

# Work Experience in PAIS – Concepts, Measurements and Potentials

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**Abstract.** Process-Aware Information Systems consider various characteristics of resources, such as capabilities, as a driver for allocating task to humans. Work experience has been discussed as a possible variable of history-based allocation. However, work experience has been considered in a limited extend, reducing the perspective on measurements to single aspects such as years of working in an organization, ore amount of performed tasks. Further, the allocation has mainly been oriented towards the best possible fit of humans to the requirements of the task and the process. This contribution is a first step towards an human-centric work experience allocation. It concentrates on the question how experience collected by individuals working with business processes may be measured in PAIS. A collection of work experience measurements at various organizational levels is provided. The measurement collection resulted from a literature review of PAIS theory, selected psychological literature and an qualitative analysis of job offers.

**Keywords:** Human-centric allocation, work experiences, experience-based allocation.

## 1 Introduction

Process-Aware Information Systems (PAIS), offer various advantages to organizations such as increased quality of output, shorter cycle times and faster feedback. However, PAIS have received criticism as well, mainly referring to their potential to support a too rigid or mechanistic work. Over the last years, there have been several works addressing various aspects of human orientation in PAIS, such as the interaction of automated and human workflows, like BPEL4People [2][4], human interactions [33] [14], flexibility in workflow enactment [9], strategic resource allocation for longer-term skill acquisition and diversification in organizations [1], understandability of business processes [20] [19], and the human-oriented tuning of functionalities in such systems [38], which contributed toward the growing attention on humans and the effects on their performance, satisfaction, and motivation by working with such systems.

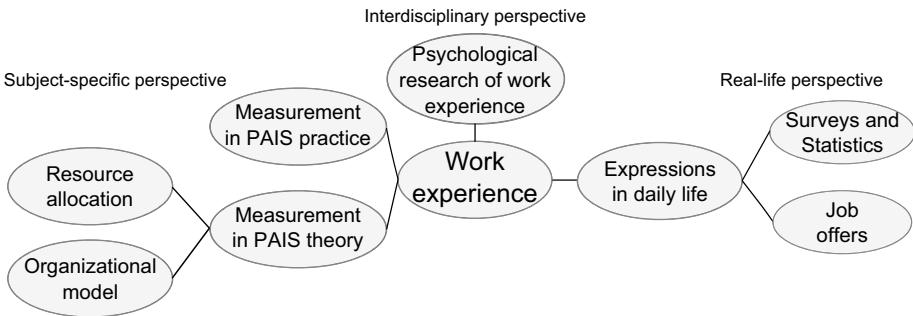
Human work experience has been considered particularly in capability-, and history-based allocation as one of the attributes according to which the assignment of humans to tasks were guided. However, work experience has mainly been considered as a simple count or measurement in PAIS so far, such as the indication of previous work experience in the field in years (capability) or amount of execution tasks (history). However, work experience is more complex than simple measures such as ‘more executions = more experience’ [39]. In this work we aim to support an understanding of work experience as a complex, multidimensional construct. Our study comprises a literature review of PAIS theory led by the question how resources in PAIS are described, an analysis of job offers that should provide an understanding of the common practice of expressing and measuring work experience in daily life, and an insight into the construct work experience as illustrated in selected psychological theory. Further, this contribution aims at discussing the potentials of work experience as the driver for human-centric allocation in PAIS.

## 2 Classification and Literature Study

An optimal performance of processes and their tasks is essential for the organizations’ competitiveness, however it has been shown that job satisfaction and experience might increase performance as well. Our goal is to support a shift of perspective on the allocation in PAIS from a process-oriented to a human-centric one. In a *process-centric view*, task allocation is oriented according to the best possible fit of humans to task requirements. In a *human-centric view* the center of interest is on humans working with a PAIS. Allocation is led by humans’ development and considers individuals’ goals of development in an organization and development strategies (such as specialization and generalization). A human-centric allocation should ensure at least a comparable quality of process performance as provided by an process-oriented allocation. We argue, that human-centric allocation can be strongly supported by work experience as a driver for the alignment of tasks to human requirements.

