Toward a Typology of Business Process Management Professionals: Identifying Patterns of Competences through Latent Semantic Analysis

While researchers have analysed the organisational competences that are required for successful Business Process Management (BPM) initiatives, individual BPM competences have not yet been studied in detail. In this study, latent semantic analysis is used to examine a collection of 1,507 BPM-related job advertisements in order to develop a typology of BPM professionals. This empirical analysis reveals distinct ideal types and profiles of BPM professionals on several levels of abstraction. A closer look at these ideal types and profiles confirms that BPM is a boundary-spanning field that requires interdisciplinary sets of competence that range from technical competences to business and systems competences. Based on the study's findings, it is posited that individual and organisational alignment with the identified ideal types and profiles is likely to result in high employability and organisational BPM success.

Keywords: business process management, professionals, competences, knowledge, skills, abilities, latent semantic analysis, typology

1. Introduction

Business Process Management (BPM), an active field of research in the Information Systems (IS) discipline, is an interdisciplinary approach to the analysis, design, implementation, and improvement of organisational work processes and supporting Information Technology (IT) systems (Davenport and Short 1990; Hammer and Champy 1993; vom Brocke and Rosemann 2010). The goal of BPM is to increase operational efficiency and effectiveness (e.g., product/service quality, compliance) by organising a company around core business processes instead of functional departments (Hammer and Champy 1993). Typically, BPM initiatives are associated with major investments in enterprise information systems in order to integrate previously separated business activities into cross-functional, end-to-end business processes (Wetzstein and

Leitner 2011; Altinkemer, Ozcelik, and Ozdemir 2011).

The practical relevance of BPM and related process-oriented management approaches is undisputed (Gartner 2011; McKinsey 2011). Nevertheless, as Bandara and colleagues (2010) state, most companies still "lack sufficient internal competencies needed to undertake these BPM initiatives" (p. 744).

Extant research provides insights into organisational competences that are required in BPM initiatives, such as through BPM maturity models (e.g., Van Looy, De Backer, and Poels 2012; Rosemann and de Bruin 2005a; de Bruin and Rosemann 2007; Hammer 2007). However, such frameworks provide only limited insights into what process management competences are required at an individual level. Besides some rare exceptions, such as Antonucci and Goeke (2011) and Launonen and Kess (2002), the topic of individual BPM competences has been largely neglected in academic research. The contemporary understanding of BPM as a holistic approach suggests that BPM initiatives require comprehensive competence portfolios, so BPM professionals, as well as executives and educators, face the challenge of identifying and developing meaningful combinations of competences.

Against this background, *the purpose of the present study is to clarify BPM competence requirements at an individual level*. Following related research in the IS discipline, this goal is addressed by conducting a content analysis of job advertisements (ads). Specifically, this study ties in with several well-recognised studies that have used job ads to examine individual competence requirements (e.g., Gallivan, Truex, and Kvasny 2004; Litecky and Aken 2010; Todd, McKeen, and Gallupe 1995). Job ads are one of the most important recruitment instruments, so they can serve as a proxy for the competences required of professionals (Todd, McKeen, and Gallupe 1995). Therefore,

job ads represent an appropriate data source for an examination of the required competence sets of BPM professionals.

Latent semantic analysis (LSA), a text mining technique, is used to analyse 1,507 BPM-related job ads collected from a global online job platform and derive a typology of BPM professionals (Doty and Glick 1994). The typology developed is comprised of a number of ideal types and profiles of BPM professionals. It is hypothesised that, at an individual level, matching the profile of one of the ideal types identified will likely result in the ability to gain and retain employment (Hillage and Pollard 1999). At an organisational level, it is posited that a complete competence portfolio comprised of all of the individual ideal types identified is required if process-oriented organisations are to be effective.

The remainder of this paper is structured as follows. The next section provides a theoretical background on typologies, ideal types, and human resources in IS research. Then the data collection and analysis approach is presented by introducing the research method, i.e. LSA, and providing specific information on the individual steps of the study's research process. This section is followed by a detailed description of the study's findings, a discussion of the attained results against the background of existing studies and their implications for research and practice. Finally, study limitations are pointed out and the paper is concluded with an overview of the contributions that stem from this research.

2. Research Background

2.1. Typologies and Ideal Types

According to Doty and Glick (1994, p. 230), "[t]ypologies are a very popular, but often misunderstood form of theory." Typologies have often been confused with classification

systems (e.g., taxonomies), which partition phenomena into mutually exclusive and exhaustive sets (Doty and Glick 1994), while typologies are sets of "ideal" types, that is, types that are considered to be especially *effective* or *successful*. Therefore, typologies go beyond pure description by stating relationships between independent variables (ideal types) and dependent variables (organisational or individual success). Many typologies posit, for instance, that the closer an entity comes to the profile of an ideal type, the greater its effectiveness is, although a complete match usually does not happen in reality (Weber 1949).

One prominent example of a typology is Mintzberg's (1979) theory on the structuring of organisations, which describes five ideal types of effective organisational structures: simple structure, machine bureaucracy, professional bureaucracy, divisionalised form, and adhocracy. Each of these ideal types is described with an ideal profile that uses a common set of descriptors, such as age, size, horizontal and vertical specialisation of jobs, and formalisation of behaviour. These descriptors are aggregated into the two broader categories of context and structure. For example, the profile of a simple structure is described by young age, small size, and low horizontal and high vertical specialisation.

Typologies can be defined theoretically or empirically (Doty and Glick 1994). Researchers who model typologies theoretically deduce ideal types and ideal profiles from existing theories and literature (e.g., Guillemette and Paré 2012). Ideal types and profiles can also be derived inductively from an empirical sample (e.g., Govindarajan 1988). In this case, a researcher identifies entities from the sample that seem to be especially effective or successful, so they resemble ideal types. Then the researcher describes the identified ideal types by specifying ideal profiles for each ideal type.

This study follows the empirical approach to typology development by analysing a large sample of BPM-related job advertisements. The idea underlying this study is that job profiles that are in high demand on the job market represent effective ideal types, or they would not be in high demand. As it is explained in detail below, text mining is used to identify groups of similar jobs in high demand (i.e., ideal types) and extract patterns of frequently used descriptive terms that describe the competence requirements of these jobs (i.e., ideal profiles).

Independent of the process of typology development, Doty and Glick (1994) stress the importance of using consistent and theoretically relevant descriptors to specify ideal types. Following this recommendation, the IS literature on human resources was reviewed in order to identify frameworks and constructs suitable for describing ideal types of BPM professionals. The next section reports on this review.

2.2. Human Resources in Information Systems Research

The study of human resources (HR) in the IS discipline dates back to the late 1960s, when the importance of IS personnel in organisations was first recognised (e.g., Brady 1967). Since then, numerous studies have addressed questions concerning the demand for IS professionals and their related competences (e.g., Lee, Trauth, and Farwell 1995; Nelson 1991; Todd, McKeen, and Gallupe 1995). A competence is defined as a work-related knowledge, skill, or ability held by an individual (Nordhaug 1993). In broad terms, knowledge refers to the theoretical understanding of a concept (e.g., what the notion of a business process means), while skills relate to the practical application of that knowledge (e.g., how to model a business process). In contrast to knowledge and skills, which can be learned, abilities are attributes that are innate to an individual (e.g., a person's ability to abstract).

Although there is a consensus on the conceptualisation of competence, most empirical IS studies use the notions of work-related knowledge, skills, and abilities interchangeably (e.g., Lee, Trauth, and Farwell 1995; Nelson 1991; Todd, McKeen, and Gallupe 1995). The same holds true for the vast majority of job ads, which were analysed in this empirical study. Therefore, it was decided to abstain from making strict distinctions between the notions of knowledge, skills, and abilities and use the broader term *competence* instead.

While the HR literature identifies a great number of classification systems for organising work-related competences (Le Deist and Winterton 2005), few classification systems are specific to BPM. Therefore, the IS literature was examined to identify frameworks that may provide descriptors for a typology of BPM professionals. After analysing several IS competence classifications (e.g., Tang, Lee, and Koh 2000; Litecky et al. 2009), the scheme proposed by Todd et al. (1995) was selected for further use.

Todd et al. (1995) manually analysed job ads to determine how the competence requirements for programmers, analysts, and IS managers changed over time. Based on a classification scheme provided by the Association for Computing Machinery (ACM), the authors coded the job ads by assigning the competences in them to three categories: technical competences, business competences, and systems competences. Then they split each of the categories into a set of two to three sub-categories, enriched with short descriptions (Table 1).

Table 1 Classification of IS competences by Todd et al. (1995)

Category	Sub-category	Description
Technical	Hardware	Servers and personal computers. Other devices such as storage devices, controllers, printers, and other peripherals plus networks.

	Software	Application systems, operating systems, packaged products (e.g., databases), networking software and programming languages.
Business	Domain	Functional expertise (e.g., finance, marketing) and industry expertise (e.g., retail, mining).
	Management	General management skills including leadership, project management, planning, controlling, training, and organization.
	Social	Interpersonal skills, communication skills, personal motivation and ability to work independently.
Systems	Problem Solving	Creative solutions, quantitative skills, analytical modeling, logical capabilities, deductive/inductive reasoning, innovation.
	Development	Knowledge of systems development methodologies, systems approach, implementation issues, operations and maintenance issues, general development phases, documentation, and analysis/design tools and techniques.

