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Accessible Business Process Modelling

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***Abstract*—**This article concerns with the accessibility of Business process modelling tools (BPMo tools) and business process modelling languages (BPMo languages). Therefore the reader will be introduced to business process management and the authors' motivation behind this inquiry. Afterwards, the paper will reflect problems when applying inaccessible BPMo tools. To illustrate these problems the authors distinguish between two different categories of issues and provide practical examples. Finally the article will present three approaches to improve the accessibility of BPMo tools and BPMo languages.

***Keywords*—**Accessibility, Business Process Management, BPM, Event Process Chains, Modelling Languages

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I. Introduction

COMPANYS' output is based on a number of activities performed. To organize these activities a company has to identify its business processes and understand their interrelations. Therefore, business process management is a major driver for enterprises to promote a more efficient creation of value, as the analysis of internal processes occupies a centre stage [1]. The origin of process management dates back to Henry Ford in 1903, when he organized and introduced the assembly-line work [2]. The first published paper, related to process management, was written by Frederic Winslow Taylor back in 1903, and was called Shop Management [3]. In 1911 he additionally published the first book, attending process management, called Principles of scientific management [4]. Along with e.g. globalization, technological progress and the scarcity of resources during the second half of last century, enterprises' business processes gained more importance and complexity. Hammer and Champy are known, as the modern era promoters for process management. Their publications in the early 1990s focused on business process reengineering [5], to call attention to opportunities to adapt to new competitive landscapes. Since the mid-1990s enterprises try to support and optimize the operation of their business processes with information technology (IT) like enterprise resource planning (ERP) systems or customer relationship Management (CRM) systems [6]. Therefore, the identification and understanding of business processes is a crucial factor for enterprises. To dominate such complex processes, detailed process documentation is inevitable. Process documentation provides necessary information for e.g. gap analyses or requirement specifications for IT-implementation [7].

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To ensure efficiency of business process documentation, specific software applications are applied.

As information technology today is strongly intermeshed with business processes, requirement specifications for IT-implementations obtain much more significance for enterprises' prosperity. The on-going technological progress precipitates more valuable IT. This facilitates enterprises to offer more efficient and convenient processes to the customer. In contrast, process documentations become more complex and consume a higher amount of e.g. financial and human resources for its construction. Requirement specifications have to be more detailed and accurate to be viable by IT departments. This again requires more qualified personnel, as tasks / activities for process modelling increase.

Process modelling divisions tend to be frequently understaffed. The success of modelling projects depends on a few employees, who are deeply involved in additional projects and barely find capacities to generate or maintain the required specifications. In addition, process modelling can be a very complex and cross departmental task. Hence, the comprehension and acceptance of process modelling activities and process modelling results by the participants are regularly divergent. As a consequence, IT-projects often are terminated or delayed. In the worst case, incomplete, inaccurate or/and unintelligible specifications are delivered, which cause additional costs, occurring later in the engineering cycle.

Apart from this, the working age population is decreasing and the demographic transition leads to a global aging [8]. By 2050, the world population aged over 65 will increase, from 7.6% currently to 16.2% [9]. Referring to a Survey of "USA Today", 55% of people ages 60-64 were in the American labour market in 2010. This is an enhancement of about 14.5% compared to the same survey in the year 2000. In contrast, the portion of people ages 16-24 in America's labour market decreased from 66% in the year 2000 to 55% in the year 2010 [10]. Therefore the acquisition of young and qualified personnel could potentially be more difficult in the future and age distributions within the companies probably will increase. The dwindling workforce potential and the ascending quantity of older personnel requires enterprises to adapt business applications to the requirements of a wider range of user groups and to prevent negative health effects from the entire staff, induced by software usage, to sustain productivity of BPMo activities. In fact, many injuries or illnesses associated with computer work are attributed to a software ergonomic nature [11]. The implementation of an accessible BPMo application would positively affect ergonomic aspects related to human computer interaction [12]. Providing accessible BPMo applications additionally could optimize the utilization of the working population potential. Enterprises would gain attractiveness for qualified disabled people. Worldwide there are about 650 million people with disabilities [13]. Europe counted approximately 500 Mio inhabitants in the year 2009

[14]. 67.1 per cent out of those 500 Mio inhabitants were declared as working-age population [15]. 15.7 per cent, respectively 52.7 Mio people of that working population either have a long-standing health problem or a disability [16]. Furthermore, accessible BPMo tools could support the cross departmental comprehension and acceptance of process modelling tasks and therefore reduce delay and termination rates of IT-projects. Fig. 1 summarizes some fields, which possibly could benefit from implementing accessible BPMo tools.

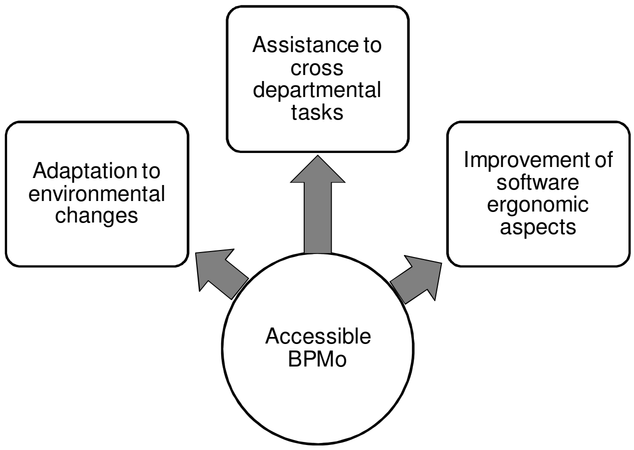

Fig. 1 Benefits from accessible BPMo tools

The following chapters will introduce the reader to business process modelling and specific problems, when using inaccessible modelling languages. Chapter IV will provide an approach to ensure a higher degree of accessibility for a specific modelling language. Target of this inquiry is to provide recommendations for action to improve the accessibility of a specific BPMo tool and thereby to ensure that BPMo tools can successfully be adapted to an altered environment.