Towards a human-centric allocation we want to provide an understanding of work experience as a complex construct with various facets. The underlying study was guided by the question *whether and how can work experience of humans be measured* (a) in the field of PAIS, e.g., to use this information for the allocation of tasks to humans, (b) in *work psychology* to provide an interdisciplinary view on work experience, and (c) in *daily life* to provide an overview of common practice of describing work experience. Figure 1 illustrates sources that were used to find out more about work experience and its measurements. The source categorizations resulted from applying Brainstorming [23] in a small group of researchers to the topic *Where to find work experience measurements?*

‘*Work Experience*’ in Process-Aware Information Systems. A literature review was conducted based on the goal to find out *to what degree work experience of humans has been considered in PAIS theory*, for example, as a supportive



**Fig. 1.** Sources for work experience measurements as a result of Brainstorming

factor for the allocation of business process tasks to humans. As a more general question, we also wanted to find out *how individuals have been described in PAIS theory*, and even more general, *how resources have been specified in PAIS theory*.

*'Work Experience' in Daily Life.* The labor market in general, and job offers in particular appeared to be an appropriate source for gathering information about work experience as handled in practice. Furthermore, selected surveys and studies were used to illustrate common practice in capturing information about work experience.

*'Work Experience' in Psychology.* To bring perspectives from other disciplines into our field of view, *psychological research on experience*, and particularly on work experience was considered in this study.

## 2.1 ‘Work Experience’ in PAIS Literature - A Review

A literature review was conducted to capture information about how *resources* in general, and persons and their work experiences in particular are described in PAIS theory. The literature review was conducted in four phases: broad and deep search, selection of matches, coding, and analysis.

Five broad and two deep searches were conducted by means of Google Scholar using different search terms as illustrated in Figure 2. As Google Scholar sorts the hits according to their relevance, the first 100 hits of each of the broad searches 2, 4 and 5 were considered in the list of results. The broad searches resulted in a total of 443 hits, the deep search in a total of 164 hits (Information Systems: 11 hits, Data and Knowledge Engineering: 11 hits, MIS Quarterly: 7 hits, Business Process Management Journal: 32 hits, BPM: 31 hits, CAiSE: 72 hits). To sum up, the broad and deep searches resulted in a total of 607 hits.

The text material was further selected according to text availability and duplicate reduction. Further, keywords were used to automatically highlight relevant text segments in the text material. Examples of keywords were *resource*, *human*, *actor*, *role*, *experience*, *capability*. The highlighted text passages offered

Search Terms of the Broad and Deep Search				
Iteration	All words	Exact phrase	With at least one of the words	Hits
Broad Search 1	Resource, allocation, capabilities, experience, workflow	Process aware information systems	Skills, competencies, attitudes	61
	Organizational, resources, perspective	Process aware information systems		
Broad Search 2	Organizational, model, workflow	Process aware information systems	Capabilities, skills, competencies, experience	100/ 593
Broad Search 3	resource allocation, organizational model	Workflow system, Workflow management system	Capabilities, skills, competencies, experience	82
Broad Search 4	Actor, human agent, resources, human resources, work distribution	Workflow system, Workflow management system	Capabilities, skills, competencies, experience	100/279
Broad Search 5	Resource, organizational, perspective		Capabilities, skills, competencies, experience	100/233
Deep search 1	Single search: Resource view, resource perspective, resource allocation, organizational perspective, work experience		Capabilities, skills, competencies, experience	164
Deep search 2				

**Fig. 2.** Search terms of the searches via Google Scholar

a basis to manually categorize contributions according to their relevance to the leading literature review questions. 142 contributions included text phrases relevant for the further analysis. The selected contributions<sup>1</sup> were manually coded by one researcher according to predefined rules, the categories were elaborated inductively. One broad category was *resources* in which text passages were summarized that included a description of particularly ‘humans’ as resources. This category could be subdivided into further 19 subcategories, as illustrated in Figure 3. We summarize that a resource may be of different types, e.g. human or non-human and a member of various resource classes that may be based on capabilities, such as functional requirements, or the structure of the organization. A resource may be an entity, or item, object, service, actor, agent, participant, person, subject, employee, user, individual, worker, workflow participant which is able to perform a task. A resource may have attributes, features and particularities (such as an identifier, name, description, availability/absence status, costs), one or more roles, capabilities, a position (function, job), skills, relations, experience, privileges, constraints, responsibilities, and behavior. A resource may belong to organizational units (also including e.g. branches, divisions), teams or work groups, and an organization. The task of a resource is doing work, such as performing tasks, or projects. A resource may use other (e.g. non-human) resources.

