DIN DKE

WHITEPAPER

THE BUSINESS ORIENTED BENEFIT OF SMART STANDARDS IN STANDARD APPLICATION PROCESSES

AUTHORS/CONTACTS

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Raymond Puppan, DKE
Stefanie Voit, TS.advisory GbR
Dr. rer. nat. Magnus Redeker, Fraunhofer IOSB-INA

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Raymond Puppan, DKE
Martina Paul, Huawei Technologies Switzerland
Michael Noll, Open Grid Europe GmbH

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Raymond Puppan, DKE
Stefanie Voit, TS.advisory GbR
Dr. rer. Nat. Magnus Redeker, Fraunhofer IOSB-INA

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Stefanie Voit, TS.advisory GbR

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Raymond Puppan, DKE
Stefanie Voit, TS.advisory GbR

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Stefanie Voit, TS.advisory GbR
Raymond Puppan, DKE

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DIN e. V.

Burggrafenstraße 6
10787 Berlin
Germany
Phone: +49 30 2601-0
E-Mail: presse@din.de
Internet: www.din.de/en

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE
Merianstraße 28
63069 Offenbach am Main
Germany
Phone: +49 69 6308-0
Fax: +49 69 08-9863
E-Mail: standardisierung@vde.com
Internet: www.dke.de/en

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Content

1 MANAGEMENT SUMMARY

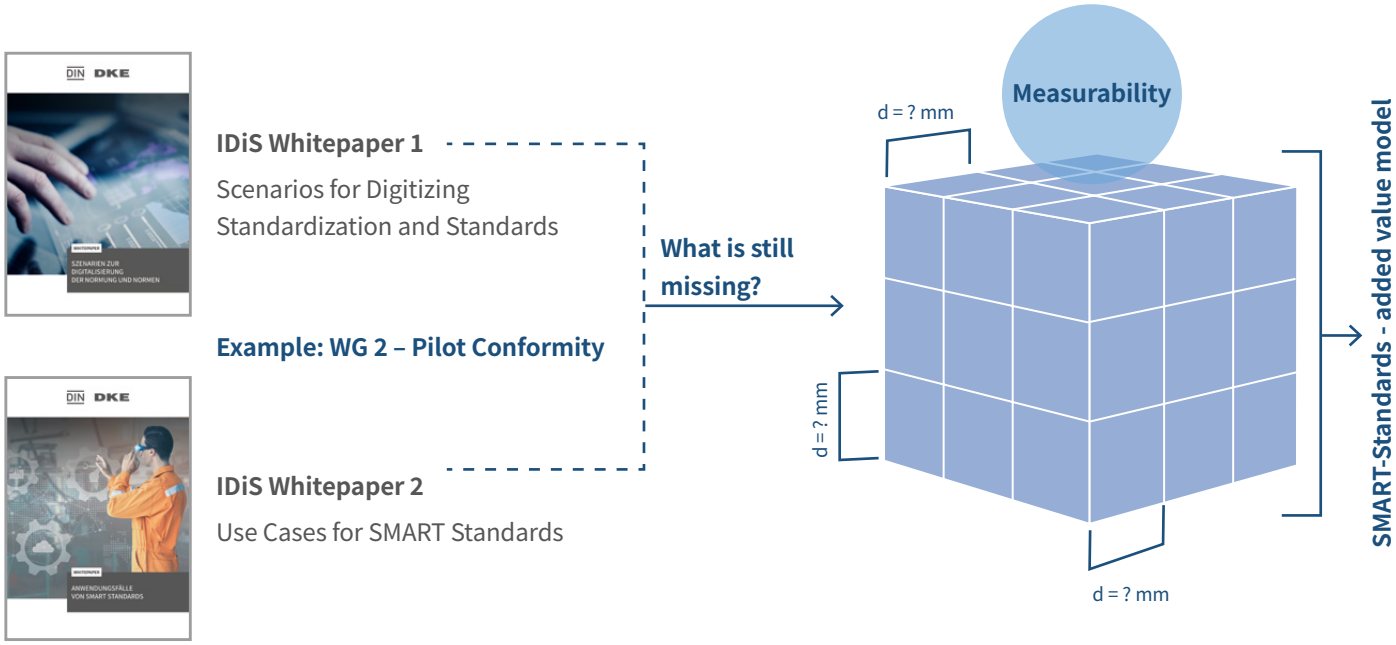

Fig. 1-1: Whitepapers 1 and 2, as well as the open question of measurability (Puppan, DKE)

This white paper looks at the business-oriented aspects of standard application processes using a specifically developed **SMART standards added value model.**

The model is used for the economic evaluation of the added value of SMART standards in corporate processes in which standards are applied.

The earlier IDiS white papers 1 and 2 answer the following questions:

→ What are SMART standards, which levels of maturity are available (utility model) and what will their effect be in the value adding process?

→ Which use cases are there? – 11 generic user stories (GUS)

As several IDiS pilots have shown how SMART standards can be implemented in practice, this white paper 3 now answers the question of what value SMART standards can have for companies in implementation practice.