II. Business Process Modelling

There are different opportunities to document enterprises' processes. Additionally, enterprises face plenty of software applications, providing various modelling languages and functionalities. To ensure a consistent comprehension of business process modelling, the authors will provide a definition for business process modelling as well as an introduction to common modelling languages. Finally this chapter concludes with an introduction of the modelling language Event driven process chains (EPC).

A. Definition

To define the term "business process modelling", the authors will separate it. First a definition for *business processes* will be provided. Afterwards the term *modelling* will be defined.

1. Business process

Literature occupies with business processes for a long time. It is not surprising, that, in time, a variety of definition attempts have been published. The authors refer to several definitions, created at different times. The sum of these definitions will show that the essence of business processes remained similar over time.

2. Davenport and Short (1990)

A defined business outcome can be achieved by a set of logically related tasks performed [17].

3. Hammer and Champy (1993)

"We define a business process as a collection of activities that takes one or more kinds of input and creates an output that is of value for the customer" [18].

4. Draheim (2010)

"A business process is a net of activities that work together to achieve a defined goal, i.e., a defined business objective" [19].

5. Modelling

Business economy is characterized by a very complex mesh of activities, executed by millions of people respectively systems. It is necessary to reduce this complexity, to understand business economic processes. A model can provide the required simplification by structuring extracts of reality [20]. The structure may consist of graphical objects, mathematical symbols or natural text. The term modelling refers to the actual activity, the process of creating the model.

By combining these two comprehensions of business processes and modelling, the authors apply following definition of a business process model:

"A Business process model consists of a set of activity models and execution constraints between them. […]. Each business process model acts as a blueprint for a set of business process instances, […]. Business process models are the main artefacts for implementing business processes" [1].

B. Modelling Languages

To render a business process, several modelling languages can be used. Each modelling language comes up with assets and drawbacks. This section shall provide an abstract overview of common modelling languages available. Therefore, the languages are classified into the categories formal languages, informal languages and semiformal languages.

1. Formal languages

Formal languages consist of a set of symbols and some formation rules, by which these symbols can be combined [21]. They can be understood as an abstraction of the general characteristics of programming languages [22]. Syntax and semantics are precisely defined. The mathematical characteristics of formal languages allow the automatic verification and execution of processes [23]. Since formal languages only use a few symbols to model a process on an abstract level, they provide a low degree of freedom and are difficult to understand for traditional stakeholders. Besides, the minor number of symbols makes it cumbersome to describe complex processes [24]. An example for formal modelling languages is the notation of Petri Nets [25].

2. Informal languages

Informal languages apply natural language to model a process. That makes informal process models convenient for discussions or documentations based on e. g. PowerPoint presentations [26]. They also provide a high degree of freedom and therefore promote the creativity of the modeller. However, they do not underlie precisely defined syntax and semantics, what makes it difficult to verify or execute them automatically [27]. Furthermore informal languages often are ambiguous, as the reader is given the possibility for interpretation. Examples for informal modelling languages are PowerPoint presentations, Word documents or other textual descriptions.

3. Semiformal languages

Semiformal languages combine aspects of formal and informal languages and so build a hybrid modelling language. On the one hand they try to keep a high formality by using a precisely defined syntax and providing determined graphical modelling objects. These objects underlie explicitly stated semantics, so that a trained reader is able to understand the meaning of an object. On the other hand they grant possibilities for the modeller to enrich these objects with informal descriptions. The source code of semiformal process models therefore cannot easily be executed automatically. However, they can be helpful for understanding complex process coherencies, if the addressees comprehend the natural language [27]. Examples for semiformal modelling languages are the event-driven process chains (EPC) [28], the business process modelling notation (BPMN) or the unified modelling language (UML) [29].

Fig. 2 provides a graphical classification of the modelling languages along the dimensions degree of freedom, ambiguousness and formality.

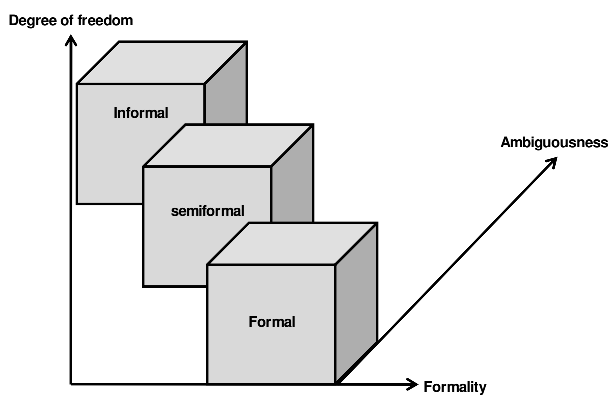

Fig. 2 Classification of modelling languages

As far as the authors know, none of the presented modelling languages seriously considers accessibility issues. Visually impaired people for example are not able to perceive graphical symbols easily. Hence, informal languages could fit the requirements of those user groups, since they concentrate on using text entries instead of graphical symbols. Also formal languages could fit the specific requirements of visually impaired people, if the utilization of graphical symbols is prevented.

Nevertheless, the most applied languages in daily business have a semiformal-nature, as their proper balance of formality and understandability is a major criterion for enterprises [30].

Therefore, this article will mainly focus on accessibility issues of semiformal languages, particularly the EPC method.

C.Event Driven Process Chains

The EPC [31, 32] has been developed in order to model business processes. It is part of the ARIS Framework. In the EPC model, a process consists of business functions, which are triggered by events. Thus, each function starts and ends with an event. The event, as the outcome of a function, triggers another function. This flow continues until the ending-event of the process is reached. Further, Boolean operators (*AND, OR, EXCLUSIVE OR*) enable the illustration of complex business decisions by the EPC [33]. The authors identified nine activities, which need to be executed to create a process model. These activities refer to operations within ARIS 7.1.

