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Train-the-Trainer Concept for the "Industrie 4.0-CheckUp"

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Abstract

The digitalization of society is causing companies' environmental conditions to change. New customer demands, a change in employee thinking and a market situation altered by new competitors are making the digital transformation of companies a necessity. Identifying capabilities in a company, recommending actions and then implementing actions necessitates ascertaining the company's level of development in terms of digital transformation. A multitude of capability maturity models and different approaches to use exist to meet the needs of SMEs and large companies. Since the dimensions of Industrie 4.0 are understood slightly differently all over the world, this paper formulates a train-the-trainer approach that ensures a global baseline understanding based on a dedicated capability maturity model. The paper concludes with a discussion of future applications for this method.

Keywords: Industrie 4.0, digitalization, capability maturity index, capability analysis, performance evaluation, innovation management

1. Introduction

Industrie 4.0 represents a paradigm shift for industrial manufacturing. Once Acatech publicized its plan for Industrie 4.0 at the Hannover Messe in 2013, this new approach to modernizing manufacturing spread and established itself in Europe. Similar initiatives have been launched in almost every country in the European Union. With a perspective on global trends, the basic concepts have been adopted and adapted to the requirements of domestic industry in various countries, sometimes addressing a wider circle of companies and service providers along the industrial value chain. Industrialized nations such as the US with its "Industrial Internet Consortium", China with its "Made in China 2025" initiative or Japan with its "Industrial Value Chain Initiative" are setting their own agendas to strengthen their competitive position in manufacturing.

What all these approaches have in common is the fundamental demand for greater use of digital technologies and data in manufacturing, greater connectivity of machines and manufacturing processes, and the associated and necessary establishment of new business models for companies in the industry.

While Industrie 4.0 and digitalization have been hot-button issues on various levels of government, academia and industry, small and medium-sized businesses especially often find it difficult to identify the benefits of digitizing processes, products and services. These difficulties are often the product of a limited view of digitalization as a purely technical issue, i.e. exchanging manufacturing equipment for connected equipment, while keeping everything else (e.g. processes, interfaces, staff qualifications, etc.) the same. Providing companies with a realistic assessment of their Industrie 4.0 capability development as well as highlighting potential benefits to be leveraged is needed to encourage the adoption of new technologies and initiate the necessary adaptation processes in companies. The promotion of an integrated company assessment based on a dedicated capability maturity model helps to identify a company's current status vis-à-vis digitalization and additionally establishes a perspective for a realistic road map for a company to plan its development path over the medium-term.

To this end, the Fraunhofer IFF developed and successfully employed its Industrie 4.0-CheckUp in over a dozen companies in Germany. Additionally, the Industrie 4.0-CheckUp was successfully employed in a number of international pilot projects, focusing on transfer activities in other cultural contexts.

This paper provides insights into the methodology of the Fraunhofer IFF's Industrie 4.0-CheckUp, including its

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underlying capability maturity model. It focuses on the international transfer activities to adapt the methodology to requirements of international companies as well as the development of a train-the-trainer method to build capacity to perform the CheckUp in other countries, specifically Thailand.

2. The scope of digital transformation

The principle of Industrie 4.0 is implemented in a smart factory [1]. Obermaier posits that the smart factory is characterized by automation and digitalization, on the one hand, and by the connectivity of industrial infrastructures and the actors operating in this value adding structure, on the other hand [2]. Siepmann notes that this industrial infrastructure can be interconnected in stages [3]. Not only the technological view, but also the transformation of the company's organization and culture must be considered when implementing Industrie 4.0 [4].

