Personas and Tasks for International Data Space-based Ecosystems

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Abstract: The International Data Space (IDS) is a platform developed for a global data ecosystem, composed of interconnected devices which gather, process, exchange and trade data. IDS and industry data are the research focus of many scientific papers dealing with analysis from a technical and economic point of view (Brost et al., 2018; Graube, 2018). This paper examines the users of the IDS as personas, a method for presenting and communicating stakeholder needs for IDS. By applying a user picture and name, properties and description a persona provides product users and developers with a representation of the design target. Using this research approach, the industry-wide requirements of potential users are analyzed in a task-oriented scientific approach and presented in personas. Applying this task-oriented approach, the new roles and associated new tasks of this domain are essential, as the people and tasks are extremely risky, hard to access and complex. The results provide the prerequisites for designing user-centric interfaces for the IDS.

1 INTRODUCTION

The intelligent use of data in IDS enables the creation of new products, services and the reinforcement of research and development. "The data value chain is at the center of the future knowledge economy, bringing the opportunities of the digital developments to the more traditional domains (e.g. transport, financial services, health, manufacturing, retail)" (European Commission, 2013). In this context data is becoming a valuable economic and commercial asset.

The IDS[1] is a platform designed for the industry-wide use, composed of interconnected devices which gather, process, exchange and trade data. It was initiated and developed by various researchers from economics, law and computer science with a focus on service architecture and security (Otto et al., 2016; Teuscher, 2018; Otto et al., 2019).

Against the background of human-computer interaction, this brings with it new roles and tasks and associated new user interfaces for users. For this reason, potential users respective roles, as well as business critical and high risk tasks connected with the system, must be researched. In this respect, an error-free performance must be enabled to ensure successful interaction. The analysis focuses for instance on activities (What does the user do?), settings (How does the user think about the system?) and skills (What is the existing experience with the system?). In order to merge and present the extensive and complex connections on the user level intuitively, high demands are placed on the analysis. Topic-centred interviews with experts from the domain were conducted to identify business-critical, high-risk tasks and user needs. In the subsequent analysis, the insights gained are derived in user models and provided with, for example, a name, a function, a usage context as well as tasks and activities, transferred into personas. By providing personas, for instance, a development team can put itself in the position of a potential user and thus more easily understand its perspective during the development process. Segmentation and cluster analysis methods are used to develop primary and secondary personas, which represent the user groups. Using a hierarchical task analysis (HTA) in the analysis of solution independent tasks, the goals, tasks and actions of users are determined and structured (Diaper and Stanton, 2003; Sharp et al., 2019). Summarizing, the research work aims at the creation of generic requirements, which are based on a cross-domain task analysis. In this context, the article addresses the following research questions:

1. How can the users of the IDS be characterized?
2. What tasks do these users have perform?

These persons and their tasks are the basis for a user-

[1]The title "Industrial Data Space" has been replaced by "International Data Space". At the beginning of the project, the focus was limited to industrial domains and expanded in the course of the project.

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centered development of the user interface of IDS systems.

2 RELATED WORK

2.1 International Data Space

The IDS represents a reference architecture model[2] based on a high level of abstraction (Otto et al., 2019). Farther, the IDS is to be understood as a global virtual data room, in which the participants are enabled to exchange and link data. The human-computer interaction is technically established by the IDS-connectors which connect data of machines, processes and systems and can be controlled by the participants via user interfaces. This network[3] involves different participants in specific roles who interact with each other, Figure 1 shows examples. The functions of the role enable data to be integrated and controlled, data to be made available for exchange, and data to be received from the data provider. In the exemplary scenario, the company (1) provides or exchanges data with the participant/s in other companies (n) via a connector. The associated data usage restrictions (UR) of the application case regulate the contractual framework conditions. The configuration and management of data exchange is controlled via user interfaces (UI). Broker and Appstore are optional factors. There are currently