The "bottom up" approach is taken to ascertain and visualize the benefit, as there is no sound basis for assessment in the popular answer "digitalization is coming anyway - if you don't jump on board, you'll get run over".

The chosen approach gives companies a reliable basis to see whether digital transformation of company processes is expedient in the usage of standards. This is the case when it leads to planning certainty and improved savings in terms of time or costs.

For this reason, the SMART Standards added value model was developed, which forms the basis for this white paper.

The pivotal point of the considerations are corporate processes in which standards are applied.

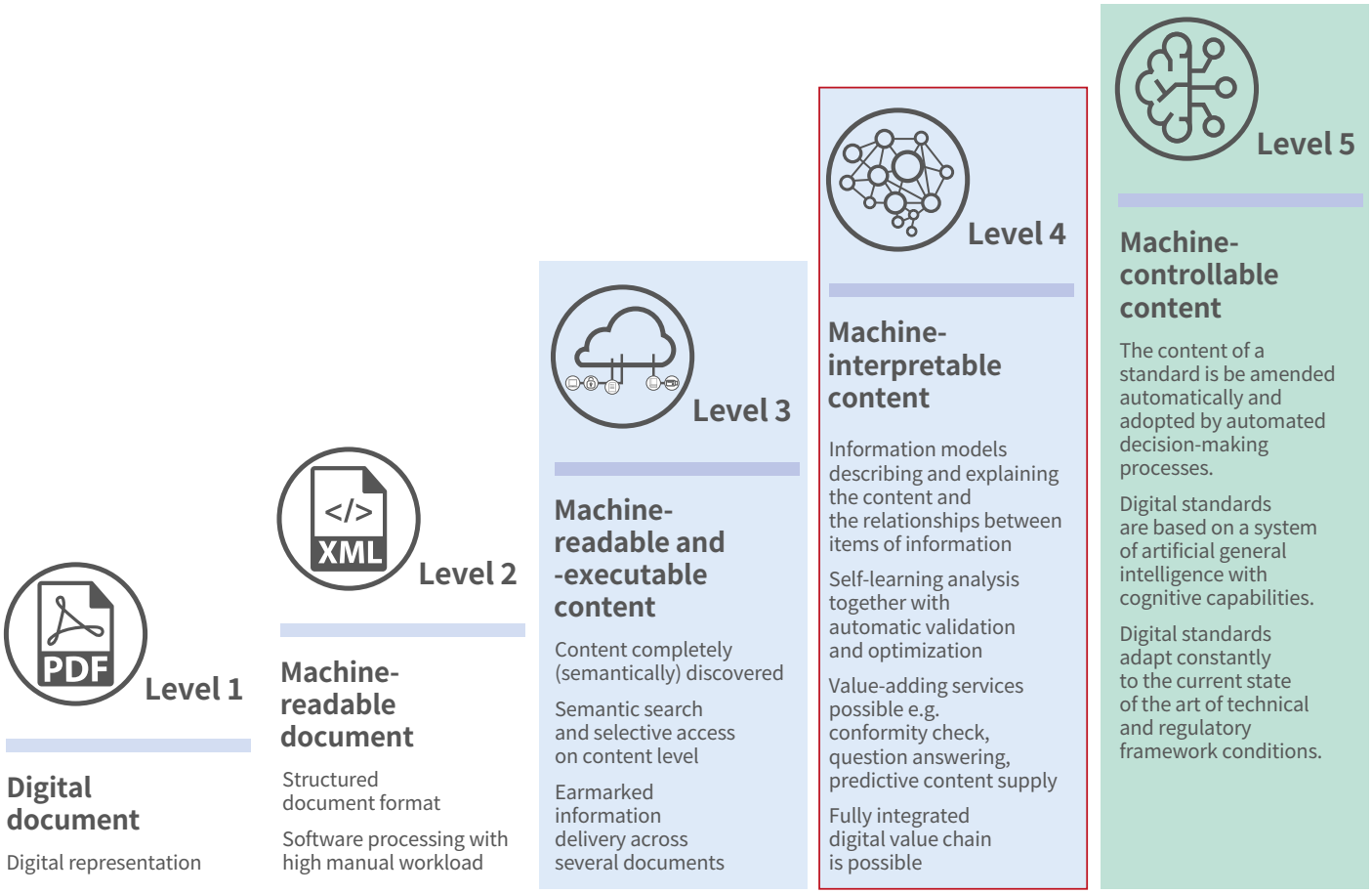

Fig. 1-2: The extended utility model – IDiS white paper[1]

One challenge of the before-and-after comparison is to make change in process flows visible. The previous focus on a complete or sectional standards document will in future concentrate on the product to be developed and thus its requirements (specification centering). With a uniform semantics within the SMART standards, there is now an identifiable and classifiable information unit (Figure 1-2) available, which can be addressed purposefully on demand (by describing the requirement).

Product development processes are shortened because processes are no longer sequential, but can now run in parallel (see Figure 3-1).

