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Conference Papers

Adoption of Factory of the Future technologies

Concept of an impact indicator system to track the path towards the Factory of the Future

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***Abstract*— One of the main innovation potentials to maintain the long-term competitive advantages of the manufacturing sector in high-wage countries is the adoption and implementation of Factory of the Future technologies. Different types of existing Industry 4.0 maturity models open up opportunities of defining the company's strategic position – an important starting point.**

The presented impact indicator system extends those models to support the path towards the Factory of the Future. Its starting point is a qualitative evaluation of critical success factors, which allows a company to derive measures to utilize the company's innovation potential. Based on this strategic input, the core part of the developed approach is a strategic framework for the quantitative assessment of impacts on the operational performance of a company's value stream and innovation potential.

Keywords—impact indicators, performance measurement, Factory of the Future, Industry 4.0

I. Introduction

Based on rapidly shortened technological life cycles of products and fast technological developments, innovations have developed to a crucial success-factor for manufacturing companies and their value streams [1]. In order to stay competitive in a market and to secure the long-term corporate success, companies need to innovate their products, processes and business models [2,3]. Recent studies [3–5] clearly show the positive impacts of innovative companies compared to their competition. The growth-rates of innovative companies is clearly and significantly higher than those of less innovative companies [4].

Today's innovation is mainly pushed by digital technologies [6]. Keuper et al. [7] claim the nowadays necessity of being digital in order to be innovative. The digital transformation has become the most valuable driver for innovation, leading to an increased performance in the innovation-process and a better utilization of a company's innovation potential [7].

The digital transformation influences the capability of innovation in various ways. It enables a better collaboration between the actors of an innovation process by using platforms, social media and other communication tools [8]. This creates the possibility of performing collaborative innovation projects and ensures a broad knowledge-base to enhance the ideation process [8].

Digital technologies also improve the organizational creativity, which is defined as the company's ability to use the creative potential of employees in order to boost the performance [9]. Simões [9] claims that innovation is the process which follows the creativity. Therefore, they define an innovation as the implementation of an idea. Implementing digital technologies like virtual reality and additive manufacturing to support creativity can tap innovation potentials [10]. Digital technologies also support the responsiveness, the agility and flexibility of both production and administrative processes, leading to shorter lead times in innovation- and production processes [11].

Following the Digital Economy and Society Index (DESI), an initiative of the European commission to measure the progress of digitalization in economy and society, countries of the Alpine Space like Austria are lagging behind the leaders like Denmark [12]. A number of causes are decisive for this development. Besides the continuous lack of qualified employees, issues related to data security and the need of high investments, small and medium-sized enterprises (SMEs) especially state uncertainties concerning the return of investment and the impact of new technologies [13].

Anyway, the main challenge for many companies, especially SMEs, is the right choice of technologies and digitization activities [5]. In order to support this path towards the Factory of the Future (FoF), Fraunhofer Austria Research GmbH developed an impact indicator system (IIS), which can be used as a strategic controlling-tool on this path. Chapter II gives a short overview of the state-of-the-art, focusing on the distinction of classical maturity models and the developed approach. After this, the methodology of the approach will be described (chapter III). Chapter IV presents the developed concept of the impact indicator system and its main targets. The paper will be closed by the discussion of the findings (Chapter V) and a conclusion (Chapter VI).

II. State of the Art

"Factory of the Future", "Smart Factory", etc. are some of the buzzwords describing the ongoing interconnection in manufacturing systems driven by technology, sustainability, optimization and the need to meet customer demands [14,15]. Through great impacts in the fields of asset efficiency, quality, costs, safety and sustainability, FoF takes the role as a major driver for global competitiveness [14]. This concept defines a variety of enabling production technologies as well as IT solutions that are orientated towards ensuring the availability of all relevant information in real time by connecting all elements participating in the value chain [11,15]. According to the International Electrotechnical Commission , a few major concepts can be defined to characterize the FoF [15]:

Open value chain: Value chain systems need to become more adaptable, agile and resilient in order to respond to requests arising from increased product lifecycles and the demand for personalized products. Digital technologies enable close-to-real-time numerical simulation and optimization of value chain planning and execution, leading to a shift from human centered production control to self-control by IT systems [15].