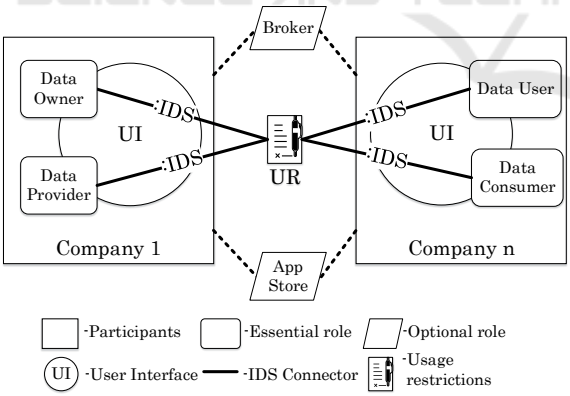

Figure 1: Roles and interactions in the Industrial Data Space.

a few company-specific developments of connectors, but there are no generally valid user interfaces that allow cross-domain use. The IDS enables the participants to exchange controlled data. The establishment of contact can be made directly or via intermediaries. If the data link is established, intervention by the participants is optional. In this all-embracing scenario, the human being as a participant is essential for establishing and controlling the connections. Each participant has to take on different roles in which he has to perform specific tasks. These participants or persons and their tasks must be identified.

2.2 Analysis of Users

The persona originates from psychology and is described as the outwardly shown attitude of a person. In the field of psychology, the persona serves social adaptation and is sometimes also identical with a self-image (Jung, 2011). In the field of Human Computer Interaction this procedure was transferred and developed further by a multitude of authors[4]. A persona is an abstractions of groups of real persons who share common characteristics and needs. Further, personas are hypothetical stereotypes constructed from the characteristics and behavior of real people, as figure 2 illustrates. A persona description is fictitious,

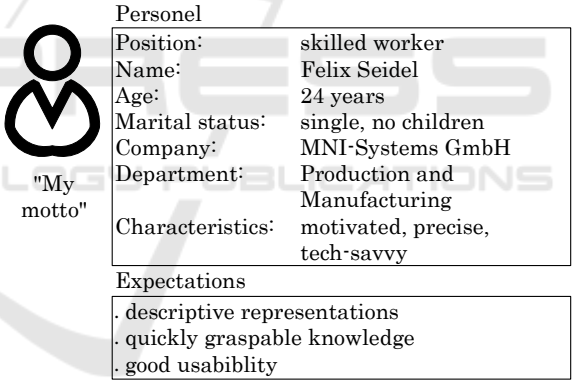

Figure 2: Persona example.

but precise and specific in order to encourage the empathy of the development team (Pruitt and Adlin, 2005; Pruitt and Adlin, 2006). By dropping redundant or unessential information personas keep their stereotypical characters and become clearly distinguishable from each other. When comparing the persona development process according to Cooper (2015) and Pruitt (2006) it should be noted that the basic process at the beginning is similar in data collection, processing and analysis. However, Cooper (2015) focuses on the behavioral variables from the beginning. The comparison is shown in the table 1.

[2]This research topic will be examined from various perspectives in further scientific papers (Brost et al., 2018; Graube, 2018).

[3]also referred to as "Business Ecosystem"

[4](Pruitt and Adlin, 2005; Pruitt and Adlin, 2006; Mulder, 2006; Sears and Jacko, 2009; Mayas et al., 2012; Cooper et al., 2015)

Table 1: Identification variables and values and personas Persona procedure models of Cooper (2015), Pruitt (2006).

Artifact	Cooper	Pruitt
Variables and values	Identify behavioral variables, Map interview subjects to behavioral variables.	Discuss categories of users, Process data.
Personas	Expand description of attributes and behaviors, Designate persona types.	Develop skeletons into personas, Validate the personas.

Referring to Cooper (2015) different roles are interviewed, from which behavioral variables are to be derived. Following this, the variables are assigned to the interview partners and significant behavioral patterns are identified. The individual components form a new unit through their composition. After checking for rendudance and completeness, the stereotypes can be named. In the further course these are subject to a constant expansion. The procedure is shown in the figure 3.

