

# BUSINESS PROCESS MODELING AWARE TO THE ENVIRONMENT CHANGES

## *A Pattern Driven Approach*

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**Abstract:** Nowadays enterprises perform in an extremely competitive business environment, therefore business processes, although complex must be highly flexible to react to new demands. This purpose implies that these processes should be continuously maintained through a flexible modeling. This paper addresses this problem and provides a process modeling approach able to govern the high variability of the environment parameters affecting the processes in use, through the well-known pattern paradigm and the decision tables formalism. Furthermore, the authors discuss the experience of the proposed approach in a real case. Results are encouraging and drive further investigations in such a way.

## 1 INTRODUCTION

In order to improve competitiveness, enterprises have to make business processes flexible, adapting them to the business environment. New objectives, new technologies, industrial standards, quality programs, budget, workers, tools, cultural factors or changes rising from acquired experience impact directly on the adequacy of the business processes and on the enterprise responsiveness (Morisio, 2000) (Singh, 2004). Therefore, when we model a process, we have to take into account the complexity of its relationship with business environment. Moreover, process formalization has to be very flexible so that processes models can change so quickly as business environment (Bhat, 2005). In the last years, these needs have deeply urged enterprises to Business Process Management (BPM) (Van der Aalst 1, 2003) (Elzinga, 2005), that provides methodologies for business process modeling, deploy, monitoring and continuous improvement, in order to govern the process complexity and the environment dynamism in a more and more effective and efficient manner.

This paper provides an approach to support BPM through flexible process modeling according to the operative environment. We start from the concept that modeling a process means also modeling the environment factors influencing it. For this purpose our approach uses the well-established concept of

pattern: a pattern identifies a recurring problem and a solution and aims to capture and explicitly state abstract problem-solving knowledge that is usually implicit and gained only through experience (Winn, 2002). Any pattern refers to a tern <Problem, Context, Solution>: given a problem, a pattern not only suggests a general solution, but also it identifies a more specific one according to the actual context. For this reason, patterns support flexible process modeling from a methodological point of view as they allow to represent the relationships between contexts and solutions.

In particular, the study presented here suggests the use of decision tables as implementative support to the pattern theory: they assure compact overview of a large number of information, modular knowledge organization, effective evaluation of consistency, completeness and redundancy. These peculiarities guarantee a representation of the relationships among problems, contexts and solutions in a complete manner, without inconsistencies and fast reusable. That's why decision tables allow to represent all the possible contexts for each problem and to reject the inconsistent ones, so that they identify the corresponding specialized solution for each possible context. Moreover, decision tables are easily maintainable. This fact increases flexibility of dynamic reengineering of the relationships among problems, contexts and solutions: when the

environment changes, we can identify the new specialized solution just changing some elements of the decision tables and we can easily change the process replacing the existing solution with a specialized one according to the new context.

Briefly, the approach here proposed investigates the following Research Questions (RQ):

- *RQ1*: How to organize and relate environment factors, general processes and specialized processes.
- *RQ2*: How to represent and use the relationships among environment factors, general processes and specialized processes.

In order to face this research questions the following instruments are respectively proposed:

- a pattern-driven model
- an appropriate decision tables set

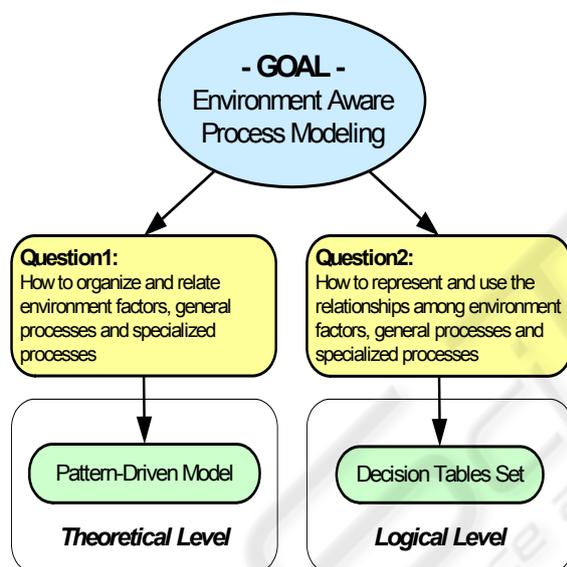


Figure 1: GQM Schema of the proposal.