This has a positive impact not only on process and product quality but also on the turnover potential of a company as well as as well as "the personnel" deployment and organizational structure.

These characteristics are described in the following white paper in order to enable a subsequent value-added calculation using a value-added calculator.

The added value model quantifies and compares established and transformed processes on the basis of established controlling Key performance Indicator (KPI).

Ceteris paribus, the following added value for industrial companies can be demonstrated when applying SMART standards:

1. Reduction of the time required for the activities involved in application of standards, so that with the same per 1.5 to 2 times more orders can be processed with the same can be processed than in the status quo.
2. Reduction in costs associated with standards application activities of between 48% and 64%.
3. Increase in the order margin between 60% and 85% with constant order volumes and sales prices.
4. Increase in turnover between 32 and 60% with constant percentage target margin.

1 https://www.dke.de/idis-whitepaper-1_en

Acknowledgements

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→ Melanie Kattwinkel, SMS Group GmbH (illustrations)
→ Michael Noll, Open Grid Europe GmbH (company processes)
→ Martina Paul, MBA, Huawei Technologies Switzerland (company processes)
→ Dipl. -Ing. (FH) Raymond Puppan, DKE (SMART standards added value model, company processes)
→ Dr. rer. nat. Magnus Redeker, Fraunhofer IOSB-INA (Asset Administration Shell-based SMART standards)
→ Dipl.-Ing. HS1 Christian Rüther, CLAAS KGaA mbH (illustrations)
→ Stefanie Voit, WP, StB, TS.advisory GbR (Business management considerations, SMART standards added value model and calculations)
→ Bahram Salimi, Publication management and graphic assistance

The benefit of using standards could only be made measurable in business terms with the contributions of all involved persons in this white paper 3.

Specific input was also received from
- Annette Eschenbach,
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- Sarah Haake-Schäfer (Carl Zeiss Vision),
- Dipl.-Ing. Univ. Dietmar Lochner (Schaeffler Technologies AG & Co. KG),
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Special thanks go to Ms. Stefanie Voit, WP, StB, who played a leading role in the development of the SMART standards value-added model and thus made its measurability possible in the first place.

2 INTRODUCTION

Up to now, IDiS[2] has published two white papers on SMART standards.

White paper 1 deals with scenarios for digitizing standardization and standards. The scenarios were described using the four value creation process phases content creation, content management, content delivery and content usage, and describe which processes have to be adapted for a digital standard. The extended utility model was developed to describe the attributes of the digitalization level.

White paper 2 deals with the applicability of SMART standards in context of use cases. They give a basic description of what will be possible when dealing with SMART standards in terms of creation, management, provision and usage of standards. A large number of use cases were summarized in 11 generic user stories (GUS) to describe generic usage scenarios for SMART standards.

The task of IDiS white papers consists on the one hand of bringing the future closer to the present in terms of content and, on the other hand, describing the path into the future from the perspective of the present.

The approach taken by IDiS white papers is for the essence of an overarching theme to made legible, comprehensible and transparent so that the developments can be swiftly accessed.

What other developments at IDiS substantiate the statements?

Several IDiS pilot projects have investigated at the technological requirements for SMART standards (see IDiS Management Summary).[3]

Further development steps for SMART standards have been derived from the findings obtained in this way.

One example consists in the IDiS pilot "Conformity Assessment", which was developed in two phases:

1. Simulation
2. Measurement-based assessment

The pilot clearly revealed the interaction between **software, hardware** and **SMART standard**. Using standards is a crucial step in developing new products. The work is usually carried out in laborious manual steps in which the required information must be recorded from the relevant standard (in PDF), extracted and transferred to other systems for use.

The concepts and results developed in the project form the basis for possible automation in this field by minimizing the manual workload and reducing possible errors in transmission, in order to clearly enhance quality and efficiency while creating documentable evidence.

2 https://www.dke.de/idis
3 https://www.dke.de/idis-piloten-2022-en
4 https://www.dke.de/idis/pilotprojekte/konformitaetspruefung

