Facility Management in the Context of Self-Organisation

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Abstract: Nowadays there is a rise of complexity in most areas of planning, managing and executing modern production systems. One part is the facility management. Processes such as approval and maintenance in the production systems environment are important for modern companies. These processes generate enormous data during the lifecycle of a production system. The approach of self-organisation supports the handling of these data among others. In this position paper, a concept of a modern facility management with semantic technologies and augmented reality will be introduced at the beginning. Then a definition of three different conceptual use cases of self-organisation in the context of facility management will be illustrated. At the end, the adaption of contexts for supporting self-organized systems will be shown in this conceptual paper.

1 Introduction

Trends in production systems planning and management have lead to elaborated approaches for changeable and energy-efficient factories during the last years and decades. This development is increasingly being facilitated by the application of information technology [Cl13]. Digital and virtual models, tools and methods are of high relevance for the implementation of changeability in modern production systems [He03]. But more digital data does not necessarily lead to better systems and processes. First of all, complexity rises.

Just recently concepts such as the Digital Factory approach [Vd08] or the Internet of Things based on cyber-physical systems have been summarised by the Industry 4.0 initiative as an immediate challenge for the whole industrial landscape. This initiative is strongly focused on data. Internet and Web technologies are said to be widespread in factories in 10 to 15 years already. In the course of that, the visualisation of data,

assurance of semantic interoperability and user-specific information provision are the challenges to face [Sa11].

Typical aims of the digitalisation are an increased process control, improvement of planning quality, costs and time. The focus lies on the integrity, actuality and the reduction of redundancies in production data, the improved utilisation of planning knowledge and extensive support of communication and collaboration [BGW11].
The two fields of planning and management of production systems can hardly be separated anymore, since there are many interrelated, repetitive tasks connecting them. A basic requirement for projects in the Industry 4.0 is hereby an integrated data-management in the digital factory that reproduces the connection between the real and virtual world by synchronising the data between different working groups and tools during the whole lifecycle of a production system. The overall vision is to provide an integrated virtual model of the real production system in real-time [Vd09].

All in all, the integration of data that is spread across organisational borders and that has to be collected from many different data sources still leaves more questions than answers when it comes to the implementation of what was described above.

2 Concept of a Modern Facility Management with Semantic Technologies (and Augmented Reality)

In the so-called "FMstar" project (see http://www.fmstar.de) seven partners from science and industry develop a respective solution with focus on facility management (FM) processes such as approval and maintenance in the production systems environment. Hereby, an overall concept and corresponding prototype for the integration and presentation of planning data based on semantic technologies and visualization via augmented reality (AR) on mobile devices is being developed. The focus lies on building services engineering and factory maintenance planning applications that generate the most relevant data for the facility management processes in scope. They provide data with reference to 3d-models of the building structure. This data has to be integrated for presentation to the approval and maintenance staff and is supposed to support their work in different ways.

The basic idea for the integration of the data is the utilisation of semantic technologies as described by [BHL01] for the semantic web. Semantic searching within traditional, unstructured documents is just as semantic databases and webs still subject to intensive research [Ba13]. It is an important challenge to facilitate the patency of the data and a semantically correct mapping between the different tools [Vd09]. Hereby it's important to assure data correctness, consistency, integrity, actuality, security and avoidance of redundancy. One way to synchronize such distributed, partial models is using ontologies [Ha05]. Ontologies are a key concept when it comes to the improvement of information systems integration, communication and information- and knowledge-management in production systems planning and management [SL09]. In the project a basic ontology for

the relevant context is being developed. It describes the structure of the semantic database and is used for the mapping between the different models and files.

But besides the technical aspects of that, the question arises how to utilise the integrated data in the facility management processes. Part of the answer is that there is a fundamental paradigm shift going on from strongly structured approaches to more iterative, gradually detailing approaches with a particular consideration of the human/social perspective that puts the planning efforts under a self-organisational paradigm [S+06]. This empirical method is already relying on experiential knowledge, pragmatism and intuition of the involved people today. Also expert systems that support operative work in a self-organisational manner by providing accumulated know-how from previous utilisation in similar situations are a known concept in this context [BGW11].

As described in [Co14] for Big Data BI-projects, it is of substantial importance to use the gathered data, information and knowledge in the respective processes for a sustained improvement in the context at hand though offering guidance to workers in a self-organisational manner. This proves that self-organisation is a core concept in this context. However, the practical implementation of the before mentioned concepts is still far behind what is described in guidelines and scientific publications [AMR11]. So in the next sections different conceptual use cases for the self-organisational utilisation of the integrated data will be discussed in more detail for the facility management context.