The paper is structured as following: in section 2 related works are explained and compared; section 3 presents our proposal, including theoretical and logical model; section 4 discusses the application of the methodology in a real case; finally, the last section explains the conclusion and the future development of this work.

## 2 RELATED WORKS

The flexible process modeling is a question long debated by the scientific community in the last years

and there are many literary contributions investigating in such a way.

A formal approach to defining patterns for business processes is presented in (Van der Aalst 2, 2003), (Van der Aalst, 1996). These works are based on the workflow view of business processes. The patterns define many ways of ordering activities in workflow for example task sequencing, split parallelism, join synchronization, and iteration. This approach can be quite useful for tasks as analysis and design patterns definition or workflow management systems building and evaluation. It differs from approach proposed in this paper because even if it applies the process components reuse, however it focuses only on organizing a sequence of activities without identifying a relationship between process and context.

A methodology to define and exploit business process patterns is presented in (Malone, 2003), (Brynjolfsson, 1989). Here a general process pattern is defined as a number of generalized activities that will be specialized at design time. A large collection of general and specialized patterns has been built based on this approach, and it is in use for process improvement. The main aspect we learn from this approach is the idea of pattern specialization. However process patterns specialization is at design level, not at analysis and modeling level, so the process reengineering becomes complex and not flexible to adapt to a new context.

In (Hongli, 2006) an approach taking in account context variability is shown. Here a flexible modeling method has been proposed based on the capability of extensible organization description, but this approach considers only the changes in the organizational context without taking into account the ones in other contexts (for example legislative context or market context).

Finally, in (Yao, 2006) the authors represent the relationship between the context and the solutions specialized for that specific context through the Cased-based Reasoning technique. This technique consists in solving a new problem remembering a previous similar situation and reusing information and knowledge of that situation.

The approach introduced in this paper is born from the demands highlighted by the state of the art about process modeling. It aims to elaborate a new methodology for process modeling as a set of tasks and process components, which can be specialized according to the operational context through an unique and schematic representation of environment conditions and previous acquired experiences.

### 3 PROPOSED APPROACH

The proposed approach adapts the pattern concept to the business processes modeling: a pattern allows to find a solution (a process component) able to model a given problem (a part of a process to be modeled) according to the specific context where the solution has to work. In particular:

- for “problem” we mean a part of a process to be modeled to which a general process component (general solution) to specialize has to be associated;
- for “context” we mean the set of factors characterizing the context where the process works (i.e. technologies, industrial standards, budget, tools, cultural factors), whose values determine the suitable actions to specialize the general solution;
- for “solution” we mean the process component suitably specialized solving the problem in that specific context.

A typical scenario consists of modeling a problem in a specific context starting from a general solution and identifying a set of actions to specialize the solution itself according to the given context. The specializing actions can have influence on the activities, on the artifacts or on the control flow of the general solution. In fact they can:

- add new activities
- specialize existent activities
- modify artifacts
- modify control flow

The pattern-driven approach is then implemented through decision tables. That’s why the approach consists of two different levels:

- *Theoretical Level*, representing concepts and functions supporting the pattern-driven approach;
- *Logical Level*, implementing the theoretical level through the decision table formalism.

#### 3.1 Theoretical Level

At this level the proposed approach is formalized through specific functions.

The theoretical level consists of two steps:

- *Problem Step*: beginning from a specific problem, we identify a general solution modeling it.
- *Context Step*: beginning from a general solution and a specific context, we identify the specialized solution solving the problem in that context.

#### 3.1.1 Problem Step

Given a problem, we have to find a general solution modeling it. If we call P the set of the problems, to which a general solution is associated, and if we call GS the set of the general solutions themselves, we define:

$$\varphi: P \rightarrow GS, \forall p \in P: \varphi(p) = gs$$

where  $\varphi$  is the function able to select the general solution  $gs$  solving the problem  $p$ .