Flexible production: Similar to value chain systems as a whole, also singular production systems have to adapt to changing customer demands. This gets possible by integrating various sensor systems to provide real-time data, thus allowing the transfer of individual product specifications to production plans [15].

Human-centered manufacturing: FoF technologies enable a shift towards a more flexible relationship between humans and the factory, with open share of knowledge and increased ergonomics by robotics [15].

Successfully transforming a production system to a FoF is connected with major challenges, as defined in chapter I. On the path towards the FoF, the ability to measure the current progress in the company becomes increasingly important, as Tonchia and Quagini point out that *"you cannot manage what you cannot measure"* [16]. Today, performance measurement, the *"process of quantifying the efficiency and effectiveness of actions"* [17], has developed to a fundamental part of business management, allowing to learn from the past and to plan the future progress of an enterprise. Performance measurement is applicable to all kinds of business strategies [18], often taking the role of a decisive element. As a management dashboard, the core of a performance measurement system (PMS) is composed of a set of key performance indicators (KPIs), which assume a value and determine a measure. A central requirement for a PMS is the consistent and accurate availability of these indicators, together with a formal review of the processes involved in decision-making and organization in general [16].

Referring to the current a broad range of maturity models have been created over the past years, aiming at supporting enterprises on the path towards these trends [19–22]. Commonly, these maturity models are used in the evaluation process, which are often based on good practices and success factors derived from projects that have demonstrated favorable results to an organization or an industry sector [20,23]. The degree of maturity measures the reliability, effectiveness and efficiency of processes, systems or organizations [24]. Representing qualitative methods of assessment, maturity models focus on various areas such as people, culture, processes, structures, objectives, technologies, etc. [25]. According to Ahlemann et al., a maturity model can be defined as *"a model that defines different levels of maturity in order to evaluate to what extent a competence object fulfils the universal requirements that are defined for a class of competence objects"* [26].

A broad range of maturity models is already available, supporting companies on defining their maturity and deriving improvement potentials. Created as self-assessment tools or as cooperative instruments to be evaluated with external experts, all maturity models share to objectify the current progress towards future production systems, thus enabling the derivation of further needs for action [19–22]. The *"Industry 4.0 Maturity Model"* [23] aims at assessing the industry 4.0-maturity in nine different business dimensions. The maturity is measured using pre-defined maturity attributes taking into account the specific strategy and vision of the enterprise towards Industry 4.0. A special focus of the *"Industry 4.0 Maturity Model"* lies on human and cultural elements, broadening the solely technical view of the topic. The detailed description of the maturity levels allows the consideration of the state-of-the-art developments in practice as well as the technological readiness of enabling technologies [23].

Such maturity models offer a good starting point to assess the current achievements, to set strategy-specific goals and, in case of the presented Fraunhofer Austria maturity model, to provide further guidance towards best-practice scenarios [23]. On the other hand, a disadvantage of most maturity models is the restricted applicability regarding the impact assessment related with the progress of a company towards Industry 4.0. While showing best practices and proposing areas of activity, maturity models are not suitable to track effective consequences, such as the financial effect of Industry 4.0-related decisions. A major problem is the missing link between maturity levels and quantitative performance measures to track effective improvements. As described in Chapter I, one of the most important causes for the low implementation level of digital technologies in the Alpine Space, are uncertainties concerning the return of investment and the impact of these technologies in the company [13].

Due to the stated disadvantages, especially regarding the missing information about short-term or long-term performance developments, maturity models are not sufficient to overcome this issue. Therefore, a new approach is required, differentiating from simple maturity models.