3 Self-Organisation in Context of Facility Management

A part of the mentioned project FMstar is to develop conceptual use cases of self-organisation in context of facility management. Generally, self-organisation is the ability of systems to develop structures outside predetermined structures directly from the system [Pa82]. In context of the project self-organisation is defined as the ability of our prototype-system to generate new information structures from existing partial information of production system planning, building services and facility management. Hereby, information will be available new organized and new structured for maintenance and factory acceptance. This is, no less importantly, essential for context-based information.

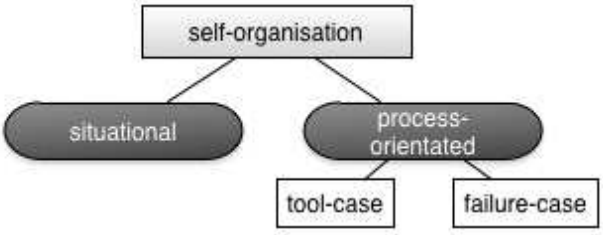

Figure 1: Conceptual use cases of self-organisation

Subsequently, three use cases of self-organisation in context of facility management (compare figure 1) will be introduced conceptually. In general, the use cases are distinguished between situational and process-oriented. On the one hand, situational means there are no predefined procedures for the technician. The technician must decide (especially the first steps) by oneself what to do. On the other hand, in a process-oriented case, there exist process operations to selected situations.

The conceptual approach of the classification and chronology of the cases is illustrated in figure 2. There is a general distinction between the socio-technical system and the information system. The socio-technical system handles with the descripted approach of self-organisation in this chapter. Hence, this exterior level system contains the technician with the mobile device and the information system. Contrary to this exterior level, the interior level – information system – describes the adaption of contexts. This concept will be submitted in chapter four of this paper. Following, the three conceptual cases are related to the exterior level.

In the first mentioned use case (situational) the technician shall be supported by the system. Therefor, the system will provide information specifically to the given situation of the technician. This information will depend on the qualification, competence or historical action with the tablet of the technician. This case is illustrated as “S1” in figure 2, which shows an overview of classification and chronology of the cases.

The next use case is the tool case, which is classified as process-oriented. The tool case scenario is relevant for the preparation of maintenance orders. Hereby, the system will put forward proposals for picking the tool case on the basis of upcoming orders (compare figure 2: “S2”). The risk that locally is a lack of tools, materials or special lubricants will be reduced.

Last but not least the case of failure is shown in “S3” in the figure 2. At this, on one side the system will analyse the failure case and support quick assistance for the planner. On the other side, the system will support the technician locally to fix the occurring failure quickly.

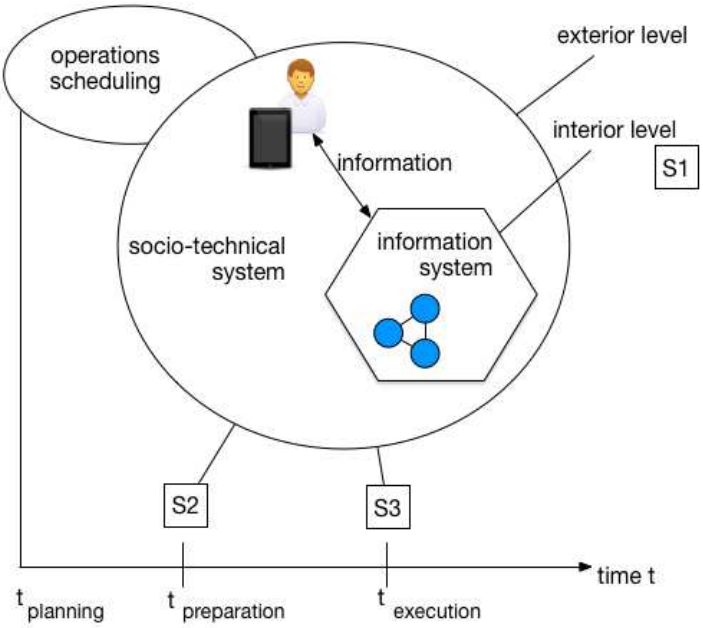

Figure 2: Overview of classification and chronology of the cases

4 Adaption of Contexts to Support Self-Organised Systems

One of the major thematic priorities of the project FMstar is the context-based filtering of the integrated data. The general objective is to avoid time-consuming and tedious search for information on the mobile assistance system to be developed. The context-based information supply is concerned with the question, how only relevant information can be provided to a FM technician. According to the Relevance Theory from Wilson/Sperber, relevance strongly depends on the reference of information to a specific user situation [WS02]. The situation of the user can be characterized by the context of the Human-Computer Interaction. According to Dey, context is „[…] any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves“ [De00].