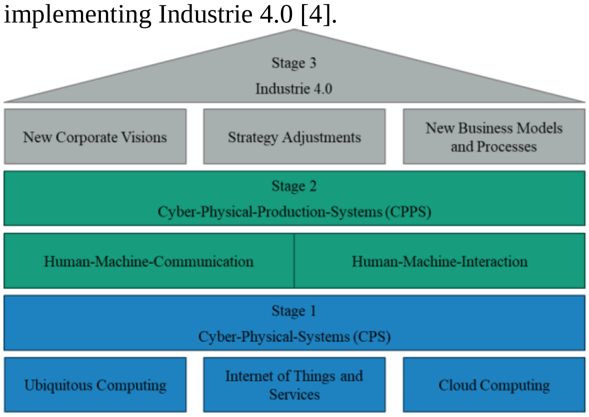

Figure 1: Components of Industrie 4.0 [3]

Cyber-physical systems (CPS) are the foundation of a smart factory. These systems are possible by embedded systems (ubiquitous computing), the Internet of Things (IoT) and other services such as cloud computing [5]. The combined use of human-machine communication transforms CPS into cyber-physical production systems (CPPS) [6]. Only by an aligned conformation of the corporate vision, strategy as well as business processes and models, it is possible to transform manufacturing companies towards digitalization and implement the principle of Industrie 4.0 holistically [5].

In light of the last point in particular, reducing Industrie 4.0 to technological innovations appears inexpedient since the underlying technological capabilities have existed for years. Linking the technologies with "fundamentally changed ways of thinking compared to traditional approaches to production" [3] engenders innovation. Schenk also notes that effective implementation of the principle of Industrie 4.0 requires a paradigm shift in a company [7]. Accordingly, Siepmann formulates five central paradigms that describe the "realization of the idea behind Industrie 4.0" [3]:

- Vertical and horizontal integration
- Decentralized intelligence
- Decentralized control
- Integrated digital engineering
- Cyber-physical production systems

Vertical integration means integrating a hierarchy of all internal company systems, on the one hand, and exchanging data between hierarchy levels by interfaces [5]. On the other hand, horizontal integration makes it possible to connect the actors involved in manufacturing on one level [2], i.e. the integration of a continuous and dynamic value creation network even across company boundaries [3]. According to Bauernhansl, the use of CPPS results in decentralized intelligence and leads consequently to an approach of decentralized control [8]. Decentralized intelligence describes the capability of manufacturing equipment and systems to transfer relevant information independently to a decentralized control system [3]. The approach of digital engineering should be approached in order to increase the production system's flexibility integrally, [9]. Continuous data integration is used to incorporate changes into an existing model in order to be able to simulate impacts and risks before implementation [10]. The physical and the virtual world thus interlock seamlessly and the complete process is represented in real time [3].

Along with the capabilities provided by the principle of Industrie 4.0, there are also risks. Fallenbeck and Eckert state that new methodological and technological approaches are needed to ensure the security and veracity of information and communication systems. Targeted manipulation of data collected for the purposes of controlling and monitoring internal processes could have devastating consequences [11]. In addition, new fields of action also open up in the domain of occupational health and safety. Günthner et al. state that work must remain manageable and transparent for employees – despite the use of technical systems. Moreover, any sense of outside control by restrictive technical systems should be avoided, such as being overwhelmed by excessive complexity [12].

The digital integration of customers and suppliers beyond company boundaries is extremely important to the organization of dynamic and, especially, end-to-end value chain networks. Different international views of Industrie 4.0 are thus playing an increasingly important role in global value networks.

3. Different international views of Industrie 4.0

The presentation of Industrie 4.0 at the 2013 Hannover Messe initiated a global discussion on potential implications and impacts digitalization might have on manufacturing, the economy as a whole and society at large. The initial concept for Industrie 4.0 propagated in Germany focused on promoting the export-oriented manufacturing sector and machine tool industry, ensuring the high-wage country’s competitiveness, counteracting demographic change, and boosting resource and energy efficiency. Germany aimed to establish an international lead market for Industrie 4.0 solutions, while becoming the leading developer of solutions for export to world markets. Efforts were concentrated on technology development and standardization to facilitate the adoption of solutions [13]. Other countries around the world similarly developed their own industrial strategies to promote digitalization, especially in manufacturing. While they extensively reference Germany’s approach to Industrie 4.0, a comparison of different national digitalization strategies reveals that each exhibits specific national traits that represent the countries’ specific cultural backgrounds, industrial make up and social challenges. China, for instance, is clearly focusing on leveraging automation capabilities in a centrally managed national strategy [14]. The USA has taken an economy-wide approach focusing on value chain optimization [14]. Austria is concentrating on social and non-technical factors specifically addressing the social challenges of digitalization [15]. The UK is focusing on nationwide productivity gains to reduce regional disparities [16]. European efforts are largely aimed at coordinating national initiatives, either through the European Commission’s “Digitising European Industry” strategy [17], public-private initiatives such as EFFRA [18] or dedicated agreements and working groups among national initiatives such as Germany, France and Italy’s trilateral group for smart manufacturing [19].

