

# Chapter 9

## Business Process Intelligence Tools

Johannes Schobel and Manfred Reichert

**Abstract** This chapter analyzes contemporary software tools enabling Business Process Intelligence (BPI). BPI is one of the emerging trends in enterprise computing, which allows companies and organizations to maximize the value derived from their business processes. Moreover, BPI constitutes an umbrella term that summarizes different software tools, methods and best practices for real-time process analytics. The chapter presents an analysis of the features as well as the strengths and weaknesses of contemporary BPI tools along two characteristic application strategies of modern enterprises.

**Keywords** Business process intelligence · Process performance measurement · Process mining

### 9.1 Introduction

*Business process intelligence* (BPI) constitutes an umbrella term that summarizes different software tools, methods and best practices for real-time analytics, monitoring, decision support, and root-cause analysis in respect to operational business processes [4, 14].

The main goal of BPI is to either monitor individual business activities or entire business processes in order to reveal their malfunctions and inefficiencies. Based on respective analysis, new business strategies can be derived and optimized business process support can be provided for enterprises.

Currently, many BPI tools are available on the market. However, as each of these tools have different strengths and weaknesses, or provide specific unique features, it is often difficult to select the most suitable tool when introducing BPI in an enterprise.

---

J. Schobel (✉) · M. Reichert  
Institute of Databases and Information Systems, Ulm University, Ulm, Germany  
e-mail: johannes.schobel@uni-ulm.de

M. Reichert  
e-mail: manfred.reichert@uni-ulm.de

To provide a representative as well as detailed overview of contemporary BPI tools, we analyzed two strategies for their application in an enterprise. In order to achieve reproducible and valid results, we focused on a common method to evaluate these tools. Furthermore, all software tools were analyzed, tested and evaluated by BPI experts.

To be able to compare the features of the considered tools, we further set up a realistic test scenario. Moreover, a sophisticated data set from an operational SAP system was used and analyzed with the considered BPI tools in order to evaluate their features as well as their strengths and weaknesses.

### 9.1.1 *Strategies for Using a BPI Tool*

This section outlines two major strategies for using a BPI tool in an enterprise or organization. These strategies were elaborated in cooperation with BPI experts as well as consultants from the field of business intelligence. Both strategies provide typical scenarios for the use of BPI tools.

**Strategy I (One Time Usage).** In the context of a *one time usage* strategy, the BPI tool is solely used in a particular application (e.g., environment project) or for a restricted period of time. To foster such short-term usage, the BPI tool should be self-explanatory and easy to use. Moreover, it should offer simple data integration mechanisms. Usually, the analytical capabilities provided by a BPI tool of this category are not very powerful. Moreover, a quick overview on a specific business process or a set of activities is considered as most important. Thus, the goal is not to provide in-depth analysis.

**Strategy II (Long Term Usage).** The second strategy we consider is the *long term usage* of a BPI tool. Regarding this strategy, the BPI tool should be connected with all relevant information systems of the respective enterprise architecture. Usually, a multitude of predefined connectors to software systems, providing information on operational business processes, is available. The long term usage of a BPI tool enables profound insights into operational business processes, which fosters decision making and process optimization [11].

### 9.1.2 *Dimensions for Evaluating BPI Tools*

To evaluate contemporary BPI tools against the two strategies (cf. Sect. 9.1.1) we divided these scenarios into five different dimensions based on attributes applied in software selection schemes. However, certain dimensions are more important for certain strategies than others. As example consider dimension *Visualization*. On one hand, when applying a BPI tool solely to a single project, the visualization of

discovered results is less important. On the other, when using BPI tools in the long term, the use of a variety of techniques enabling visual analytics allows for insights into existing business processes and their data.

The remainder of this chapter is structured as follows: Sect. 9.2 describes the methodology for analyzing BPI tools, whereas Sect. 9.3 presents a case study we conducted to evaluate these tools. In Sect. 9.4, assessment criteria and relevant attributes are described. Section 9.5 provides information about the BPI tools we evaluated. Section 9.6 presents detailed results. The chapter concludes with a discussion and summary in Sect. 9.7.

## 9.2 Methodology

In the context of the BPI tool study, we apply the *Analytic Hierarchy Process* (AHP) [15]. AHP constitutes a systematic procedure for representing the elements of a problem. In particular, it breaks the latter down into smaller components, and compares the latter pairwise to develop priorities at each level. Though AHP is unable to find the *correct* decision, it helps with identifying that one, which suits best to the problem at hand.

In general, AHP serves several purposes. On one hand, it allows finding a proper solution for a given problem, minimizing the time required for this. On the other, it provides comprehensible and reproducible results for decision making. Moreover, AHP fosters the discovery of inconsistencies as well as the comprehension of the problem.

The AHP process can be structured into several steps, which are easier to comprehend and deal with (compared to the overall process). Figure 9.1 visualizes these steps.

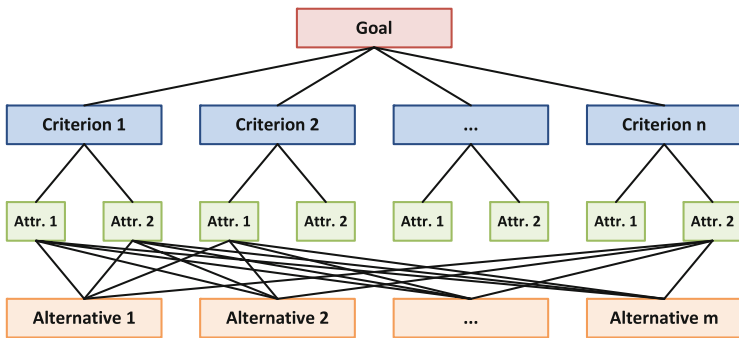


Fig. 9.1 AHP phase model

**Table 9.1** AHP values for rating and comparing the attributes and dimensions

Value	Meaning	Description
1	Equal importance	Two activities equally contribute to the given objective
3	One alternative has a slightly higher importance	Experience and judgment slightly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Demonstrated importance	An activity is strongly favored and its dominance is practiced
9	Absolute importance	The evidence favoring one activity over another is the highest possible order of confirmation
2, 4, 6, 8	Intermediate values	Compromise (when needed)

### 1. First Step:

- Define the problem and the knowledge needed.
- Gather required data and criteria.
- Structure the hierarchy from the top level (i.e., broad perspective on the problem) through intermediate levels (i.e., criteria) to the bottom level (i.e., alternatives).