TABLE I
ARIS MODELLING ACTIVITIES

Task Nr.	Modelling activity
1	Select modeling database
2	Create new model
3	Identify graphical objects
4	Drag graphical objects onto designated area
5	Name graphical objects
6	Enrich graphical objects with meta data
7	connect graphical objects
8	format model layout
9	Save model

These activities require the user to possess specific capabilities. For example, the user has to be able to navigate to specific areas within the BPMo tool to select a database, to create a model or to drag and drop an object. Furthermore, the user has to be given the opportunity to enrich objects with metadata. In most cases these steps are only possible via computer mouse and keyboard control. However, many disabled people neither are able to use a computer mouse precisely nor are they capable of using a keyboard device. In the context of this paper, therefore we distinguish into two groups of disabled users. The first group embraces visually impaired people. This user group rather prefers keyboard operation instead of computer mouse control. The second user group covers people, who are physically impaired. This group of users is dependent on alternative devices that simulate computer mouse and keyboard functionalities, as they are not capable to use any of the traditional devices.

The authors extend the group of disabled people by systems respectively applications. In many cases systems / applications possess similar restrictive capabilities like humans do.

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Systems / applications cannot understand every format or language for example. Moreover systems' / applications' capability to gain access to or provide access by different devices is often limited.Modelling languages like the EPC method are always embedded in a specific tool, so the user can apply the language. When examine the accessibility of the EPC method, a consideration of the corresponding BPMo tool is always necessary as well. The authors applied ARIS 7.1 for further examination, since software AG belongs to one of the branch leaders, when focussing business process management [34] and the EPC method is very much related to ARIS [35]. Therefore, the next chapter concentrates on problems for people and systems / applications, when operating with the EPC method within ARIS 7.1.

III. Problems Based on the Inaccessibility of ARIS and the EPC Method

The authors identified two major categories of issues, which have to be taken into consideration when using inaccessible BPMo tools. The first category this chapter will concentrate on, are capability related issues. Afterwards the authors will concern themselves with the second category, interoperability related issues. The authors point to the fact, that the following paragraphs do not include a complete accessibility evaluation of ARIS and the EPC method. More likely they illustrate several issues, the authors identified, when experimentally using the EPC method in ARIS. Three disabled people participated at this evaluation. One by one they executed the modelling activities mentioned in Tab. 1. The identified issues, which occurred while executing the modelling tasks, will be aggregated in form of practical examples in the next paragraphs.

A. Capability Related Issues

Enterprises hire a variety of employees to run their businesses. The total of employed individuals comes up with a diversity of capabilities, which they use to accomplish different tasks and activities. It's almost not noteworthy, that the prosperity of enterprises does mainly depend on human individuals given the opportunity to apply their capabilities target-oriented. Enterprises proffer this opportunity by providing a specific configured framework, consisting of organizational, technological and human factors. BPMo has interfaces to all these categories. To use BPMo tools and modelling languages efficiently the user has to possess specific capabilities on the one hand. On the other hand, the BPMo tool has to meet particular requirements, which determine whether the tool respectively the language is usable or not. These requirements are embraced by the term "usability". To ensure a unique understanding of that term, the authors apply the definition, formulated by the International Organization for Standardization (ISO).

ISO 9241-11: "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" [36].

This definition implies that the usability of a product depends on the specification of users, who will utilize it. This again connotes, that the product does not meet requirements of users, who are not within this specification. Example one shall clarify this issue.

Example 1

Initial situation: The user specification for the EPC modelling method includes employees, who are familiar with process modelling and process terminology. The modelling division employs several process modellers. The tasks of those modellers include the recording of requirements, designing of the business process and at last modelling the business process with the EPC notation. Each modeller is responsible for a key business process. When the work on a business process is completed, one of three department chiefs evaluates the business process by checking it step by step.

Problem case: The evaluating department chief is afflicted with dyschromatopsia, so he is not able to distinguish between red and green colours. He is familiar with the EPC method and understands the syntax and semantics. Nevertheless, possible mistakes, made by the process modeller are easily overlooked, since plenty of EPC objects have a similar shape, as Fig. 3 illustrates

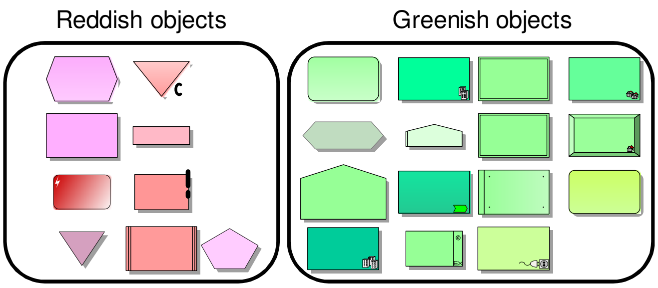


Fig. 3 Similar EPC objects

Result: There is an increased possibility, that a flawed process model is accepted by the department chief. This might lead to misunderstandings in later development phases or even might lead to the development of systems, which do not meet the defined requirements.

There are many more possible issues, that might occur when user groups are excluded, respectively are not taken into consideration. Over time personnel structures will change, even though several enterprise software applications remain. New individuals with new different capabilities will join the enterprise and certainly they will operate with existing software applications, which were once designed for specific user groups. BPMo tools most likely are applied in enterprises with complex processes, which possess a long lifespan [37]. So, the BPMo tool, as well as the included modelling languages, will be utilized by diverse users. Example two will provide an illustration.

Example 2

Initial situation: The department, responsible for process modelling, is experiencing a high churn rate. Essential knowledge carriers, as well as important process modellers left the department. The department leader advertises the vacancies. After several job interviews, only three candidates are qualified for the job.