Todd et al.'s (1995) framework is a comprehensive and versatile approach to classifying job competences in the IS discipline, as it recognises both the duality and the alignment of business and technology. Moreover, this framework has been widely accepted and applied in numerous studies (e.g., Lee, Trauth, and Farwell 1995; Hardin, Joshi, and Li 2002). Therefore, the categories and sub-categories (which Todd et al. originally termed "classes" and "categories", respectively) of this scheme were adopted in this study as common descriptors for characterising the ideal profiles of the typology of BPM professionals. Particular competences classified into categories and sub-categories form an ideal profile, which describes a certain ideal type. All of the ideal types of a particular phenomenon together form the typology — in this case, a typology of BPM professionals.

3. Data Collection and Analysis

3.1. Introduction to and Example of Latent Semantic Analysis

A quantitative analysis of advertisements in the BPM job market was conducted in order to derive ideal types and profiles of BPM jobs empirically. Specifically, the quantitative text-mining technique LSA was used to identify patterns in job advertisements. LSA detects patterns of word use in texts through statistical analysis (Landauer, Foltz, and Laham 1998). The underlying idea is that the contexts (e.g., documents, paragraphs, sentences) in which a word appears or does not appear contain valuable information about the meaning of both the word and the text. LSA was originally developed in the late 1980s as an information retrieval method (Deerwester et al. 1990), but it has since shown its usefulness in a great variety of applications and domains.

The rationale for selecting LSA was based on its growing importance as a methodology in the IS discipline, particularly in automated quantitative content analysis (Evangelopoulos, Zhang, and Prybutok 2012). Content analysis is a method of systematic analysis of texts in order to identify concepts and patterns therein (Jauch, Osborn, and Martin 1980), traditionally done through manual coding. When LSA is used for content analysis, the identified patterns of word use are interpreted as concepts. For example, Sidorova and colleagues (2008) used LSA to examine 1,615 abstracts of papers published in three leading IS journals in order to identify five core research areas of the discipline, and Larsen et al. (2008) used LSA to cluster 14,510 abstracts from 65 IS journals into seven intellectual communities. Sidorova and Isik (2010) analysed 2,700 abstracts of papers using LSA and identified 20 distinct but interrelated sub-topics in the field of BPM. Finally, Indulska and colleagues (2012) performed LSA on 8,544

abstracts from IS, management, and accounting journals to reveal core topics in these disciplines and to show how they have evolved over the last 25 years.

LSA was also selected because it has been used successfully in the field of HR management (Giesbers, Rusman, and Bruggen 2006; Haley et al. 2005). For example, Laham, Bennet, and Landauer (2000) applied LSA to develop a software tool for the US Air Force that can match job requirements with employees by using "the explicit and implicit knowledge that already exists in extensive textual computer files of systems documentations, training and test materials, task analyses, and service records" (p. 173). Experiments with data comprised of more than 2,000 task descriptions and 9,000 descriptions of airmen and airwomen indicated that LSA has the potential to extract job knowledge requirements from different types of textual documents (e.g., descriptions of occupations, job tasks, personnel, training materials) accurately and in detail and to determine the similarity between jobs and jobs, jobs and employees, and employees and employees. The prototype was later extended to include additional data sources (job listings from the US Department of Labor Occupational Network and résumés from Yahoo and other online employment platforms) in order to serve further purposes, such as identifying training needs (Laham, Bennett, and Derr 2002).

The proofs-of-concept for applying LSA in IS and HR management described above indicate that LSA is a viable method for analysing job ads in the IS field. The next part of the discussion describes the method itself.

A typical LSA is comprised of three phases. (See Tables 2 – 5 for an illustrative example.) The goal of the first phase is to transform a collection of documents (Table 2) into a term-document matrix (Table 3) that consists of rows that represent words and columns that represent documents. The cells of the matrix contain the number of times a particular word appears in a particular document. In an efficient and effective analysis,

documents and words typically undergo a series of pre-processing steps, such as reducing terms to their stems (e.g., flexibility and flexible to “flexib”), filtering out uninformative stopwords (e.g., “the”, “about”), and weighting terms according to their relative importance. (For reasons of simplicity, term stemming and weighting are omitted in the example in Tables 2 and 3.)

Table 2 Hypothetical job advertisements

ID	Job title	Job description (extract)
JobAd1	BPM Analyst	We look for a business analyst in the area of business process management...
JobAd2	Workflow Developer	...you will be a developer for technical workflows...
JobAd3	Business Process Improvement Manager	...improve business process performance...
JobAd4	SAP Process Architect	...technical process architect with SAP experience...
JobAd5	SAP Netweaver BPM Developer	We need a developer with SAP Netweaver BPM skills...
JobAd6	Process Performance Manager	...you will be responsible for the management of business process performance...

Table 3 Term-document matrix for the job descriptions in Table 2 (without stopwords)

Term	Document					
	JobAd1	JobAd2	JobAd3	JobAd4	JobAd5	JobAd6
analyst	1	0	0	0	0	0
architect	0	0	0	1	0	0
bpm	0	0	0	0	1	0
business	2	0	1	0	0	1
developer	0	1	0	0	1	0
improve	0	0	1	0	0	0
management	1	0	0	0	0	1
netweaver	0	0	0	0	1	0
performance	0	0	1	0	0	1
process	1	0	1	1	0	1
sap	0	0	0	1	1	0
technical	0	1	0	1	0	0
workflows	0	1	0	0	0	0

In the second phase, the term-document matrix is analysed using a statistical technique called Singular Value Decomposition (SVD) to reduce the dimensionality of the term-document matrix without losing relevant information by identifying groups of highly correlated words (i.e., words that co-occur together in documents) and highly correlated documents (i.e., documents that contain similar words). The result of the SVD is a set of semantic factors with associated term loadings (Table 4) and document loadings (Table 5), which together describe specific patterns of word usage (Sidorova et al. 2008).

Table 4 Term loadings

	Factor 1	**Factor 2**
analyst	**0.688**	-0.141
architect	0.207	**0.564**
bpm	0.028	**0.657**
business	**2.357**	-0.381
developer	0.053	**1.131**
improve	0.460	-0.034
management	**1.209**	-0.206
netweaver	0.028	**0.657**
performance	**0.981**	-0.100
process	**1.875**	0.324
sap	0.234	**1.221**
technical	0.232	**1.038**
workflows	0.025	0.474

Table 5 Document loadings

	Factor 1	**Factor 2**
JobAd1	**2.416**	-0.333
JobAd2	0.088	**1.119**
JobAd3	**1.615**	-0.081
JobAd4	0.726	**1.332**
JobAd5	0.098	**1.553**
JobAd6	**1.828**	-0.154

The extracted word-usage patterns are interpreted in the third phase. Depending on which variant of LSA-based analysis is used (see Evangelopoulos, Zhang, and Prybutok 2012 for a detailed discussion), the interpretation involves additional statistical analyses (factor analysis, clustering, or classification) and expert judgments.

In the small illustrative example, Tables 4 and 5 (i.e., the results of the SVD) can be interpreted right away without any further statistical analysis. Table 4 presents two extracted factors and the associated loadings of terms taken from the job description extracts. Assuming an exemplary factor loading threshold of 0.5, the results indicate that Factor 1 is primarily related to the terms “business”, “process”, “management”, “performance”, and “analyst” and that Factor 2 is mostly related to the terms “SAP”, “developer”, “technical”, “Netweaver”, “BPM”, and “architect”. Table 5 shows the same two factors and the corresponding document loadings. Factor 1 is primarily related to Job Ads 1 (BPM Analyst), 6 (Process Performance Manager), and 3 (Business Process Improvement Manager), whereas Factor 2 is primarily associated with Job Ads 5 (SAP Netweaver BPM Developer), 4 (SAP Process Architect), and 2 (Workflow Developer). Examining the high-loading terms and the titles of the high-loading ads together suggests that Factor 1 describes business-oriented jobs (a type of job that could be labelled Business Process Performance Manager, for example), and Factor 2 refers to technical jobs (which could be labelled SAP BPM Developer, for example).

The next sections outline how LSA was applied to analyse online job advertisements on a large scale. Figure 1 and Table 9 illustrate the phases, activities, and inputs/outputs of this study’s data collection and analysis approach . While the basic procedure explained in the illustrative example above was followed, Figure 1 and Table 9 contain more detailed steps required for the large-scale analysis, which are

explained in the next sections. In addition, it is indicated in Figure 1 and Table 9 which steps can be executed automatically and which require human judgment.