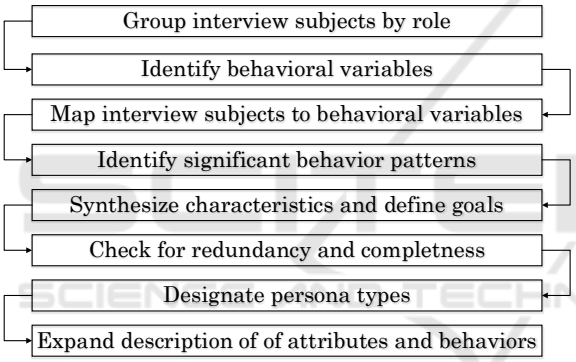

Figure 3: Persona creation process according to Cooper (2015).

According to Cooper (2015) and Mayas (2012) personas can be understood as a ”design tool” used early in the development process. They offer the following strengths (Mayas et al., 2012; Cooper et al., 2015)

- User-centered determination of goals and tasks in dealing with a system, product or service.
- Creation of a common communication system for the development team and stakeholders involved.
- Mediation of a design consensus.
- An early evaluation of design decisions using personas instead of real users.
- Support of product marketing.
- Support the identification of actors and scenarios in IDS.
- The prioritization of system requirements.
- Reflect the ideated tasks and activities of a role.
- In the requirements review or test phases, the use of personas ensures that the user perspective is taken into account and ensured.
- By integrating the user perspective Personas support in this case by decision making, evaluation or even compliance with requirements.
- Additionally, the persona method closes the gap between requirement-oriented, user-centered software development and human-computer interaction.

The approach according to Cooper (2015) is very suitable for the present research project, as it selects the observable characteristics of people and later condenses these into personas. Furthermore, the requirements elicitation and persona development provides the opportunity to derive context scenarios from which interaction design principles and patterns can be created.

2.3 Analysis of the Tasks

Task analysis is primarily concerned with the analysis of processes (procedural knowledge). To be able to analyze procedural knowledge, it is necessary that a user has structured knowledge about the system and the application domain. This is where mental models are used for task analysis. These are formed by interaction with a system, by observing the relationship between one's own actions and subsequent system reactions (Benyon, 2013). If the structured knowledge is available, the analysis of the procedural knowledge (user, system, application domain) can be performed. The task analysis deals with the performance of a ”work system” which is related to the user and the technology of a certain application domain. In the figure 4 the relationship of the ”performance of work” between the work system (consisting of the human – people or agents and the technology) and the application is visualized. A task is seen as a goal in combination with a certain amount of actions. The goals, tasks and actions of the users are the focus of the consideration (Benyon, 2013). The methods of task anal-

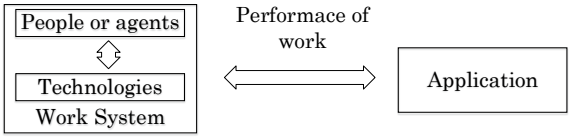

Figure 4: Task analysis according to Benyon (2013).

ysis can be divided into two superordinate categories. On the one hand, there is the method of task logic, in which the sequences of work steps that the work system must go through to achieve a goal are defined. A

typical example of task logic is hierarchical task analysis (HTA). On the other hand, there is the method that deals with the understanding of cognitive aspects. In this method, the cognitive processes that a user has to go through in the work system in order to reach a goal are analysed. A typical example for the analysis of cognitive aspects is GOMS – Goals, Operators, Methods, Selection Rules (Benyon, 2013). However, this method is based on already existing interaction solutions. The purpose of an HTA is to concretise and fix the purpose of the analysis as far as possible. Subsequently, the task objectives are to be defined. Furthermore, the data for the preparation of the task modelling shall be collected. In the following, a validation is carried out, in which the tasks are broken down and checked with, for example, a development team or users. This identifies significant paths or actions. This step enables the development of possible hypotheses about user performance, which are to be tested. The figure shows an example for the programming of a video recorder. In the sequence of tasks of

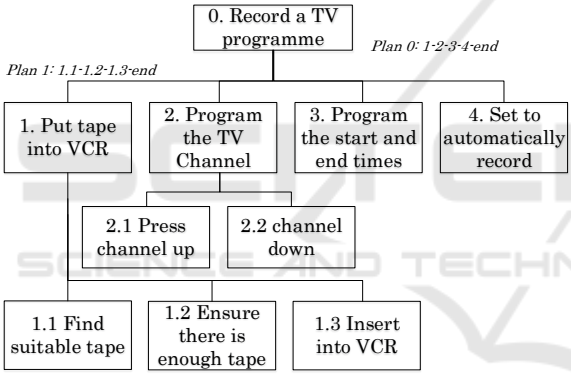

Figure 5: HTA according to Benyon (2013), Basic example: HTA for programming a video recorder.