The discussion is steadily shifting from this strategic sphere to the shop floor. Companies want to understand how they can put these concepts into practice. The strategic approaches with different national traits are built around the largely similar basic concepts of increasingly connected manufacturing and products, while increasing the use of data generated by equipment and production. The technological starting point is thus largely the same in every country, while considering the general level of technical progress. Germany is often seen as a benchmark. Companies want to understand what Industrie 4.0 means for them in their own corporate context. Additionally, there is a demand for the transfer of methods such as capability maturity assessment methodologies to build local capacities to support businesses.

4. Industrie 4.0 capability maturity models

Organizing digital transformation confronts manufacturing companies with the challenge of using a suitable methodology that meets their strategic and operational requirements, e.g. enhancing the customer experience, increasing or maintaining competitiveness, networking the company and developing new business models. These requirements are essential to meet the objectives of Industrie 4.0. Once the goals have been achieved, digital transformation ushers in a change in the corporate environment which can be seen as both an opportunity and a risk [20]. When starting to organize, it is nevertheless essential to determine the company’s starting situation and to decide whether its capabilities can be reconciled with the requirements of the changing corporate world. This necessitates a company analysis in the first step, which can be performed using methods from strategic planning [20]. Widespread methods of corporate analysis include the value chain based on Porter, portfolio analysis, experience curve analysis, and strengths-weaknesses analysis or capability analysis. These do not adequately meet manufacturers’ demands, though, because analysis domains are too small or visualizations are insufficient to derive concrete recommendations.

The use of capability maturity models in practice has established itself in the context of digital transformation as a useful method for evaluating companies integrally and identifying capabilities. According to the literature, a capability maturity model is described as an "anticipated, logical, desired or typical development path for objects of a class in successive stages, beginning in an initial stage up to [...] maturity" [21] in terms of predefined features [22]. Capability maturity models are used simply to describe the change of analyzed objects (evaluation) and then to derive recommendations for action in order to reach the next higher level [22]. The distinctive benefit of capability maturity models is the possibility of internal and external comparisons and benchmark analyses [23]. When supporting digital transformation, capability maturity models thus constitute a helpful tool, especially for executives in charge, to ascertain the stage of development and to derive individualized development paths from them [24].

At present, many capability maturity models that assess companies’ current status in terms of their digital transformation exist or are being created all over the world. Research institutions, private consultants and agencies publish capability maturity models as part of studies or on their websites. There is a certain degree of arbitrariness in a large number of these models, and not all developers disclose the underlying conditions and the method, with which the model was developed [21]. A multitude of capability maturity models are based on subjective self-assessments. Unlike an objective description of the conditions in the individual stages of development, subjective comparisons lack the requisite comparability of the results. A classification and critical analysis of different capability maturity models, different requirements for capability maturity models as a function of company size as well as international differences have been discussed in detail in previous papers [25, 26, 27]. One of the goals of these publications was to identify significant capability maturity models on the market, to systematize requirements for different types of companies, and, finally, to provide recommended actions for developing capability maturity models for small and medium-sized enterprises (SME).

Mittal et al. and William et al. primarily focused their studies on the basis of a literature search to derive a capability maturity model specifically for SMEs. Mittal et al. especially highlighted the key differences to multi-national enterprises (MNE) once again through an initial comparison between SMEs and MNEs [25]. Among other things, the more limited financial resources, the limited capacities for research and development, the limited flexibility in management and the strict decision-making by the CEO or shareholders are noteworthy [25]. The Industrie 4.0-Quick-CheckUp examined here is intended to help SMEs with digital transformation [26].