### 2. Second Step:

- Construct comparison matrices for each pair of criteria. Thereby, a particular criterion might dominate others. Furthermore, express these weightings as integers (cf. Table 9.1). This step is accomplished for all levels of the hierarchy.

### 3. Third Step:

- Weight all criteria based on a mathematical model.

## 9.3 A Practical Case

As a benchmark for evaluating the BPI tools, a *purchase-to-pay* process, which had been extracted from a SAP system, was used. More precisely, the considered data set consisted of 519,633 events, 26,807 cases, 15 activities, 6,769 process variants, 344 resources, and 34 attributes. The data set was collected in the period from August 2011 to October 2011 (3 months). In order to enable a better understanding of the data and the respective business process, first of all, we present the process (cf. Fig. 9.2).

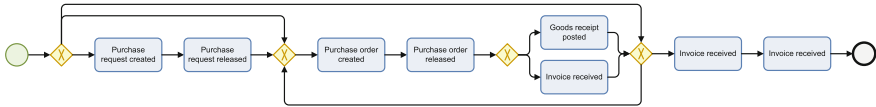


Fig. 9.2 The purchase-to-pay process (BPMN 2.0 notation)

### 9.3.1 Purchase-To-Pay Process

The purchase-to-pay process is one of the service processes of an enterprise’s business. It describes the sequence of events and activities that starts with a demand for goods or services and ends with the payment. Most activities of this process can be characterized as transactional. Per definition, transactional activities are labour-intensive, but can be simply performed. However, as the purchase-to-pay process does not add any value to products or services of the enterprise, generally, it is considered as a cost driver.

The purchase-to-pay process looks simple at first glance: Starting with a demand for goods or services, a purchase request is created. Often, requests for quotations are then sent to potential vendors whose responses are rated against each other. The final purchase order contains information about the vendor for which the good or service is ordered, the quantity of items to be bought, and the related prices. Goods are delivered and related stock and inventory accounts are updated by receipt postings for the corresponding goods. Once services have been performed, a service acceptance is recorded through a separate workflow. In practice, however, there exist numerous deviations from this standard process, which move it from being simple and straightforward to become difficult and complex: Down payments might be involved, ordered goods be sent in more than one delivery, or goods be returned. Furthermore, purchase orders might not be created or be identifiable on the invoice. Moreover, invoiced prices might not match the prices of the purchase order, deficient goods receipts be recorded or invoices not be matched automatically (e.g., when they arrive prior to the goods).

### 9.3.2 Leveraging the Strengths of BPI Tools

Process complexity and the large amount of available information in existing information systems leverage the strengths of BPI tools [5]. Traditionally, purchase-to-pay analyses are difficult to perform for several reasons. First, three separate business departments with “silo thinking” are involved: purchase, logistics, and accounting. Second, the “to-be process” descriptions in enterprises do not precisely fit reality or “as-is process” descriptions are opaque. Finally, interviewees rarely have end-to-end information or provide only the minimum required information. Usually, process owners have a good understanding about tasks performed incorrectly as well as

potential improvements. However, they lack accurate information to support their opinion. Thus, companies never gain transparency and full insights into the actual end-to-end process. Techniques provided by BPI tools, in turn, support decision-makers in gaining further insights into business processes and related operational data. For example, BPI tools allow users to drill down the “as-is process” and to visually identify deficiencies together with their root causes. In turn, this enables process owners as well as process experts to derive suitable counter measures. However, literature on practical applications of BPI techniques in the large scale is still scarce nowadays. Furthermore, there exist specific BPI tools on the market providing specific advantages and disadvantages.

We conducted an extensive analysis of available BPI tools. The main purpose of this tool analysis was to demonstrate the applicability of the provided techniques to real business needs as well as to determine the systems suited best for achieving process optimizations [22].

## 9.4 Assessment Criteria and Strategies

This section presents the assessment criteria we used to rate the considered BPI tools. Furthermore, strategies for using the latter are described.

### 9.4.1 Strategies

The study examines two different strategies for using a BPI tool. These strategies are *One Time Usage* of a BPI tool on one hand and its *Long Term Usage* on the other.

**One Time Usage** means that the tool is solely used for a particular project or a limited duration of time. Hence, a tool only requires simple connectors (e.g., CSV or Microsoft Excel) as well as fast and easy-to-use data integration facilities, as users will not be specifically trained to be able to use these tools. Regarding the one time usage of a BPI tool, providing a quick overview over the process or the data is therefore considered as most important.

**Long Term Usage** means that the BPI tool is intended to be used over a longer period of time. Therefore, it should be connected to all relevant information systems, which requires a variety of connectors (e.g., ERP connectors, database connectors, CSV or Microsoft Excel files). Through the integration of heterogeneous applications with the BPI tool, deeper insights into enterprise process data become possible (e.g., based on cross-process analyses) [9]. If a BPI tool is used for a longer period and a multitude of information systems need to be connected, higher installation, configuration and data integration efforts are acceptable.

### 9.4.2 Dimensions

The study considered five BPI tool dimensions: *system*, *data integration & extraction*, *data processing & analysis*, *mining*, and *data visualization*. The dimensions were elaborated in close consultation with domain experts to allow for a fine-grained classification. As AHP is used for evaluation purposes, every attribute has a specific weight within its corresponding dimension. Furthermore, each dimension is weighted depending on the strategy applied.

**System** This dimension describes how the tool behaves and how it can be handled. Attributes of this dimension include, for example, extensibility, usability and performance.

**Data Integration & Extraction** expresses how data can be extracted from enterprise information systems, providing data on the operational business processes (e.g., ERP systems, workflow management systems) [12, 22].