This paper aims at presenting an impact indicator system (IIS), suitable to track effective and efficient improvements after transfer and adoption of FoF technologies and -practices on various levels in the company. The approach combines quantitative and qualitative elements in order to cover all influencing factors, while at the same time providing detailed performance values. The developed IIS offers a strategic tool to support the path towards the FoF.

III. METHODOLOGY

The aim of the developed IIS is to provide a system of KPIs, covering both quantitative and qualitative measures that allow to identify the impact of FoF technologies and -practices adoption at various levels of the manufacturing value chain. The purpose of this indicator system is to offer a reference system, which manufacturing companies can use to derive specific actions on their path towards the FoF.

A. Delimination of the impact indicator system

Resulting from the stated challenges described in chapter II, the IIS is supposed to differentiate from available maturity models. Main delimitations of the IIS are presented below:

Purpose of the model: Deriving from chapter II, maturity models usually aim at tracking the current maturity level regarding a specific topic, in order to enable the identification of further needs for action. In contrast, the IIS aims to investigate the impact of technology- and practices adoption, thus dealing with the challenge of developing a ROI towards the factory of the future.

Focus of the model: With a few exceptions, I4.0-maturity models primarily focus on a technical level in order to provide specific solutions to successfully integrate I4.0-technologies. The identification of the technological impact requires an extended view on multiple perspectives in order to track the full impact on various levels in a company. The IIS, instead of providing detailed technical solutions, therefore addresses a more generic level, focusing on critical framework conditions and success factors towards FoF.

B. Model requirements

The IIS is subject to a set of requirements, which guarantee the inclusion of relevant stakeholders and influencing factors, while on the same time ensuring a broad applicability of the system. The main requirements and specifications for the developed approach are defined below:

Different perspectives: A broad range of existing performance measurement systems rely solely on monetary indicators to evaluate performance developments. In this respect, the indicator system should offer a better approach by considering multiple perspectives [27] such as competitiveness, smartness, innovativeness etc. in the impact analysis.

Different stakeholders: A key element to guarantee the usefulness and the informative value of the indicator system is achieved by integrating all relevant stakeholders into the model. The indicator system is therefore supposed to consider all interest groups along the manufacturing value chain, such as suppliers, external partners, customers, etc.

Different measurement modes: Finally, different modes of impact evaluation should be considered to ensure the collection of all necessary information. This requirement is met by defining quantitative and qualitative indicators in the model. While quantitative indicators represent numeric measures such as the financial performance of a company or the number of employees in a division, qualitative indicators are useful in cases where important outcomes are difficult to capture quantitatively.

The concept of an impact indicator system presented in this paper strongly builds on existing frameworks and preliminary work performed in the BIFOCAlps project. The following section provides an overview of the theoretical background relevant for the impact indicator system.

C. Critical Success Factors

In order to track specific impacts and improvements along the value chain, it is nonetheless necessary to analyze the current maturity level on the path towards FoF. This requirement is essential to be able to link specific FoF-inputs and investments to outcoming results. The major challenge of the IIS therefore lies in combining a qualitative maturity assessment to quantitative performance indicators, tracking the effective improvements. The basis for the maturity assessment is formed by a validated methodology developed in previous working packages of the BIFOCAlps project. The objective of the methodology is to enhance FoF long-term sustainability through innovation and knowledge transfer among business, academic and policy actors. Based on over 100 conducted best case interviews with experts and manufacturing companies in the Alpine Space, the methodology consists of comprehensive guidelines for fostering innovation processes towards the factory of the future. These guidelines can be assigned to five priority areas, representing critical success factors (CSF) and enablers for FoF –technologies and -practices adoption. The section below provides a short summary for each of these CSF, which have been identified by the analysis:

CSF 1 - Strategy: In order to manage the transition towards a factory of the future, companies need to define a clear strategy, stakes, objectives and benefits of the digital transformation. Communicating these matters to all stakeholders enables the establishment of a supportive corporate culture, which is necessary for the transformation of the company. The strategy should further include a specific procedure, duration, milestones, budget, risks, etc.