Further, we were interested in the explanations of particular terms such as *capabilities, features, competencies, skills, qualification and experience* which were partly used to describe resources, and often mentioned as being important for the composition of roles. We experienced during the analysis, that in most of the contributions the terms used were not further explained in detail, e.g., ‘*capabilities may include qualifications and skills.*’. It could occur that similar terms were used to express different meanings. Some examples will be presented in the following.

<sup>1</sup> Literature list available under <http://cs.univie.ac.at/research/projects/projekt/infproj/1026/>

Category	Subcategory	Cases	Category	Subcategory	Cases
RESOURCE_MAY BE	OF TYPES	51	RESOURCES_MAY BELONG TO	PRIVILEGES	3
	ENTITY	38		CONSTRAINTS	2
	MEMBER OF RESOURCE CLASSES	11		RESPONSIBILITIES	2
RESOURCE_MAY HAVE	ATTRIBUTES, FEATURES	26		BEHAVIOR	2
	ROLE(S)	36		ORG UNITS	24
	CAPABILITIES	17		TEAM, WORK GROUP	10
	POSITION	11		ORGANIZATION	5
	SKILLS	6		RESOURCE_TASK	16
	RELATIONS	5		RESOURCE_MAY USE	2
	EXPERIENCE	4		RESOURCE(S)	2

**Fig. 3.** Categorization of text phrases referring to resources

*Capabilities* have been used to describe both human and non-human resources. Referring to the former, capabilities were synonymously used for *attributes* (3 cases) and were understood as direct property of the resource (3 cases), and qualities that persons possess (2 cases). Capabilities were argued to be used to clarify the suitability or ability of performing work items (7 cases). Capabilities were considered as skills (8 cases), qualifications (7 cases), as well as specific responsibilities (4 cases) and previous work experience (4 cases) (both subsumed as ‘job-related or personal attributes’ (4 cases)), functional requirements (3 cases), and equipment (1 case). Capabilities might be recorded (2 cases), such as in the organizational model (1 case), and might have several metrics, such as name, type, and values (4 cases). Capabilities might be considered for work distribution (2 cases), and evaluated during runtime (1 case).

The use and the textual description for the term *feature* in order to describe resources was found in just a few contributions: ‘which further describe specific characteristics that they [individual resources] may possess that could be of interest when allocating work items.’ [30, p. 4][31, p. 221].

*Competencies* seemed to be understood in two different ways: some contributions considered competencies as separated from the resource, e.g. connected to the position (such as privileges) (2 cases), whereas others considered them as attributes of the person and strongly connected to a task (2 cases). Referring to the latter, competencies have been understood as, for example, the combination of knowledge, skills and behavior utilized to improve performance (1 case). There seem to be different types of competencies, such as generic, organic and changing ones, or in-stock (previously acquired), in-use (currently put in practice), and in-making (target competencies) ones (1 case). Competencies have been considered for evaluating and monitoring persons (3 cases), and the trade-off between the transparency of competencies and user privacy has been mentioned as an emerging challenge (1 case). Competency management has been considered as support of competency identification, assessment, acquisition, and usage (1 case).

*Skills* were considered as the ability of being able to fulfill a function or role (2 cases), capability (1 case), and particular knowledge (1 case). Skills were argued to be measurable (1 case), and changing over time (e.g. due to development) (2 cases). A skill was considered as a service a person might offer, a direct property of a person (1 case), and as part of a person’s skills set (3 cases).

*Qualifications* were explained as ‘*expressed as the roles they [human and non-human resources in a business] can fulfill.*’ in [10, p. 51]. Qualifications were considered as direct property of the person (2 cases). [32] distinguish among capabilities (including qualification and previous work experience) and abilities to undertake certain tasks (such as *licenses held, trade certifications*) [32, p. 185]. Qualifications were described by means of a name, description, comment, and condition (1 case).