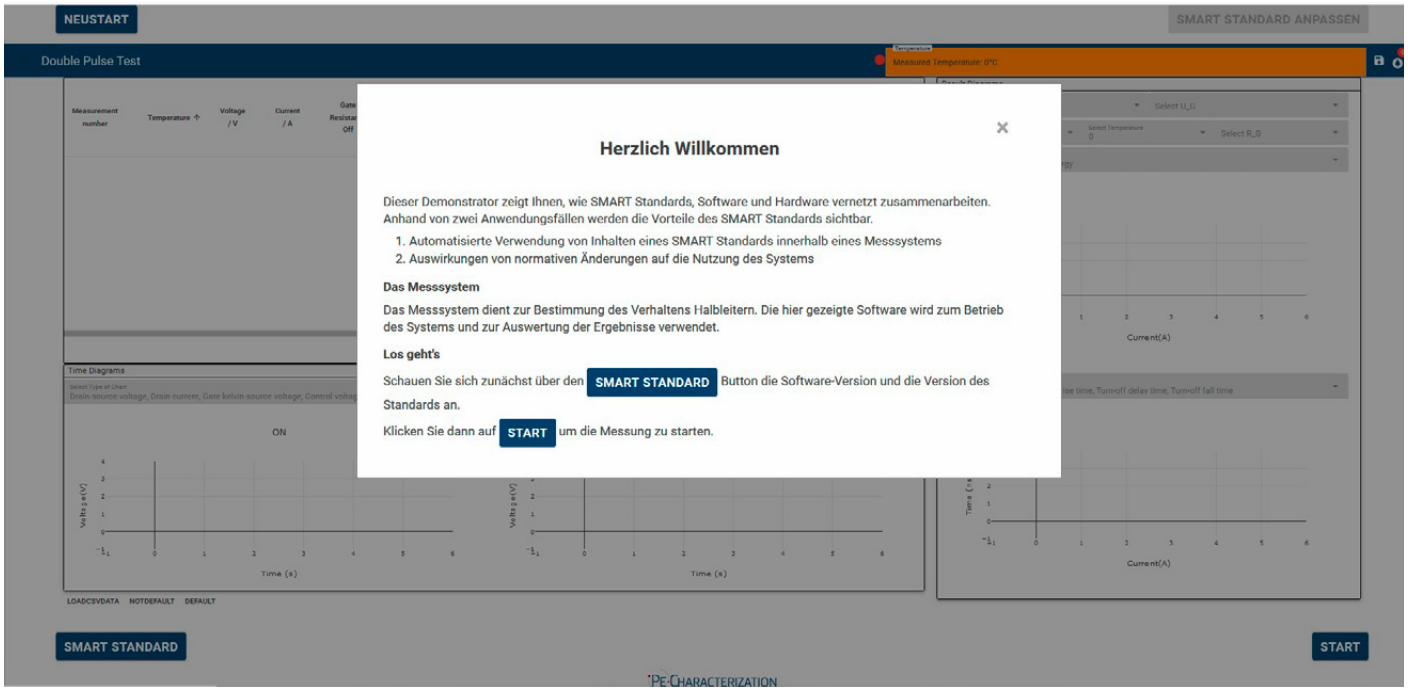


Fig. 2-1: IDiS pilot Conformity testing 1 (source: PE-Systems)

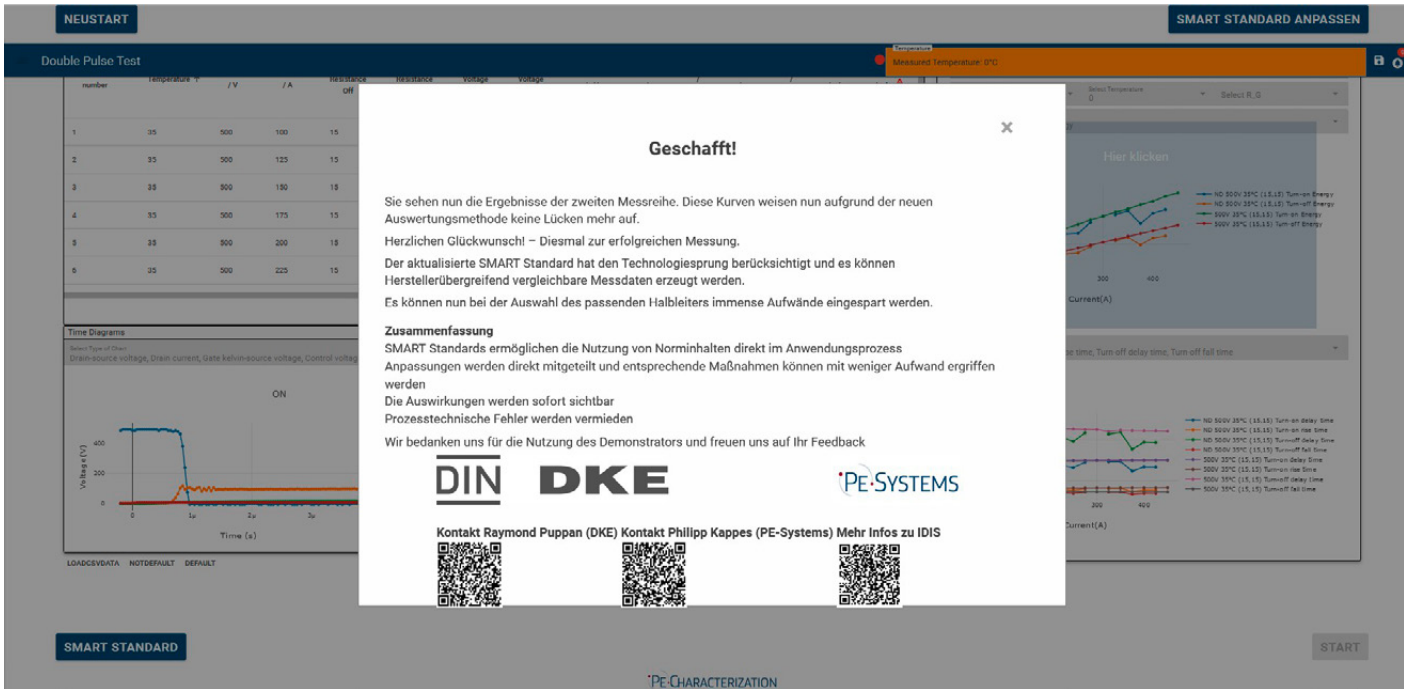


Fig. 2-2: IDiS pilot Conformity testing 2 (source: PE-Systems)

