan Paul, New York, 1963.
[14] R. Stamper, K. Liu, M. Hafkamp, Y. Ades, Signs plus Norms—One Paradigm for Organisational Semiotics, The First International Workshop on Computational Semiotics, Paris, 1997.
[15] S. Dingley, A composite framework for the strategic alignment of information systems development, PhD Thesis, Aston University, Birmingham, 1996.
[16] A. Basu, R. Blanning, in: J.F. Nunamaker, R.H. Spargue (Eds.), Metagraph Transformations and Workflow Analysis, Proceedings of the Thirtieth Annual Hawaii International Conference on System Sciences, vol. 4, IEEE Computer Society Press, Silver Spring, MD, 1997, pp. 359–366.
[17] F. Dignum, J.L.G. Dietz, E. Verharen, H. Weigand, Communication Modelling—the Language/Action Perspective, Electronic Workshops in Computing, Springer, Berlin, 1996.
[18] G. Goldkuhl, M. Lind, U. Seigerroth, The Language Action Perspective on Communication Modelling, Proceedings of Third International Workshop, Jönköping International Business School, Sweden, 1998.
[19] A. Grasso, J-L. Meunier, D. Pagani, R. Pareschi, Distributed coordination and workflow on the World Wide Web, Journal of Collaborative Computing 6 (2–3) (1997) 175–200.
[20] M.K. Kwan, P.R. Balasubramanian, in: J.F. Nunamaker, R.H. Spargue (Eds.), Dynamic Workflow Management: A framework for Modelling Workflow, Proceedings of Thirteenth Annual Hawaii International Conference on System Sciences, vol. 4, IEEE Computer Society Press, Silver Spring, MD, 1997, pp. 367–376.