*Experience* was understood in several ways, such as *who has the most experience with this type of work item* [32, p. 187], *who has had the least numbers of failures when tackling similar tasks* [30, p. 19] [32], or was expressed as *familiarity* (how familiar is a resource with performing a work item [16]. [8, p. 910] described the *actor experience* as experience of an actor (human or software) in performing a specific job. [8] and [24, p. 308] distinguished a actors’s (human or software) level of experience, such as novice, expert and guru. Still referring to experience, [24, p. 308] argues that *typically, an activity will be allocated to actors with the highest level of expertise available*, bringing another term, *expertise*, into the field of view. As a measurement of experience, the *number of sibling work items the resource has already performed*, including the best past execution were mentioned. [6] describes an *experience index calculation* which was divided into 3 steps: the level of activity performance of each performer was summed for each degree of activities, then each sum was multiplied per a coefficient/weight which expressed the complexity degree and the sum of all these multiplications was finally normalized by using a value associated to an expert scale (discipline advisor - very expert specialist - expert specialist - senior specialist - basic specialist) [6, p.307 ]. A more simple experience measure was proposed by [39], indicating that *more executions of an activity = more experience*. Other statements referring to work experience addressed the work experience measurement in years, e.g., ‘How many years have you been in the IS profession’ [36]. As a specification of individual characteristics, [32] mentioned *previous jobs*, which can also be seen as previous work experience. [21] mentioned *the amount of work done in a PAIS*, and *the time worked with the PAIS* in the context of internal validity of their study, however these factors may also be considered as measurements for work experience. History-based allocation was mentioned as a resource pattern that provide information that may be seen as analogue to human work experience with PAIS [30].

*Lessons Learned.* The results of the literature review of PAIS theory indicated no evidence that a human-centric allocation based on work experience has already been proposed in the field of resource allocation in PAIS. Further we could identify a mix of terms used for describing characteristics of humans considered as resources in PAIS. The various terms seem to be used intuitively rather than following a clear and separated understanding of the respective terms. We recognized that often terms were just mentioned without further explaining their understanding by the author and offered a basis for different interpretations by the reader. Further, several graphical illustrations were not completely described and explained which aggravated finding a common understanding of terms. We

focused on explicit explanations of the terms in textual form which reduced the relevant text material compared to the initially found literature.

## 2.2 ‘Work Experience’ in Daily Life

In order to find out more about ‘work experience’, e.g., how it is expressed and proven in daily life, a qualitative content analysis of job offers was conducted. The job offers were collected from the online career network *jobpilot.de*. A total of 83 job offers (without duplicates) were selected which resulted from searching for ‘permanent positions’, ‘career level: experienced’, ‘worldwide job offers’, ‘occupational fields: strategic management, information technology’, all specifications, all branches, all regions, ‘job offers of the last 4 weeks’. The number of employers could not be identified, as several job offers were announced in an anonymous way via recruitment agencies. Altogether, the material for analysis comprised 24,516 words. Categories were elaborated inductively and are illustrated as results of the qualitative analysis of job offers in Figure 4.

Category	Subcategory	Count*	Example
Work experience	Industry/Employment experience	16,9% (14/14)	'They are looking for an engineer who is CCNA-CCNP level with 3-5 years of industry experience.'
	Experience in the field	43,4% (53/36)	'To be qualified for this role, this individual should have over 7 years of experience within development and architecture.'
	Functional experience	8,4% (7/7)	'Strong experience in a database administration role...'. ..preferably bying a qualified accountant with at least 5 years of functional experience.'
	Hands-on experience	56,6% (77/47)	'2-3 years of experience with C# and ASP.NET and the SDLC.'
	Generic experience	7,2% (7/6)	'This individual should also have lead experience.' 'Language skills...'
Proof	Time (years)	43,4% (45/36)	'10-12+ years experience in relevant software or internet service industry with a service operational background.'
	Track record	22,9% (20/19)	'1 year project management experience with digital agency, a proven track record in delivering various digital advertising projects...'
	Work knowledge and skills	80,7% (110/67)	'Experience in writing or executing test cases.'