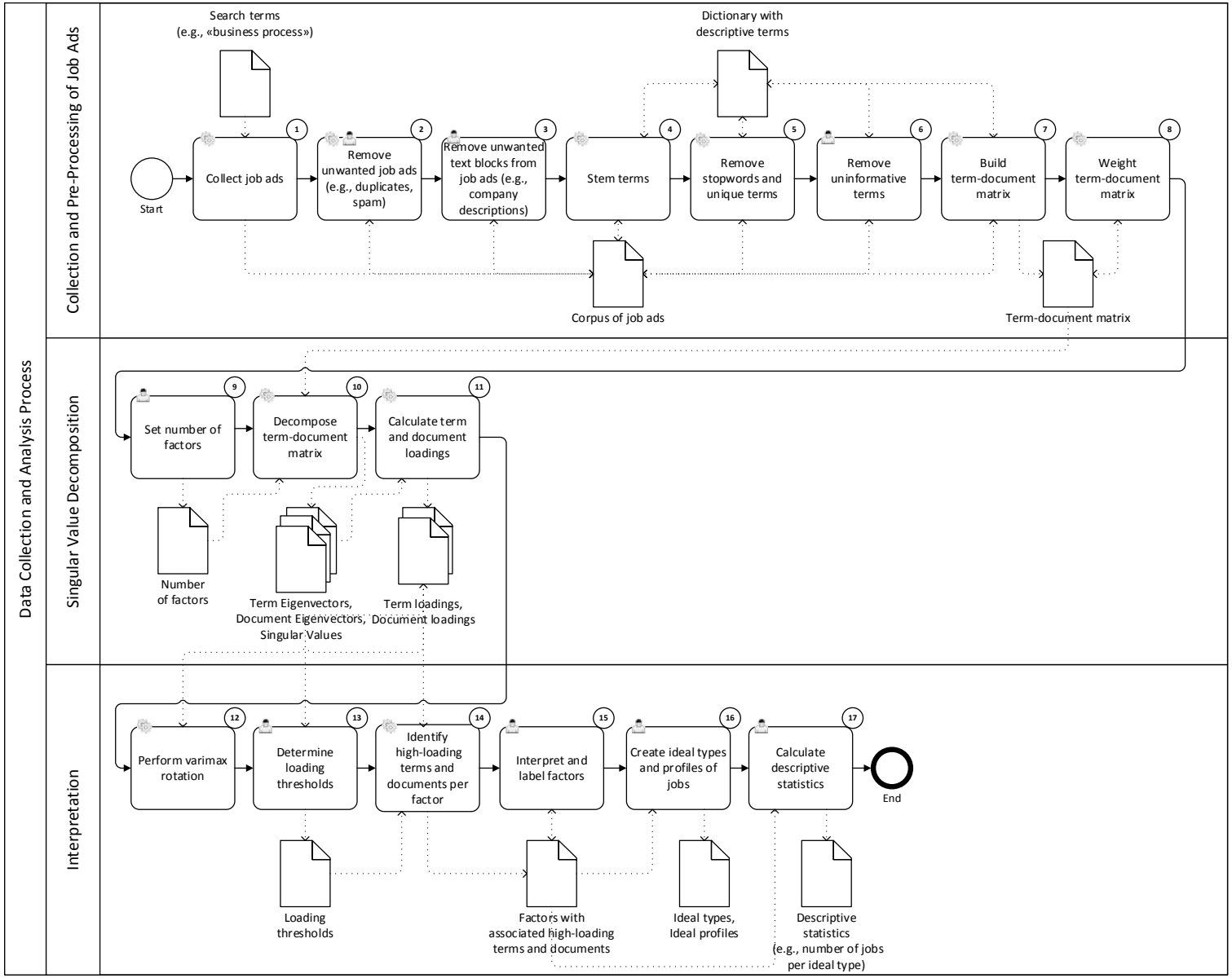


Figure 1 Research Process

3.2. Collecting and Pre-Processing Job Ads

Online job ads were analysed in order to gain a comprehensive picture of the current demand for BPM professionals since, based on the increasing use of online job markets and the increasing global competition for experts (Jansen, Jansen, and Spink 2005; Douglass and Edelstein 2009), online employment platforms are a major distribution channel for organisations' vacancies. Against this background, job ads were collected from a premier global online employment platform (Step 1 in Figure 1 and Table 9) and searched for ads in English-speaking countries, downloading those that contained the term "business process" from the platform websites in the US, Canada, the UK, and Australia (Table 6).

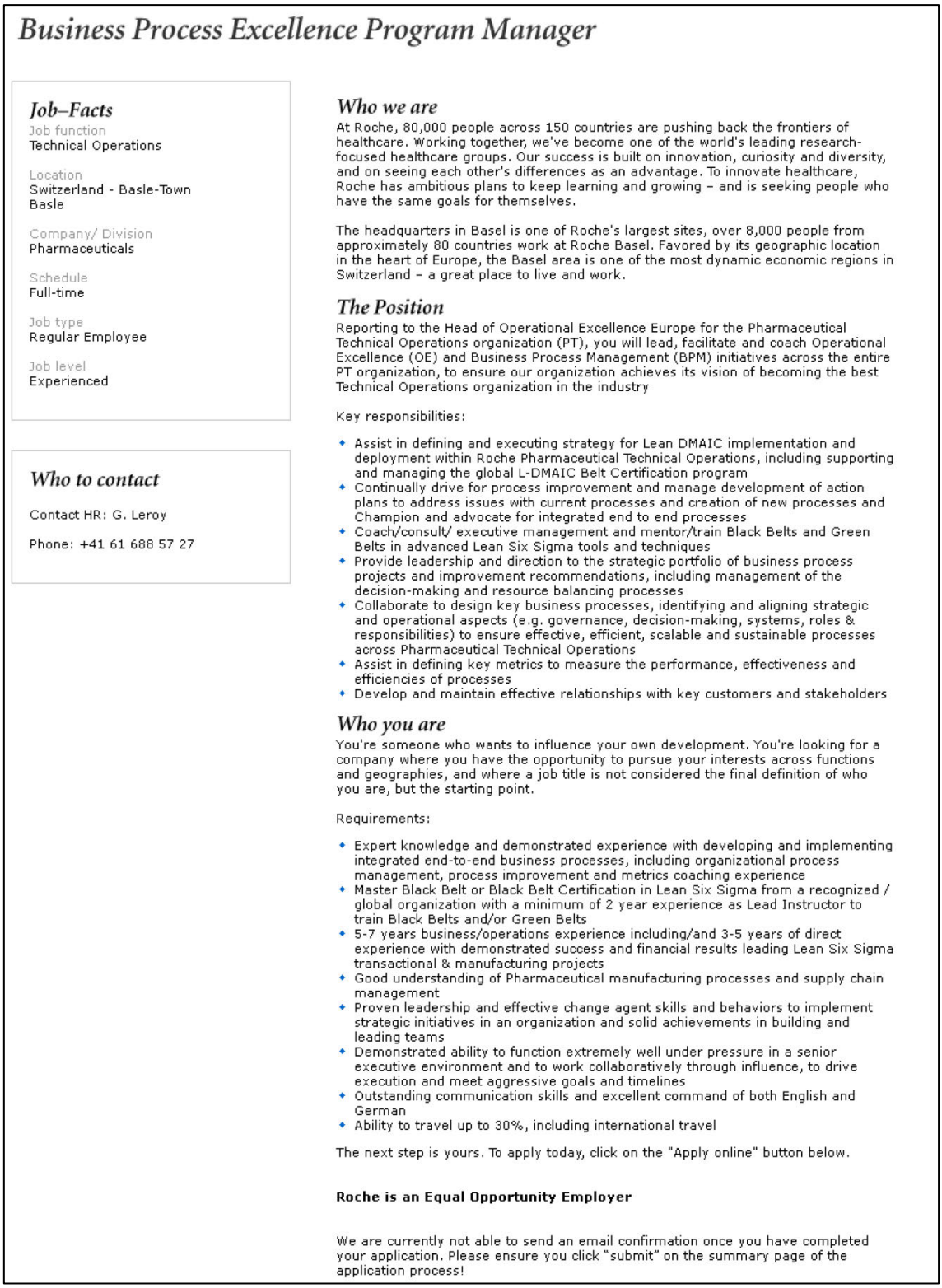
Table 6 Number of hits per country for the search term "business process"

US	Canada	UK	Australia
1.000	638	480	161

Unwanted job ads (Step 2) and unwanted text blocks (Step 3) were then removed as follows. After 45 irrelevant job search hits were removed (i.e., non-English ads or spam), 2,279 ads remained. Manual inspection of the downloaded ads and an LSA pre-test revealed a number of anomalies. First, a significant number of ads were close to being duplicates. As duplicates bias the LSA without providing additional information, a duplicate-finder tool was used to identify and remove groups of ads with a similarity score greater than 95 per cent. Second, a considerable proportion of the ads' content was comprised of standard company descriptions (Figure 2). Pre-tests showed that these text blocks bias the LSA by, for example, producing semantic factors that describe large companies, such as Deloitte or IBM, so these standard text blocks were

manually removed. Third, in some job ads the search term “business process” was mentioned in the company description but not in the job description (e.g., ads in which business process outsourcing companies were searching for a team assistant). Therefore, after removing the standard company-description text blocks, it was checked whether the ads still contained the term “business process” and those that did not were removed. After pre-processing, the final dataset contained 1,507 unique BPM-related job ads.

Following well-recognised text-mining procedures (Manning, Raghavan, and Schutze 2008), the document collection vocabulary was reduced before starting the LSA. The complete vocabulary defined by the 1,507 job ads initially contained 11,376 terms. To make the number of terms manageable for further analysis, automatic term stemming was applied (i.e., shortening inflected terms to their common stems, such as shortening coordinator, coordinating, and coordinate to “coordin”). Stemming reduced the vocabulary to 6,785 terms (Step 4). In addition, standard stop words (e.g., “the”, “and”, “about”) and terms that occurred in only one document were removed algorithmically (Step 5). The remaining 3,732 terms were analysed manually to identify uninformative terms that frequently occur in online job ads (e.g., “apply”, “salary”) (Step 6) in an effort to keep only those terms that were specific to the competence requirements of the ads. In this process, two researchers independently examined the list of terms and identified terms to be excluded. The two coders disagreed in about 17 per cent of the cases. These conflicts were then reviewed and resolved by a third researcher. Persisting conflicts were resolved in a consensus discussion that included all researchers. The resulting controlled vocabulary consisted of 1,422 terms and was used as a dictionary for the further analysis.



Business Process Excellence Program Manager

Job–Facts

Job function
Technical Operations

Location
Switzerland - Basle-Town
Basle

Company/ Division
Pharmaceuticals

Schedule
Full-time

Job type
Regular Employee

Job level
Experienced

Who to contact

Contact HR: G. Leroy

Phone: +41 61 688 57 27

Who we are

At Roche, 80,000 people across 150 countries are pushing back the frontiers of healthcare. Working together, we've become one of the world's leading research-focused healthcare groups. Our success is built on innovation, curiosity and diversity, and on seeing each other's differences as an advantage. To innovate healthcare, Roche has ambitious plans to keep learning and growing – and is seeking people who have the same goals for themselves.