The **Asset Administration Shell** (AAS) is a concept for Industry 4.0-compliant implementation of digital twins[5,6]. The digital twin of a represented asset improves, among others, cross-lifecycle documentation and interoperability. Assets include e.g. components, machines or systems for which standards or parts of standards are used for documentation or certification. Today this is a manual process based on documents obtained from proprietary document management systems for viewing or reviewing, or on paper.

The IDiS pilot NormAAS demonstrates how AAS can be extended by adding standard content or possibly relevant standard fragments to significantly accelerate the development processes for new products. The digital pre-certification service, that is executable in the pilot. Assesses the respective develop-ment stage of a product in terms of fulfilling the requirements of those standards that the product is supposed to comply with: Which requirements are already fulfilled in the current development stage and where does the product need further specification? In the prototype, this assessment – easy to use while accelerating the product development process is based on an automated matching of the product's capabilities with their interoperable description in the product AAS and the requirements with their interoperable description in the standard's ASSs.

Fig. 2-3 visualizes the prototype digital pre-certification service. The digital pre-certification service assesses the product capabilities of the current development.

More details about the service and the AAS-based standards can be found in section 4.1.

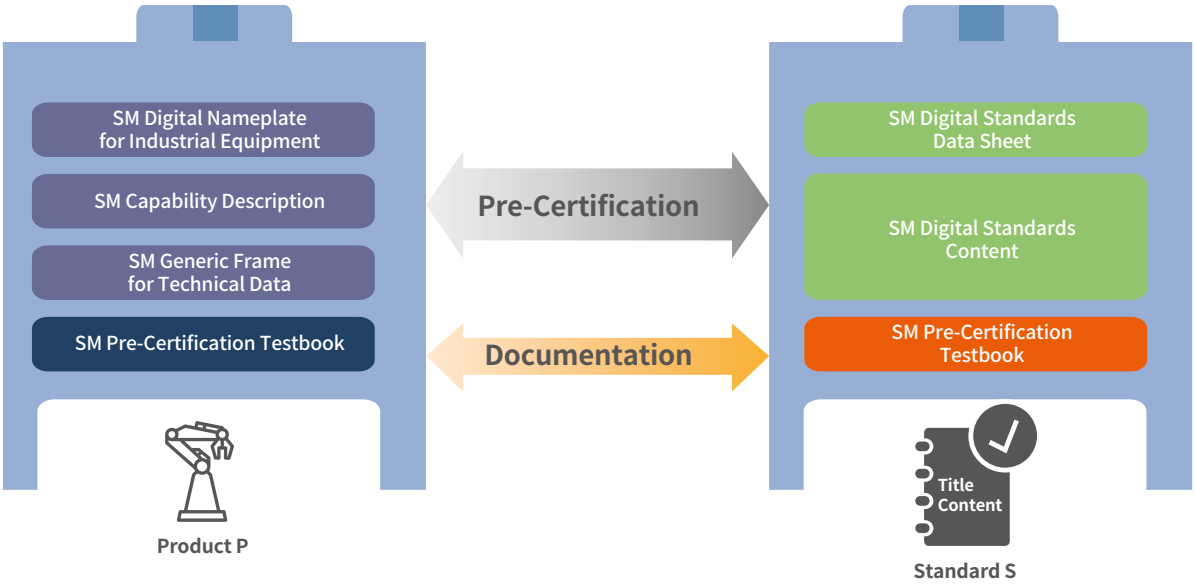


Fig. 2-3: Digital pre-certification in the IDiS pilot NormAAS. The AAS of a product on the left and the AAS of a standard on the right, with their respective sub-models (Redeker, Fraunhofer IOSB-INA)

5 DIN SPEC 91345: Reference Architecture Model Industrie 4.0 (RAMI4.0), DIN Std. DIN SPEC 91 345, 2016, https://dx.doi.org/10.31030/2436156

6 Specification of the Asset Administration Shell Part 1: Metamodel – IDTA Number: 01001-3-0, https://industrialdigitaltwin.org/content-hub/aasspecifications/idta_01001-3-0_metamodel

Summary:

→ SMART standards enable the use of standard content directly in the application process.
→ Adjustments are reported directly
→ Measures can be taken with less effort.
- The effects are immediately visible.
- Process-related errors are avoided.

Why a white paper 3 now?

As mentioned at the start, white papers 1 and 2 led to the question of measurability: what savings or added value result from the SMART standards?

A bottom-up approach has been chosen to measure the benefit.