**Data Processing & Analysis** describes possibilities for analyzing the gathered data in the BPI tool. Common methods include Key Performance Indicators (KPIs) and Bottleneck Analysis.

**Mining** deals with extracting knowledge from a given data set (e.g., a database of event log) and transforming it into understandable structures such as process graphs or organization models [8].

**Data Visualization** examines the different ways of representing the results from data analyses or mining algorithms.

### 9.4.3 Attributes

Table 9.2 provides selected lists of attributes for the described dimensions. For a table comprising all attributes we refer to Appendix A.

## 9.5 Business Process Intelligence Tools

This chapter provides information about the BPI tools we assessed. We assigned the tools to different categories according to their origin. Examples of these categories include Business Intelligence and Business Process Management suites. All tools were rated in the same way and tested against the introduced strategies (cf. Sect. 9.1) based on the described data set (cf. Sect. 9.3).

**Table 9.2** Selected list of assessment attributes

Dimension	Attribute	Description
System	Extensibility	Is it possible to extend the tool (e.g., based on available plug-ins or a provided application programming interface (API))?
	User and Rights Management	Refers to the ability to manage users as well as to define their permissions for importing, analyzing and visualizing data with the BPI tool
Data Integration & Extraction	Connector Handling	Refers to the intuitiveness of the connectors: are wizards provided guiding users through the process of data integration?
	Real-Time Measurement	Refers to the ability to integrate data in real-time based on push mechanisms
Data Processing & Analysis	Key Performance Indicators	Refers to the ability to define Key Performance Indicators (KPIs) with a formula editor. How powerful is this editor?
	Bottleneck Analysis	Is there a way to automatically identify bottlenecks in a business process?
Mining	Process Discovery	Refers to the ability to extract the as-is process from a given data set
	Conformance Checking	Compare the as-is process with the model of the to-be process and check for outliers and deviations
Data Visualization	Process Graph	Display results provided by process mining algorithms in a graph-like representation (e.g., in terms of a process model)
	Reports	Create a user-defined report and use it as a template in another project

### 9.5.1 Tool Shortlist

At the beginning of the tool study, relevant software vendors as well as their BPI tools were determined. The resulting longlist provided the basis for the following tool analysis and evaluation. To set a focus as well as to enable a hands-on assessment



**Table 9.3** Shortlist of the evaluated BPI tools

Software vendor	System	Origin
Software AG	ARIS MashZone [16]	Business Process Intelligence
Software AG	ARIS PPM [17]	Business Process Performance Manager
Celonis GmbH	Celonis discovery [2]	Business Process Intelligence
Fluxicon	Disco & ProM [3]	Business Process Mining
Microsoft	Business intelligence [10]	Business Intelligence
QlikTech	QlikView [13]	Business Intelligence
TIBCO Software Inc.	TIBCO Spotfire [19]	Business Intelligence

of selected tools, the longlist was reduced to a shortlist that finally comprised seven BPI tools (cf. Table 9.3).

### 9.5.2 Tool Categories

**Traditional Business Intelligence (BI) Tools** BI [1] defines procedures and methods for the systematic analysis (i.e., collection, evaluation and visualization) of business data. The overall aim is to gain information that facilitates strategic as well as operational decisions taking defined business goals into account. Usually, this is accomplished based on historic data.

**Process Mining Tools** Process mining tools [7, 20] focus on the analysis of executed business processes. This is accomplished by analyzing event logs recorded by the information systems. The aim is to extract relevant knowledge from these logs; e.g., in order to optimize business processes. Process mining tools allow discovering process models verifying that given process model complies with imposed rules (i.e., constraints).

**Business Process Intelligence Tools** BPI tools focus on the real-time analysis of operational business processes. Compared to traditional BI tools, BPI tools are more focused on the analysis of operational business processes. Moreover, BPI tools not only provide simple KPIs, as common BI tools, but also detailed information about control flow, (social) interactions between the actors involved in the process, related documents (e.g., invoice documents), and relevant attributes (e.g., overall duration of the business process or effective working time regarding specific activities [6]).

**Table 9.4** ARIS MashZone

Value	Description
+	Easy creation of business dashboards
+	Direct connection to ARIS Process Performance Manager
+	Application runs within a web browser
+	Convenient combination of data feeds with special editor
–	No process mining support
–	Missing support of more advanced process analyses
–	Limited support for defining KPIs
*	Intuitive approach for linking data and calculating KPIs
*	Easy data integration via drag & drop techniques
*	Easy data manipulation and transformation with wizards and editors

### 9.5.3 Fact Sheets for the Evaluated BPI Tools

This section presents key facts for each BPI tool we evaluated. The corresponding fact sheet includes a short description of the tool as well as the pros (marked with +) and cons (marked with –) discovered during its evaluation. Furthermore, specific features (marked with \*) are elaborated. Note that the latter could not be compared with the other tools as they are unique for the respective tools.

**ARIS MashZone** ARIS MashZone is a free BI tool provided by Software AG [16]. It enables users to create and manage business dashboards. Since ARIS MashZone can run in a web browser, it may be accessed from anywhere. Table 9.4 summarizes the pros and cons of this tool as well as its unique properties.

**ARIS Process Performance Manager** ARIS Process Performance Manager is a BPI tool provided by Software AG [17]. It allows calculating Key Performance Indicators (KPIs) as well as visualizing the business processes of an enterprise. In particular, it enables comprehensive process analysis supports of different kind. Table 9.5 summarizes the pros and cons of this tool as well as its unique properties.

**Celonis Discovery** Celonis Discovery is a BPI tool developed by Celonis GmbH [2]. It focuses on the extraction of process knowledge from ERP systems (e.g., SAP) as well as on process optimization. Furthermore, Celonis Discovery may be used for obtaining a quick overview on the KPIs of the discovered processes. Since Celonis Discovery is able to run in a web browser, it may be accessed from anywhere. Table 9.6 summarizes the pros and cons of this tool as well as its unique properties.