The headquarters in Basel is one of Roche's largest sites, over 8,000 people from approximately 80 countries work at Roche Basel. Favored by its geographic location in the heart of Europe, the Basel area is one of the most dynamic economic regions in Switzerland – a great place to live and work.

The Position

Reporting to the Head of Operational Excellence Europe for the Pharmaceutical Technical Operations organization (PT), you will lead, facilitate and coach Operational Excellence (OE) and Business Process Management (BPM) initiatives across the entire PT organization, to ensure our organization achieves its vision of becoming the best Technical Operations organization in the industry

Key responsibilities:

- Assist in defining and executing strategy for Lean DMAIC implementation and deployment within Roche Pharmaceutical Technical Operations, including supporting and managing the global L-DMAIC Belt Certification program
- Continually drive for process improvement and manage development of action plans to address issues with current processes and creation of new processes and Champion and advocate for integrated end to end processes
- Coach/consult/ executive management and mentor/train Black Belts and Green Belts in advanced Lean Six Sigma tools and techniques
- Provide leadership and direction to the strategic portfolio of business process projects and improvement recommendations, including management of the decision-making and resource balancing processes
- Collaborate to design key business processes, identifying and aligning strategic and operational aspects (e.g. governance, decision-making, systems, roles & responsibilities) to ensure effective, efficient, scalable and sustainable processes across Pharmaceutical Technical Operations
- Assist in defining key metrics to measure the performance, effectiveness and efficiencies of processes
- Develop and maintain effective relationships with key customers and stakeholders

Who you are

You're someone who wants to influence your own development. You're looking for a company where you have the opportunity to pursue your interests across functions and geographies, and where a job title is not considered the final definition of who you are, but the starting point.

Requirements:

- Expert knowledge and demonstrated experience with developing and implementing integrated end-to-end business processes, including organizational process management, process improvement and metrics coaching experience
- Master Black Belt or Black Belt Certification in Lean Six Sigma from a recognized / global organization with a minimum of 2 year experience as Lead Instructor to train Black Belts and/or Green Belts
- 5-7 years business/operations experience including/and 3-5 years of direct experience with demonstrated success and financial results leading Lean Six Sigma transactional & manufacturing projects
- Good understanding of Pharmaceutical manufacturing processes and supply chain management
- Proven leadership and effective change agent skills and behaviors to implement strategic initiatives in an organization and solid achievements in building and leading teams
- Demonstrated ability to function extremely well under pressure in a senior executive environment and to work collaboratively through influence, to drive execution and meet aggressive goals and timelines
- Outstanding communication skills and excellent command of both English and German
- Ability to travel up to 30%, including international travel

The next step is yours. To apply today, click on the "Apply online" button below.

Roche is an Equal Opportunity Employer

We are currently not able to send an email confirmation once you have completed your application. Please ensure you click "submit" on the summary page of the application process!

Figure 2 Exemplary Job Advertisement

After defining the final set of documents and terms, a 1,422-by-1,507 term-document matrix was built (Step 7) that contained the number of times each term

appeared in each document. This raw matrix was then transformed by weighting terms based on their occurrence in and across documents (Manning, Raghavan, and Schutze 2008) (Step 8). The commonly used TF-IDF (Term Frequency - Inverse Document Frequency) weighting scheme was applied, which promotes the occurrence of rare terms in a document and discounts the occurrence of more common terms (e.g., “business”, “manage”). The weighted term-document matrix built the foundation for the subsequent SVD.

3.3. Singular Value Decomposition

After compiling the weighted term-document matrix, the SVD was performed using the statistical computing software R. The determination of the number of factors to be extracted is not performed by SVD itself but has to be done by the researcher. The appropriate number of factors is heavily discussed in the literature (Evangelopoulos, Zhang, and Prybutok 2012). Several solutions were explored in this study, including 2, 3, 5, 7, 10, and 20 factors (Step 9), decomposing for each solution the term-document matrix into a matrix of term eigenvectors, a matrix of document eigenvectors, and a diagonal matrix of singular values (Step 10). Multiplying the matrices of the term eigenvectors and the document eigenvectors by the singular values matrix produces the term and document loadings for each factor (Step 11), which signify the degree to which a specific term or document is relevant to a given semantic factor.

3.4. Interpretation

Following Evangelopoulos et al.’s (2012) recommendation, the next step was a procedure that is comparable to the traditional factor analysis of numerical data. High-loading terms and documents were extracted for each factor in order to uncover the latent semantic structure of the BPM jobs collection. Since cross-loadings of documents

are possible (i.e., a document can be assigned to more than one factor), a job ad may be assigned to more than one topic (e.g., business process design and enterprise resource planning (ERP) systems). While such cross-loadings seem to be reasonable because of the interdisciplinary character of the BPM field, it was aimed to identify the most distinct ideal types of BPM jobs and, therefore, it was proceeded as follows.

First, a standard statistical procedure, varimax rotation, was performed to improve the distinctiveness of the semantic factors and to simplify their interpretation (Sidorova et al. 2008) (Step 12). This procedure maximises the variance of the term loadings on a factor by rotating the coordinates of the semantic space such that each factor has a few large loadings and many small loadings, making the term-factor association clearer and easier to interpret because a term is either descriptive (high loading) or not descriptive (low loading) for a particular factor. To maintain the representation of the documents in the same factor space, an identical rotation was then performed with the document loadings matrix.

To decide whether a particular term or document should be assigned to a factor, a specific loading threshold must be defined. Following the approach of Sidorova et al. (2008), the threshold of a k-factors solution was determined (Step 13) by identifying the top-1/k documents and terms. For example, in the 20-factor solution, the top 5 per cent of high-loading terms and documents were extracted (Step 14), so that each term and document loaded on an average on one factor. However, cross-loadings are still possible. (See Table 10 in the appendix.)

Next, the factors were interpreted by co-examining the associated terms and documents (Step 15). This job was done manually by three researchers, with each researcher independently interpreting and labelling each factor by analysing the list of extracted high-loading descriptive terms and job ads and then comparing the results. In

almost all cases, factor interpretation was straightforward and unambiguous; minor disagreements in labelling were resolved during a discussion involving all researchers.

The last steps were comprised of further categorising the high-loading terms of each factor in order to derive ideal profiles for each ideal job type (Step 16) and calculating additional descriptive statistics (Step 17). These steps are described in detail in the next section.

4. Results

4.1. Ideal Types

The identification of ideal types can be conducted on several levels of abstraction, which is reflected statistically in the selection of an appropriate number of factors for the SVD. The solutions with 2, 3, 5, 7, 10, and 20 factors were explored and it was found that as more factors are considered, the resultant ideal types become more fine-grained.

On the most abstract level, the 2-factor solution, job ads were distributed in almost equal parts into more business-related jobs and more systems-related jobs. The five highest-loading descriptive terms for the more business-related jobs, which was labelled Business Analysts, were “manag”, “busi”, “project”, “improv”, and “process”. Typical titles of high-loading job ads were Business Analyst, Business Process Manager, and Project Manager. In contrast, the top five descriptive terms for the more systems-related jobs were “busi”, “system”, “test”, “develop”, and “design”. Frequent job titles included IT Solutions Architect, Development Manager, and Data Architect. This broad group of jobs was labelled Systems Analysts.

Figure 3 provides an overview of the 2-, 3-, 5-, 7-, 10-, and 20-factor solutions and illustrates how, from level to level, ideal types are added, refined, split up, and

dissolved. For example, the Systems Analyst ideal type is split up and dissolved into various other positions on more detailed levels of analysis (e.g., Technical Architect, Business Intelligence (BI) Analyst, and Enterprise Content Management (ECM) Developer). Similarly, the more detailed the analysis, the higher the number of differentiated Business Process (BP) Manager ideal types that emerged (BP Manager Sales & Marketing, BP Manager Accounting & Finance, BP Manager HR, BP Manager Supply Chain). Figure 3 also contains the relative number of job ads assigned to each ideal type, which is an indicator of the demand for the identified ideal types in practice. (The percentages do not add up to 100 per cent, as some job ads load on more than one ideal type or on no ideal type at all.)