Moreover, given a problem, it can be useful to specify it through the identification of a sub-problem. This requires in some cases the investigation of a hierarchy of more and more specific problems before the identification of a general solution. So the function  $\varphi$  becomes:

$$\forall p \in P: \varphi(p) = \begin{cases} gs & \text{if } lp=1 \\ \varphi^*(p^*) & \text{if } lp>1 \end{cases}$$

where  $\varphi^*$  is a  $\varphi$ -type function able to investigate a set of sub-problems of  $p$  (i.e. problems more specific than  $p$ ),  $p^*$  is a sub-problem of  $p$  and  $lp$  is the depth level in the problems hierarchy.

#### 3.1.2 Context Step

Many factors (here called diversity factors) characterize a context: business environment, technology, industrial standard, quality program, vision, budget, size, structure and culture of enterprise. These factors have an influence on processes and must be taken into account when we model them. So, after having identified the suitable combination of diversity factors able to characterize the context, we can define a specific context (here called context profile) assigning a value to each diversity factor.

To each  $gs \in GS$  is associated a set CP of context profiles as to which the general solution can be specialized. A context profile characterizes a specific context and can be represented as a vector of instantiated diversity factors  $DF_i$   $i=1, \dots, n$ . Each  $DF_i$  is a factor characterizing a particular aspect of the environment and has a definition domain  $[DF_i] = \{df_{i1}, df_{i2}, \dots, df_{iq}\}$  where each  $df_{ij}$   $j=1, \dots, q$  is an instance of  $DF_i$ . So we can say that the set CP is:

$$CP = [DF_1] \times [DF_2] \times \dots \times [DF_n]$$

$\forall gs \in GS$  given a context profile, we have to identify the set of the actions able to specialize  $gs$  according to that specific context profile. If we call SA the set of the actions we can apply to specialize  $gs$ , and SAS the set of the SA subsets, i.e. the set of

all the possible combinations of specializing actions, we define:

$$\chi' : CP \rightarrow SAS$$

$$\forall cp \in CP: \chi'(cp) = sas, \quad \text{with } sas = \{sa_1, \dots, sa_r\}$$

where  $\chi'$  is the function that, given a context profile, determines sas the set of specializing actions corresponding to the specific context profile.

Moreover, fixed a specific context in some cases it can be useful to specify it much more through a more in-depth survey considering a more specific context profile. This requires in some cases the investigation of a hierarchy of more and more specific context profiles before the identification of the set of specializing actions. In these cases the function  $\chi'$  becomes the function:

$$\forall cp \in CP: \chi'(cp) = \{sa_1, sa_2, \dots, sa_h\} \cup \chi'_1(cp_1) \cup \chi'_2(cp_2) \cup \dots \cup \chi'_k(cp_k)$$

where  $sa_i$  are specializing actions,  $cp_j$  are context profiles specifying cp and  $\forall j \chi'_j$  is a  $\chi'$ -type function able to investigate more specific profiles.

When the specializing actions are identified, it's necessary to find the specialized solution applying these actions to the general solution gs. So for each function  $\chi'$  we can define the function:

$$\chi'' : SAS \rightarrow SS,$$

where  $\chi''$  is the function able to identify the specialized solution ss corresponding to a set of specializing actions. So, for each general solution gs it is possible to define the function  $\chi = \chi'' \cdot \chi'$ :

$$\forall cp \in CP: \chi(cp) = ss$$

where ss is the specialized solution obtained applying on the general solution gs the set of actions specializing it according to the context cp.

In conclusion, for each general solution gs it is possible to define a function  $\chi$  to suitably specialize this component according to the context where it works.

### 3.2 Logical Level

This level aims to implement the theoretical level functions through the decision tables formalism.