The Fraunhofer IFF's Industrie 4.0-CheckUp with its integrated analysis of the thematic fields of Industrie 4.0 and its incorporation of all of a company's organizational units has to be adapted to the basic conditions in different versions available. Further examination of capability maturity models will be described taking the Industrie 4.0-CheckUp and the simplified tool of the Industrie 4.0-Quick-CheckUp as examples. To this end, the Industrie 4.0-CheckUp's basic structure is briefly explained first.

5. Industrie 4.0-CheckUp

The Industrie 4.0-CheckUp is performed in five steps, which are adapted individually to the objective of analysis as well as to the company's specifics and requirements. The general procedure is presented in Figure 2.

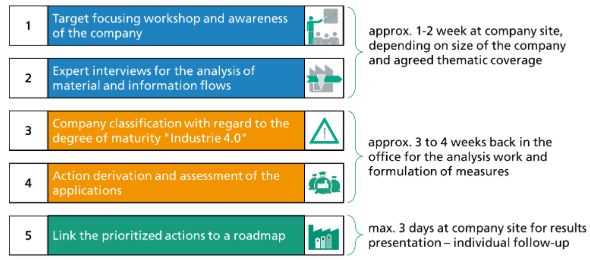

Figure 2: General Industrie 4.0-CheckUp method [26]

A kick-off workshop is conducted with the company at the start of an Industrie 4.0-CheckUp in order to make the capabilities and relevant opportunities of digitalization tangible to the company staff. During the kick-off, visions of Industrie 4.0 are presented, concrete digitalization actions are discussed, and a basic understanding of digitalization and the desired interconnectivity of the entire value chain are discussed. Expert interviews will be conducted with selected company representatives to compile a common base of data and information, which later will constitute the base of knowledge for the Industrie 4.0-CheckUp. Along with executives' and employees' longstanding experience, engineers' planning expertise and technology assessments are also recorded. This top-down management approach to implementing Industrie 4.0 in combination with a bottom-up improvement process promises excellent prospects for the implementation phase since solutions are developed with the involvement of value-adding staff and generally more accepted as a result. This participatory planning approach has repeatedly proven to be effective, especially when implementing digitalization and automation solutions.

In the next step, the results of the assessments are analyzed with Fraunhofer trainers by structuring problems and comprehensively identifying drivers in a cross-section of the company based on a methodological tool kit. The objective is a detailed understanding of how the results of the capability maturity model can be interpreted by the company for further use, developing an individual strategy and implementation road map.

Based on the evaluation, appropriate actions and road maps toward Industrie 4.0 will be developed and an action plan for implementation will be generated. On-site consulting in each company is necessary to specify concrete digitalization capabilities and detailed actions. Industrie 4.0-CheckUps performed in companies have revealed that some business units complete more activities and projects intuitively and iteratively than other units (Figure 3).

Figure 3: Example of an assessment from an Industrie 4.0-CheckUp

This can result in the coexistence of different stages of Industrie 4.0 integration in one company. Format changes and interface problems between different generations of technology manifest themselves as obstacles for improvement. Since interdisciplinary and process-driven plans are often missing, the task is to advance every unit to the same stage of integration based on

- identifying and weighting innovation drivers,
- identifying concrete measures for each unit and placing them in the overall focus,
- analyzing different options for action and likelihood of success,
- creating a capability maturity model and performing a cost-benefit analysis, and
- providing decision support for potential capital-intensive projects.

Concrete actions for each business unit can subsequently be identified and placed in the company's overall focus; always under the premise of avoiding local optima by using interdisciplinary and process-driven plans. Actions for employee awareness creation and training are as much a part of this as changes to and modifications of processes and technology.

The Fraunhofer IFF's trainers use assessment models specifically modified for digitalization to evaluate measures qualitatively or quantitatively – based on client requirements. These assessments ultimately establish the basis for drawing up a strategy road map. This provides a company with a digitalization strategy with potential migration paths, thus revealing a tangible evolutionary path.

The simplified Industrie 4.0-Quick-CheckUp derived from the Industrie 4.0-CheckUp, can be implemented with considerably less financial commitment because less labor is required in the information gathering and analysis phases [26].