CSF 2 - Technology: Obviously, technical factors are main enablers towards the FoF. Major challenges concern the reliability, maturity, high costs and false expectations of new technologies. A critical step therefore lies in strengthening the reliability of these technologies through pilot applications, analyzing the value creation and potential areas of applications, etc. Another challenge concerns the safety of data, which has to be met with an appropriate IT infrastructure.

CSF 3 - Capacity for innovation: This success factor addresses the availability of supportive structures inside the company. According to the interviews performed, it has proven to be important to engage in R&D-activities in order to enable the digital transformation and the adoption of new technologies. R&D-activities cover internal processes in dedicated R&D departments as well as collaborative projects transcending company borders.

CSF 4 - Ecosystems support for innovation: Companies that benefit from industry networks, funding programs and collaborations with external companies, research institutes, universities, etc. have a far greater chance to master the digital transformation successfully. The direct environment of a company therefore emerges as a critical success factor towards FoF.

CSF 5 - Skills and change management: The last and probably most important success factor addresses the availability of skilled workers. Special trainings are essential to create awareness about the technological changes and to acquire the right skills to handle the digital transformation. Change management is another key issue that determines a company's ability to motivate its employees to support the transformation towards FoF.

D. Input-Process-Output-Outcome model

The Input-Process-Output-Outcome (IPOO)-framework [28] represents a widely used and accepted process based performance management framework, developed by Brown and Svenson in 1988. The IPOO-Model serves as a framework to combine relevant indicators in order to manage and control innovation activities [29]. The framework is based on an ideal sequence of the innovation process and includes four main categories inputs, processing system, outputs and outcomes, which represent the transformation of R&D-related investments into specific results on various levels. In more detail, different types of inputs enter the innovation process, where these inputs are handled by the processing system. In this context, the processing system consists of all R&D-activities, which generate outputs such as new products, patents, knowledge or new methods. According to Brown and Svenson these outputs then enter the receiving system [28], an umbrella term for all business units that are involved in distributing and capitalizing the outputs. The receiving system itself is not a part of the IPOO-framework, but it is necessary to show the connection to outcome indicators, which represent the monetary success of all preceding innovation processes [30].

In order to provide a better understanding of the differences between indicators in the four categories inputs, processing system, outputs and outcomes, the following section presents these process elements in more detail [28,30,31,29]:

- **Input indicators:** As described above, input indicators capture resources, which enter the innovation process. In order to build a comprehensive model it is necessary to consider multiple perspectives besides costs. Therefore, input resources should include tangible as well as intangible assets of a company such as employees, equipment, information, expertise or financial resources. The significance of input measures is limited due to various reasons. For example, an increase in input resources does not necessarily result in higher outputs rates. In this context, the effectiveness and efficiency of resource allocation and the processing of system inputs is far more important than just the amount of resources provided. Still, input measures should definitely be considered in a performance measurement framework, as they are relatively easy to gather and suitable for the derivation of comparative figures and reference values.

- **Process indicators:** The transformation of input factors into specific outputs is the main activity in a companies' strive for innovation. As a result, guaranteeing effectiveness and efficiency of this change process should be of greatest importance for every decision maker. Selected indicators in this category can support this goal by providing relevant information and ensuring transparency in the whole processing system. Frequently used measures include cycle time, adherence to delivery dates as well as cost- or quality related indicators.

- **Output indicators:** In general, organizational innovation activities aim at creating knowledge, new products or new processes. Output indicators are necessary to evaluate the successful achievement of these objectives. Depending on the specific objective, different types of measures can be defined. To capture the success in new product or process development, particularly quantitative measures can be utilized, such as the total number of new products or methods. A common approach to evaluate the growth of knowledge on the other hand is to count a companies' output in patents in relation to the total number of employees. This indicator can serve as an approximation, even if the quality of patents applied is more important than the quantity.