Future scenarios were used to elaborate the structure of the added value model. These future scenarios were defined, giving due consideration to typical process workflows in the companies.

It was thus possible to ascertain the impacts of using SMART standards in terms of process quality, product quality and turnover potential, as well as the impacts on the workforce or organization.

3 REQUIREMENTS FOR COMPANIES WHEN IMPLEMENTING SMART STANDARDS

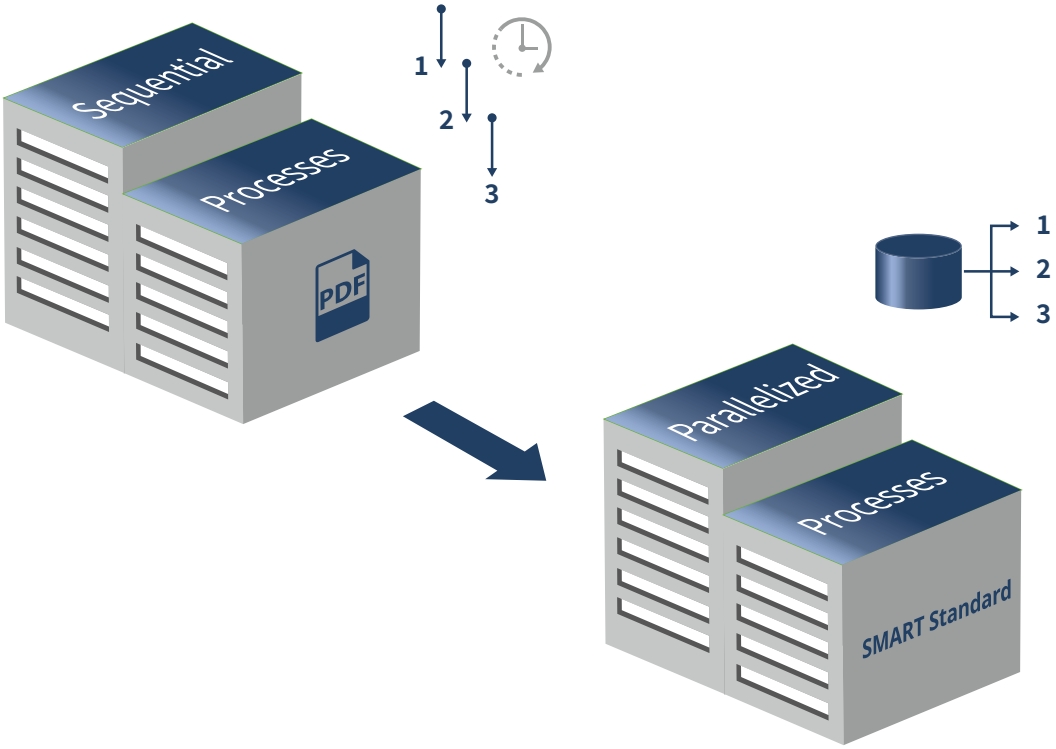


Fig. 3-1: Comparing companies with PDF process (sequential) and SMART standards process (parallel) – (Melanie Kattwinkel, SMS Group)

Obtaining an initial picture is a challenge due to the meagre information available from companies about whether they quantified the costs and effort involved in using standards, as the only costs to be registered were usually those involved in purchasing standards (paper, as a PDF, individually or using corresponding subscriptions, etc.). Experience shows that there are no uniform, consistent measures in place for measuring the benefit by assessing various activities in the individual companies, for example in product development processes.

The added value of SMART standards can therefore only be assessed indirectly by drawing a comparison with the former use of paper or PDFs in the past. An overarching conclusion of the results from the analysis of the change from previously sequential business processes to parallel processes. That means that SMART standards not only have the potential of "lubricating" the process chain by supporting more efficient workflows in a classic process chain: they also change the process chain and redesign it directly. Only this overarching approach makes it possible to derive any corresponding added value (Fig. 3-1).

In the status quo, the expenses involved in researching standards, collecting information relevant to the usage process through to extracting it and manually transferring it when using PDF documents is associated with a high level of effort if these have not previously been automated via software systems at greater expense.

Some companies are already investing a great deal in digitalizing workflow processes involved in value creation. When it comes to XML formats for example, companies face the challenge of having to process the standards into a suitable form before they can be actually used.

This leads to the conclusion that the effort required for the ready-to-use preparation of digital standards in companies will merely shift the effort of researching and determining the relevance of previously used PDF standards forward in the overall context.

For companies that "produce" their own digital standards, this means increased effort for deploying qualified skilled staff for the compilation (**initial cost**) and maintenance (**subsequent cost**), to ascertain whether the data are relevant and up-to-date and to make the standard contents ready for the process.

This effort can be reduced cost-effectively if the provision and application support of standards is provided by digital services (Content-as-a-Service) that require SMART standards.

If SMART standards are now made available to a company ready for use, they can be embedded in the company's existing IT infrastructure where their data can be further processed. If such a structure is available or being planned and if the company has a digitalization strategy and a defined implementation timeframe, then nothing stands in the way of generating added value through SMART standards.