**Table 9.5** ARIS process performance manager

Value	Description
+	Visualizes process as graphs (i.e., EPCs)
+	Allows for the direct import of data from SAP systems
+	Provides an intuitive user interface for creating and managing dashboards
-	Very complex data integration
-	High configuration and customization efforts, resulting in an awkward handling of the Customization Tool Kit (CTK)
-	Cumbersome definition of performance indicators (KPIs)
*	Direct connection to SAP systems
*	Ability to mine processes across different systems

**Table 9.6** Celonis discovery

Value	Description
+	Allows for an easy Microsoft Office integration to foster evaluation and analysis
+	Complete web application; i.e., runs in a web browser
+	Calculates KPIs for activities in a process model
-	Limited data import support (relies on third-party application)
-	Insufficient and cumbersome user management
-	Cumbersome editor for defining KPIs
*	Office integration for Microsoft Excel
*	Proprietary mining algorithms
*	KPIs for activities and state transitions

**Disco & ProM** Disco and ProM constitute process mining tools [21]. ProM constitutes an open source system released by TU Eindhoven, whereas Disco is a commercial tool developed by Fluxicon [3]. Disco focuses on data integration, data transformation, and data analysis based on process discovery techniques, whereas ProM provides a larger variety of algorithms that allow for detailed process analyses based on event logs. Table 9.7 summarizes the pros and cons of these tools as well as their unique properties.

**Table 9.7** Disco/ProM

Value	Description
+	ProM comprises a multitude of mining algorithms
+	Very intuitive handling of Disco
+	Scientific environment and connections to research institutes
+	Provides a very quick overview of business processes
-	Time consuming integration of data in ProM
-	Disco provides an easy-to-use data transformation interface
*	Animation of business process execution
*	Displaying variants of business processes, highlighting their differences

**Table 9.8** Microsoft business intelligence

Value	Description
+	Good performance when analyzing large amounts of data
+	Variety of formulas for representing KPIs
+	Distribution of KPIs and dashboards using Microsoft SharePoint Server
+	Comes free with Microsoft SQL Server
-	Very complex data integration
-	Missing process analysis features
*	Tight integration with Microsoft SharePoint Server and Microsoft Office
*	Integrated script editor (Plug-In for Microsoft Visual Studio) for managing the data cubes
*	Predefined data mining algorithms enabling sophisticated data analyses

**Microsoft Business Intelligence** Microsoft Business Intelligence is shipped free with the Microsoft SQL Server [10]. It enables the setup of data cubes and allows for a tight integration with Microsoft SharePoint Server. In turn, the latter enables users to distribute and visualize KPIs in an enterprise portal. Table 9.8 summarizes the pros and cons of this tool as well as its unique properties.

**Table 9.9** QlikView

Value	Description
+	Fast and intuitive creation of business dashboards
+	Integrated script editor that allows extending the predefined functionality
+	Analyzing and visualizing data on mobile devices
+	Creating reports using drag & drop and publishing them on different channels
–	No process mining techniques available
–	No support for analyzing business processes
*	Support of using smart mobile devices for analyzing business data
*	Publication of business dashboards on web platforms (e.g., web page, portal)
*	Comes with a built-in programming language to enhance the system with user-defined functions

**Table 9.10** TIBCO spotfire

Value	Description
+	User-friendly user interface
+	Easy-to-use data import function based on copy & paste
+	Intuitive creation of business dashboards
–	No process mining techniques available
–	No support for business process analyses
*	Commercial add-ons available to extend standard functionality
*	Integration of smart mobile devices for analyzing business data

**QlikView** QlikView is a BI tool distributed by QlikTech [13]. It allows for the easy creation of sophisticated business dashboards based on a powerful drag & drop editor. In addition, common data interfaces are supported to foster ease of use. Table 9.9 summarizes the pros and cons of this tool as well as its unique properties.

**TIBCO Spotfire** TIBCO Spotfire is a BI tool distributed by TIBCO Software [19]. Like QlikView, TIBCO Spotfire allows creating business dashboards quickly based on drag & drop techniques. Overall, TIBCO Spotfire allows for quick overviews on business data. Table 9.10 summarizes the pros and cons of this tool as well as its unique properties.

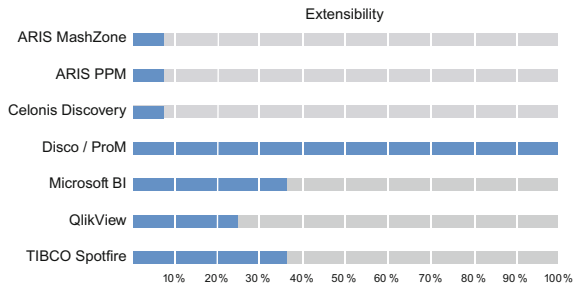
## 9.6 Applying the Tools to the Case

The bar charts presented in this section give insights into the experiences gathered when applying the process intelligence tools to the described sample process. The evaluation was carried out by experts from the areas of business (process) intelligence and process mining respectively. The data set (cf. Sect. 9.3) was imported by the respective tools and used to analyze process instances. Results were then normalized based on the given maximum values. In certain cases, the systems were not rated as 100% as the experts agreed that respective attributes could still be improved.

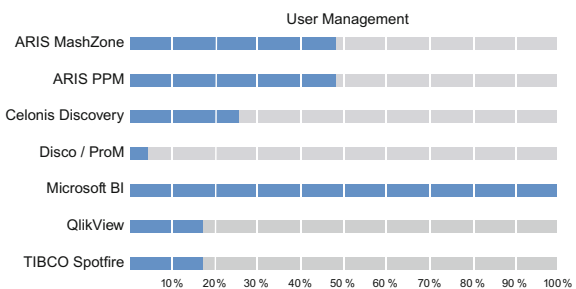
### 9.6.1 System

This section presents evaluation results regarding the *system* dimension (cf. Table 9.2); i.e., tool behaviour and tool handling. Figure 9.3 assesses the extensibility of the tools, whereas Fig. 9.4 evaluates the user & rights management in the respective tools. For example, Disco/ProM is rated by far best regarding extensibility, whereas Microsoft BI is rated best in respect to user & rights management.