the main task *0. Record a TV programme*, the tasks with subtasks, *1. Put tape into VCR*, *2. Program the TV Channel*, etc. and actions *1.1 Find suitable tape* and *2.1 Press channel up* illustrated in a hierarchy. The HTA method is based on a graphical representation in one of the structure chart notation forms. In addition, task sequences with subtasks and actions are displayed in a hierarchy. This form of presentation allows an overview of all tasks and also serves for quick validation with involed persons. The method focuses on the task objectives and discloses the user's task solution process. The user and his or her needs are placed in the foreground. Furthermore, significant paths or actions can be identified. HTA also allows information to be given on whether an iteration or selection of tasks is present. Structured paths in the form of a "plan" are possible via the hierarchy. Due to the high novelty value of the system for the present research question, both the personas and the task analysis must be carried out with theme-centred interviews.

2.4 Theme-centred Interviews

Theme-centred interviews are characterised by the setting of relevance by guiding the interview participants to a certain degree. The conduct of certain thematic areas is specified in the form of guiding questions. Furthermore, narrative generating questions and structuring questions can be combined (Schorn, 2000; Witzel, 2000; Bohnsack et al., 2018). Similar to the expert interview, the criteria of restriction to thematic complexes are set, which presupposes existing knowledge of the subject area. In the execution of the interview the interviewer steers by means of open questions. Here the narrative potential of the interview partner within the given thematic complex is to be exploited as much as possible. The procedure offers the possibility to quickly identify initial insight in a largely unknown field of knowledge. The extensive information from the theme-centered interviews can be evaluated with a qualitative content analysis.

2.5 Qualitative Content Analysis

Qualitative content analysis is a method of data evaluation. This method originates from empirical social research, which aims to order and structure unambiguous and latent content (Mathes, 1992).

The method was applied in Human Computer Interaction and has been further developed by many researchers[5]. Data material shall be evaluated inductively, deductively or inductive-deductively. Inductive coding – categories used are derived from the data material. Deductive coding – categories are derived from one or more theories. A mixed form of both codings is possible.

The figure 6 shows - according to Mayring (2010) - the applied method. The procedure begins with the determination of units of analysis. In the second step, the text is divided into individual text sections and reproduced in your own words. The next step is a generalization of a defined level of abstraction. Afterwards a first reduction by selection and deletion of paraphrases with the same meaning takes place, a second reduction by bundling, construction as well as the integration of paraphrases takes place on a desired level of abstraction. The combined category system is then verified together with the source material. The procedure according to Mayring (2010) enables the extraction of results by a successive abstraction. Further-

[5](Mayring, 2010; Gläser and Laudel, 2010)

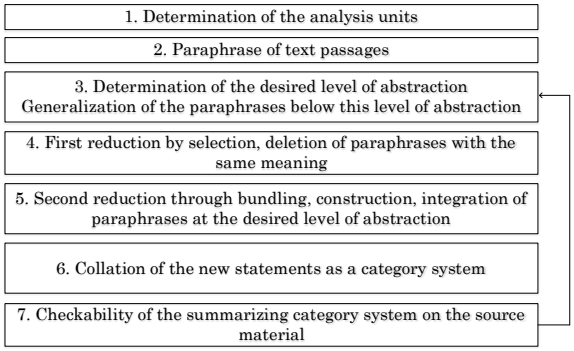

Figure 6: Process model summarizing content analysis (Mayring, 2010).

more, the procedure enables the categories that appear in the further course of the project to be assigned to a theory. These can additionally form a theoretical framework. The Mayering method allows a high degree of transparency despite a high degree of subjective interpretation. Thus, the possibility of traceability and verifiability of decisions is given by coding.

