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THE DIAGNOSIS OF INFORMATION POTENTIAL OF SELECTED BUSINESS PROCESS MODELLING NOTATIONS

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The paper presents the findings of the ease of understanding tests for selected business process modelling notations as an element of diagnosing the notations information potential. The easiest-to-understand notation is identified, as well as the attributes determining the choice of this notation as the easiest to understand. Three notations used in business process modelling have been subjected to diagnosis: EPC, BPMS and BPMN. Based on the results of these analyses, recommendations have been formulated for organisations where process modelling requires the involvement of all employees and where process awareness needs to be developed. Using an intuitive notation may contribute to improved communication between users representing different professional profiles and translate into a higher effectiveness of organisational changes.

Keywords: business process modelling, modelling notations, modelling technique, BPMS, BPMN, EPC

1. Introduction

Over the past two decades, the concepts, methods and tools of the process approach have been continually evolving, leading to the formation of business process management (BPM) as a new field of organisational management in the contemporary economy. To implement BPM, an organisation needs to systemise the knowledge of its processes. This task involves the identification, documentation

and modelling of these processes. Process modelling can be applied to many areas. However, the most common is to formally define and document processes in order to fully understand them, enabling their continuous improvement and management. Business process modelling and management is constantly evolving, which is why, despite widespread literature on this subject, there are still ambiguities in terminology and a shoratage of studies drawing attention to the differences between the terms, concepts, occurring standards and prerequisite choices of modelling notation.

This article aims to fill the gap in the cognitive information potential of the selected business process modelling notations. We can achieve this by evaluating the most commonly used graphical objects used to represent the actual business processes from the perspective of the user. The following modelling techniques were selected for analysis: EPC (Event-Driven Process-Chain), BPNM (Business Process Model and Notation) and the business notation of BPMS (Business Process Management System). Results of our desk research in this field is given in the first part of the paper.

Starting from the literature review we will base our analysis on the developed formal part of the evaluation process, conducting research on the information potential. In our research the ease of understanding of each of the selected business process modelling notation will be examined.

The following research objectives were set for the study:

- to evaluate the ease of understanding the selected business process modelling notations as an element of diagnosing the information potential of the notation,
- to identify the notation perceived to be the easiest to understand,
- to identify the features which determine the notation to be selected as the easiest to understand.

The results of the study, presented in the second part of the paper, may provide crucial support in the choice of the methods and notations of business process modelling, depending on the area in which the modelling is applied. Recommendations for selecting the business process modelling notation at the operational level will be the practical purpose of the study.

2. Business Process Modelling

Business Process Modelling can be defined as a process of documenting business processes through a combination of text and graphic notation. In the context of business process management, it is most typically defined as a process used for mapping “the real world” (the *as-is* modelling), while being an active creation at the same time, which reflects the potential future states of the organisation or its processes, and suggests the potential directions of changes (the

to-be modelling) [11]. Process models help define processes and process interfaces, document processes, and present logical and chronological relations between process tasks, thereby enabling analyses, the assignment of agents, identification of information being transformed in the course of the process and information received as the process output.

Process models can be used as a basis for developing a performance measurement system applicable to processes, as well as to the whole organisation. In projects intended to enhance an organisation's performance through improving its processes, Business Process Modelling requires the involvement of employees, external consultants and managers as well as the organisation's rank and file from various departments. It is therefore essential for everyone to identical and comprehensible process modelling methods and tools. Furthermore, this requirement should prompt one to select an appropriate modelling notation which will:

- allow the necessary elements defining the process to be described at a given level of detail [1, 16, 17]
- contain graphic symbols and associated semantic rules comprehensible to all concerned, including the employees not professionally involved in process modelling [1, 14]
- facilitate communication between employees with different professional profiles
- enable the processes to be systemised logically and graphically within a framework concept, a not insignificant factor, as the models will be read and analysed by individuals who did not participate in the modelling directly [14, 15].

Process models that are comprehensible to employees will enable them to understand the processes performed throughout the organisation and will help them to view their tasks in the context of the entire value adding process. If a comprehensible notation is used in modelling, the employees may more readily engage in the identification, improvement and updating of the processes.

Business Process Modelling is a key element in the organisational change management and has many and varied applications, not solely limited to projects intended to develop a process-oriented organisation. Other important areas of the business process model application include arrangements preceding the selection or development of an IT system supporting business management (adjusting the system to the organisation, not vice-versa, a common language for IT and Business), designing workflow systems, documenting processes in the implementation of quality management systems, including ISO 9001 certification, and process benchmarking or Activity Based Management [15]. Therefore, selecting a notation gains significance in the context of the modelling objective and planned application of the business process model.