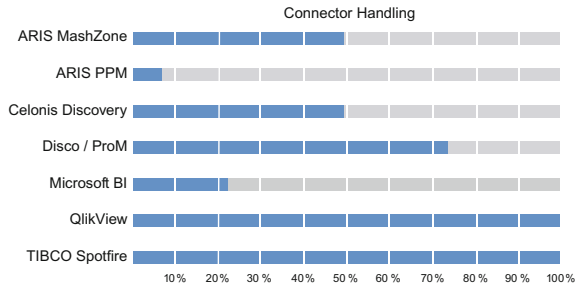
**Fig. 9.3** Results for attribute *extensibility*



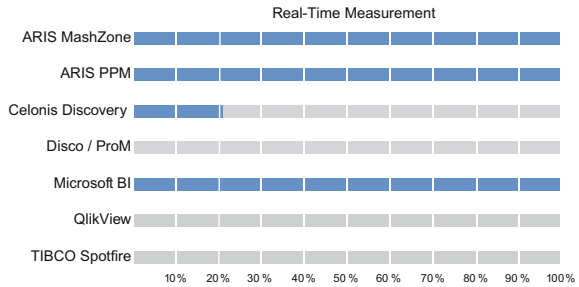
**Fig. 9.4** Results for attribute *user and rights management*



**Fig. 9.5** Results for attribute *connector handling*



**Fig. 9.6** Results for attribute *real time measurement*



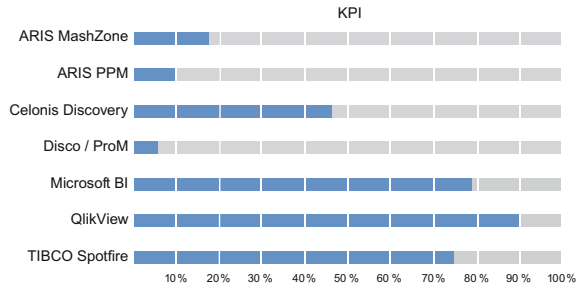
### 9.6.2 Data Integration & Extraction

This section presents evaluation results regarding the *data integration & extraction* dimension (cf. Table 9.2); i.e., the capabilities to import data from different sources (i.e., systems). Figure 9.5 shows the results in respect to connector handling, whereas Fig. 9.6 reveals the results for analyzing data in real time. As can be seen, QlikView and TIBCO Spotfire show the best results regarding the handling of data connectors as they provide an easy to use approach for integrating required data. In turn, the ARIS tools and Microsoft BI enable the monitoring of the respective data in real-time.

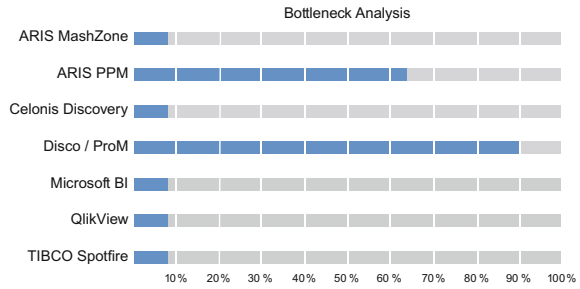
### 9.6.3 Data Processing & Analysis

This section presents evaluation results regarding the *data processing & analysis* dimension (cf. Table 9.2); i.e., the capabilities to process the extracted data within the BPI tool. Figure 9.7 presents the capabilities of defining and evaluating KPIs, whereas Fig. 9.8 presents bottleneck analysis capabilities for the analyzed tools. While Microsoft BI, Qlikview and TIBCO Spotfire are on a par, Disco & ProM is far behind. However, Disco & ProM is the only tool that provided sufficient capabilities for bottleneck analysis.

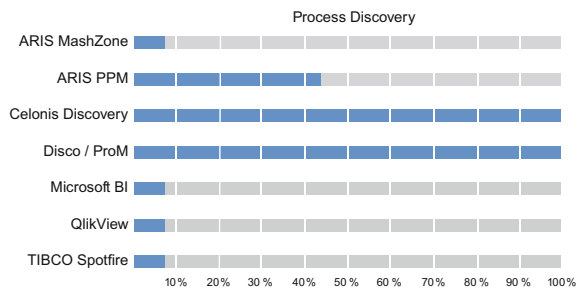
**Fig. 9.7** Results for attribute *KPI*



**Fig. 9.8** Results for attribute *bottleneck analysis*



**Fig. 9.9** Results for attribute *process discovery*

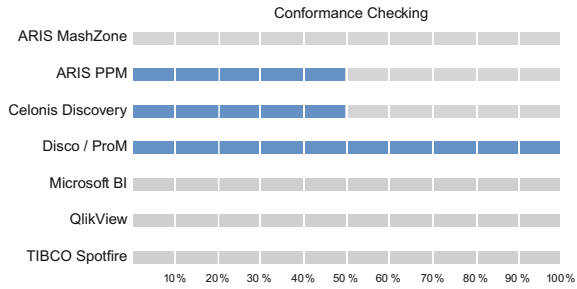


### 9.6.4 Mining

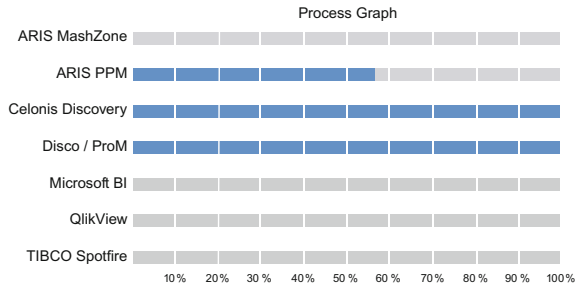
This section presents results for the *mining* dimension (cf. Table 9.2); i.e., the support of process discovery (cf. Fig. 9.9) and conformance checking (cf. Fig. 9.10). The tools originating from process mining tools (i.e., Disco, ProM, and Celonis Discovery) showed the best performance. Note, that several tools did not offer conformance checking features.