\* % of job offers (count of the statement / number of job offers where statement was found)

**Fig. 4.** Categories of ‘work experience’ resulting from job offer content analysis

The qualitative content analysis included the search and coding of statements that referred to *experience*. Five sub-categories were elaborated to reflect the meaning of *experience* in the statements. Some statements referred to past employment experience which were subsumed into the subcategory *industry/employment experience*. Statements, that referred to experience in a broader area, such as ‘internet technologies’ were subsumed to *experience in the field*. More specific statements which included explicit functions, jobs, or roles were

aggregated into the subcategory *functional experience*. The sub-category *hands-on experience* included statements that focused on experience from practicing, e.g., developing software in Java. In the final subcategory *generic experience* statements were collected that refer to work experiences that can be seen as transferable among different subjects, disciplines and hence interpreted as more generic experiences, such as ‘experience with leadership and budget responsibilities’. This subcategory was included to highlight that there were not exclusively subject-specific (fundamental to the subject, discipline) work experiences stated in the analyzed job offers. The second category focused on the *proof of work experience*. Three subcategories were derived from the underlying job offer text material: *time* (typically expressed in years), *track record* (including records such as projects, employers and functions), and *work knowledge and skills*. Many of the statements referred to work knowledge and skills (e.g., ‘experience working with version control systems’, financial experience’). All these statements were summed up to one subcategory as they had one aspect in common: independent of the further supportive records - finally it is the individual who needs to proof the experience, e.g., by demonstration.

The qualitative content analysis of selected job offers helped us to understand, that there seemed to be different perspectives on work experience and that work experience cannot be captured in its complexity by one simple measure. The search in surveys and scales supported this perception. Traditional measurements of work experience in, for example, earning studies were to deduct the years of completed schooling from the individuals’ age (in years) at the start of a specific period in order to receive the years of accumulated experience. Further work experience measurements have been, for example, the time spent in the labor force, time employed, and time since school graduation as mentioned above [25]. In addition to the general perspective on work experience, there were also measurements of hands-on experiences, for example in business process modeling studies which noticed modeling experiences (e.g., levels such as novices and experts) as a factor influencing, e.g., task performance [27]. Often the participants of the surveys were asked to self-assess their level of experience, to express their modeling experience in time (e.g., number of years experience in process modeling overall, number of months experience in a particular process modeling grammar), or in the number of process models created [28].

### 2.3 ‘Work Experience’ in Psychology - An Initial Touch

In the following section, our intention was not to provide a holistic insight into psychology research on work experience but rather to initially sense the construct ‘work experience’ as discussed in psychology. Considered were contributions of the Journal ‘Personnel Psychology’ including research around people at work. A search via ProQuest by using the search terms ‘work experience’ resulted in 6 hits. In the following we will summarize these contributions by illustrating the model of work experience as proposed by [35] (based on [26]), and providing an overview of work experience components, as well as quantitative and qualitative work experience measurements.