What is the state of digitalization in German enterprises?

Studies on the digitalization potential of enterprises in Germany draw the following picture:

1. Germany consists to more than 99% of small and medium-sized companies (SME).
2. Large companies have already reached a high level of digitalization within which defined processes are already taking place.
3. Most SMEs are forced to exist in a supply chain where they are co-dependent on large companies, resulting in a certain migration pressure.
4. SMEs therefore have to estimate the potential benefit in order to calculate the necessary costs, as standards must continue to be used of communication across companies.

It is certain that the migration to SMART standards will pose business challenges for SMEs in particular, as they will incur costs fpr the transformation to be digitalized application of standards.

To improve acceptance, predictability and thus investment propensity, companies need a tool to assess the impacts for example in terms of product and process quality or turnover potential, as well as the impacts on the organization. Such a tool visualizes the fundamental process workflow changes that are necessary in order to exploit the full business-oriented potential in SMART standards.

More precise analysis of the digitalization potential of companies can be found in Annex A.

This is based on a representative analysis of the follow-up survey on digitalization processes among SMEs of the Institut für Mittelstandsforschung (IfM - Institute for SME Research) in Bonn in 2022, IfM materials no. 291[7], which compares the progress of digitalization in companies with the situation in 2016.

Results of the study:

→ Since 2016 there has been a greater orientation toward more efficient production and business processes.
→ There is also an increasing focus on using digital technologies to improve products and services.
→ Companies forge ahead with digitalization when they see a direct operative and business-oriented added value.
→ Overall, there is a high level of dynamism in digitalization within and across companies.

Organizational transformation

The following assumptions serve as a starting point:

a. Intrinsically speaking, SMART standards according to the extended utility model are deemed to be software (programming code). Thought must therefore be given to how companies will have to adapt their processes in future to make the best possible use of SMART standards.
b. If these processes are already machine-supported, it can be presumed that at least these aspects of a company's workflows are already at least partially digitalized.
c. In cases where processes are not machine-supported or where the corresponding workflows are not visualized in digital systems, the reverse assumption applies, namely that basic aspects of these processes are not yet available as digital models.
d. From a company's perspective, digitalization is not an end in itself but should generate benefit and create value. The extent to which the use of SMART standards is justified therefore depends greatly on a company's business orientation.
e. Appropriate, value-creating use of SMART standards is therefore also an indicator of the digital maturity[8] of a company in the context of its corporate purpose.

CONCLUSIONS AND SUGGESTIONS

Depending on which of these assumptions and conditions applies, a different approach must be chosen or it must be checked whether an adaptation of the processes is necessary and makes sense.

The deployment of SMART standards may be appropriate in cases coming under point b.

Annex A describes more detailed observations of generic example processes based on the assumptions made and links them to the Generic User Stories (GUS).

7 IfM Materials Digitalization Processes of SMEs in Manufacturing – follow-up survey

8 Degree of change in strategy, business model, organization, processes and culture in companies by using digital technologies to enhance competitiveness. https://web.archive.org/web/20200602080850id_/https://www.nomos-elibrary.de/ 10.5771/0042-059X-2016-2-98.pdf

4 ADDED VALUE OF SMART STANDARDS IN OPERATION

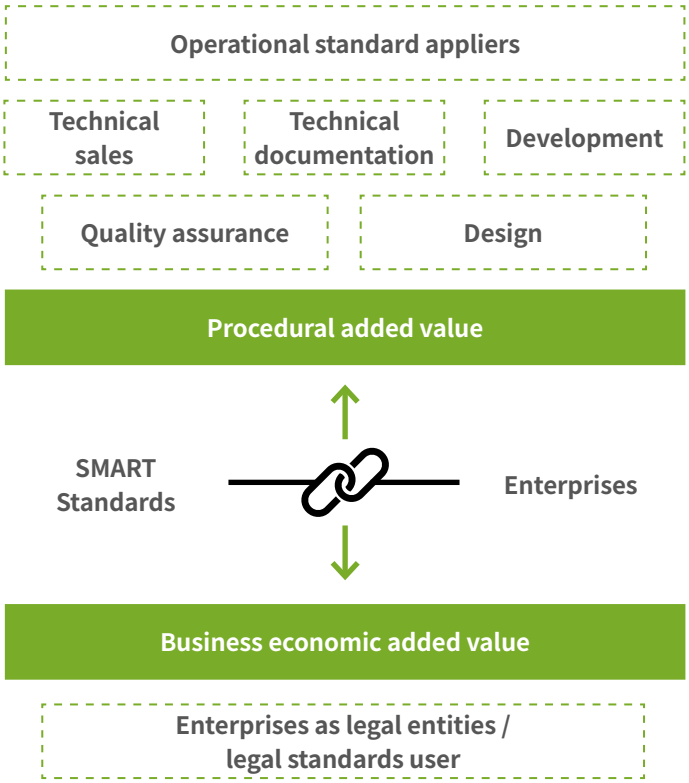


Fig. 4-1: Added value of SMART Standards
(Kattwinkel, SMS Gruppe GmbH)

For the **operative standards user**, a successive changeover from the status quo of standard usage in level 0 or level 1 to a higher level of digitalization (level 4 in future) brings an immediate process improvement in using standards pursuant to ISO 9001 for quality management systems, by making it possible to replace manual methods with IT-supported workflows in the core processes (including technical sales, design, development, technical documentation, quality assurance), particularly when it comes to retrieval, usage and change management of standards.