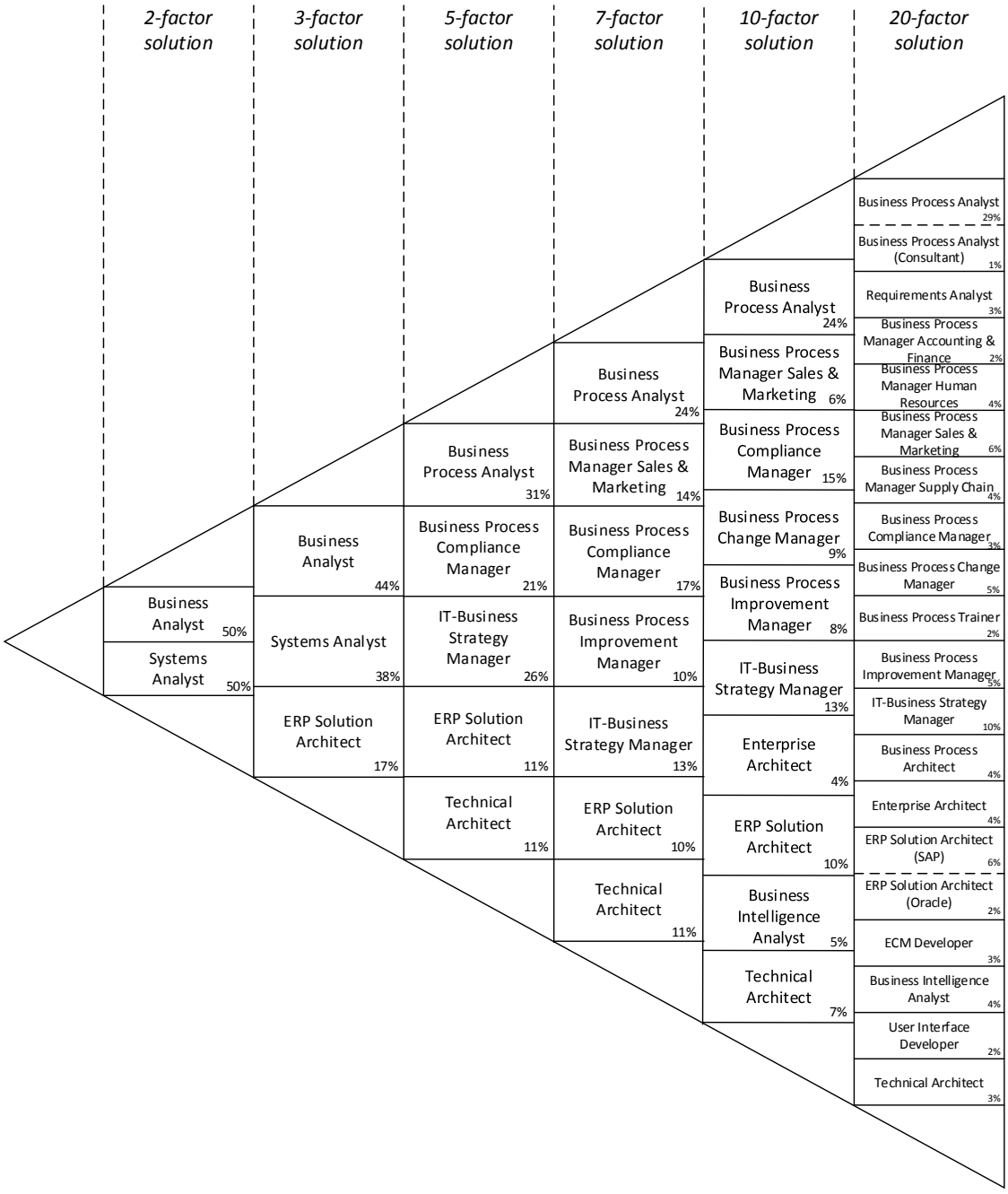


Figure 3 Overview of Ideal Types of BPM Professionals

This section reports in detail on the 7-factor solution. It was chosen to focus on this solution, as it provides a comprehensive picture that is neither too abstract nor too detailed. The 7-factor solution revealed seven clearly distinguishable ideal types of BPM professionals whose profiles are analysed in detail in this section. Table 7

provides the number and percentage of ads assigned to a particular ideal type, which acts as an indicator of the level at which these jobs occur in practice.

Table 7 Ideal types of BPM professionals (7-factors solution)

Ideal Type	Description	Number of Ads	Percentage of Ads
Business Process Analyst	… elicits, analyses, documents, and communicates user requirements and designs according business processes and IT systems; acts as a liaison between business and IT	358	23.8
Business Process Compliance Manager	… analyses regulatory requirements and ensures compliance of business processes and IT systems	256	17.0
Business Process Manager Sales & Marketing	… designs sales processes and analyses requirements for related IT systems; supports and executes sales and marketing processes	212	14.1
Business Process Improvement Manager	… analyses, measures, and continuously improves business process, e.g., through application of Lean or Six Sigma management techniques	147	9.8
ERP Solution Architect	… implements business processes in ERP systems	152	10.1
IT-Business Strategy Manager	… aligns business and IT strategies; monitors technological innovations and identifies business opportunities	191	12.7
Technical Architect	… develops and integrates hardware and software infrastructures	160	10.6

4.2. Ideal Profiles

The ideal profiles specify the competence requirements for each of the seven ideal types through high-loading descriptive terms. The ideal profiles were derived using multiple coders: three coders independently assigned the high-loading descriptive terms of each factor to the categories and sub-categories provided by Todd et al.'s (1995) framework. In case of coding conflicts, all researchers reviewed the disagreements and discussed

them until consensus was reached and all conflicts were resolved. Even though the single terms provide only a rough indication of the exact competences required in each profile, assigning the terms to Todd et al.'s (1995) categories and sub-categories gives additional context that allows gaining a more precise idea of the competences actually required by each profile.

The analysis also shows how LSA allows us to discriminate clearly among the competences of ideal types, even though single competence-related terms load on more than one ideal-type factor. For example, the term "analysi" loads on the ideal types Business Process Analyst and IT-Business Strategy Manager. The term's concrete meaning can be determined by interpreting it in the context of the other high-loading terms. For example, in the ideal type Business Process Analyst, the term "analysi" co-occurs with terms like "user", "specif", "gather", "elicit", and "problem", indicating the need for competence in user requirements analysis, while in the ideal type IT-Business Strategy Manager, "analysi" occurs with terms like "strateg", "plan", and "risk", indicating the need for more strategic analytical competences.

In the following the profiles of all seven ideal-type BPM professionals are described in more detail. (The tabular ideal profiles are presented in the appendix; one exemplary profile is presented in Table 8)

Business Process Analyst: The balanced distribution of terms across the categories of Todd et al.'s (1995) framework indicates that a Business Process Analyst requires a broad portfolio of competences. For example, management competences relate to project planning and management, as the terms "project", "lead", "ensur", and "success" suggest; social competences refer to communication and collaboration (e.g., "stakehold", "communic", "collabor", "interview"); problem-solving competences relate to the analysis of specific user requirements (e.g., "elicit", "user", "specif",

"issu"); and development competences mainly refer to design and documentation of processes and systems, as suggested by terms like "document", "map", "model", "architecture", and "design". In addition to high-loading descriptive terms, the ideal profile includes exemplary job titles of high-loading job ads (e.g., Business Analyst, Business Systems Analyst, Business Process Analyst), which help us to interpret further the nature of this ideal type of BPM professional.

Business Process Compliance Manager: The high-loading terms were mostly assigned to domain and management competences. The terms in the domain sub-category refer to controlling and auditing (e.g., "monitor", "complianc", "standard", "intern", "control", "audit", "polici", "qualiti"), while term stems like "coordin", "plan", "perform", "administr", and "report" indicate that management competences are also important in this job profile. The strong focus on compliance is also apparent in high-loading job titles like Trade Compliance Manager, Business Process Controls Specialist, and Audit Compliance Specialist.

Business Process Manager Sales & Marketing: Again, most of the descriptive terms were assigned to the domain and management sub-categories, yet compared to the Business Process Compliance Manager they refer to other competences here. Required domain competences relate primarily to customer service and product sales (e.g., "key", "account", "service", "deliveri", "sale", "market", "product"), while management competences relate to competences like project and process management, as suggested by terms like "lead", "project", "consult", "strategi", and "process". A look at high-loading job titles like CRM Business Solutions Advisor, Support Sales Account Executive, Director International Marketing Services, and Managing Consultant Customer Innovation supports the interpretation that this BPM ideal type of professional

is engaged both in the design of marketing & sales processes and systems and in the support and execution of marketing & sales activities.

Business Process Improvement Manager: Most of the terms in this ideal profile were assigned to the management and problem solving sub-categories (cf. Table 8). Examples of descriptors that suggest management competences are “manag”, “process”, “busi”, “project”, “lead”, and “organ”, indicating a need for process and project management competences. Examples of descriptors related to problem solving competences include “improve”, “lean”, “six”, and “sigma”, which refer to the Lean and Six Sigma process improvement methodologies. The titles of high-loading job ads confirm this proposition (e.g., Business Process Excellence Manager, Lean Consultant, Director Business Process Improvement).

Table 8 Ideal profile of a Business Process Improvement Manager (7-factors solution)

Ideal Type		
Business Process Improvement Manager		
High-loading job titles		
Business Process Excellence Manager, Lean Consultant, Operations Excellence Manager, Director Business Process Improvement, Business Process Re-Engineering Leader		
Competence requirements		
Category	**Sub-Category**	**High-loading descriptive terms (stemmed; in order of highest loading terms)**
Technical	Hardware	-
	Software	tool, engin, excel
Business	Domain	oper, manufactur, qualiti
	Management	manag, process, busi, project, lead, continu, organ, strategi, leadership, plan, initi, demonstr, organiz, effect, leader, execut, practic, strategy
	Social	chang, drive, influenc, coach, facilit, cross, team
Systems	Problem Solving	improv, lean, sigma, six, belt, methodolog, techniqu, measur, black, metric, control, key, identifi, perform, certif
	Development	implement, model, develop

ERP Solution Architect: The high-loading terms show a balanced distribution across software, domain, management, and development competences, and the terms tie in well with each other. While most terms in the sub-category of software competences refer to specific modules of SAP ERP (e.g., “sd” for sales & distribution, “fi” for finance, “mm” for materials management, and “pp” for production planning), terms in the development sub-category relate to the customisation of such modules (e.g., “configur”, “implement”, “integr”, “test”). Domain-related terms refer to areas like supply chain management, finance, and manufacturing, the very domains that are supported by the ERP modules mentioned above. Finally, terms related to management and social competences refer to competences required in classic consulting projects (e.g., “lead”, “project”, “consult”, “provid”, “plan”, “team”, “travel”).