Problem case: Two candidates are visually impaired. One of them (A) is blind. The other one (B) still has eyesight of about 30%. Both do require assistive technologies like a screen reader to utilize the EPC method. This requires that keyboard control is supported by ARIS or the EPC method. The third qualified candidate is physically impaired. He neither can use mouse devices nor can he use keyboard devices, due to his disability. He requires assistive technologies, like a speech command and recognition system to operate within the BPMo tool.

Result: ARIS does only support rudimentary keyboard control and no alternative operation mode, like speech recognition and command for example. Furthermore ARIS does not support the Microsoft active accessibility interface, which is required to grant access for e. g. a screen reader. So, the department leader needs to decide, either to employ three less qualified people without visual and physical impairments or to induce an expensive customization of the applied BPMo tool to increase accessibility. As the department really lacks knowledge carriers on the one side, but is confronted with a restricted budget on the other side, both alternatives will not be satisfying. If accessibility would have been considered earlier, this decision could have been easier.

The most important problem of semiformal modelling languages like EPC method is that the modelling process absolutely requires computer mouse control. As for the operation in ARIS, not a single process modelling activity can be completed without a computer mouse. Functionalities like drag and drop of objects, connection of objects or the enrichment of objects with Meta data are impossible to complete without computer mouse control.

This degree of inaccessibility is obviously related to the semiformal nature of the EPC method and the fact that the development of BPMo tools in the past years did not concern with accessibility aspects. By applying accessibility standards right from the beginning, these issues, as well as many more issues, could be alleviated, respectively avoided.

To emphasize the distinction between usability and accessibility a definition for accessibility formulated by ISO will be provided.

ISO 9241-171: "The usability of a product, service, environment or facility by people with the widest range of capabilities" [38].

Accessibility does not exclude specific user groups. It considers every possible user group by appointing usability to people with the widest range of capabilities.

Therefore, it is fairly obvious, that the construction of accessible systems requires a strong integration of usability and accessibility standards.

In fact, this integration already proceeded. As ISO distinguished guidance on accessibility and guidance on usability in 2003 [39], accessibility guidance was integrated into ISO usability standard "9241" by 2006. Whereas the 2003 version of guidance on accessibility concentrated more on web pages and multimedia, the integrated 2006 version focuses on software applications as well.

B.Interoperability Related Issues

BPMo is one of many more activities in enterprises that exceeds functional boundaries and requires interdisciplinary collaboration along the horizontal organizational structure [40]. This circumstance extends the capability related approach mentioned in chapter III. A. Besides diverse capabilities along the horizontal structure, BPMo is often realized by different systems and software applications. That implies, collaboration during BPMo activities requires e. g. the possibility to exchange process models among different BPMo tools or/and the possibility to inspect process models from different locations with different systems. These and more similar system abilities are aggregated to the term "interoperability".

Definition of interoperability: "The capability, prompted but not guaranteed by joint conformance with a given set of standards, that enables heterogeneous equipment, generally built by various vendors, to work together in a network environment" [41].

Examples three and four will provide an illustration to point out possible problems, when systems lack interoperability.

Example 3

Initial situation: The department, responsible for process modelling, finished its work on the enterprise process model. In one week, the process model concept has to be presented to the top management for acceptance. So this week the department concentrates on evaluating the process model, to eradicate possible errors. Unfortunately, an important employee (A), responsible for 50% of the process model, is on a business travel for the next week.

Problem case: B, responsible for the evaluation period, stumbles over several issues related to the process model, which he can't resolve. The knowledge about these process parts is possessed by A. B contacts A and asks about the issues and how they can be resolved. A could help, but he needs to see the process model. A did not take his laptop along. Since the company uses a web version of ARIS, A tries to gain access via his iPad. Ineffectual, as it turns out, because this ARIS version is not compatible to apple products.

Result: B has to evaluate the issues and eradicate the flaws on his own. He tries to resolve them on the best of his knowledge. As the department presents the process model to the top management, the flaws attract the attention of the top management. B couldn't properly resolve them. The top management refuses the current status of the process model.

Example 4

Initial situation: The process model, build by the modelling department, successfully passed the evaluation of the top management. Now the validated process model has to be transferred to the IT department for development.

Problem Case: The IT Department applies the perspectives of object orientation. Hence, they work with e.g. use cases and activity diagrams and apply the modelling tool "Innovator", which is based on the unified modelling language (UML). The process models rendered with the EPC method in ARIS therefore has to be translated to UML for "Innovator". As the readability of the ARIS Markup language is fairly poor [35], the developers are having big problems to translate the EPC process models completely and correctly to UML.

Result: The translated EPC models are of rather poor quality. Many descriptions of functions or events are missing. Some EPC objects could not be translated correctly to UML. This affects the development process dramatically, so that several milestones could not be reached in time. In the end even the project timeline was not achieved punctually, so that significant additional costs burden the project.

A major criterion of accessibility is device independence. Accessible software demands, that the software can be accessed by any device [42]. Furthermore, accessibility claims for a proper readability of content [43]. This includes the readability of mark-up languages as well.

By implementing accessible BPMo tools, problems mentioned in example 3 and 4 could be avoided. In fact, there are many more examples concerning interoperability related issues when working with inaccessible BPMo tools.
Below, the reader finds the actual ISO 9241-20 definition, pointing on the interoperability of accessible systems.

ISO 9241-20: "ISO 9241-20:2008 is intended for use by those responsible for planning, designing, developing, acquiring, and evaluating information/communication technology (ICT) equipment and services. It provides guidelines for improving the accessibility of ICT equipment and services such that they will have wider accessibility for use at work, in the home, and in mobile and public environments. It covers issues associated with the design of equipment and services for people with a wide range of sensory, physical and cognitive abilities, including those who are temporarily disabled, and the elderly" [44].