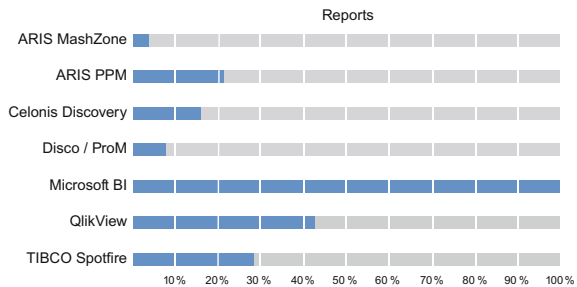
**Fig. 9.10** Results for attribute *conformance checking*



**Fig. 9.11** Results for attribute *process graph*



**Fig. 9.12** Results for attribute *reports*



### 9.6.5 Data Visualization

This section provides results for dimension *data visualization* (cf. Table 9.2); i.e., the capabilities to present the processed data extracted from different sources. Figure 9.11 shows the features to represent mined processes as graphical process models (in common notations like BPMN 2.0 or EPCs). Furthermore, Fig. 9.12 presents the results we obtained when creating custom reports for the extracted and processed data. Obviously, the tools performing best in respect to attribute *process discovery* also perform best in respect to attribute *process graph* within this dimension. Microsoft BI is the most powerful tool regarding the creation of reports due to its tight integration with SharePoint and Office.

## 9.7 Discussion

Based on the results of the evaluation presented in Sect. 9.6, the following recommendations can be made regarding the use of business (process) intelligence systems. In particular, these recommendations will foster system selection depending on the given application environment and strategy respectively.

### 9.7.1 One Time Usage

As demonstrated in the graph below, it is not possible to nominate a clear winner as none of the evaluated tools performs best in all dimensions. However, certain dimensions should be considered as more important than others. Figure 9.13 provides an overall rating regarding the One Time Usage of BPI tools.

**System** In general, dimension *system* is not as important as others regarding the One Time Usage strategy. The only attribute relevant in this context is usability. Regarding the latter, Disco & ProM, QlikView, and TIBCO Spotfire obtain the best evaluation results.

**Data Integration & Extraction** This dimension is crucial for any One Time Usage strategy. Note that an easy and fast data integration is indispensable when analyzing business processes and their underlying data. For a simple BI use case, ARIS MashZone and QlikView are the most suitable tools since they allow for a quick and intuitive data integration. If a more powerful BPI tool is needed, the combined use of Disco & ProM might be the right choice. In particular, both tools offers a variety

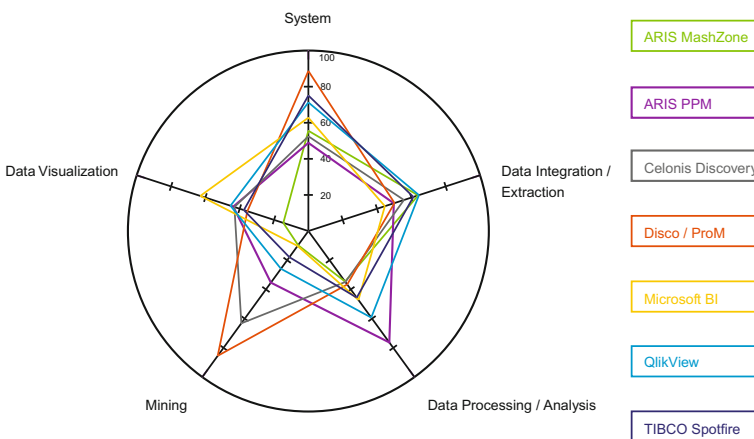


Fig. 9.13 One time usage—overall rating

of techniques for process analysis as well as for an intuitive and user-friendly data integration.

**Data Processing & Analysis** For a project-based strategy, data processing and data analysis are less important. Note that SixSigma Formulas [18] or user-defined KPIs are not always required to gain a broad overview on business processes. No tool clearly stands out in this dimension, i.e., all evaluated tools obtained middle-range scores.

**Mining** has a high priority as the purpose of the One Time Usage strategy is to gain a rough overview of the business processes. Furthermore, visualizing the business process reveals additional insights into the process itself. This dimension includes attributes like process discovery, conformance checking, and process visualization. The combination of Disco and ProM can be considered as winner since it provides a wide range of mining algorithms.

**Data Visualization** It is crucial to be able to visualize business data in an intuitive and quick way when applying the One Time Usage strategy. In general, however, it is not necessarily required to provide a wide range of visualization features (e.g., several different diagram types). TIBCO Spotfire and QlikView are comprehensively convincing providing powerful visualization possibilities and easy-to-use diagrams.

One Time Usage Recommendation

Altogether, it becomes necessary to distinguish the strategy depending on how the tool is going to be used. If a BPI tool is needed, the combination of Disco & ProM is recommended in the context of the One Time Usage strategy. If a BI tool is required, QlikView or TIBCO Spotfire allow for a fast and quick overview on the data gathered.

### 9.7.2 Long Term Usage

Like for the One Time Usage strategy, it is not possible to define a clear winner for the Long Term Usage strategy. None of the evaluated tools clearly wins or loses the evaluation. Nevertheless, regarding the Long Term Usage strategy, we identified some differences regarding the importance of the evaluated dimensions. Figure 9.14 shows the overall rating for the Long Term Usage of BPI tools.

**System** In general, this dimension is not as important for Long Term Usage as the others. The only attribute, which may be considered as important, refers to the usability of the tool. Regarding this attribute, Disco & ProM, QlikView, and TIBCO Spotfire perform best.