IT-Business Strategy Manager: Most of the descriptive terms for this profile were assigned to the management sub-category. In particular, strategic planning and decision making are key competence areas, as indicated by terms like “strateg”, “plan”, “risk”, “resourc”, “recommend”, “decis”, “ensur”, and “perform”. However, social competences like collaboration and communication (e.g., “team”, “particip”, “share”, “activ”, “communic”) also play an important role in this job profile. The aspect of IT-business alignment becomes apparent through high-loading job titles like IT Business Analysis Team Lead, IT Strategy Architecture Manager and IT-Business Consultant.

Technical Architect: Almost all high-loading terms were assigned to the software sub-category. Descriptors refer mostly to specific technologies, products, and vendors (e.g., “oracl”, “java”, “net”, “framework”, “sharepoint”, “ibm”, “microsoft", “soa”). The high-loading terms also indicate a clear need for development competences

(e.g., “design”, “architectur”, “implement”, “configur”, “integr”, “test”). High-loading job titles like Technical Analyst and Java Architect underscore the technical competences required in this job profile.

Comparing and contrasting various profiles shows that their focus differs substantially. The relative importance of each competence sub-category was calculated by determining the proportion of high-loading terms in a given sub-category to the total amount of high-loading terms assigned to the ideal type (Figure 4). This analysis shows major differences in the competence profiles of the seven ideal types. While it can generally be said that BPM professionals require a mix of technical, business, and systems competences, the relative importance of these three categories differs significantly among the identified seven ideal types. Typically, two to three of the seven detailed competence sub-categories defined by Todd et al. (1995) play a major role in a particular BPM job.

For example, for the Technical Architect ideal type, around 60 per cent of the high-loading terms were classified as technical (hardware and software), while approximately 15 per cent of the terms were placed into the business category and 25 per cent into the systems category. In contrast, the position Business Process Manager Sales & Marketing focused on business competences (domain, management, and social), as around 80 per cent of the high-loading terms were assigned to this category, while technical and systems competences were approximately equally distributed among the remaining 20 per cent of the terms. Looking at the Business Process Analyst ideal type, around 45 per cent of the high-loading terms were allocated to the systems category (problem solving and development), while another 45 per cent of the terms referred to business competences and around 10 per cent to technical competences.

In sum, the comparison of the ideal profiles shows major differences regarding their scope and focus. In fact, many of the BPM positions analysed revealed one core competence area. For instance, the IT-Business Strategy Manager shows a clear concentration on business competences. However, there are also ideal types which require an equal distribution of competences among the three main categories. The Business Process Improvement Manager shows an almost equal distribution of high-loading terms across the technical, business, and systems competence categories.

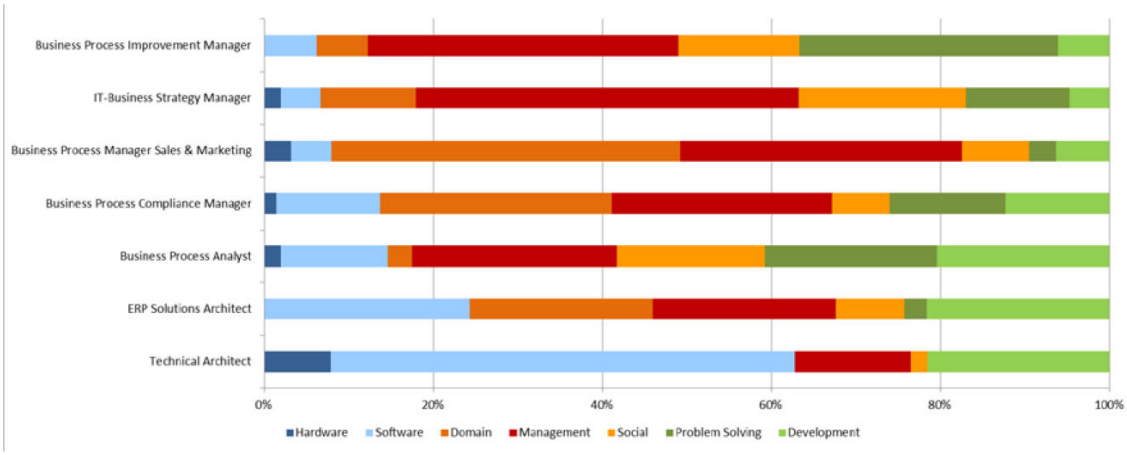


Figure 4 Overview of Ideal Profiles of BPM Professionals

4.3. Propositions

The results of the empirical analysis in this study suggest a number of propositions regarding the ideal types and profiles of BPM positions and their consequences for individual professionals and organisations.

Ideal types and profiles can be identified on several levels of abstraction. Typologies ranging from 2 to 20 ideal types were empirically derived. While the 2-factor solution resulted in equal partitioning into business- and systems-related jobs, the 20-factor solution revealed more specific job types. Hence, it is posited that *ideal types of BPM professionals can be defined on several levels of abstraction, ranging from a*

coarse-grained distinction between Business Analysts and Systems Analysts to a fine-grained differentiation among positions responsible for the various parts of the BPM lifecycle (e.g., analysis, improvement, compliance), types of business processes (e.g., sales & marketing, supply chain, accounting & finance), and classes of supporting IT systems (e.g., ERP, BI, ECM) (Proposition #1a).

Because of the lack of classification systems for BPM-specific competences, the IS knowledge and skill framework developed by Todd, McKeen, and Gallupe (1995) was applied to define ideal profiles of BPM professionals. The framework proved to be a valuable lens through which to analyse and classify BPM-related competences. In particular, the analysis revealed that the ideal types of BPM professionals identified are T-shaped or π-shaped, that is, general competences in all three categories of competences and a specialisation in one or two specific sub-categories are required. Hence, it can be stated that *each ideal type of BPM professional is associated with an ideal profile that consists of a broad range of technical, business, and systems competences and a specialisation in one or two specific sub-categories of competences (e.g., domain, management, software) (Proposition #1b).*

It can also be argued that, in order to be highly employable, individual BPM professionals should possess competences that are aligned with one of the ideal profiles identified. The rationale behind this argument is that employability can be broadly defined as an individual's ability to get and keep fulfilling work, and "for the individual, employability depends on the knowledge, skills and attitudes they possess" (Hillage and Pollard 1999, p. 2). Hence, as the ideal profiles have been derived from an empirical analysis of the demands of the BPM labour market, it can be posited that *individuals who possess competences that are aligned with any ideal profile of a BPM professional*

are likely to be more employable in the BPM field than are individuals who possess competences that are not aligned with any of the ideal profiles (Proposition #2a).

At an organisational level, it can be argued that, in order to achieve BPM success, process-oriented organisations should have a complete portfolio of all the ideal types of BPM professionals from one level of abstraction. Following the logic of contemporary BPM maturity models, the underlying assumption of this argument is that BPM success (i.e., efficient and effective business processes) is a function of the depth and width of organisational BPM capabilities (e.g., Rosemann & de Bruin 2005b; de Bruin & Rosemann 2007). According to the resource-based view of the firm, organisational capabilities stem largely from having valuable, rare, inimitable, and non-substitutable resources in the firm (Wright 2001). It can be argued that the ideal types of BPM professionals that were identified in this study represent such resources because they have been derived from analysing and aggregating competences that are in high demand on the labour market. Hence, it is posited that *organisations that have a complete portfolio of BPM professionals that is aligned with the overall set of ideal types for a given level of abstraction have better business process performance than do organisations that have a portfolio that is not aligned with the overall set of ideal types (Proposition #2b).*

It can also be argued that each organisation faces specific contextual factors that influence the type of required BPM personnel. Large companies with a highly mature BPM tend to employ more BPM-specific personnel than do smaller companies with less BPM maturity (Rosemann and de Bruin 2005b; Hammer 2007). Likewise, more BPM maturity is typically associated with a broader portfolio of BPM capabilities (Jesus et al. 2009). Hence, it is posited that *organisational context factors (e.g., company size, BPM*

maturity) determine the appropriate level of abstraction of the ideal types of BPM professionals (Propositions #2c).

5. Discussion

The objective of this study was to clarify individual BPM competence requirements. Comparable empirical research in the field of BPM is scarce, but two studies related to the research objective of this study were identified and the results were compared and contrasted.

Launonen and Kess (2002) investigate the roles and skills relevant for business process re-engineering (BPR) teams based on five case studies of manufacturing units of electronics companies. They apply the team roles classification proposed by Platt et al. (1988) and argue that a BPR team should have eight functional skills: innovation, resource investigation, organising, teamwork, meeting, finishing, evaluation, and project work. While the identified roles and skill requirements reflect the one-time project nature of classic BPR, the positions and competence profiles generated in this study are based on understanding BPM as a holistic and continuous management approach, so they also include continuous positions and associated competence requirements (e.g., Business Process Manager Sales & Marketing).

Another recent study of BPM positions and responsibilities, by Antonucci and Goeke (2011), is based on the Gartner report, “Role Definition and Organisational Structure: Business Process Improvement” (Melenovsky and Hill 2006). The authors identify four BPM positions—Business Process Director, Business Process Consultant, Business Process Architect, and Business Process Analyst—and related responsibilities using a survey-based approach. These four positions are well in line with the results of this study. Most of the responsibilities of a Business Process Director coincide with the

competences required from an IT-Business Strategy Manager, and the Business Process Consultant role involves competences, which in this study are assigned to a Business Process Improvement Manager and a Business Process Analyst. The responsibilities of a Business Process Architect correlate to those identified, for example, for Technical Architects and ERP Solutions Architects, and the Business Process Analyst role largely corresponds to the Business Process Analyst and Business Process Compliance Manager profiles. Therefore, the seven ideal types of BPM professionals determined in this study do not contradict the results attained by Gartner and verified in Antonucci and Goeke (2011) but provide a more detailed and comprehensive view of this topic.