3. Assessment of modelling notation understandability: related works

Choosing an adequate Business Process Modelling Technique is one of the key issues to be considered at the stage of designing a business process model. Notation adequacy dictates that a model designed according to notation guidelines must have the adequate potential in terms of information and utility which meet the expectations of all its users. In the context of the Cognitive Fit theory [18], this potential can be viewed as the degree in which the notation fits the needs of the model user-supplier, the intended objective of model development and the form process information presentation. Hence, the information potential of the model depends on the properties deriving, primarily from its notation qualities, i.e. its structure, legibility, and ease of understanding [6]. Accordingly the assessment of the business process model potential should reflect the extent to which four key criteria are satisfied: ease of generation, ease of understanding, completeness, accuracy [10].

Ease of generation is the degree of ease associated with the design of business process models using a specific Business Process Modelling Technique (BPMT). In other words analysed BPMT is easy to use and it is easy to conceptualize a process using this approach [10]. *Ease of understanding* BPMT is the ability to design a process model easily understood by its users. A graphical representation of processes using BPMT are clear. *Technique completeness* means that process representation using this approach is complete and sufficiently detailed. *Accuracy* is the capacity in which BPMT allows the correct design of the business process models, and in accordance with business reality. High accuracy means that BPMT leads to accurate process representation [10]. A similar approach is presented by Recker&Mendling, who indicate that business process modelling technique/notation should allow for designing models that can be used as a basis for communication between users with different profiles (eg. business vs. workflow analysts). Furthermore, the notation should be easy to comprehend, intuitive and should ensure interpretational flexibility of the model [13].

The findings of cross-sectional studies on methodologies used to assess the business process model comprehension reveal the consistency of approach that has been used. Table 1. contains examples of the objective and subjective measures used for assessing effectiveness of notations, taking into account the complexity of the purpose of studies presented in the article.

As independent variables, model notation and complexity were used in the research models discussed, while model comprehension/understanding and perceived ease of use understanding were taken as dependent variables. The dependence of variables was determined based on two groups of indicators: effectiveness and efficiency of the modelling notation used. Effectiveness of the models was generally measured by means of a comprehension test (e.g. multi-

choice comprehension questions). The efficiency assessment was based on relative and absolute measures representing the input required to understand the model (e.g. time needed to understand, number of correct answers/time of answers).

Table 1. Measures of Business Process Modelling Technique effectiveness

References	Objective measures	Subjective measures		
	Correct answers on model content	Problem solving based on model content	Verification of model content	Perceived ease of model understanding
Bavota et al., 2011	✓			
Figl & Laue, 2011	✓			✓
Fuller et al., 2010	✓			
Kock et al., 2009	✓		✓	✓
De Lucia et al., 2008	✓			
Genero et al.2008	✓			✓
Mendling et al., 2007	✓			✓
Recker et al., 2007	✓	✓		✓
Serrano et al., 2007	✓			
Hardgrave et al., 1995	✓			✓

Source: an analyses based on [5, 7, 8, 10, 12, 13]

4. The methodology of analysing the ease of understanding as an element of diagnosing the modelling notation information potential

The ease of understanding analysis was designed and carried out using a literature review and the business process modelling notation requirements for the area of application as a basis. The analysis constitutes an element of diagnosis of the modelling notation information potential.

According to the assumptions and the methodology accepted for the study, the analysis covered business process modelling notations based on an activity diagram and presenting a formal description of the process, with events and agents performing the activities addressed: EPC - Event-Driven Process Chain, BPMS - Business Process Management System and BPMN - Business Process Model and Notation. This is an unprecedented selection – the three notations not having been analysed before for their informational potential in terms of any of these criteria in such a combination as this. The notations selected have been used for modelling a process titled *"Processing a freight forwarding order"*. The structure of this process is compatible with the a generic model of a processing a freight order.

It initiates an external event "*Forwarding order received*". The result of the process is the preparation of shipping documents to implement a carriage service. An example of the analysed process model in chosen BPMT is shown in Figures 1–3. This modelling was performed by means of IT process modelling tools selected for the study, while the survey among respondents was conducted without indicating nor using these tools.