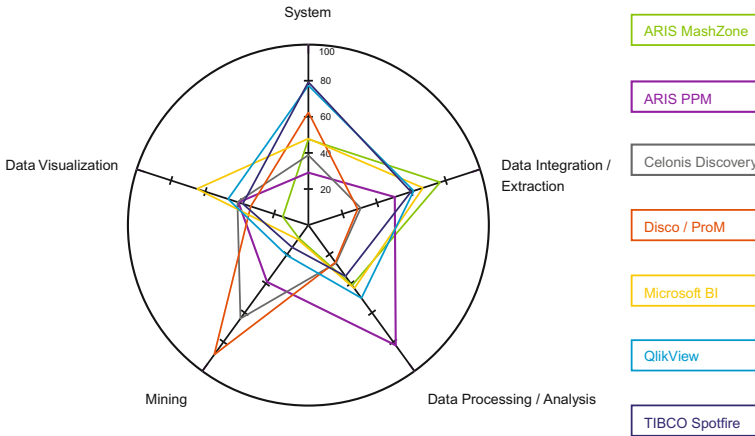


Fig. 9.14 Long term usage—overall rating

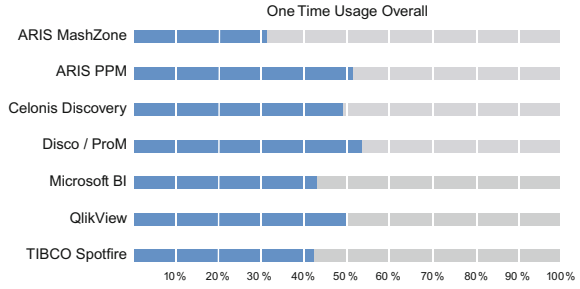
**Data Integration & Extraction** This dimension is rated lower for the Long Term Usage strategy since a more complex data integration pays off for it. Attributes like real-time measurement and providing predefined connectors are more important compared to any One Time Usage strategy. Overall, ARIS PPM and Microsoft BI achieved the highest rating since both allow retrieving data from several systems in real time.

**Data Processing & Analysis** is more important for Long Term Usage than for One Time Usage of the tool. Attributes such as benchmarking or defining KPIs are required for enabling an in-depth analysis of the data set. If a BPI tool with a variety of data processing algorithms is needed, ARIS PPM can be used. However, its usability is not as intuitive as the one of other tools evaluated. Instead, Celonis Discovery can be considered as a better and more user-friendly choice if fewer possibilities to analyze enterprise data are sufficient.

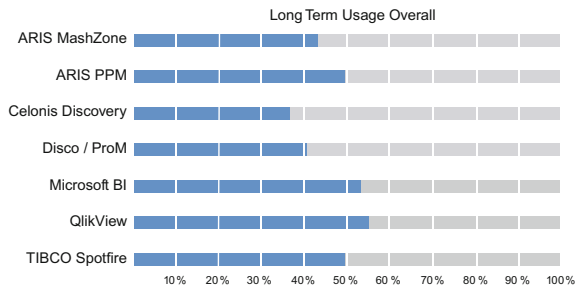
**Mining** constitutes an important dimension in the context of the Long Term Usage strategy. It includes attributes like process discovery or conformance checking. The combination of Disco and ProM performs best in this dimension due to the variety of mining algorithms provided and process modeling notations supported.

**Data Visualization** It is useful to visualize data in different ways for a Long Term Usage of the BPI tool (e.g., dashboards or reports). Microsoft BI allows to publish results via Microsoft SharePoint Server, which constitutes an advantage compared to all other tools we evaluated.

**Fig. 9.15** Overall results for one time usage



**Fig. 9.16** Overall results for long term usage



**Long Term Usage Recommendation**

If an intense initial setup and configuration phase is acceptable, ARIS PPM offers a variety of different features for analyzing and processing data. If this does not apply, Celonis Discovery or the combined use of Disco and ProM are alternatives. Microsoft Business Intelligence is recommended for the Long Term Usage of a BI tool due to its tight integration with Microsoft SharePoint Server, which allows realizing a company portal enriched with business dashboards.

The overall results, both for the One Time and Long Term Usage of BPI tools are provided in Figs. 9.15 and 9.16.

### A Assessment Attributes

See Table 9.11.

**Table 9.11** Complete list of all assessment attributes

	Attribute	Description	
System	Extensibility	Is it possible to extend the system (e.g., based on plug-ins or an API)? Is the system open source?	
	Usability	Refers to the ease of use and intuitiveness of the system. This includes learnability, efficiency, memorability and satisfaction	
	Performance	Refers to the system's ability to handle small (< 1 million instances), medium, or large (> 10 million instances) data sets in reasonable time	
Data Integration & Extraction	User & Rights Management	Refers to the possibility to manage users as well as to set up their rights and permissions to import, analyze and visualize data within the system	
	Connector Handling	Refers to the intuitiveness of handling connectors. Are wizards available guiding the user through the process of data integration?	
	Connectors	Which connectors are available (e.g., connectors for SAP, CSV, XLS, or DBMS)?	
	Upload Interface	How easy is it to import external data (e.g., field assistant, wizards)?	
	Real-Time Measurement	Refers to the ability to integrate data in real-time base on push mechanisms	
	One Time Active Extraction	Refers to the ability to integrate data once based on pull mechanisms. Is the system able to import data from a given source?	
	Continuous Active Extraction	Refers to the ability to integrate data based on continuous pull mechanism from a source	
	Process Template	Are there predefined data integration templates for common source systems (e.g., SAP)?	
	Customized Templates	Is it possible to create user-defined templates for data integration and to reuse them in other projects?	
	Benchmarking	Compare "as-is" and "to-be" states. How many processes can be compared at once?	
Data Processing & Analysis	KPI	Refers to the ability to define KPIs with a specific formula editor. How powerful is this editor?	
	SixSigma Formulas	Are predefined SixSigma formulas available and ready-to-use?	
	Ad-Hoc Analysis	Does the system support ad-hoc analyses (e.g., filter attributes)?	
	Bottleneck Analysis	Is there a way to automatically identify bottlenecks for a given business process?	
	Alerting & Compliance Monitoring	Is there a way to define business rules and to assign alerts when these rules are violated?	
	Extraction & Export	Refers to the ability to export data in different formats for their further processing within third party systems (e.g., Microsoft Excel, Visio, PDF)	
	Saving of Analysis	Is it possible to save ad-hoc analysis, conserve the status of a dashboard or a chart, and bookmark frequently used queries?	