To conclude this chapter, the authors suggest not considering accessibility as a disjunctive instrument to improve labour conditions, exclusively for disabled and elderly employees. Instead accessibility should be considered as a key instrument to provide usable software and methods for every user on the one side, as well as to provide a fundament to improve interoperability among the applied systems on the other side. Accessibility should be part of every software requirement specification, to ensure the prevention of unpleasant situations as mentioned in examples 1-4.

In the next chapter the reader will find recommendations for action to improve the accessibility of BPMo tools respectively ARIS, as well as the accessibility of the EPC method. These recommendations are based on the results of the evaluation, conducted in chapter III.

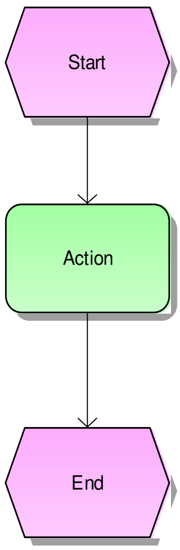
IV. Recommendations for Action

For improving the accessibility of the EPC method in ARIS several principles could be applied. Typical accessibility principles are e.g. Perceptibility, Understandability, Operability or Technical openness [45]. These principles have to be considered when proposing recommendations for action.

Investigations of the operability of ARIS revealed that the modelling process is only compliable with computer mouse controls. Keyboard navigation is nearly impossible, as only few functions of ARIS can be reached by keyboard control. Additionally, compatibility to Microsoft active accessibility interface is missing, what makes it impossible for visually impaired users to perceive the content shown within ARIS. Moreover, ARIS cannot be accessed by widespread devices. Hence, the following paragraphs will deliver functional recommendations for improving the accessibility of ARIS and facilitating the application of the EPC method for people with and without disabilities as well as for systems and applications.

A. Markup Language Modelling

A markup language (e. g. XML, HTML) defines the content of a document and provides instructions to format the document. The markup language consists only of printable characters [46]. An associated document type definition (DTD) file furthermore determines how the markup language should be interpreted by an application reading the document [47]. In context of BPMo, the markup language would define the process model (content) and instructions to format that process model. The document type definition would determine how ARIS or any other application should interpret the document. ARIS uses the ARIS markup language (AML) for defining the content and an ARIS export DTD as a proprietary XML interchange format [48]. So, the EPC is represented in a markup language that uses natural language and therefore could be perceived by visually impaired people, using a screen reader for example. Fig.4 illustrates a short EPC represented by AML.




```
<AML>
<Group Group.ID=" Group.Root ">
<ObjDef
ObjDef.ID="ObjDef.1234--0-----p--"
TypeNum="OT_EVT">
<AttrDef
AttrDef.ID="AttrDef.1235--0-----50l"
AttrDef.Type="AT_NAME">
<AttrValue> Start </AttrValue>
</AttrDef>
<CxnDef
CxnDef.ID="CxnDef.1236--0-----q--"
ToObjDef.IdRef="ObjDef.1237--0-----p--">
</CxnDef>
</ObjDef>
...
<Model
Model.ID="Model.1238--0-----u--"
Model.Type="MT_EEPC">
<ObjOcc
ObjOcc.ID=" ObjOcc.1239--0-----x--
"ObjDef.IdRef=" ObjDef.1234--0-----p--
"SymbolNum=" ST_EV " >
<Position Pos.X=" 0 " Pos.Y=" 0 " />
<Size Size.dX=" 250 " Size.dY=" 156 " />
<CxnOcc
CxnOcc.ID=" CxnOcc.1240--0-----y--
"CxnDef.IdRef=" CxnDef.1236--0-----q--
"ToObjOcc.IdRef=" ObjOcc.1241--0--x-- " >
<Position Pos.X=" 125 " Pos.Y=" 156 " />
<Position Pos.X=" 125 " Pos.Y=" 312 " />
</CxnOcc>
<AttrOcc
AttrOcc.ID=" AttrOcc.1242--0-----12-
"AttrTypeNum=" AT_NAME " />
</ObjOcc>
...
```

Fig. 4 Representation of an EPC with AML

The AML code, shown in Fig. 4, has at least two major flaws, when considering accessibility. First, AML uses cryptic element names and abbreviations, which significantly reduce the readability for the user [48]. XML guidelines propose to use telling names and no abbreviations to improve readability [49], [50]. Second, object type definitions and icons of object occurrences are stored in the TypeNum and SymbolNum attribute. For example, an EPC Event has an object type OT_EVT and a symbol type ST_EVT. But these values are not enumerated in the DTD and additionally do not have telling names. To comprehend their meanings, the developer has to analyse the AML code of process models, which can be very time consuming. For interoperability related issues these flaws only count, when the models have to be moved to other applications. The restricted readability of AML, then, is a barrier for transformation programs [48]. Nevertheless, for capability related issues this imperfection is a major problem as well, as the authors will describe later. For further information about AML see [51].

Mainly to improve the interchangeability of EPC models rendered in ARIS, Jan Mendling and Markus Nüttgens developed a XML based tool-neutral interchange markup language for EPC business process models, the *Event driven process chain markup language* (EPML) [52], [53], [54]. The EPML refers to specific design principles derived from ASC X12 reference model for XML Design [55] and Petri Net markup language [56]. Fig. 5 provides an overview of the applied EPML design principles.