- **Outcome indicators:** By pursuing an innovation-orientated strategy, every company expects to either extend its market position through revenue growth by new products or cost reduction with improved production methods and more efficient processes. Therefore, besides considering the amount of new products, patents, etc. the market success of these outputs has to be taken into account. Outcome indicators thereby are necessary to evaluate the overall success of the innovation process with respect to the business mission. Typical measures include the revenue increase or growth in terms of market share. Frequently, also the customers' perspective is considered, by measuring the average satisfaction or the customer benefit of a new or improved product.

Structuring innovation activities into the described process elements inputs, processing system, outputs and outcomes enables a classification and systematic representation of performance measures. According to Gleich and Quitt [32], systematically monitoring measures in these categories could be a key success factor to manage all innovation activities with regard to specific objectives and therefore to ensure the innovation success of a company.

Concerning the objectives of this paper, the IPOO-model as a basic framework allows to evaluate the impact of different inputs and investments on various levels of the innovation process. Broadening the scope of the IPOO-framework by replacing the innovation-based approach by a more comprehensive point of view, the framework becomes an optimal starting point for the development of the FoF-impact indicator system. The challenge is to elaborate suitable indicators that fit the quoted process elements.

IV. Impact Indicator System

The developed concept of an impact indicator system defines a set of indicators for impact measuring on company level. The specific objective is the evaluation of the correct path towards FoF. The basic structure of this model is build according to the IPOO-framework [29], where the model elements inputs, processing system, outputs and outcomes were defined. These elements allow an assessment regarding the model requirements for different perspectives, stakeholders and measurement modes, defined in chapter III.

A. Basic structure of the impact indicator system

The fundamental structure of the impact indicator system according to the requirements defined above is shown in Figure 1. The system provides a qualitative assessment in order to track relevant input values entering the system. Since the indicator-system is meant to provide a reference model towards the FoF, inputs should capture tangible and intangible assets paving the way towards this goal. Due to this reason, the CSF defined in chapter III offer a perfect starting point to set up the qualitative assessment, as these factors represent main enablers for the digital transformation. The following three elements processing system, outputs and outcomes then mainly aim at evaluating the impact of CSF-related investments and improvements on different levels in a quantitative way. This structure has been developed to determine relevant indicators for each column of the model.

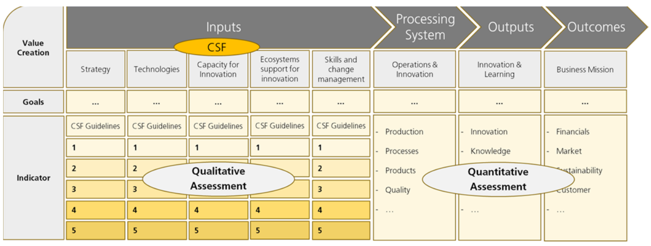

Figure 1 – basic structure of the impact indicator system

This structure offers a model for the impact indicator system regarding the process-based structure as well as the distinction between quantitative and qualitative indicators. Furthermore, the described impact indicator system derives measures and lists of actions in the model directly. Since all manufacturing enterprises differ from each other regarding the status of FoF-implementation, the objectives or the environment, business critical goals that are generally valid cannot be defined. Similar to the balanced scorecard [33], one of the most important performance measurement systems [34], it is useful to link the selected indicators to company-specific long-term and short-term goals.

B. Quantitative and qualitative indicators

Since the assessment of the CSF-maturity level in the input-category is based on guidelines defined on the analysis of over 100 best-case interviews in the BIFOCAlps project, a scoring model offers a suitable approach for the evaluation. A scoring model links a set of questions to a predefined rating scale, which experts can use to provide their qualitative assessment. By using a five-point Likert scale [35], which is ordinal [36], experts have the possibility to specify whether they agree or disagree with the implementation of a specific guideline for each CSF in their company. The Likert scale can represent a various scale, which has to be defined by the interrogator. A scale with many answer options offers a more detailed analysis, while fewer answers keep the application of the model simpler, as the experts have to decide between fewer answers. As the evaluation in a scoring model mainly depends on subjective perception of internal experts, the assessment method is of qualitative nature.