The basic approach for utilizing the context for information supply within FM is to analyse the day-to-day operating processes of FM associates. This was based on a process and document analysis, workshops with industry partners and a small user survey [G+14]. As a result four context categories were identified (Figure 3: Context categories). The mobile assistance system being developed shall be capable to measure the respective context factor values of the users' situation and to interpret the context and intention of the Human Computer Interaction (HCI). Use cases utilize the context factors to filter or prioritize displayed information on the mobile device.

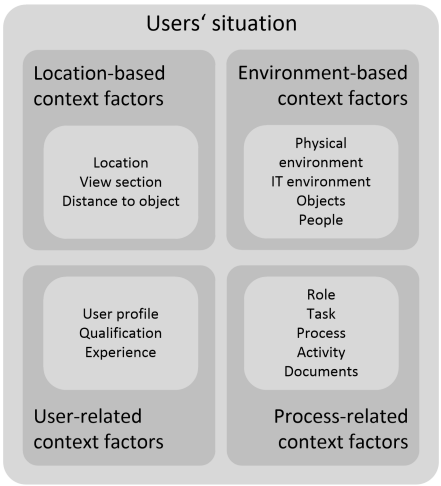

Figure 3: Context categories

In the following, our approach will be pointed out based on a use case regarding the main topic of the paper self-organisation. Figure 4 illustrates the differences between the learning of the socio-technical system and the information system itself. Context information can support both concepts. The following simple example (Figure 4: Use case with self-organisational effect) introduces how the information system can learn from the historical usage by the FM technician. The general assumption of the use case is that the relevance of information objects (e.g. attributes of a component) can be determined by the historical behaviour of the technician. If specific information objects were relevant in the past, they might be relevant in the present and future as well.

The objective of the use case is to shorten a given attribute list to a specific component by means of the context factor “historical relevance”. In the past the technician “used” the attribute 3 four-times and the attribute 1 two-times. In the current situation the list will be shorten to attribute 3 and 1. To achieve this functionality the application has to capture the usage and to transform it into a specific weight of the attribute. The TDB (Triple Data Base) assigns the respective weight to the attribute. The context sensor (e.g. service to provide a specific weight of an attribute) provides the weight of an attribute at runtime of the application. A context model interprets the value in the purpose of the use case (e.g. weight value into star category). The resulting self-learning effect of the software enables self-organisation because relevance of attributes can be considered without a predetermination of it in the planning phase. The relevance will be determined automatically by using the mobile assistance software.

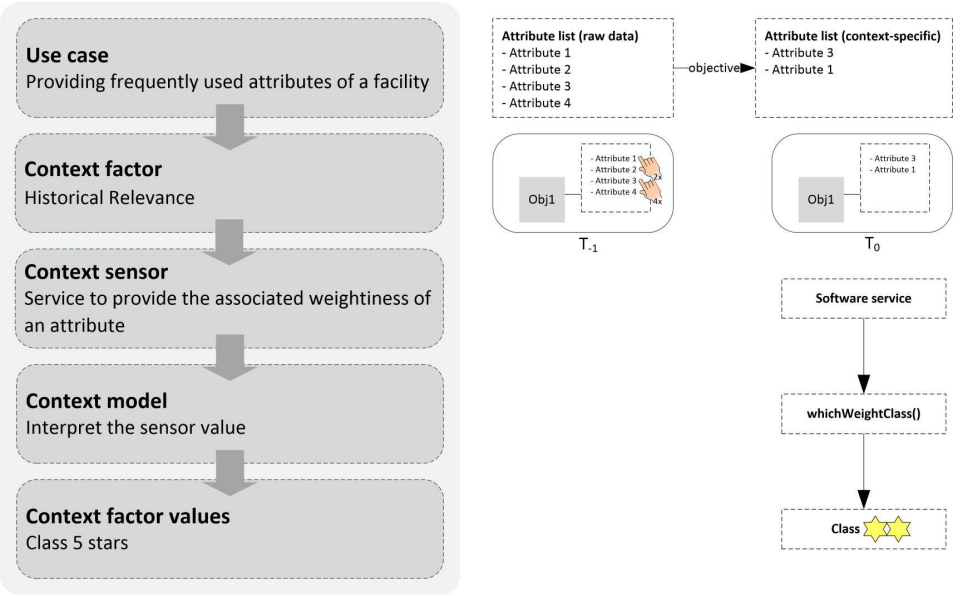

Figure 4: Use case with self-organisational effect

5 Conclusion

This paper showed a concept of a modern facility management with semantic technologies and different conceptual use cases of self-organisation in context of facility management. To support self-organized systems the adaption of contexts was described.

Finally, the mentioned use cases and the described approach of a facility management with semantic technologies and augmented reality will be continued to develop in the project "FMstar". Currently, the project team develops conceptual use case definition. In the next steps the technical needs, implementation, evaluation and a case study will be occurred.

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