The method of Event-driven Process Chains (EPC) is a Modelling language used to describe business processes and workflows. EPC is the result of a collaborative project conducted by SAP AG and IDS Scheer AG in the years 1990-1992 [9]. This method was developed within the framework of Architecture of Integrated Information Systems (ARIS) in order to model business processes. EPC notation consists of events, functions and three types of connectors (logical AND, logical exclusive OR XOR and logical OR). According to EPC Modelling the assumption model consists of sequences of events triggering functions included in the business process. The whole process is triggered by the initial events [4].

In the case of the *"Processing a freight forwarding order"* process modelled in the study, EPC has been supplemented with elements of organisational structures (Fig. 1.) - in order to present the same elements of the process by means of each of the notations selected for analysis.

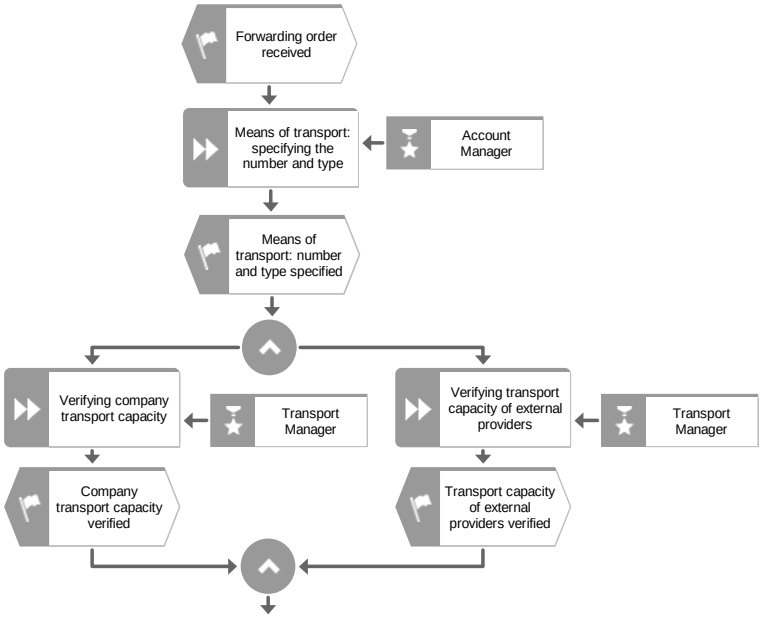

Figure 1. A fragment of the *"Processing a freight forwarding order"* process in EPC notation. Preparation in ARIS 9.7 Architect System

Business Process Management System (BPMS) is a framework for process management supporting a continuous process and total organisational improvement. BPMS is developed by BOC Information Technologies Consulting GmbH established in 1995 by Prof. Dimitris Karagiannis. The main idea of BPMS is to represent the dependencies between the core elements of an organisation: business process, product, organisational units, information technology and to make them controllable. According to BPMS approach modelling is done using the so-called model types which can be understood as "templates" for modelling processes, organisation units, roles, documents, etc [2]. The *"Processing a freight forwarding order"* process in BPMS notation is presented with elements corresponding to those in the remaining notations. A fragment of the process is shown in Fig. 2.

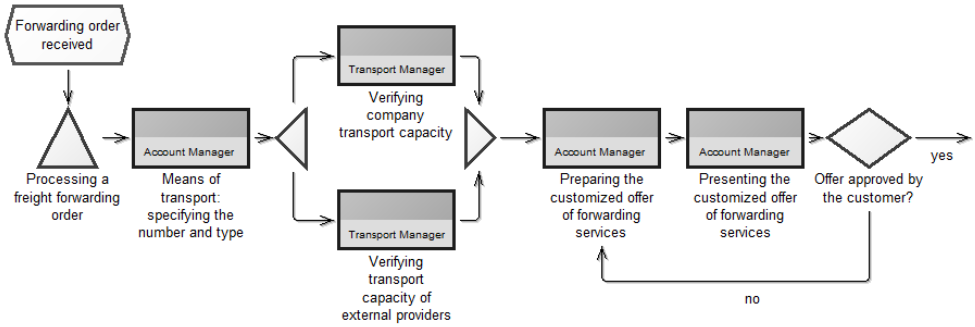

Figure 2. A fragment of the *"Processing a freight forwarding order"* process in BPMS notation. Preparation in ADONIS 5.1 Business Process Management Toolkit

Business Process Model and Notation (BPMN) is the global standard for process modelling, and was developed by Business Process Management Initiative (BPMI). Currently is maintained by the Object Management Group (OMG). According to their definition, BPMN is a graphical representation for specifying business processes in a business process model [3]. This notation allows both business modelling (basic level) and technical execution of processes (advanced level). At the basic level of complexity a model visually represents a business process flow (descriptive modelling). At the second level, the model gives possibility either to analise the process performance using simulation tools or to create requirements for IT solutions (analytical modelling). The model complexity at the third level may deliver an executable code implemented as an application (executable modelling).