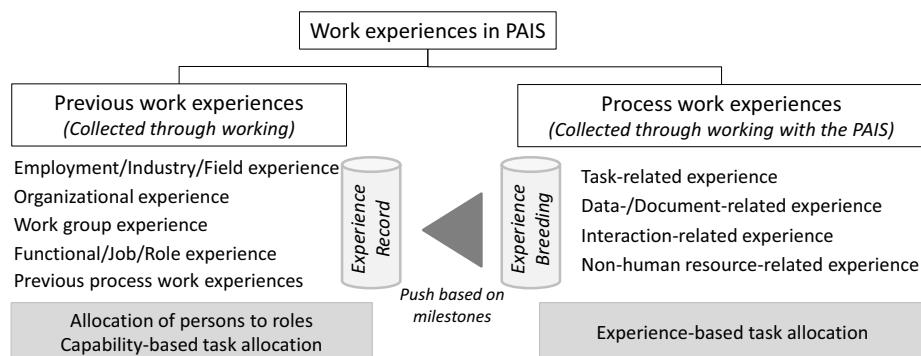
*Understanding of work experience.* [35] suggest to consider work experience as a ‘multidimensional, multilevel, and temporarily dynamic construct’[35, p. 326] and describe a model of work experience that includes three major components of work experience: the quantitative, qualitative, and the interaction component. The *quantitative component* includes in general two measurement methods, time-based and amount-based measurements. Explicit quantitative measurements are (citations were taken from [26][35]): time on a task [26], time on the job/position (job tenure) (e.g.,[17][5]), time spent in an organization (organizational tenure) (e.g., [18]), number of times a task has been performed (activity level, task frequency) (e.g., [15][37][7]), number of jobs held in an organization [26][35], and number of employers. The advantage of the amount measurements (e.g., number of times a task has been performed) is that they imply information about qualities that affect work experience, such as the opportunity to perform and practice particular tasks. The *qualitative component* of work experience includes aspects (such as variety, challenge, and complexity) that will differ in their relevance for different domains. Explicit qualitative measurements are: variety of tasks, breadth (number of different tasks), and responsibilities performed in a job, types of challenges encountered in an assignment, task type (difficulty/criticality/complexity of the task performed)[26], job complexity [26], type of organization [26], opportunities to develop new knowledge and skills through training (see also [35]), working with a highly supportive mentor (see also [35]), recency of tasks [7], and supervisory tasks [7]. The *interaction component* considers the interaction between the qualitative and quantitative components of work experience. The interaction may be reflected in ‘density’ which intends to capture the level of intensity of experiences. A scenario that illustrates a high-density experience is an individual in a one year assignment who faces many challenging situations while another individual in a similar assignment faces just a few challenging conditions. Another interaction component is ‘timing’. How an individual is influenced by an experience depends on when the experience occurs during a career. Experiences can be sequenced in ways that maximize motivational and performance outcomes [35, p. 330]. The *level of specificity* determines how specific is the measure of experience in question. Experience measurement can be specified in different levels such as the task-, job-, and organizational level [26], and the work group level (measurements may be the number of different work groups and the type of teams such as cross-functional problem-solving teams)[35, p. 330]. Work experience can lead to the development of knowledge and skills, motivation, and attitudes and values that factor into performance and other organization-valued outcomes’[35, p. 334]. For example, the number of times a task has been performed can enhance proficiency by honing skills through practice. Direct outcomes may be increased work knowledge and skills, motivation, and work-related values and attitudes. Indirect outcomes of work experience may be performance, and participation in developmental activities [35].

### 3 ‘Work Experience’ as Critical Factor in PAIS

According to the psychological theory there is a recognizable correlation between work experience and job performance. From our point of view, humans as critical ‘resources’ in PAIS have received too little attention in PAIS theory so far.

Work experience can be considered as twofold: it may be understood as (a) the experience a person has gained from and in performing a business activity and task; or (b) the perception of one’s work. Referring to the latter, performing a business activity or task may be experienced as, for example, stressful, pleasant, challenging, or dull. How work is experienced affects personal and organizational outcomes [3,22]. Qualitative measurements of work perception may be placed on different time levels [3, p. 532], e.g. immediately, asking individuals what they are doing now and how they feel about it; short-termed, asking individuals after a short period of time about their experiences, e.g., after a working day; or long-termed, asking individuals to recollect or reconstruct experience over an extended period of time. The perception of a person’s work may be positively or negatively influenced by the task allocation strategy in PAIS. In the following, we put our focus on the former understanding of work experience, the experiences an employee has gained by performing business activities and tasks.

The description of humans in PAIS is typically based on the concept of *roles*. A role may be seen as a group of humans with specific capabilities and privileges. While privileges are assigned to an organizational position, capabilities are considered as a direct property of the person. We understand work experience as a specification of capabilities. As illustrated in Figure 5 we subdivide work experiences into *previous work experiences* and *process work experiences*.



**Fig. 5.** Work experiences in PAIS

*Previous work experiences* to be considered in PAIS may include work experiences that were gathered, on the one hand, *before* a person started to work in the current organization, job, or role, and, on the other hand, during working in

an organization up to a particular milestone. As illustrated in Figure 5 we subdivide the previous work experiences according to the levels of specificity of [35] (as discussed in Section 2) into employment/industry/field experience (occupation level), organizational experience (organization level), work group experience (work group level), functional/job/role experience (job level), and previous process work experience (task level). Measurements about previous work experiences were subdivided into the measurement modes *time* and *amount* (quantitative measurements), as well as *type* (qualitative measurements) according to [26][35] and are illustrated in Figure 6. Information about previous work experiences is particularly relevant for the *allocation of persons to roles* and *capability-based task allocation in PAIS* and needs to be recorded adequately in a database (*Experience Record*). The information about previous work experiences can improve a more fine-grained allocation of persons to roles, such as the allocation of a new employee to a role based on start values derived from CV and the job interview, or the (more objective) suggestion of potential internal employees for the reoccupation of a post. A capability-based task allocation in general, and a previous work experience-based task allocation in particular makes sense if previous work experiences can be used to describe in more detail what business activities and tasks require in order to be adequately performed. Typical work experience information already used is, for example, the number of employers, the type of employers, or previous work experience in years (e.g. 10 years work experience in Airbus servicing [30, p. 17]) as described in the capability-based allocation resource pattern [30].