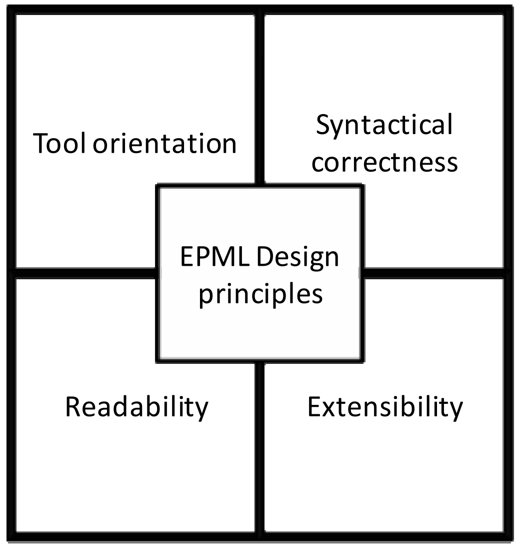
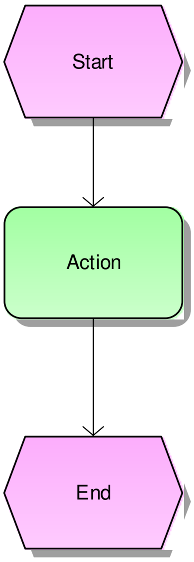


Fig. 5 EPML Design principles [54]

The principle readability demands EPML elements and attributes to have intuitive and telling names. Originally, this is an important principle, since EPML is not only used by applications but by Humans as well, who write e. g. scripts that transform between EPML and other XML vocabularies. Extensibility requires EPML to express random business perspectives instead of only supporting a pre-defined set. Tool orientation expects EPML to be able to store various layout and position information for EPC elements. Syntactical correctness reflects aspects that concern with EPC syntax elements and their interrelations.

For more detailed information about EPML principles the authors recommend the workings of Jan Mendling and Markus Nüttgens [52], [53], [54]. Fig. 6 illustrates improved readability by representing the short process, shown in Fig. 4, with EPML. Fig. 7, then, will depict the extensibility principle by adding different business views to the process.




```
<epml>
<definitions>
<definition defId="111">
<name>Start</name>
</definition>
...
</definitions>
<directory name="Group.Root">
<epc epcId="1">
<event id="1" defRef="111">
<name>Start</name>
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<position
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width="250" height="156"/>
</graphics>
</event>
<arc id="14">
<flow source="1" target="5"/>
<graphics>
<position x="125" y="156"/>
<position x="125" y="312"/>
</graphics>
</arc>
...
```
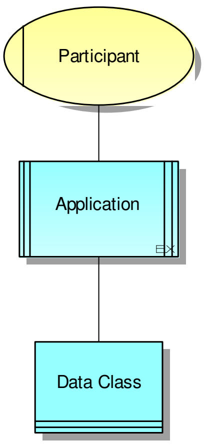

Fig. 6 Representation of an EPC with EPML [48]




```
<definition defId=“0“
type=“relationshipType“>
<name>uses</name>
</definition>
...
<epc epcId=“1“ name=“example“>
<participant id=“1“>
<name>Participant</name>
</participant>
<relation id=“12“ defRef=“0“
from=“1“ to=“2“/>
<application id=“2“>
<name>Application</name>
</application>
<relation id=“23“ defRef=“0“
from=“2“ to=“3“/>
<dataClass id=“3“>
<name>DataClass</name>
</dataClass>
```

Fig. 7 EPC Business views represented with EPML [48]

The EPML principles on the one hand do improve interchangeability of EPC business process models, so interoperability related issues mentioned in chapter III. B. could possibly be alleviated. On the other hand, EPML provides important design principles for reducing capability related issues, mentioned in chapter III. A. as well. The interchange format, provided by EPML, possesses an easy-to-read natural language. The syntax and semantics of EPML could be easily perceived by visually impaired people when using a screen reader for example. So, the visually impaired user would be able to read graphical EPC models in form of that EPML interchange format.

But not only readability can be improved by applying EPML. Furthermore, operability for disabled users could be ensured as well. By defining a process with the EPML language the process model is rendered in a formal language. Syntax and semantics of these languages are precisely defined. These mathematical characteristics enable an automatic execution of the language by programmes [23].

As an enterprise cannot afford, respectively expect all personnel to learn the operation of a modelling language like EPML, instead of using the graphical user interface of e. g. ARIS, the EPML has to be transformed onto a graphical surface again. Since EPML is based on XML, this transformation can be executed with a XML Parser. The Parser transforms the EPML code into a scalable vector graphic shape (SVG), so users that are not familiar with the EPML code are able to perceive the graphical process model [57]. In addition, SVG's do improve accessibility significantly, as these objects are scalable and can be zoomed and resized by the reader as needed [58]. By defining extra types like *X* and *Y* coordinates, as well as *height* and *length* attributes for the objects, the layout can be easily determined. Fig. 8 illustrates an exemplarily transformation of code to a graphical object.

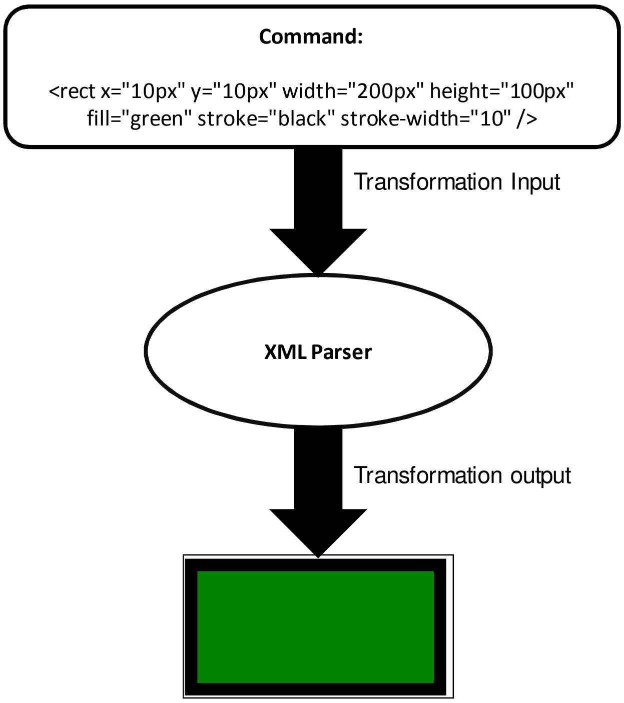


Fig. 8 Transformation of EPML code to a graphical object

So, by providing a combined operating mode, disabled people, especially visually impaired people, would be able to read a process model by its code and furthermore be capable of participating at the modelling process. The operability of healthy users would not be interfered, as the graphical surface can be used without any restrictions. Additionally, productivity could increase as interchangability improves and transformations of EPC process models from ARIS to other BPMo tools are facilitated.