OMG assumption was to provide the same modelling notation understood by business analysts and technical developers [3]. Fig. 3. presents a fragment of the "*Processing a freight forwarding order*" process modelled using BPMN.

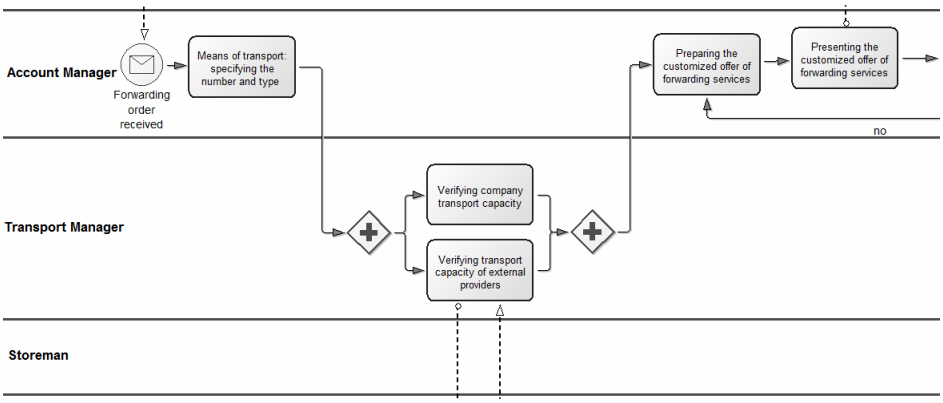

Figure 3. A fragment of the *"Processing a freight forwarding order"* process in BPMN notation. Preparation in ADONIS CE 3.0: Free BPM Tool

The survey was conducted among a group of the II-nd cycle university students (faculties: economics, business management), who were unaware of the process modelling techniques. Considering the respondents' lack of experience in the modelling notations use, we assumed that their perception was similar to that of employees in organisations initiating business process modelling projects. The survey yielded 172 correctly completed questionnaires. The interviews were guided by the interviewers so as to allow all respondents the same response time.

The survey included two main tests of notation comprehension: a test diagnosing the subjective choice of the notation perceived as the easiest to understand; and, a test designed to identify the attributes determining the choice of the easiest to understand notation.

The general test of notation comprehension enabled the subjective assessment of understanding the business process flow and contents based on the model and a verification test. The detailed test of notation comprehension enabled subjective assessment of understanding a process fragment, with a particular focus on understanding logic gates. Furthermore, the detailed test included a verification component, which enabled objective assessment of respondents' understanding of the notation.

For the purpose of comparative analysis, an *ease-of-understanding indicator* has been constructed for both tests of business process modelling notation understanding:

$$\textit{Ease-of-understanding indicator for notation } x = \frac{\sum xc}{\sum xs},$$

where:

$\sum xc$ – the number of all respondents who answered the question verifying subjective perception of notation *x* correctly,

$\sum xs$ – the number of all respondents who perceive notation *x* as comprehensible.

The indicator gives a synthetic measure of notation understanding and allows the comparison of analysis results for all notations included in the study. The indicator can be used to analyse the results obtained in groups of respondents who have chosen the given notation as the easiest one to understand, as well as in the whole population of respondents, regardless of their choice of notation.

5. Research findings

According to the respondents' subjective judgement, BPMS is easiest to understand – 61.6% of them chose this notation. Furthermore, the results of tests conducted in the respondent groups who have indicated the given notation as the easiest to understand, BPMS turned out to be the most comprehensible. The detailed comprehension turned out to be more difficult for respondents than the general comprehension test and more corroborative notation comprehension.

Table 2. Survey outcomes in respondent groups who have chosen the given notation as the easiest to understand

	Ease-of-understanding indicator for notation x		
	EPC	**BPMS**	**BPMN**
Subjective perceived ease of understanding a model	11.6%	61.6%	26.7%
Test 1 – general comprehension test of ease of understanding of business process modelling notation	94.4%	96.1%	76.2%
Test 2 – detailed comprehension test of ease of understanding of business process modelling notation	44.4%	57.0%	53.9%

An analysis similar to that summarised in Table 2. was conducted for the entire group of respondents, regardless of their choice of the notation easiest to understand. The outcomes support the findings of the survey in respondent groups who have chosen the given notation as the easiest to understand.