Previous Work Experiences Measurements in PAIS			
Labels of Previous Work Experiences	Level of Measurements	Measurements in PAIS	
		Quantitative Measurements	Qualitative Measurements
Employment/ Industry/Field experience	Occupation	Time employed	Type of field
		Time employed in a field	
Organizational experience	Organization	No. of organizations	
		Time spent in an organization (seniority)	Type of organization
Work group experience	Work group	No. of work groups	Type of work group
		Time spent in a work group	
Functional / Job / Role experience	Job, Role	No. of functions/ jobs/ roles performed	Type of function/ job / role
		Time in a role	Type of responsibilities
Previous process work experiences	Process/Task	See Fig. 7: Collection of process work experiences measurements	

**Fig. 6.** Collection of previous work experience measurements

The greatest potential of work experiences measurements in PAIS we see in the measurements located at the task level. We called the work experiences measured at task level *process work experiences*. Process work experiences are gained from working in processes with the PAIS. We subdivided the process work experiences into task-related, data-/document related, interaction-related, and non-human resource-related experiences. The process work experience measurements were subdivided into quantitative (time, amount) and qualitative (type, and (self-, and peer-) evaluations) ones, as illustrated in Figure 7. Additionally

to the measurement modes time, amount and type we argue, that work experience measurements that refer to the *quality of tasks results* need to be considered in PAIS. Such measurements can be of quantitative and qualitative nature. For example, Andy has performed the rough-grained task ‘writing a research paper’ 100 times so far. However, the number of times the task has been performed does not provide insights into the quality of the task results. In order to get a picture of the quality of the resulted research papers, we need specific measurements, for example, depending on the type of the research papers (such as journal article, conference paper, workshop paper, book section), the impact factor of the journal, organization-internal rankings of publication organs, the number of citations (e.g. without self-citations), and feedback of the reviewers could be considered. We suggest that process work experiences are collected by various measurements during a period of time up to a particular milestone (*Experience Breeding*) and then pushed into the *Experience Record* database in which information about previous work experience is stored. Milestones could be, for example, experience levels to be reached (e.g. newbie, valuable, special force, magister), and dates (e.g. filling of a post). While the milestone is not reached, work experience values are collected and aggregated in the Experience Breeding database. If the milestone is reached, the aggregated values are pushed to the Experience Record database.

The information collected about process work experiences is highly relevant for *process experiences-based task allocation in PAIS* as it provides more fine-grained characteristics of employees performing in the same role. The fine-grained information about process work experiences can improve task allocation to humans, e.g., in the following ways: (a) breeding of process work experiences up to a particular level, (b) support of work experience-building strategies (such as the support of specialists and generalists), and (c) mentoring, e.g. to support exchange and the sharing of experiences across levels.

Process Work Experiences Measurements in PAIS		
Labels of Process Work Experiences	Measurements in PAIS	
	Quantitative Measurements	Qualitative Measurements
Task-related experience	No. of times performing a task	Type of task (difficulty, complexity, criticality)
	Time on a task (task completion time)	Types of challenges encountered in the task
	No. of task types (variety)	Actor evaluation
	No. of sibling tasks performed	
	No. of task success/failure	
Task-result quality measurements		
Data-/Document related experience	No. of times working on data/a document	Type of data/document
	Time working on data/a document	Data-/Document evaluation
	No. of times working in an interaction	Type of interaction (e.g. teams, customers)
	Time in an interaction	Persons interacted with Interaction evaluation
Non-human resource-related experience	No. of times working with a resource	Type of non-human resources
	Time working with a resource	