B.Touch Screen Modelling

Besides code oriented modelling, as described in chapter IV. A., another promising method of control is touch screen modelling. Touch screen functionalities are provided by apple for a long time. iPhone and iPad are only the latest technologies, offering state of the art touch screen technology within their operating system. Additionally, apple implemented the screen reader *VoiceOver* in these technologies. The combination of these two technologies provides significant advantages to visually impaired people in terms of process modelling. An actual practical example is provided by the company Signavio (www.Signavio.com). As the world's first software vendor, they provide a business process modelling tool for apple's iPad. Besides touch screen control, this tool is compatible with the integrated screen reader *VoiceOver*. So, each element, triggered by the users' finger tips, will be read out loud by the system. The operation is held as simple as possible, so the visually impaired user can e. g. easily drag and drop business process objects to the designated area, simply connect process objects or enrich objects with meta data. Moreover this BPMo tool uses SVG's for rendering the business process [59]. Advantages of using SVG's were described in chapter IV. A.

By developing this touch screen modelling method Signavio revolutionized the operation of BPMo tools not only for visually impaired users, but healthy users as well. Interoperability related issues mentioned in chapter III. B. could be vanquished, as the perception and rendering of process models can now be realized with more flexibility.Recently Microsoft announced that their upcoming operating system, Windows 8, will provide touch screen functionalities innately [60]. The provided Windows 8 touch screen interface then could be applied by software developers to design business applications, which completely support that additional operating mode. In combination with Microsoft's active accessibility interface [61], which ensures compatibility between e. g. application and screen reader technology, future business software, respectively BPMo tools for the computer could provide a much higher degree of accessibility to the users.

C.Voice Recognition and Command

There are some alternative devices for physically impaired people, like *mouth sticks* or *head mounted pointers*, which simulate computer mouse functionalities. Nevertheless, the utilization of these peripheral devices is often exhausting and inconvenient for disabled people [62]. In addition, the enterprise would have to generate heterogeneous workstations with different disability-oriented peripheral devices, which would cause extra expenditures. Instead of providing various peripheral devices, software requirements could be enriched by automatic speech recognition (ASR) functionalities. Especially for physically impaired people, who cannot operate with keyboard or computer mouse devices, voice recognition and command is a superb alternative. Depending on the applied software application the concept for voice recognition and command functionalities would alter. Different applications require different voice commands. These predefined commands could be stored in a voice command repository [63]. In literature specific requirements are defined, that must be fulfilled by the system [63]. The ASR system needs to support a framework, managing the interaction between human and machine. This includes processing of in- and outputs that enables the user an individualized interaction that is most natural to him and fits the skills and physical needs of the user. Rule-based systems are able to realize this requirement. They describe the behaviour of the user in a way that the system can understand and save it. Furthermore, the user can edit and parameterize the described behaviour to fit it to his needs [63]. As the intended system behaviour depends on the current system state and the context of the user, the system needs to permit saving, reading and changing of the current context. To learn more about voice system requirements see [63]. The main disadvantage, when using ASR is that voice recognition is not 100% accurate [64]. The average accuracy rate lies between 90-98 per cent, depending on software and testing environment [65], [66], [67]. This means that out of a hundred words spoken, 2 to 10 words would not be recognized correctly by the ASR system. According to the context of use, this failure rate can be unacceptable.

To improve the voice recognition accuracy rate of ASR systems a combination of multimodal interactions between human and system could be enabled. Possible modalities are e. g. GUI –based (Graphical user interface), speech-based and gesture-based [63]. The authors illustrate the combination of these modalities with a BPMo example.

BPMoExample

Task: The user shall render a short process model in ARIS, using the EPC method. The process should consist of a start event, a function and an end event. The dots in Fig. 9-12 illustrate the user's eye focus.

Multimodal interaction approach:

Step I -"Select the event object"

Step II -"Move event object to focused modelling area"

Step III – "connect event object…

Step IV - …with function"