5.1. Implications for Research

This study opens several opportunities for future research. First, a typology of BPM professionals from an empirical analysis of job advertisements in the area of BPM was inductively constructed, but empirical testing of this typology is needed to complete the theorising process. Such testing requires operationalising the typology constructs, measuring those constructs in practice, and testing the stated propositions. For example, the fit between the identified ideal profiles and the competence profiles of actual BPM professionals must be measured (Doty and Glick 1994) by developing a measurement scale that operationalises the categories and sub-categories of the ideal profiles. This scale could then be used to measure the degree to which a candidate possesses the competences in those categories. Testing the stated propositions at an individual level also requires measuring and comparing the employability of BPM professionals (Rothwell and Arnold 2007), while at an organisational level, testing the propositions requires analysing the alignment between a company's BPM competence portfolio and the identified ideal types and measuring the relationship between a portfolio of ideal

types of BPM professionals and a company's BPM success (Karimi, Somers, and Bhattacherjee 2007).

A second opportunity for future research arises from having used LSA to analyse the content of job ads and derive ideal types and profiles of BPM professionals, a process that included both automated statistical analysis and manual coding and interpretation. The automated part of LSA allowed us to uncover the latent semantics of texts and address the synonymy problem in natural language processing. These are two major advantages compared to simpler information retrieval models, such as Simple Boolean Matching (SBM) and the Vector Space Model (VSM) (Manning, Raghavan, and Schutze 2008). Compared to text-analysis techniques that rely on formal semantics (e.g., enhanced Topic-based Vector Space Model (eTVSM) (Polyvyanyy and Kuropka 2007)), LSA requires considerably less manual effort. However, formally defining concepts and relationships of a domain (e.g., in an ontology) would consider more linguistic phenomena (e.g., collocations and word ordering) and allow for logical reasoning (e.g., making inferences). Future research may try to combine the efficiency of the approach proposed here with the accuracy of more formal semantic techniques.

Manual coding of job ads, another alternative to the approach applied in this study, has been the standard approach to analysing job ads in the past, but it is subject to risks, such as bias from personal interpretations, so it requires triangulation of multiple researchers in order to yield reliable results. Moreover, because of its cost, manual analysis is usually restricted to small samples of ads and is less likely to be repeated regularly. In an attempt to combine the strengths of automated and manual analysis, the LSA was conducted in iterative cycles, where multiple researchers reviewed the plausibility of the automated statistical analysis and interpreted its results. A major part of these manual interventions focused on pre-processing job ads and filtering out

irrelevant words. Several attempts to automate this process were made, including trying to identify text blocks with standard company descriptions algorithmically (e.g., by identifying HTML tags that surround such blocks or using a plagiarism finder to detect recurring standard phrases). Systematically exploring strategies for reducing the manual effort of the applied approach is a worthwhile topic for future research.

Finally, future studies may also use the methodology developed in this study to analyse other areas of the IS job market (e.g., Business Intelligence, Enterprise Resource Planning).

5.2. Implications for Practice

This study provides several implications for practice. First, its results can be used to assess and develop BPM capabilities at both the individual and the organisational level. At an individual level, the results show pathways for career choices and decisions regarding continuing education, and the competence sets of the ideal types provide guidance for individuals' professional development. At an organisational level, the identified ideal types and profiles can be used as blueprints for strategic HR management (e.g., establishment of a BPM Centre of Excellence) and staffing decisions (e.g., for BPM projects).

Our findings can also be used for educational purposes, as the ideal types of BPM professionals provide direction for the development of specific educational programmes. For example, curricula may be developed on the basis of the identified BPM competences that are required in practice.

5.3. Limitations

The conducted research also contains some limitations. First, there may be limitations concerning the data source. As this study considers only current ads on BPM-related

jobs, no conclusions on the historical development of jobs in the BPM field can be drawn, only insights into the current state of employment requirements can be provided. Future research may determine how BPM-related job profiles change over time in an attempt to predict future requirements. In addition, the study considered only ads from one employment platform and only jobs in the US, Canada, the UK, and Australia. Therefore, the used data set may be culturally biased, as it covers only Anglo-Saxon countries, so the generalisability of the attained results is limited to this culture. Future research should consider job ads from other cultural backgrounds.

Another limitation refers to the use of job ads as input data for the analysis of BPM competences, as job ads may include biases. For example, they may be written to suit a particular individual, they may ask for more competences than can be reasonably expected from one applicant, and they may be based on competence categories that HR thinks the business needs (or applicants will understand), whether it does or not. While it is acknowledged that such biases may exist in the analysed data, it is believed that they are not significant for the research results, as the number of job ads that were examined should be sufficiently large to minimise the effect of biases in a few ads. The processing of such a broad data source as that used in this research gives a particular advantage to the here applied approach over other research methods, such as interviews, because it diminishes the risk of biases caused by specific contextual backgrounds.

Finally, limitations arise from the limitations of LSA. LSA is based on a bag-of-words model that ignores word orders and collocations, which can lead to words being taken out of context. For example, if the high-loading terms “Oracle” and “database” were extracted, it could be inferred that the related jobs require some kind of competence in the area of Oracle databases, but it is still not known whether the candidate should possess basic knowledge in Oracle databases, ten years of practical

experience in the area, or an official Oracle certification. Making such conclusions requires the co-occurrence of other descriptive terms, such as “experience” or “certification”.

In addition, LSA only partly addresses the problem of polysemy (i.e., the problem that some words have more than one meaning). From a computational perspective, polysemy is represented in LSA by descriptive terms that load high on multiple factors (Deerwester et al. 1990), so inspecting the terms that co-occur with a specific term helps to determine the context-specific meaning of that term. For example, when “bank” co-occurs with “money”, it likely relates to financial institutions, while it probably refers to geography when it co-occurs with “river”. Recognising and interpreting such patterns is not straightforward and requires substantial domain knowledge.

As LSA is based upon a bag-of-words representation of documents, it is less suitable for analysing texts that contain metaphorical languages (e.g., poems), causal reasoning (e.g., legal texts), or temporally or logically ordered lists (e.g., technical manuals) (Wolfe and Goldman 2003; Kintsch 2001). However, such linguistic phenomena are rare in job advertisements, so they played a minor role in the empirical analysis. Instead, the ads were characterised by the occurrence of very specific vocabulary with numerous technical terms and proper names denoting technologies or products, a situation in which LSA usually operates well (Giesbers, Rusman, and Bruggen 2006). In fact, experiments have shown that in domains with very specific vocabularies (e.g., science and technology), the performance of LSA can rival the performance of human coders in terms of accuracy (Landauer et al. 1997). Nonetheless, although the required effort is substantially lower, the heuristic approach of identifying patterns of BPM competences taken in this study does not reach the level of accuracy

that can theoretically be reached by manually enriching natural language job descriptions with formal semantic annotations (e.g., RDF, OWL).

In order to address the above mentioned limitations, future research should focus on triangulating the here presented results with findings generated by other empirical methods. This process can take three forms: First, one can compare the LSA results with results obtained by human coders analysing the same data set. At this, standard content analysis procedures and metrics (e.g., inter-coder reliability) can be used to judge the reliability and quality of the LSA results.

Second, one can ask human experts to assess the relevance of the LSA results (without analysing the underlying data set). Recently, a number of researchers have outlined processes for such evaluations. Chang et al. (2009), for example, have conducted experiments in which they have intentionally inserted random factors into the overall set of latent semantic factors and asked participants to identify these "intruders". Likewise, they also inserted random terms into the list of high-loading terms associated with a latent semantic factor and again asked participants to identify the "intruders". Low ability of human judges to identify intruders indicated a low coherence and relevance of the derived factors and terms.

Third, the here presented results can be compared and contrasted with findings obtained by applying other empirical methods. For example, one could conduct a Delphi study with BPM experts from various industries and regions to define typical BPM jobs and related profiles. This method relies on the use of expert opinions to obtain reliable consensus via a series of questionnaires with controlled feedback (Dalkey and Helmer 1963). It is typically applied to structure group consensus finding processes in complex issues which require diverse backgrounds, as for example, in the

case of identifying BPM competences that are required in different companies, industries or regions (Linstone and Turoff 1975).

6. Conclusion

Our study provides a comprehensive understanding of BPM competence requirements as seen from a practitioner's perspective. More than 1,500 current BPM job advertisements were examined through application of a state-of-the-art text-mining technique (LSA) and identified distinct ideal types and ideal profiles of BPM positions on several levels of abstraction. The analysis revealed that the competence requirements differ markedly among the various job types, yet all of them consist of a mix of technical, business, and systems competences. While most BPM jobs have a particular focus on one or two areas, some jobs require an equal distribution of competences in all areas. This study contributes to the existing IS body of knowledge on BPM by (1) proposing a typological theory of ideal types of BPM professionals, (2) giving practical guidance for building individual and organisational BPM competences, (3) informing the development of BPM curricula, and (4) demonstrating the usefulness of LSA for exploratory theory-building research.