(continued)

**Table 9.11** (continued)

	Attribute	Description
Mining	Data Mining	Does the system allow for the use of data mining algorithms (e.g., k-means algorithm)?
	Social Mining	Refers to the mining of communication and organizational structures within a process (e.g., handover of work, social network analysis)
	Process Discovery	Refers to the ability to extract the “as-is” process from a given event log
	Process Visualization	Refers to the visualization of business processes using a process modelling language (e.g., EPC or BPMN)
	Filter Possibilities	Refers to the ability to filter data on important attributes (e.g., location, fiscal year) using drill-down and roll-up features
	Conformance Checking	Compare the “as-is process” with the “to-be process” and check for outliers and violations
	Variant Mining	Determine different variants of a business process. How relevant is a particular process variant compared to others?
Data Visualization	Table	Display analysis results as table
	Balanced Scorecards	Display analysis results as a balanced scorecard
	Process Graph	Display results provided by process mining algorithms as graph (e.g., process model)
	Dashboards	Combine different visualizations in a dashboard (e.g., table, diagrams and graphs)
	Reports	Create a user-defined report and reuse it as template
	Publication	Distribute and publish the data on different channels (e.g., website, PowerPoint presentation)
	Customization	Customize the visualization of analyses results to comply with the corporate design of the company
	Interactive Filtering/Drill-Down	Filter diagrams or other visualization elements interactively

## References

1. Anandarajan, M., Anandarajan, A., Srinivasan, C.A.: Business intelligence techniques: a perspective from accounting and finance. Springer Science & Business Media (2012)
2. Celonis GmbH: Celonis Process Mining. <http://www.celonis.de/>. Accessed 03 Mar 2015
3. Fluxicon: Process Mining and Process Analysis—Fluxicon. <http://fluxicon.com/disco/>. Accessed 03 Mar 2015
4. Grossmann, W., Rinderle-Ma, S.: Fundamentals of Business Intelligence. Springer (2015)
5. Hipp, M., Michelberger, B., Mutschler, B., Reichert, M.: Navigating in process model repositories and enterprise process information. In: IEEE 8th International Conference on Research Challenges in Information Science (RCIS 2014), pp. 1–12. IEEE Computer Society Press (2014)
6. Lanz, A., Weber, B., Reichert, M.: Time patterns for process-aware information systems. *Requirements Eng.* **19**(2), 113–141 (2014)
7. Li, C., Reichert, M., Wombacher, A.: The MinAdept clustering approach for discovering reference process models out of process variants. *Int. J. Cooper. Inf. Syst.* **19**(3 & 4), 159–203 (2010)
8. Ly, L.T., Rinderle, S., Dadam, P., Reichert, M.: Mining staff assignment rules from event-based data. In: Proceedings of Workshop on Business Process Intelligence (BPI) in conjunction with (BPM'05), pp. 177–190. No. 3812 in LNCS. Springer (2005)
9. Michelberger, B., Mutschler, B., Reichert, M.: Towards process-oriented information logistics: why quality dimensions of process information matter. In: Proceedings of 4th International Workshop on Enterprise Modelling and Information Systems Architectures (EMISA 2011), pp. 107–120. No. 190 in Lecture Notes in Informatics (LNI). Koellen-Verlag (2011)
10. Microsoft AG: Business Intelligence in Office and SQL Server—Microsoft. [www.microsoft.com/en-us/server-cloud/solutions/business-intelligence/](http://www.microsoft.com/en-us/server-cloud/solutions/business-intelligence/). Accessed 03 Mar 2015
11. Mutschler, B., Reichert, M., Bumiller, J.: Unleashing the effectiveness of process-oriented information systems: problem analysis, critical success factors, and implications. *IEEE Trans. Syst. Man Cybernet. Part C: Appl. Rev.* **38**(3), 280–291 (2008)
12. Mutschler, B., Weber, B., Reichert, M.: Workflow management versus case handling: results from a controlled software experiment. In: 23rd Annual ACM Symposium on Applied Computing (SAC'08), Special Track on Coordination Models, Languages and Architectures, pp. 82–89. ACM Press (2008)
13. QlikTech: Analytics, Data Discovery, Data Visualization, QlikView BI Dashboard|Qlik. <http://www.qlik.com/en/explore/products/qlikview>. Accessed 03 Mar 2015
14. Reichert, M., Weber, B.: Enabling Flexibility in Process-Aware Information Systems: Challenges, Methods, Technologies. Springer, Berlin (2012)
15. Saaty, T.L., Vargas, L.G.: Models, Methods, Concepts and Applications of the Analytic Hierarchy Process, vol. 175. Springer Science & Business Media (2012)
16. Software AG: ARIS MashZone—Business Mashups. <http://www.mashzone.com/>. Accessed 03 Mar 2015
17. Software AG: Software AG Process Performance Manager. [http://www.softwareag.com/corporate/products/apama\\_webmethods/intelligence/products/process\\_performance/overview/default.asp](http://www.softwareag.com/corporate/products/apama_webmethods/intelligence/products/process_performance/overview/default.asp). Accessed 03 Mar 2015
18. Tennant, G.: Six Sigma: SPC and TQM in Manufacturing and Services. Gower Publishing Ltd., Aldershot (2001)
19. TIBCO Software Inc.: TIBCO Spotfire—Business Intelligence Analytics Software & Data Visualization. <http://spotfire.tibco.com/>. Accessed 03 Mar 2015
20. Van Der Aalst, W.: Process Mining: Discovery, Conformance and Enhancement of Business Processes. Springer Science & Business Media (2011)



21. Van Der Aalst, W., Adriansyah, A., de Medeiros, A.K.A., Arcieri, F., Baier, T., Blickle, T., Bose, J.C., van den Brand, P., Brandtjen, R., Buijs, J., et al.: Process mining manifesto. In: Business Process Management Workshops, pp. 169–194. Springer (2012)
22. Weber, B., Mutschler, B., Reichert, M.: Investigating the effort of using business process management technology: results from a controlled experiment. *Sci. Comput. Program.* **75**(5), 292–310 (2010)