Partners, who were also familiar with the in-depth Industrie 4.0-CheckUp were especially involved in validating the practicality of the Industrie 4.0-Quick-CheckUp in order to make it possible to compare the findings between these two approaches. To this end, a workshop was subsequently held with a group of users consisting of science and industry stakeholders. For the sake of clarity as regards to stakeholders, companies that use the Industrie 4.0-Quick-CheckUp by themselves are referred to as "users"; Industrie 4.0-CheckUp consultants that manage projects and especially shape the results are termed "trainers". The major findings can be summarized as follows:

- The vision of Industrie 4.0 is incomprehensible to many companies and still too abstract. A self-assessment does not adequately facilitate understanding – a trainer in the process helps clear up misunderstandings.
- Communication between the departments facilitated by the Industrie 4.0-CheckUp trainer is considered a significant success factor of the project.
- A self-evaluation of the company constitutes an opportunity for management to develop the individual organizational approach participative with their team and to prepare employees for Industrie 4.0 individually.
- Users of the Industrie 4.0-Quick-CheckUp ascertain the current development stage and derive the next development steps – users recognize the danger of measures not having been verified by a trainer.
- Recommendations for action derived independently after a self-assessment of the company are predominantly technologically driven.
- There is no crosschecking of the theoretical state with the necessity or relevance of the achievement of objectives when an Industrie 4.0-Quick-CheckUp is conducted independently.
- Company representatives are inclined to distort the assessment positively – the determined capability maturity level thus establishes a distorted basis for deriving recommendations for action.

Although a self-assessment is fundamentally easier and less expensive to implement, the results are not as significant as the results of a detailed Industrie 4.0-CheckUp. Furthermore, relevant and important positive impacts, such as creating awareness for digitalization issues and changing employee mindsets, cannot be achieved during an Industrie 4.0-Quick-CheckUp.

However, a major criticism of this approach, was that SMEs are left on their own too much and the focus of the method – the derivation of measures from the capability maturity assessment – usually still requires outside assistance.

One possible solution to this might be to combine the supervised Industrie 4.0-CheckUp in a condensed format of only three days for the first and second phase of the project (see Figure 2) with implementation by local consultants to meet the financial requirements in particular. The personal support of a full Industrie 4.0-CheckUp at an economy-wide SME level, however, would hardly be feasible for organizations such as Fraunhofer IFF due to a large number of companies and requisite human resources of trainers. Thus, a systematic and in-depth qualification and training of Industrie 4.0-CheckUp trainers is more promising to broaden the basic ability to Industrie 4.0-CheckUp and transfer it to other international organizations. The Industrie 4.0-CheckUp requires the development of more than just methodological skills with the help of the tool.

6. Skill requirements for Industrie 4.0-CheckUp trainers

Training requirements have been being discussed in academia and industry for many years. Among others, studies of the impact on basic and advance training in the metal and electrical industry [28], the skills for Industrie 4.0 training requirements and approaches [29], and a study by Siemens [30] deserve mention. These studies compare content, training and skills relevant to Industrie 4.0, which are required in the context of Industrie 4.0 projects. Graul’s comparison of the findings of studies of training requirements shows in particular a high degree of overlap in the training priorities of

- relation to the system,
- relation to analysis,
- relation to data,
- relation to the process, and
- relation to problem-solving skills [31].

Striking in this analysis is that interdisciplinary training and social skills only play a minor role [31]. Another approach to clustering requirements for employees is the requirement profile based on Hermann, which breaks skills down into six areas [32]:

- soft skills,
- psychomotor skills,
- perception,
- creativity,
- methodological skills, and
- cognitive skills.

These six areas were used to examine the aspects of creativity and idea generation skills in particular. Furthermore, important personal skills such as the openness to new experiences, self-management or decision-making skills were prioritized under the area of soft skills. The area of perception, which includes perception of surroundings or mood, among other things, also played a significant role.