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8. Appendix

8.1. Data Analysis

Table 9 Data collection and analysis process

Phase	Step	Activity	Input	Output	Tool	Automated/manual
Collection and Pre-processing of Job Ads	1	Collect job ads	Search terms (e.g., "business process")	Corpus of 2,324 job ads	Python script	Automated
	2	Remove unwanted job ads (e.g., duplicates, spam)	Corpus of 2,324 job ads	Corpus of 1,507 job ads	Duplicate finder	Manual/Automated
	3	Remove unwanted text blocks (e.g., company descriptions)	Corpus of 1,507 job ads	Corpus of 1,507 job ads	Text editor	Manual
	4	Stem terms	Corpus of 1,507 job ads, Dictionary with 11,376 descriptive terms	Corpus of 1,507 job ads, Dictionary with 6,785 descriptive terms	R script	Automated
	5	Remove stop words and unique terms	Corpus of 1,507 job ads, Dictionary with 6,785 descriptive terms	Corpus of 1,507 job ads, Dictionary with 3,732 descriptive terms	R script	Automated
	6	Remove uninformative terms	Corpus of 1,507 job ads, Dictionary with 3,732 descriptive terms	Corpus of 1,507 job ads, Dictionary with 1,422 descriptive terms	Spreadsheet tool	Manual
	7	Build term-document matrix	Corpus of 1,507 job ads, Dictionary with 1,422 descriptive terms	Term-document matrix	R script	Automated
	8	Weight term-document matrix	Term-document matrix	Term-document matrix	R script	Automated

Singular Value Decomposition	9	Set number of factors	-	Number of factors	-	Manual
	10	Decompose term-document matrix	Term-document matrix, Number of factors	Term eigenvectors, Document eigenvectors, Singular Values	R script	Automated
	11	Calculate term and document loadings	Term eigenvectors, Document eigenvectors, Singular Values	Term loadings, Document loadings	R script	Automated
Interpretation	12	Perform varimax rotation	Term loadings, Document loadings	Term loadings, Document loadings	R script	Automated
	13	Determine loading thresholds	Term loadings, Document loadings	Loading thresholds	Spreadsheet tool	Manual
	14	Identify high-loading terms and documents per factor	Term loadings, Document loadings, Loading thresholds	Factors with associated high-loading terms and documents	Spreadsheet tool	Automated
	15	Interpret and label factors	Factors with associated high-loading terms and documents	Labelled factors with associated high-loading terms and documents	Spreadsheet tool	Manual
	16	Create ideal types and profiles of jobs	Labelled factors with associated high-loading terms and documents	Ideal types, ideal profiles	Text editor	Manual
	17	Calculate descriptive statistics	Labelled factors with associated high-loading terms and documents	Descriptive statistics (e.g. number of jobs per ideal type)	Spreadsheet tool	Manual

8.2. Ideal Profiles of the 7-factors Solution

Table 10 Factor cross-loadings of job ads

Loading	Number of job ads	Percentage of job ads
on 1 factor	511	33.9
on 2 factors	200	13.3
on 3 factors	103	6.8
on 4 factors	38	2.5
on 5 factors	18	1.2
on 6 factors	1	0.1
on 7 factors	1	0.1
on no factor	635	42.1

Table 11 Ideal profile of a Business Process Analyst

Ideal type		
Business Process Analyst		
High-loading job titles		
Business Analyst, Business Systems Analyst, Business Process Analyst		
Competence requirements		
Category	**Sub-category**	**High-loading descriptive terms (stemmed; in order of highest loading terms)**
Technical	Hardware	technic, technolog
	Software	system, softwar, data, tool, flow, workflow, product, excel, interfac, web, environ, object, visio
Business	Domain	qualiti, standard, industri
	Management	busi, project, process, manag, plan, provid, effect, perform, conduct, present, scenario, organ, inform, defin, expert, lead, initi, ensur, success, senior, recommend, definit, priorit, execut, desir
	Social	team, stakehold, communic, facilit, collabor, interview, group, workshop, assist, particip, interact, liaison, translat, chang, accept, verbal, activ, session
Systems	Problem Solving	analyst, analysi, user, specif, gather, analyz, elicit, problem, identifi, analyt, complex, valid, evalu, request, scope, issu, research, enhanc, solv, interpret, gap
	Development	document, test, case, develop, model, design, methodolog, implement, creat, write, techniqu, diagram, support, life, cycl, map, architectur, descript, unit, sdlc, agil

Table 12 Ideal profile of a Business Process Compliance Manager

Ideal type		
Business Process Compliance Manager		
High-loading job titles		
Financial Control Analyst, Trade Compliance Manager, Business Process Controls Specialist, Audit Compliance Specialist		
Competence requirements		
Category	**Sub-category**	**High-loading descriptive terms (stemmed; in order of highest loading terms)**
Technical	Hardware	technic
	Software	system, excel, sql, databas, microsoft, offic, access, oracl, softwar, ms
Business	Domain	control, oper, procedur, data, account, audit, intern, financ, servic, monitor, polici, financi, complianc, depart, qualiti, environ, product, qualif, standard, extern
	Management	report, manag, ensur, busi, perform, process, provid, administr, project, inform, coordin, plan, effect, recommend, assign, complet, prepar, effici, profici
	Social	assist, communic, team, activ, staff
Systems	Problem Solving	user, issu, review, improv, analyst, problem, analysi, analyz, analyt, identifi
	Development	support, document, develop, test, maintain, program, implement, creat, write

Table 13 Ideal profile of a Business Process Manager Sales & Marketing

Ideal type		
Business Process Manager Sales & Marketing		
High-loading job titles		
Internal Sales Manager, CRM Business Solutions Advisor, Support Sales Account Executive, Director International Marketing Services, Managing Consultant Customer Innovation		
Competence requirements		
Category	**Sub-category**	**High-loading descriptive terms (stemmed; in order of highest loading terms)**
Technical	Hardware	technic, technolog
	Software	excel, system, softwar
Business	Domain	sale, market, servic, deliveri, account, key, deliv, financi, intern, product, industri, oper, environ, plan, record, sell, commerci, outsourc, valu, global, partner, direct, line, contract, programm, report
	Management	manag, busi, project, organis, process, consult, ensur, lead, strategi, success, demonstr, provid, proven, director, track, stakehold, drive, focus, present, effect, execut
	Social	team, relationship, chang, communic, activ
Systems	Problem Solving	analysi, improv
	Development	develop, support, build, implement

Table 14 Ideal profile of a Business Process Improvement Manager

Ideal type		
Business Process Improvement Manager		
High-loading job titles		
Business Process Excellence Manager, Lean Consultant, Operations Excellence Manager, Director Business Process Improvement, Business Process Re-Engineering Leader		
Competence requirements		
Category	**Sub-category**	**High-loading descriptive terms (stemmed; in order of highest loading terms)**
Technical	Hardware	-
	Software	tool, engin, excel
Business	Domain	oper, manufactur, qualiti
	Management	manag, process, busi, project, lead, continu, organ, strategi, leadership, plan, initi, demonstr, organiz, effect, leader, execut, practic, strategy
	Social	chang, drive, influenc, coach, facilit, cross, team
Systems	Problem Solving	improv, lean, sigma, six, belt, methodolog, techniqu, measur, black, metric, control, key, identifi, perform, certif
	Development	implement, model, develop

Table 15 Ideal profile of an ERP Solutions Architect

Ideal type		
ERP Solutions Architect		
High-loading job titles		
Business Solutions Specialist, ERP Business Analyst, SAP Solution Architect, Oracle Functional HR Consultant, SAP Business Process Expert Finance		
Competence requirements		
Category	**Sub-category**	**High-loading descriptive terms (stemmed; in order of highest loading terms)**
Technical	Hardware	-
	Software	sap, modul, system, erp, sd, fi, mm, oracl, pp
Business	Domain	suppli, chain, financ, global, order, product, expertis, manufactur
	Management	consult, busi, project, manag, process, provid, plan, lead
	Social	team, chang, travel
Systems	Problem Solving	user
	Development	configur, implement, support, integr, test, design, develop, lifecycl

Table 16 Ideal profile of an IT-Business Strategy Manager

Ideal type		
IT-Business Strategy Manager		
High-loading job titles		
IT Business Analysis Team Lead, IT Strategy Architecture Manager, IT-Business Consultant		
Competence requirements		
Category	**Sub-category**	**High-loading descriptive terms (stemmed; in order of highest loading terms)**
Technical	Hardware	technolog, technic
	Software	enterpris, object, sourc, system, data
Business	Domain	oper, valu, expert, unit, servic, expertis, extern, program, standard, agreement, intern, monitor
	Management	strateg, strategi, plan, risk, inform, resourc, recommend, decis, manag, organ, initi, direct, busi, ensur, perform, provid, potenti, trend, goal, leadership, organiz, effect, establish, impact, leader, project, situat, lead, prioriti, align, practic, execut, demonstr, approv, probe, achiev, action, set, wide, perspect, conduct, process, cost, signific, defin, present, outcom, propos
	Social	partner, team, relationship, group, collabor, particip, anticip, facilit, share, chang, cross, influenc, activ, communic, member, conflict, peer, interact, engag, assist, critic
Systems	Problem Solving	identifi, issu, complex, evalu, assess, review, problem, determin, analyz, solicit, improv, research, analysi
	Development	develop, implement, integr, support, maintain

Table 17 Ideal profile of a Technical Architect

Ideal type		
Technical Architect		
High-loading job titles		
Technical Analyst, Windows Server Developer, Java Architect, Desktop Virtualization Engineer, SharePoint Developer		
Competence requirements		
Category	**Sub-category**	**High-loading descriptive terms (stemmed; in order of highest loading terms)**
Technical	Hardware	server, technolog, technic, infrastructure, network
	Software	oracl, enterpris, sql, servic, web, data, databas, java, ibm, system, softwar, compon, platform, window, tool, sharepoint, net, xml, secur, framework, webspher, standard, microsoft, soa, suit, environ, bi
Business	Domain	-
	Management	manag, busi, bpm, consult, provid, perform, deliveri
	Social	team
Systems	Problem Solving	-
	Development	architectur, design, integr, architect, develop, model, support, implement, configur, test, program