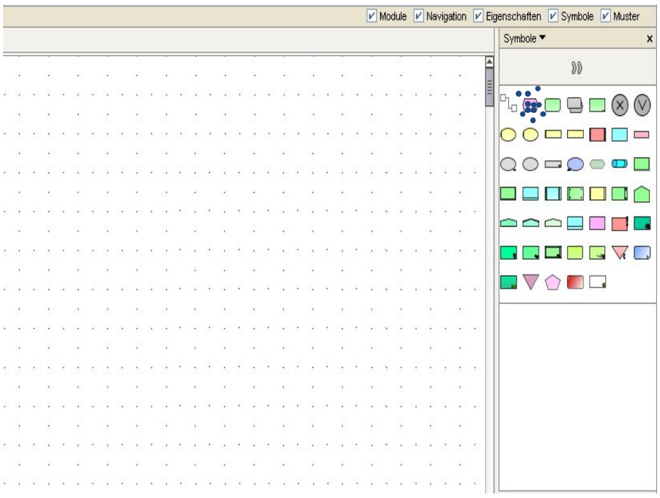


Fig. 9 BPMo with multimodal interactions step I

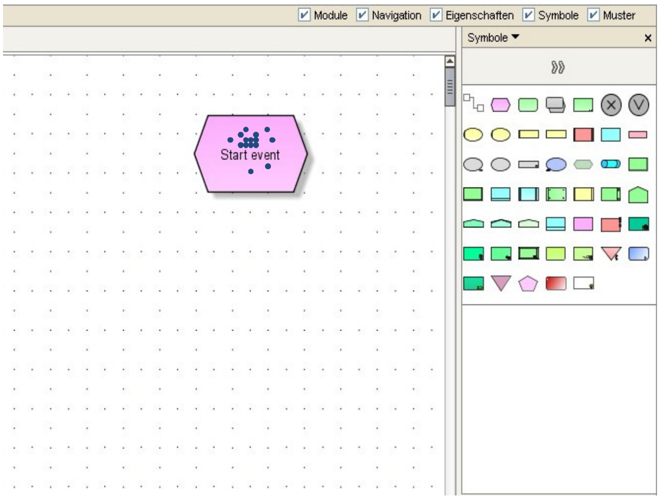


Fig. 10 BPMo with multimodal interactions step II

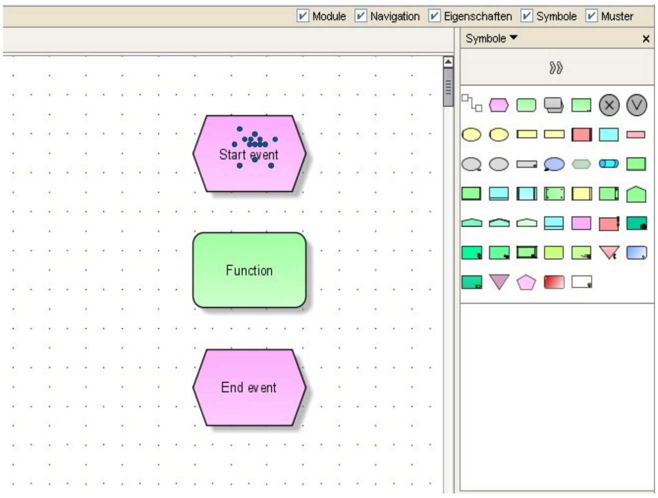


Fig. 11 BPMo with multimodal interactions step III

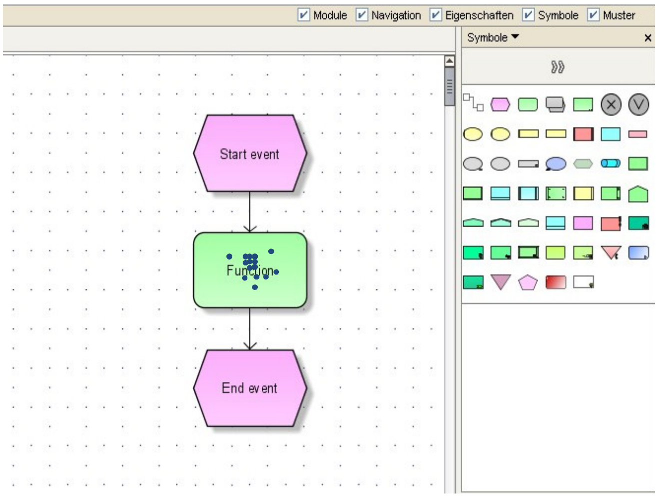


Fig. 12 BPMo with multimodal interactions step IV

The depicted process modelling example can be realized by combining an ASR system with an eye tracking system for example. The ASR system recognizes the voice command by considering the context within the command is executed and the information from the eye tracking system. Here the context is e. g. process modelling activity. As the user focuses the event object, placed on the modelling area, the system recognizes that it should not select the event object from the object box on the right, but select the eye focused object (Fig. 11). The utilization of eye tracking technologies in the context of BPMo is not new. There are experiments, which examine specific criteria for user satisfaction, when using BPMo tools with eye tracking systems [68]. The difference to the approach, mentioned in this paper is that the collected data material from eye tracking systems is not evaluated for e. g. usability studies, respectively user satisfaction studies. Instead the eye tracking data material is used as data input for the ASR system to process voice commands with a higher degree of accuracy. This raises the question whether systems' interfaces are compatible or not and how a compatibility or standardisation of the required interfaces between ASR systems, Eye tracking systems and BPMo tools can be achieved.

For physically impaired people for example this technology would dramatically improve the quality of daily business modelling tasks. Furthermore, it would be a vast value to all BPMo users, as new possible operation modes would occur, which, in one way could be healthier when considering work with software applications and in another way could positively affect productivity.

V. CONCLUSION

This article highlighted significant environmental variances, which will affect software applications used within enterprises. The inquiry then focused on BPM, particularly ARIS and the EPC method. Specific problems, which might occur when accessibility adaptations for ARIS are omitted, were illustrated by practical examples. Accessibility was accentuated as a basis for developing BPMo tools, which cover capability related issues as well as interoperability related issues. Finally three recommendations for action were proposed to improve the accessibility of BPMo tools. Firstly, the EPML was introduced as an interchange format for EPC, improving the interoperability of EPC models on the one hand, but alleviating capability related issues on the other hand as well. Secondly, touch screen modelling and its accessibility advantages were described. The first touch screen BPMo tool from Signavio was introduced to the reader. Thirdly, the authors illustrated an exemplarily application of ASR systems in the modelling process and gave multimodal interaction recommendations to improve the accuracy rate of these systems.

Future research will focus on developing a methodology for evaluating the accessibility of software applications. Furthermore, the accessibility of a wide range of BPMo tools will be evaluated with that methodology.

As ASR systems and touch screen functionalities seem to bring a great benefit to all users, future research activities will also concentrate on the elaboration of concepts to successfully integrate these functionalities into BPMo tools.

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