The first outcome of this theoretical analysis was the development of a list of requirements for future Industrie 4.0-CheckUp trainers, which can be outlined as follows:

- good to excellent university degree in an engineering program (mechanical engineering, manufacturing process engineering/manufacturing logistics, process engineering), ideally a doctorate,
- at least five years of real work experience, ideally in consulting or in several (ideally international) companies,
- project management experience/mid-level management,
- capital, innovation, and/or reorganization project experience,
- grasp of the fundamentals of information technology/digitalization,
- strong soft skills (primarily social skills and self-mastery), and
- English language skills.

This list of requirements and the substantive skills constitute the point of departure for the designing of a train-the-trainer plan.

7. Train-the-trainer program

Following the validation of the Industrie 4.0-Quick-CheckUp, a group of individuals internationally active in science, business and government was assembled to develop and formulate a train-the-trainer program. A didactic curriculum was developed at two workshops with the aid of creativity methods such as Six Thinking Hats, mind mapping and the Delphi method. The curriculum was intended to build international capacities and to ensure the transfer of knowledge in the sense of diffusing knowledge on different levels.

The program developed consists of four phases, all of which must be completed to complete the training. An overview of the four phases is presented in Figure 4.

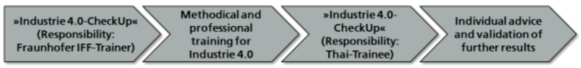

Figure 4: The 4 phases of train-the-trainer program for the Industrie 4.0-CheckUp

Exactly ten individuals with the required skills are accepted in the training program following the selection process. These ten individuals are split into two groups at the beginning of the training. They are split up based on a team role test rather than arbitrarily. A questionnaire-based approach is used to assign every trainee a role in the team building process. Analyst, creator or connector are roles assigned to the ten trainees. This initial classification ensures that the teams are put together as heterogeneously as possible.

In the first phase of the training program, trainers from the Fraunhofer IFF conduct an Industrie 4.0-CheckUp project with the two groups (following the sequence in Figure 2). The trainees can initially follow and observe all the steps of an Industrie 4.0-CheckUp in a passive role. The objective is to familiarize the trainees with the practical application before the theoretical training. Trainees can especially use the phase during information collection to develop a feeling for "asking the right questions". Daily facilitated feedback sessions at the end of a workday give the trainees the opportunity to discuss observed contents within the group. The first phase ends with a final presentation of the two Industrie 4.0-CheckUp projects. The groups experience the Fraunhofer team’s presentations to review the significant findings of the first phase in a concluding feedback session.

The second phase of the program includes the methodological and technical training. On the one hand, the goal is to qualify the trainees for the Industrie 4.0-CheckUp method. On the other hand, participants are provided with technically sound expertise in the subject of Industrie 4.0. The methodological and technical skills are additionally enhanced during this training phase by exercises that aim at strengthening personal and social skills (see soft skills above). The methodological part of the training focuses on transferring knowledge of the Industrie 4.0-CheckUp method theoretically. A developed didactic curriculum is used to combine the levels of learning, materials and relationships between trainer, trainees and content as profitably as possible. Contents include individual phases of the project and technical excurses, comprising the topics presented in Figure 1. Along with cognitive skills, these excurses also teach personal, soft and methodological skills. In keeping with the didactic curriculum intended to train trainees regionally to acquire new projects in the medium to long term, the fundamentals of Industrie 4.0, historical foundations, different international perspectives or even theoretical principles of capability maturity models are also taught. Role-playing games also test the various possible directions acquisition talks can take; in the sense of a pitch. To this end, the Fraunhofer IFF trainers assume different roles of manager types in order to teach trainees ways to address specific audiences and skills to change their argumentation strategy during a conversation. Furthermore, the contents are taught theoretically during the phases of the project following figure 2 and are either treated in review with past examples from the first phase or practiced using examples from the third phase of the training. Another element of this phase of the training is a study trip to Germany which especially concentrates on company visits from a wide spectrum of industries that have gone through the Industrie 4.0-CheckUp program. Factory tours and sharing of experiences between companies and trainees ensure a sustainable and practical learning success. This particularly enables trainees to get to know different approaches to different levels of capability maturity and to apply their experiences to future companies contextually.