The evaluation of the impact in the three categories processing system, outputs and outcomes, especially quantitative measures are suitable. Quantitative performance measures regarding processes, products, costs, financials, etc. are widely available and already implemented in all divisions of enterprises. These measures are perfectly suitable for the evaluation of the progress as subjective answers are excluded from the analysis. Therefore, the impact indicator system does not define quantitative and qualitative indicators for every stage in the value creation. Instead, the distinction is made between these stages. While input indicators are expressed through a qualitative scoring model, the stages processing system, outputs and outcomes cover a set of quantitative measure.

The qualitative and quantitative assessment will be described as follows.

C. Qualitative CSF-assessement

The impact indicator system covers a qualitative assessment regarding input factors towards FoF together with a respective quantitative evaluation of the impact. Due to the easy application as well as the higher informative value, the qualitative assessment consists of a scoring model linking relevant criteria to a 5-point Likert scale. Regarding the specific content of the model, the maturity levels of the critical success factors are only restrictedly applicable, as they provide low information on how to achieve a higher maturity. Instead, the respective guidelines, which are assigned to each CSF (extract of the guidelines of one CSF-Category as shown in Figure 2), express specific requirements a company needs to fulfil in order to successfully apply the practices. Using these guidelines as the basis for the impact indicator system, besides evaluating their current progress enterprises also get the possibility to inform themselves about further needs for action.

Figure 2 - Qualitative assessement - extract

D. Quantitative indicator selection

The definition of quantitative indicators for the impact indicator system in this paper follows a few guidelines, guaranteeing a useful output for enterprises. Firstly, it is important not to define too many indicators, as the impact indicator system should be clearly arranged and easily applicable. Simultaneously, the identified indicators should cover the respective circumstances as complete as possible. Therefore, it is necessary not to focus on too many details, but to define generally valid indicators. Taking into consideration that indicators have to be assigned to three columns processing system, outputs and outcomes, between six and ten measures should be reasonable in order to avoid a high degree of complexity in the application. Additionally, the information necessary for the calculation of the indicators has to be collectable without too much effort or costs. This requirement ensures that progress can be monitored on a regular basis, which further guarantees the applicability of the indicator system as a strategical management tool.

Figure 3 lists a set of suitable KPIs to measure the impact of FoF-technology and practices adoption on the processing system of an enterprise. As stated in the previous chapter, the processing system covers operational activities as well as processes in the R&D department. To evaluate the performance of operational activities and production processes, a wide range of indicators are applicable. Frequently used measures include those related to efficiency and productivity, to the quality as well as indicators measuring the time between the beginning and the end of a process. The indicator *Time to market* is particularly convenient to evaluate the performance capability of the R&D department.

As evident from the list of indicators, these measures especially address and evaluate advances regarding the CSFs Technology and Capacity for innovation. FoF-technology investments primarily affect production processes in a manufacturing enterprise. To evaluate the impact of these investments it is reasonable to apply the indicators stated in Figure 3 in combination with before- and after comparisons.

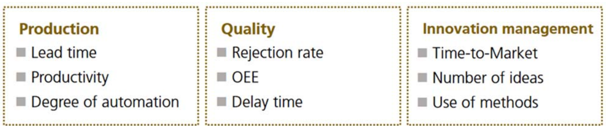

Figure 3 – extract of indicators for the processing system

Figure 4 lists indicators to evaluate to output and the results of input investments in combination with the processing system. These results can represent tangible outputs like new products, patents, applications, processes as well as intangible outputs such as the increase in knowledge or the availability or skilled workers. Regarding employees, the qualification structure is a suitable indicator to evaluate the availability of necessary skills in the organization.