3 RESEARCH IDEA

3.1 Research Question

This paper examines potential users and their needs towards a new and still widely unknown system (IDS) to answer the research questions:

1. How can the users of the IDS be characterized?
2. What tasks do these users have perform?

In the exploration of potential users, the goals, tasks and actions of cross-domains are in the focus of a completely new system. This task-oriented approach provides essential basic information that can later be used to create user-centered interaction design patterns for the IDS.

3.2 Research Method

The persona method according to Cooper was used to characterize potential users of the IDS, because the field of application has to be newly discovered. No target groups have yet been defined, only behavioural variables can be extracted from the analyses, from which personas can then be defined. The personas and their tasks were surveyed with a qualitative content analysis of the structured theme-centred interviews. The tasks were also described with an HTA to extract the task logic. This is of particular relevance for the design of subsequent interaction.

3.3 Research Design

Structured, theme-centred interviews were conducted with 15 experts from different sectors and functions, for example from the automotive industry or agriculture. Decisive for the selection of the participants were:

- previous knowledge of the IDS,
- domain-specific knowledge,
- competence of their roles,
- years of experience in a domain as well as
- representativeness for different domains.

The interviews were conducted over a 14-week period from 03 April to 08 July 2020. A written document was produced which served as a guideline. The first part analyzed information about the experience and use of business ecosystems and included questions about the industry and function of the Interviewpartner, the number of employees in the company it represents and the use of business ecosystems. In the second part, information was asked for, which served to derive personas. For example, questions were asked about activities, attitudes and skills. In the interviews a simple form was chosen for the formulation of the questions and their suitability was tested in a pre-test. If the participant agreed to the expert discussion, he or she received a written cover letter and the document in advance. In principle, the interviews were conducted by telephone, were usually held in 30-45 minutes and were transcribed. Afterwards, inductive data analysis was applied in a schema-based processing to determine the procedural knowledge. In the course of the analysis, categories were developed from codes, from which theories were derived and assigned.

3.4 Research Results

Identification of Domains

From the collection of the identified domains a structure could be derived in figure 7, which allows a first assignment of the users. From all identified domains, from automotive, to energy, to overarching domains, there are similar corporate functions ranging from production and logistics to data security and legal issues. In addition, the table 2 contains information, which provides insights into the sizes of companies represented by the interviewees. It can be deduced that the use of ecosystems is not dependent on the size of a company. Experience with ecosystems is usually limited to 2 to 5 years, which confirms the low number of connected actors in an ecosystem. Another conclusion is that usually CEOs

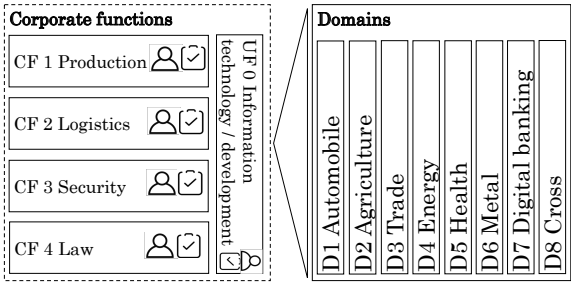

Figure 7: Overview of identified corporate functions and domains.

Table 2: Business insights, experience and roles and suggested roles for business ecosystems.

Company size	1-49	50-999	1000-4999	5000+						
Number of employees	4	3	1	3						
Years of experience	no state.	< 1	1-2	2-5	5-10	10-15	15-20	20-30	>30	
Years worked with business ecosystems	5	0	0	6	2	0	0	1	0	
Interacting actors	no state.	1	1-2	2-5	5-10	10-15	15-20	>20	>300	
Actors do you interact with	5	0	0	0	1	1	0	4	1	
Position/ Role/Function	CEO	CIO	Lawyer	Head of Education	Managing Director	Head of Dept.	Service & App. Mgr.	Solution Arch.	Project Manager	Security Consultant
Experts with a specific position/ role	3	1	1	1	1	3	1	1	1	1
Specified roles for IDS users										
Number of suggestions	1	2		3		4		7		
	Strategist *Lawyer* *Certifier* *Compliance Mgr.* *Knowledge Eng.* *Data Architect* *Data expert* *Data supplier* *Journalist* *Digitisation expert* *Technical manager* *Data Integrator* *Shopping*	*Machine Operator* *Project Manager* *Data Scientists* *Technicians* *Production* *CEO* *Decision makers*		*Marketing Sales* *Data Manager* *Broker* *Data Analyst* *Domain expert* *Security Officer* *Buyer*		*Controller* *Forwarder*		*Logistics experts*		

and heads of departments are familiar with the topic. However, users could be identified who will take on a systemically relevant role in the ecosystem.