A decision table is a tabular representation of a decision-making task, where the state of a set of conditions determines the execution of a set of actions (Vanthienen, 1998), (Maes, 1988), (Ho, 2005), (Bar-Or, 2005). In general, a decision table has four quadrants: conditions (Cond), conditional

states (S), actions (Act) and rules (x) as shown in figure 2. The table is defined so that each combination of conditions and conditional states corresponds to a set of actions to carry out. The conditional-oriented approach of a decision table allows to express knowledge related to the examined problem.

At this level, we implement the functions defined in the Theoretical Level ( $\varphi, \chi', \chi''$ ) through suitable decision tables:

- Problem Decision Table (DTp)
- Context-Action Decision Table (DTca)
- Context-Solution Decision Table (DTcs)

Cond <sub>1</sub>	S <sub>11</sub>				S <sub>12</sub>			
Cond <sub>2</sub>	S <sub>21</sub>	S <sub>22</sub>						
.....	.....							
Cond <sub>N</sub>	S <sub>N1</sub>	S <sub>N2</sub>						
Act <sub>1</sub>	-	-	-	-	x	x	x	x
Act <sub>2</sub>	-	-	-	-	-	-	-	x
.....	.....							
Act <sub>M</sub>	-	x	-	x	-	x	-	x

Figure 2: An example of decision-table.

#### 3.2.1 Problem Decision Table

For each function  $\varphi$  a DTp is implemented and structured as following:

- the CONDITION quadrant contains the problems domain
- the CONDITIONAL STATE quadrant contains the possible problem in the specific domain
- the ACTION quadrant contains
  - the general solutions available
  - a set of links to more specific DTp in order to investigate more specific problems
- the RULE quadrant identifies the relationship between each faced problem and the corresponding general solution or link to a more specific DTp.

Problems	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	...	P <sub>t</sub>
gs <sub>1</sub>	x	-	-	...	-
gs <sub>2</sub>	-	x	-	...	-
gs <sub>3</sub>	-	-	-	...	x
.....	-	-	-	...	-
gs <sub>s</sub>	-	-	x	...	-

Figure 3: An example of DTp schema.

### 3.2.2 Context-Action Decision Table

For each function  $\chi'$  a DTca is implemented and structured as following:

- the CONDITION quadrant contains the diversity factors  $DF_i$   $i=1, \dots, n$  specializing the related general solution  $gs$
- the CONDITIONAL STATE quadrant contains the possible value of each diversity factor:  $[DF_i]=\{df_{i1}, df_{i2}, \dots, df_{iq}\}$
- the ACTION quadrant contains
  - all the possible actions specializing the general solution  $gs$
  - a set of links to more specific DTca in order to investigate more specific contexts
- the RULE quadrant identifies the relationship between each context profile and corresponding specializing actions and links to more specific DTca.

$DF_1$	$df_{11}$				$df_{12}$			
$DF_2$	$df_{21}$	$df_{22}$	$df_{21}$	$df_{22}$	$df_{21}$	$df_{22}$	$df_{21}$	$df_{22}$
...	.....							
$DF_n$	$df_{n1}$	$df_{n2}$	$df_{n1}$	$df_{n2}$	$df_{n1}$	$df_{n2}$	$df_{n1}$	$df_{n2}$
$sa_1$	-	x	x	-	x	-	x	x
$sa_2$	x	-	x	-	-	x	-	x
.....	.....							
$sa_r$	-	x	-	x	-	x	-	x

Figure 4: An example of DTca schema.

### 3.2.3 Context-Solution Decision Table

For each function  $\chi''$  a DTcs is implemented and structured as following:

- the CONDITION quadrant contains all the possible actions specializing the general solution  $gs$

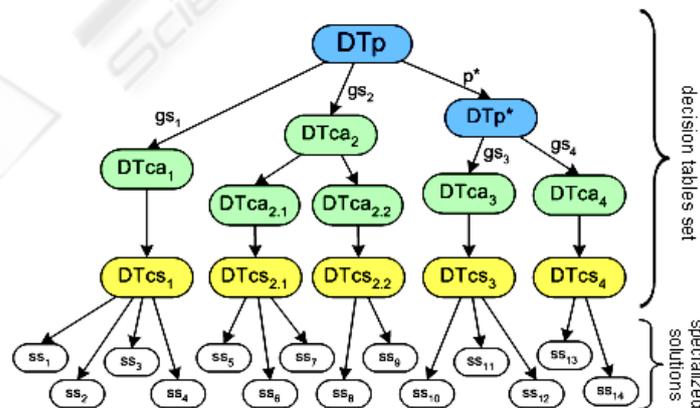


Figure 6: A typical net of the decision tables set and related specialized solutions.