During the third phase, the trainees and trainers swap roles. The trainees are primarily responsible for performing the Industrie 4.0-CheckUp. The trainers merely take the role of observes during this training phase, and intervene in the event of problems only. In addition, the Fraunhofer staffers verify all phases and results of the Industrie 4.0-CheckUp performed by the trainees. This training phase is particularly important for testing the acquired learning content acquired theoretically and practically in a real-world application, thus deepening it.

Finally, the trainees complete Industrie 4.0-CheckUp projects on their own during the fourth phase of the training. Results of these are discussed with the trainers from the Fraunhofer IFF, while their consistency is verified before being presented. The training program ends after this phase. It is assumed that the trainees will be able to act as trainers by themselves, as their responsibility and practical experience grows and the desired diffusion effect will start thereon.

8. Discussion – experiences from the validation

As has been discussed in the literature critically, it is questionable whether companies need the outside support of a consultant when drafting their Industrie 4.0 road map. Mittal et al. state that most companies, especially SMEs, do not factor in outside consultants to supervise their digital transformation [25]. The approach described in this paper emphasizes the importance of outside support when performing an

Industrie 4.0 capability maturity assessment. This is specifically based on practical experience and the incorporation of intercultural and national views of the subject.

Two different organizations validated the training program described in section seven that was initially executed in Thailand. The following findings were established:

- The requirements formulated for training the trainees proved to be necessary. Trainees without the requisite professional experience had difficulty interpreting the complex relationships within the company correctly. Furthermore, selected trainees with engineering backgrounds in science proved to be best in terms of mastering project complexity and understanding technical and economic correlations. Two trainees with business economics backgrounds sometimes had difficulties interpreting technical relationships correctly, especially in the field of information and communication technologies. The defined requirements ought to be adhered to as much as possible.
- It was also established that key facts about manufacturing and information system use cases must be available to recommend the right actions to a customer. The biggest differences between the trainers were detected in the methods of communication. Empathetic communication systematically targeting the company's mindset and weaknesses proved to be significantly more effective than just a factual explanation of a use case. Similar differences were also detected during the interview-based information collection.
- Holding regular feedback sessions during the various training phases proved to be constructive. Sharing among groups and learning from each other particularly resulted in many different discussions and contextual modifications in the program. For instance, a variety of management's views during goal-setting can be harmonized and addressed through modified communication methods.
- Alternatives to the methods defined for the Industrie 4.0-CheckUp were often presented and discussed critically during the training. Organizing the process of digital transformation together with local partners proved helpful. Based on a standardized capability maturity model, ways to modify the program for specific countries could be found, which affect the form of interaction during the presentation of the results, for instance. In particular, the form of visualization during the fourth phase of the project was adapted to the requirements. An overall better visual contextualization was necessary to establish a superior understanding of the road map.

It was also possible to derive some general recommendations for organizing digital transformation from the collaboration with companies, which were discernible from the executives' classic behavioral patterns.

- Do not follow the calculations for the return on investment. Industrie 4.0 affects the entire company.
- Implement a sustainable transformation and change management. Involve all employees.
- Keep questioning your business model by using the Business Model Canvas or the 55 pattern.
- Follow the rules of user interface design (i.e. apps) to provide good service to your employees.
- Develop your own IT expertise to program custom applications.

9. Conclusion

The purpose of this paper was to derive an approach to incorporating and harmonizing various international views and interpretations of the topic of Industrie 4.0 based on a capability maturity model. First, the validation of an earlier approach to self-assessment was presented based on an approach validated in practice. This revealed that outside support and the introduction of impulses currently not being considered at the company are indispensable in part. A program focused on training program, international trainers in Industrie 4.0-CheckUp was derived from this.

The validation of this training program delivered a sound foundation for organizing globally operating value networks. The need for further research was identified based on the findings of this paper. Therefore, next steps will be the representation and visualization of horizontal integration. Furthermore, tighter integration with companies' existing but not yet collected key performance indicators is extremely relevant. Finally, the goal is to develop a capability maturity model based on a process-oriented rather than a function-oriented representation.

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