Table 3: Behavioral variables for the IDS.

Main activities of the user	**Main capabilities of the user**
Data-	*Knowledge of…*
exchange	Domain-specific
provide	Business data and processes
brokering	IDS ecosystem
monitor	Consulting
analyze	IT knowledge
control	Certification
sharing	Project management
communicate	*Understanding of...*
retrieve	Analytical
track	Continuous knowledge enhancement
Expectations	**Main motivation of the user**
Trust in the ecosystem	Execute successful business processes and transactions
Promoting networking	Full control over the data
Readiness for digitization	
Data governance	
Data protection/security	
Usability/Intuitively/self-explanatory	
Personalization for different roles	
Individualization of the user interface	

Identification of Behaviour Variables

The core tasks have been identified as high-risk, economically critical activities, ranging from data exchange, monitoring to data control. As a result, a high level of trust and data protection plays on an overriding role. The users have a high level of expertise, combined with a strong analytical capability as well as information technology and domain-specific skills.

Nevertheless, they attach great importance to the greatest possible simplicity of the user interface, which is intuitive to use. The identified behavior variables are shown in the table 3 and sorted by relevance.

Identification of Personas in IDS

The study revealed a number of 5 personas. These are: Robert Becker – Data Economy Executive, Virginia Williams – Engineer, David Holler – Department manager, Dr. Paul Conner – Data Analyst/Scientists and Mike Chester – Developer. Three personas are described as examples which show the diversity of the tasks. The description of personas consists of the following parts;

- name with additional term in the context of its behavioral variable,
- a persona illustration and a typical statement,
- the most representative requirements,
- overview of personal information,
- expectations of the IDS and
- description of a typical daily routine.

In the figure 8 a persona is introduced.

David Holler – The on-schedule logistics specialist

"Especially small and medium sized companies want to use IDS, but they do not want to think about what the system actually does."

- is 43 years old and single.
- lives in Dortmund.

IDS Profile

Usage:	Daily use of IDS in logistics.
System knowledge:	medium
System use:	3 years
Interaction partners:	approx. 12
It is important to him:	secure data exchange, promote digitisation
Preferences:	adherence to schedules, planning scope
Limitation:	limited IT know-how

David expects

- Prompt information on the status of deliveries and outgoing deliveries
- an easy handling of the system
- a fast and efficient completion of tasks
- no delays

Notes of daily work

#works daily with about 6 different participants under and overlapping suppliers #must work in different systems – it is not easy and clear – causes stress #must follow every process closely # would prefer to work in one system only #has many years of experience with the IDS #has a lot of confidence in the system #has worked in a project on the introduction of the system #wants to have access to all information and tasks at a glance #sees the IDS as the best way to access all information and tasks #wants to work on his tasks without media and information breaks #no longer wants to worry about late status reports of deliveries #needs real-time data on his dashboard, advises new participants in IDS – very complex

Figure 8: Persona David Holler The on-schedule logistics specialist.

Persona David Holler – Logistics specialist David Holler is a 43-year-old single department manager of an automotive supplier from Dortmund. He works with the Business Ecosystem IDS and likes to save himself the work with different systems. He is an on-schedule IT-affine person who tries to complete his tasks on time. Due to his regular use of the system, David is very familiar with it, but lacks in-depth background knowledge. His working day is facilitated by trust in the system. Every now and then he has to work with different systems, but he is able to gain more and more participants who participate in the digital processes of the company. David expects timely information about the status of deliveries, easy handling of the system to get the job done in the best possible way and to avoid delays.

Persona Julian Massey – Domain and IT consultant Julian (29 years) works as a consultant in a company with over 5000 employees. In his 10 years of experience he has developed analytical skills. Julian also has good IT skills, has a good overview of the departments due to his education and is also good with people. Most recently, he participated in a further training course on the topic of digitalization. All this enables Julian to deal with processes, actions and people related to it in his daily work. In his regular training sessions with his colleagues he imparts knowledge about data exchange, data switching, data control and monitoring. With the IDS, Julian sees a great potential to bring his company to a good level of maturity in digitization.