- the CONDITIONAL STATE quadrant contains the possible values for the specializing actions (“Yes” or “No”) indicating if the corresponding specializing action must be executed or not.
- the ACTION quadrant contains the specialized solutions facing the given problem
- the RULE quadrant identifies the relationship between each set of specializing actions and the corresponding specialized solution

It is clear that the previously described structure allows to verify the completeness and effectiveness of the executed actions and consequently to extend and update the experience acquired during process execution.

$sa_1$	Yes				No			
$sa_2$	Yes	No	Yes	No	Yes	No	Yes	No
...	.....							
$sa_i$	Yes	No	Yes	No	Yes	No	Yes	No
$ss_1$	-	x	x	-	x	-	x	-
$ss_2$	x	-	-	-	-	-	-	-
.....	.....							
$ss_v$	-	-	-	x	-	x	-	x

Figure 5: An example of DTcs schema.

The figure 6 shows a typical example of the structure of a Decision Tables Set build according the proposed approach.

## 4 EXPLORATIVE INVESTIGATION

At the moment, the proposed approach is being investigated in an industrial case during a research

project. This project investigates the management of business processes about the “Data Archiving Management and Acquisition”.

The enterprise collaborating to the realization of this experimentation is a stable ICT company, whose core business is about document management solutions for public and private financial institutions. Every day the company receives packets of documents from its clients. Such documents are primarily banking files containing pure text, images, diagrams, charts and so on. Because of the high number of documents to be stored, the enterprise needs the implementation of automated processes able to scan every document in the packets, recognize errors in words, distinguish images from pure text and store everything according to proper category. To model such business processes, we have implemented two automated tools supporting the execution of the proposed methodology:

- a process developer tool, provided with a knowledge base of process patterns, for a visual business process modeling;
- a decision tables management system.

These tools support the automation of our methodology and are very useful to manage a large number of process components and decision tables.

Following it is explained in detail how the investigation has been conducted.

#### 4.1 Start-Up Analysis

A *start-up analysis* has been conducted on the 8 processes in use within the enterprise in order to:

- identify the general processes and the related general solutions (GS)
- organize and formalize, for each general process, the appropriate diversity factors (DF) affecting it
- elicit the specializing actions (SA) for each process specialization
- define the specializing processes representing the set of the specialized solutions (SS)
- relate problems, diversity factors, actions and solutions

The table 1 summarizes the extracted items ordered by the general solutions:

Table 1: A summary of extracted items.

General Solution (GS)	#DF	#SA	#SS
Consulting	6	7	12
Documents organizing	7	9	14
Documents reception	6	7	15
Documents recognizing	3	4	8
Indexing and verifying	6	8	10
Optical archiving	7	8	9
Physical archiving	5	7	8
Scanning	5	8	12
<b>Total</b>	<b>47</b>	<b>60</b>	<b>88</b>

According to the approach presented in section 3, all the collected items have been used to build a *Decision Tables Set*. Such set is made of:

- 1 DTp: managing all the general solutions
- 8 DTca: one DTca for each general solution
- 8 DTcs: one DTcs for each DTca

Using 17 decision tables the approach was able to handle 8 different general solutions, to characterize them through 47 diversity factors, to modify them using 60 specializing actions and to obtain 88 specialized solutions.

#### 4.2 Case Study

Later, a case study investigation is started in order to evaluate, on field, the effectiveness of the approach to quickly adapt the processes in use according to the environment changes.