**Fig. 7.** Collection of process work experience measurements

## 4 Discussion

*'Work Experiences'-Based Allocation in PAIS.* 'Work experience'-based allocation can be understood as a combination of capability-based [30] and history-based allocation [30]. In order to be able to consider work experiences for allocating tasks to humans in PAIS, the details captured and maintained for 'human resources' need to be extended, or the information from previous execution history of humans needs to be extracted from workflow logs to use it in the allocation process [30, p. 19]. Referring to the latter, it needs to be determined what information has to be logged whereby the design of the process logs will be affected. A concrete description and guideline for work experience-based allocation and the illustration of log design that captures work experience will be presented in future work. Work experience-based allocation has a potential to support various allocation best practices as presented in [29], such as case manager, case assignment, customer teams, flexible assignment and specialist-generalist assignment. For example, information about work experience can be used to identify the most experienced case manager in the organization in order to, e.g., guide critical cases or escalations. Customer teams may be composed based on the individuals' work experience. Furthermore, work experience may be used as a factor for identifying specialists and generalist, but also to lead individuals to a particular specialization or generalization level. Work experience can not only be used to identify individuals who have a high level of work experience, but also to find these individuals who need to build up work experience (e.g., novices). These individuals can be supported by, for example, providing a mentor for a task or a case, offering 'how-to' video streams, or exemplary output of the activity as a guideline. Highly experienced individuals may be suggested as mentors, or as experts in critical process instances. Future research will address human-centric functionalities in PAIS which are based on work experience. A challenge of considering work experience information may be the trade off between work experience transparency and the privacy of the users. To deal with this data in a sensitive way, appropriate access control need to be considered (e.g., restricted access to anonymised data).

*Benefit of Work Experience Information from PAIS for Daily Life.* Information of work experience which we suggest to be gathered and used in PAIS for the allocation of tasks to humans may provide also benefits from a more general point of view. The information of an individual's work experiences may be considered and prepared as a portfolio providing the individual with a detailed documentation of his or her work at the particular employer. This portfolio may be understood as a detailed track record, or in other words, a kind of proof of work experience collected in an organization (compare with Figure 4). Furthermore, the transparency of work experience of humans in the organization may serve the organization and the individuals as a information basis on which decisions concerning formal learning and training for specifying or broadening individuals' knowledge, skills and competencies may be taken. An important stream of

research and work in this context concentrates on competency and skills standards and specifications in order to make particularly competencies and skills usable and reusable across education, work and the labor market in a ‘lifelong’ perspective. Specifications and standards are, for example, the IMS Reusable Definition of Competency or Educational Objective Specification (RDCEO)[13], the IEEE Data Model for Reusable Competency Definitions (RCD)[12], HR-XML (human resources XML)[11], or SIFA (Skills Framework for the Information Age)[34]. These information sources should also be considered particularly when a combination of competencies/skills and work experiences are considered in PAIS.

*Collecting Data for Work Experience Research.* There are several ways of looking at how ‘work experience’ can be considered in PAIS and to what outcomes it should lead. In our point of view PAIS seem to have enormous potentials to provide a fruitful context for collecting data critical to find out more about the construct ‘work experience’. In general, PAIS may be used to find out under which conditions experience leads to a desired outcome.

## 5 Conclusion

The main goal of this work was to focus on work experience from various perspectives to perceive the construct work experience with its various facets, to bring some transparency to its measurements, and to discuss potentials its potentials as a possible individual attribute in PAIS. A literature review was conducted in PAIS theory which concentrated on the descriptions of resources, in particular human ‘resources’ in the context of PAIS. The text material analyzed partly lacked term explanations used to describe resources, particularly when individual attributes directly connected to a particular person (such as qualifications, skills, competencies, experiences) were mentioned. The woolly manner of expressions of individual attributes indicates a necessity for clarification including explanation and distinction between the terms and attributes used. The analysis of job offers showed that there were several ways to express and measure work experience in daily life. Various facets of work experience were as well reflected in the multidimensional understanding of work experience as illustrated in psychological literature. The result of the study was a collection of work experience measurement that can be considered in PAIS. The better understanding of work experience and the collection of work experience measurements for PAIS provide the basic step for further work. The potentials of work experience as one of the individual attributes describing and considering humans in PAIS are particularly seen in a finer and more value adding allocation of humans to tasks from the perspective of the individual (e.g., allocation leaded by the goal to build-up experiences). This contribution can be considered as a first step towards providing a holistic solution of integrating work experience into PAIS.

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