The qualification structure for the FoF-transformation can be influenced directly by focused staff recruitment or through development of the existing workforce. These activities directly fall within the critical success factor “Skills and change management”. Besides recruiting qualified personnel, a company has to be able to hold its employees over a long term by offering a good working environment. The indicator “*Fluctuation of qualified employees”* is suitable to measure this ability. Concerning the category Knowledge transfer, Figure 4 suggests a set of indicators which measure the fability of a company to gain and utilize new knowledge. As knowledge itself is difficult to evaluate in quantitative terms, the time required to apply this knowledge offers a good starting point for the analysis. Indicators in this category can be applied to analyze the impact of improvements regarding the CSF “*Ecosystems support for innovation”* and “*Capacity for innovation”*.

Figure 4 - extract of indicators for the output-category

Figure 5 proposes a set of indicators that can be applied to measure long-term achievements trough FoF-technology and practices adoption. The indicators are in line with typical goals and missions of manufacturing enterprises, including customer results, financial accomplishments, market objectives and sustainable development. A series of indicators can be used to evaluate the impact and success of innovative activities at company level. For example, the success of a new product introduction is reflected through new customers, increased revenue or through a higher market share. As defined in the previous chapter, outcome related indicators are suitable to track the overall achievements following FoF investments. As such, the measures in Figure 5 also indicate if the defined strategy has been rewarded.

Figure 5 – extract of indicators for the outcome-category

V. FINDINGS

In order to enable innovation in products and processes and to ensure competitive advantages, the path towards the FoF becomes a crucial enabler for the sustainable success of companies.
This paper provides an approach, which builds on the developed impact indicator system described in Chapter IV. Figure 6 shows the general idea of the developed methodology. Taking into account a holistic multi-criterial view, the impact indicator system enables the investigation of staggered effects, starting at the company’s improvements of the CSF, which can be seen as the organizational enabler for successful innovation. These success factors ensure the ability of a company to deal with the challenge FoF.

Summarized, the developed approach can be described as a strategic controlling tool for the management of a company. It clearly points out the improvement potentials in the organizational structure, based on a qualitative assessment of CSF, where actions can be deduced. Furthermore, the effects of these improvements will be analyzed by the quantitative dimensions processing system, outputs and outcomes. The indicator system therefore guarantees a holistic view of a company's path towards the FoF.

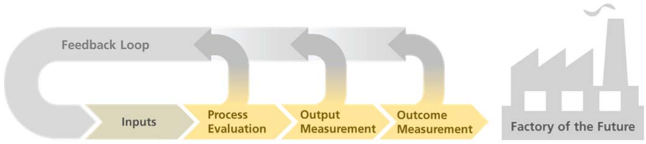

Figure 6 - Impact indicator system as a strategic tool towards the Factory of the Future

VI. CONCLUSION

The present paper addresses the challenge of missing information concerning the impact of technology adoption, which prevents SMEs from implementing FoF-technologies and -practices. This issue is met by by proposing a comprehensive indicator system that combines a qualitative maturity assessment regarding FoF with quantitative performance indicators, which track the impact on various levels in the company. The developed model therefore allows companies to track their path towards the FoF in a holistic approach and to examine the impact with a set of quantitative indicators.

Focusing on the scientific side, there are some research gaps to point out. First, the cause-effect-relationships between the indicators, especially when these relationships are timely staggered, need to be investigated. Big data analytics and machine learning approaches might be appropriate tools to describe these relationships. Second, the actual set of indicators is based on a broad literature review. Anyway, this set of indicators has to be individualized depending on the specific company. There is no common framework which defines the crucial KPIs in the context of FoF. A common framework would be an achievable goal in order to allow external benchmarking.

Based on our experiences in direct cooperation with companies and specific workshops in the BIFOCAlps project to receive feedback from companies to the developed methodology, the following critical issue can be mentioned in the implementation of the approach: Companies often do not use performance measures expect measures on the financial level. Therefore, their agility and responsiveness on changes is very slow. Therefore, a challenge is to increase the company's awareness of the important role of indicators and their correct use.

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