Percentage differences between the *ease-of-understanding indicator* value for each notation are insignificant. It is worth noting however that the biggest difference between Test 1 and Test 2 occurs for EPC, which may suggest that logical operators of this notation are the most difficult to understand. Even those respondents who indicated this notation as the easiest to understand made the most mistakes here showing that they did not grasp the process. The percentage difference between Test 1 and Test 2 is most negligible in the case of BPMN, which may prove that logical operators are presented in a more comprehensible

form here than in other notations, but only if the general process flow recorded in this notation is comprehensible.

Table 3. Survey outcomes for all respondents, regardless of their choice of the notation easiest to understand

	Ease-of-understanding indicator for notation x		
	EPC	**BPMS**	**BPMN**
Test 1 – general comprehension test of ease of understanding of business process modelling notation	89.2%	95.8%	75.3%
Test 2 – detailed comprehension test of ease of understanding of business process modelling notation	38.2%	55.7%	53.9%

Table 4. summarises the analysis of notation perception and notation comprehension verification for all respondents. The percentage of responses given by respondents who declared their understanding of the given modelling notation in the total count of the survey participants (172 individuals) is the subjective measure. The percentage of correctly answered questions in the total count of respondents (172 individuals) is the objective measure. The reasoning is similar to previous analyses.

Table 4. Notation perception and verification of notation comprehension for all respondents

		EPC	**BPMS**	**BPMN**
Test 1 – general comprehension test	Subjective perceived understanding a model content /Count of all the survey participants	59.3%	96.5%	89.5%
	Correctly answered questions/Count of all the survey participants	52.9%	92.4%	67.4%
Test 2 – detailed comprehension test	Subjective perceived understanding a model content/Count of all the survey participants	71.5%	91.9%	74.4%
	Correctly answered questions/Count of all the survey participants	27.3%	51.2%	40.1%

The attributes determining respondents' choice of notation were identified using the Kruskal-Wallis non-parametric method. The test was used to compare distributions of six qualitative variables (notation defined attributes) for three groups (notation types: EPC, BPMS, BPMN). The following dependent variables were used: number of graphic symbols, shape of graphic symbols, colour of

graphic symbols, use of pictographs, graphic way of describing business roles, graphic way of describing decision points.

Table 5. Kruskal-Wallis test outcomes for analysis of attributes determining the choice of the easiest-to-understand notation

Variable	Value of Kruskal-Wallis test	*p*-value ($p < 0.05$)
Number of the graphic symbols	2.4987	0.2867
Shape of the graphic symbols	7.9965	**0.0183**
Color of the graphic symbols	1.3883	0.4995
Use of pictographs	3.6253	0.1632
Graphic way of describing business roles	9.3722	**0.0092**
Graphic way of describing decision points	0.1596	0.9233

The dependent variables were measured by ordinal scale. A five-degree diagnosing scale was used. The results enabled assessment of the uniformity of respondents' opinion distribution in respect of the factors determining their perception of notation comprehensibility. Table 5. summarises the outcomes of these computations. The computation outcomes prove that the shape of graphic symbols and the graphic way of describing business roles are the attributes determining the level of notation comprehension.

6. Conclusions and future research

The BPMS notation (Business Process Management System) was chosen subjectively as the easiest to understand by 61.6% of the respondents (26.7% BPMN, 11.6% EPC). The notation *ease-of-understanding indicator* is highest for BPMS in the respondent groups who chose this given notation as the easiest to understand, as well as regardless the easiest-to-understand notation choice. BPMS shows highest *ease-of-understanding indicator* values in the notation perception and notation comprehension verification analyses for of all respondents.

An analysis of the attributes determining the choice of the easiest-to-understand notation shows that the graphic way of describing business roles and the shapes of graphic symbols are most important. This information may be useful for those developing IT tools supporting business process management.

Based on the findings of the study, BPMS can be recommended as the most comprehensible notation for use in organisations where process modelling requires the involvement of all employees with their process awareness needing to be built as well as the "process-oriented" work style explained in the course of training sessions, or within the frames of process documentation projects for the purpose of

ISO certification. Understanding the organisation's process models may enhance employees' commitment, mitigate their resistance to changes and improve the effectiveness of company projects.

Our future research will focus on other aspects of diagnosing the information potential of notations and on comparative analyses of various groups of notation users.

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