In this section, for space reasons, a specific part of the case study is presented. In particular a part of the business process *Document Recognizing* is discussed. Such part is representative of two different kinds of events that may affect a business process in use:

- *expected change*: faced through “pattern” peculiarities
- *unexpected change*: managed through “decision tables” properties

##### 4.2.1 Starting Scenario

In the *Document Recognizing* field a general process component is provided. It represents the general solution gs of this kind of problems (figure 7).

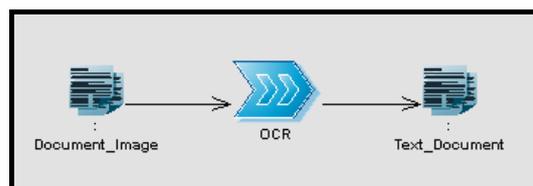


Figure 7: Process model for general solution in use.

According to gs an appropriate DTca is build and adopted (figure 8). This table aims to support all the possible specialization. The table illustrates the possible causes of context variability represented by a diversity factor (DF) as: “document type”, “writing type” and “document with images”.

Therefore according to their possible values we can identify the actions needed to properly specialize the general process gs.

Moreover, the DTca is related to a DTcs specifying the actions specializing the general solution gs to obtain the final specialized solutions (figure 9).

At first, the type of banking documents to be elaborated and stored was like “structured” and “typewriting” documents “without images”. Such values represent the context profile “cp<sub>1</sub>” and generate, by the means of the DTca consultation, the extraction of the following actions:

- Add "Layout Analysis"
- Specialize "OCR" in "OCR Typewriting"

These actions compose “sas<sub>1</sub>”, the final set of specializing actions. According to DTcs contents the specialized solution “ss<sub>2</sub>” is extracted and used (figure 10).

Document Type	Structured				Unstructured			
	Typewriting		Handwriting		Typewriting		Handwriting	
Writing Type								
Documents with Images	Y	N	Y	N	Y	N	Y	N
Add "Layout Analysis"	X	X	X	X	-	-	-	-
Specialize "OCR" in "OCR Typewriting"	X	X	-	-	X	X	-	-
Specialize "OCR" in "OCR Handwriting"	-	-	X	X	-	-	X	X
Add "Image Extraction"	X	-	X	-	X	-	X	-

Figure 8: DTca supporting the “Document Recognizing” gs.

Add "Layout Analysis"	Y				N							
	Y		N		Y		N					
Specialize "OCR" in "OCR Typewriting"	Y	N	Y	N	Y	N	Y	N				
Specialize "OCR" in "OCR Handwriting"	Y	N	Y	N	Y	N	Y	N				
Add "Image Extraction"	-	Y	N	Y	N	-	-	Y	N	Y	N	-
SS <sub>1</sub>	-	X	-	-	-	-	-	-	-	-	-	-
SS <sub>2</sub>	-	-	X	-	-	-	-	-	-	-	-	-
SS <sub>3</sub>	-	-	-	X	-	-	-	-	-	-	-	-
SS <sub>4</sub>	-	-	-	-	X	-	-	-	-	-	-	-
SS <sub>5</sub>	-	-	-	-	-	-	X	-	-	-	-	-
SS <sub>6</sub>	-	-	-	-	-	-	-	X	-	-	-	-
SS <sub>7</sub>	-	-	-	-	-	-	-	-	X	-	-	-
SS <sub>8</sub>	-	-	-	-	-	-	-	-	-	X	-	-

Figure 9: DTcs specializing the “Document Recognizing” gs(compact version table).

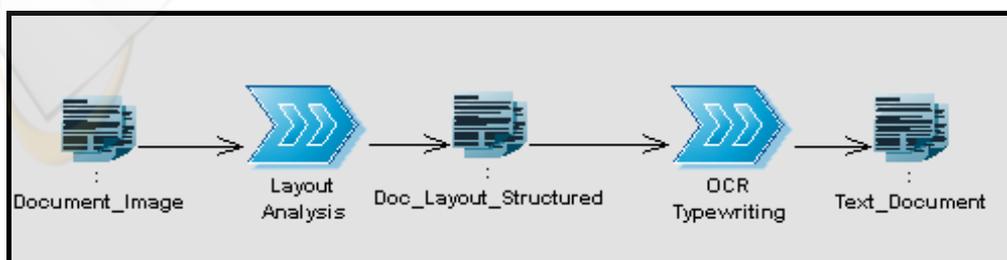


Figure 10: Specialized solution “ss<sub>2</sub>”.