Persona Mike Chester – Developer and IT expert The developer and programmer Mike is 28 years old and an innovative employee. For about 3 years he has been working on industrial data and business ecosystems. Two years ago the CEO decided that his company should be IDS certified. For this, Mike had to do a lot of bureaucratic and programming work. After the certification, he developed interfaces which established a connection between the machines of his company and a supplier. Since then, Mike's tasks include the implementation of the requirements, which are taken up by a domain and IT consultant. For this, Mike develops front- and backend solutions. This means that he needs to know the user needs and he must have knowledge of interface programming. Of course, there are always hurdles in development and unfortunately there are not many forums where he can share his knowledge and quickly absorb new knowledge. Mike's development work would be made much easier by design templates, so he wouldn't have to start from scratch again and again. Nevertheless, Mike is convinced that his CEO's decision was the right one and that data exchange via business ecosystems is a forward-looking approach.

Identification of Tasks in IDS

Core activities were identified which are configurable, manageable as well as processable, traceable and traceable as information objects:

0	App Store/Marketplace	16	Language management
1	Participants	17	Development environment
2	Dashboard	18	IT Asset
3	Rights and role administration	19	Research and development
4	Contracts	20	Mediate
5	Data security	21	Connector
6	Data/data streams	22	Managing unit
7	Official documents	23	Digital twins (Machines)
8	Legal rules	24	Communication
9	Business Rules	25	Collaboration
10	Transports	26	Document
11	Verification	27	Acquiring application
12	Projekt Management	28	Operate machines
13	Marketing	29	Finance
14	Events	30	Environmental Management
15	Tasks	31	Quality assurance system

Figure 9: Identified core tasks.

The table 9 shows an consolidation example of the major task *Manage contracts* (Plan 4: 1-2-3-4-end) for the management of the contracts and its subtasks (1. Create a new contract, 2. Edit existing contract, 3. Show all contracts).

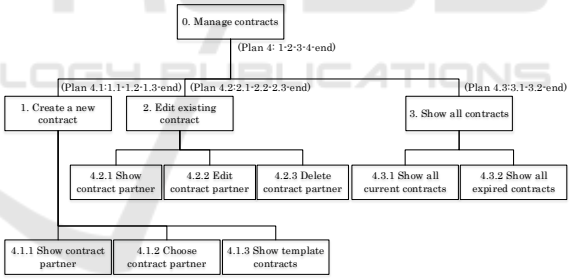

Figure 10: Hierarchical task analysis – Manage contracts.

4 DISCUSSION AND CONCLUSION

The proposed combination of methods presents in its entirety an approach for identifying personas and tasks of a new domain. The basic variables, personas and tasks related to the IDS are to be confirmed in this empirical study, so far an exemplary set of five personas and 31 core tasks could be identified. The application of the methods promotes the introduction of a human-centric design in the domain of business ecosystems. Personas intensify the differentiated consideration of the widespread target group and the translation of user needs into concrete tasks.

In this highly specialized field of knowledge, hardly any knowledge about the users is known, so that currently information technicians or scientists are involved. The persona method, however, is mostly used to identify familiar people in everyday life, so it is difficult to imagine in the context of the IDS. The IDS is subject to constant development. The knowledge gained about the users is also subject to constant further development due to this fact, but represents a first human-centred approach. The personas can also be represented in different business areas and companies in various forms. Going forward, the identified tasks have a generic approach. Both can be modified in the future. However, the tasks and processes have to be reviewed again and again, as they are subject to constant change. Taking these points into account, it should be noted that the personas and tasks confirmed in this study are not exhaustive and are being further developed and modified in the scientific debate, they represent a first approach. The described personas and tasks are a framework for the overall design of utility and usability in all phases of development. Interaction patterns can be derived from the tasks, which can be tailored exactly to the needs of the personas. For further developments they also have the function to provide a framework of orientation within which the requirements for interaction with the International Data Space can be detailed.

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