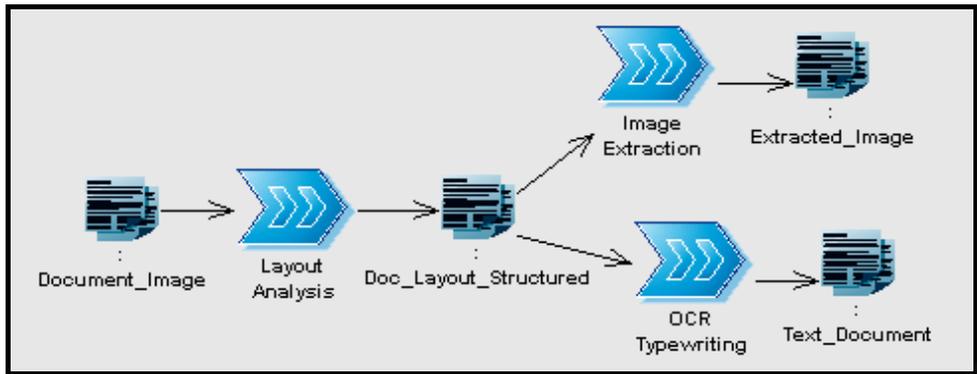


Figure 11: Specialized solution “ss<sub>1</sub>”.

Document Type	Structured								Unstructured							
	Typewriting				Handwriting				Typewriting				Handwriting			
Writing Type	Y		N		Y		N		Y		N		Y		N	
Documents with Images	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
<b>Formal Control</b>	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Add "Layout Analysis"	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-
Specialize "OCR" in "OCR Typewriting"	X	X	X	X	-	-	-	-	X	X	X	X	-	-	-	-
Specialize "OCR" in "OCR Handwriting"	-	-	-	-	X	X	X	X	-	-	-	-	X	X	X	X
Add "Image Extraction"	X	X	-	-	X	X	-	-	X	X	-	-	X	X	-	-
<b>Add "Formal Control"</b>	X	-	X	-	X	-	X	-	X	-	X	-	X	-	X	-

Figure 12: Updated DTca (adding “Formal Control” diversity factor).

### 4.2.2 Expected Change

After just six months, a business intelligence strategy suggested to manage also images inside the documents. Such change was expected and planned, according to the Pattern-Driven Model, in the Decision Tables Set. Therefore this change is mainly faced through pattern model and then it implies just a new browsing of the tables set. In fact a new context profile (cp<sub>2</sub>) is considered (now we consider diversity factor “Document with Images”=“Y”). The result of the DTca consultation is represented by the following actions:

- Add "Layout Analysis"
- Specialize "OCR" in "OCR Typewriting"
- Add "Image Extraction"

These actions compose “sas<sub>2</sub>”, the new set of specializing actions. According to DTcs contents the specialized solution “ss<sub>1</sub>” is extracted and used (figure 11).

### 4.2.3 Unexpected Change

Eight months later, a new type of banking order required a formal control activity in order to verify the text content after the recognizing phase. Such unexpected diversity factor requests a reorganization in the Decision Tables Set of the relationship between the general solution “gs” and all of the possible specializations, also adding the variants referred to the introduced diversity factor. The decision table formalism supports the impact of such changes through the updating of DTca and DTcs (figure12 and 13):

- the DTca is updated adding one row for the diversity factor “Formal Control” and one row for the specializing action “Add Formal Control”.
- the DTcs is updated adding the specializing action “Add Formal Control” and eight rows referring to the new specialized solutions that the table is able to provide.

Add "Layout Analysis"	Y								N											
Specialize "OCR" in "OCR Typewriting"	Y				N				Y				N							
Specialize "OCR" in "OCR Handwriting"	Y	N			Y			N	Y	N			Y			N				
Add "Image Extraction"	-	Y	N		Y	N		-	-	Y	N		Y	N		-				
Add "Formal Control"	-	Y	N	Y	N	Y	N	Y	N	-	-	Y	N	Y	N	Y	N	Y	N	-
SS <sub>1</sub>	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SS <sub>2</sub>	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SS <sub>3</sub>	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
SS <sub>4</sub>	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
SS <sub>5</sub>	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
SS <sub>6</sub>	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
SS <sub>7</sub>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
SS <sub>8</sub>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
SS <sub>9</sub>	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SS <sub>10</sub>	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SS <sub>11</sub>	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SS <sub>12</sub>	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
SS <sub>13</sub>	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
SS <sub>14</sub>	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
SS <sub>15</sub>	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
SS <sub>16</sub>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-

Figure 13: Updated DTca (adding "Formal Control" specializing action).

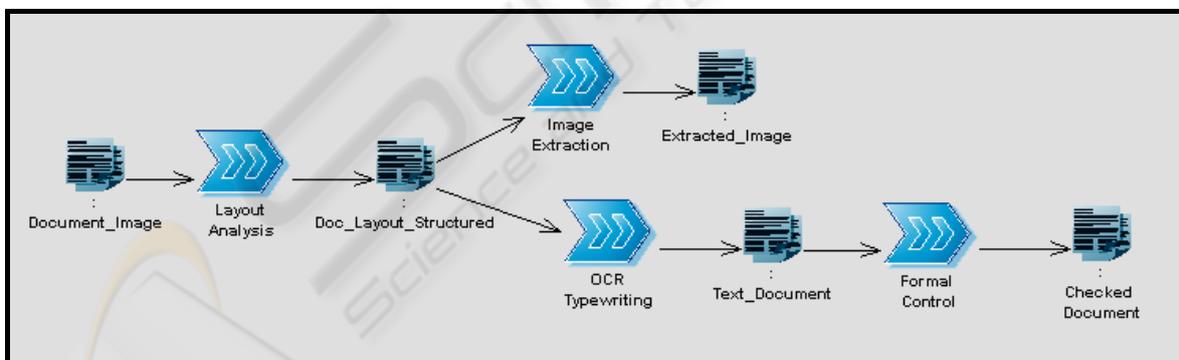


Figure 14: Specialized solution "ss<sub>9</sub>".

After the tables updating, the DTca is consulted and the result of the consulting is represented by the following actions:

- Add "Layout Analysis"
- Specialize "OCR" in "OCR Typewriting"
- Add "Image Extraction"
- Add "Formal Control"

These actions compose "sas<sub>3</sub>", the new set of specializing actions. According to the new DTcs

contents the specialized solution "ss<sub>9</sub>" is extracted and used (figure 14).

In synthesis, within one year and a half, the enterprise has been able to opportunely reengineer business processes and quickly adapt them according to two context changes. Using the proposed methodology, the enterprise has been able to increase business flexibility and constantly guarantee reliability, correctness and completeness.

## 5 CONCLUSIONS

This paper represents a contribution in the process modeling issues. In particular it concerns with the relationships between processes and operative environment that drives to a context-based process model specialization.

We propose a pattern-driven approach to capture and explicitly represent abstract problem-solving knowledge. This approach uses a decision tables set to formalize the relationships between all the possible environment factor configurations and the specialized solutions.

This approach has been experimented in a real context with encouraging results. The combined use of the pattern-driven model and the decision table notation has been able to promptly react to each environment change. In particular, it is adequate mainly for expecting changes because the pattern-driven approach permits to show the path for the new specialized solution: a new context factor value implies a table consultation and the extraction of new specialized actions in order to re-modeling the business process on use. The proposed approach is useful also for unexpected changes because it implies the reorganization of relationships between processes and the operative context through a quick decision table update.

In order to validate the proposed approach, we have conducted an on-field investigation in several industrial environments using two automated tools. Our future studies will be aimed to the optimization of these tools.

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