Besides improving operative processes, the use of SMART standards also generates business-oriented added value from the perspective of the overall company as **legal standards user** (= management view). Among others, the advantages include shorter process lead times and improved legal compliance[9] when standards are used in the company, with IT support to ensure that standard usage is complete, up-to-date, correct and redundancefree, together with corresponding conformity[10].

Companies upstream or downstream in the supply chain (e.g. external suppliers) or customers are not included in the added value analysis in this white paper. Furthermore, the perspectives of the standards creators and tool providers for the implementation of SMART standards are not taken into account in the current elaboration.

9 Compliance refers to the way companies abide by business and legal rules, i.e. complying with laws, regulations and voluntary codes (German Wikipedia 07.12.2023).

10 Conformity describes the way products for example fulfil applicable specifications (such as normative or legislative regulations).

4.1 Process-related added value – improving the standards workflow

Workflow with PDF

Up to now, standards have been used in most companies on paper or, at very best, as PDFs. The advantage of having documents available in digital form (here: PDF) is easily visualized for example in engineering processes in the context of product development processes (see Fig. 4-2).

But there is only marginal benefit in using the ISO/IEC SMART standards utility model in level 1 (PDF) compared to level 0 (paper), as the standards are only made available to a certain group of people in the company, and usually only within one department. Other groups of people therefore have no access to the information. One major challenge up to now has been to guarantee the flow of information, for example, in ensuring customer requirements are passed on via sales to the design and development department. Since the introduction of PDF documents, the transfer of information between departments has improved because standards have become accessible to multiple areas, for example through a corporate license.

However, the changeover to PDFs did not make it any easier to do any research in the relevant applicable documents, or to check customer specifications for the use of standards, to procure and read all the documents, and then to extract and appropriately combine the relevant information. There is a risk of "information transfer errors" after and between each of these process steps, which can impact all aspects of a product (safety, security, performance, costs and thus market acceptance) (Fig. 4-2).

The weaknesses of an existing workflow systems are revealed by analyzing the most frequent processes. This usually refers to a sequence of linked process steps visualized as a whole by means of a process chain. Processes tend to stagnate when one link in the chain does not work (for instance, inadequate expertise, lacking resources, etc.), and when errors or even gaps occur in the flow of information due to overload situations, for instance. As a result, the following steps (sub-processes) no longer work properly. In the end, this can result in considerable monetary or liability risks for a company.

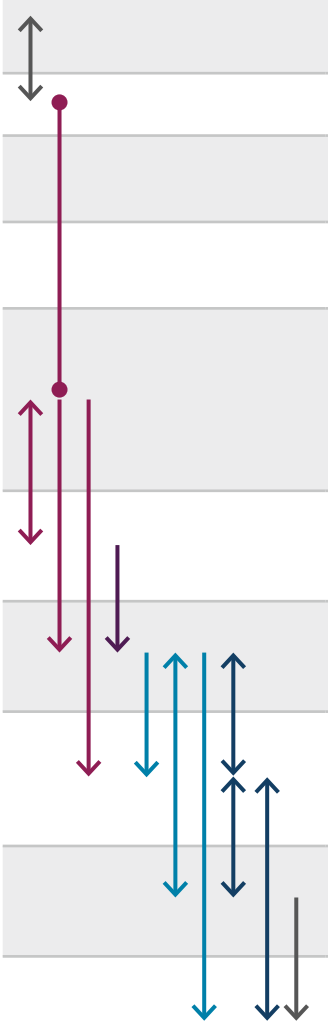
Workflow with SMART standards

Digitalization in the context of SMART standards can help here by initiating a change in the process landscape. When outlin-ing the standards usage process, a comparison in the use of PDF and SMART standards (from level 3) shows the difference between a sequential and a parallel product creation process (see figures 4-2 and 4-3). In other words, the individual sub-processes are decoupled. The information flow no longer takes place via a classic process chain but is controlled at the start of a sub-process or its planning. As a result, various co-dependencies are partly or almost completely eliminated.

For example, the demonstrator of the IDiS pilot NormAAS integrates requirements from AAS-based SMART standards automatically into product development processes (see Fig. 4-4 and Fig. 4-5). Once the standards relevant for a product have been selected in step 0 of a product development process (see also Fig. 4-3), the corresponding AASs of those standards are downloaded from standard provider platforms (CaaS in Fig. 4-3) and made available on the company's internal AAS servers (company database in Fig. 4-3).

SEQUENTIAL PROCESS

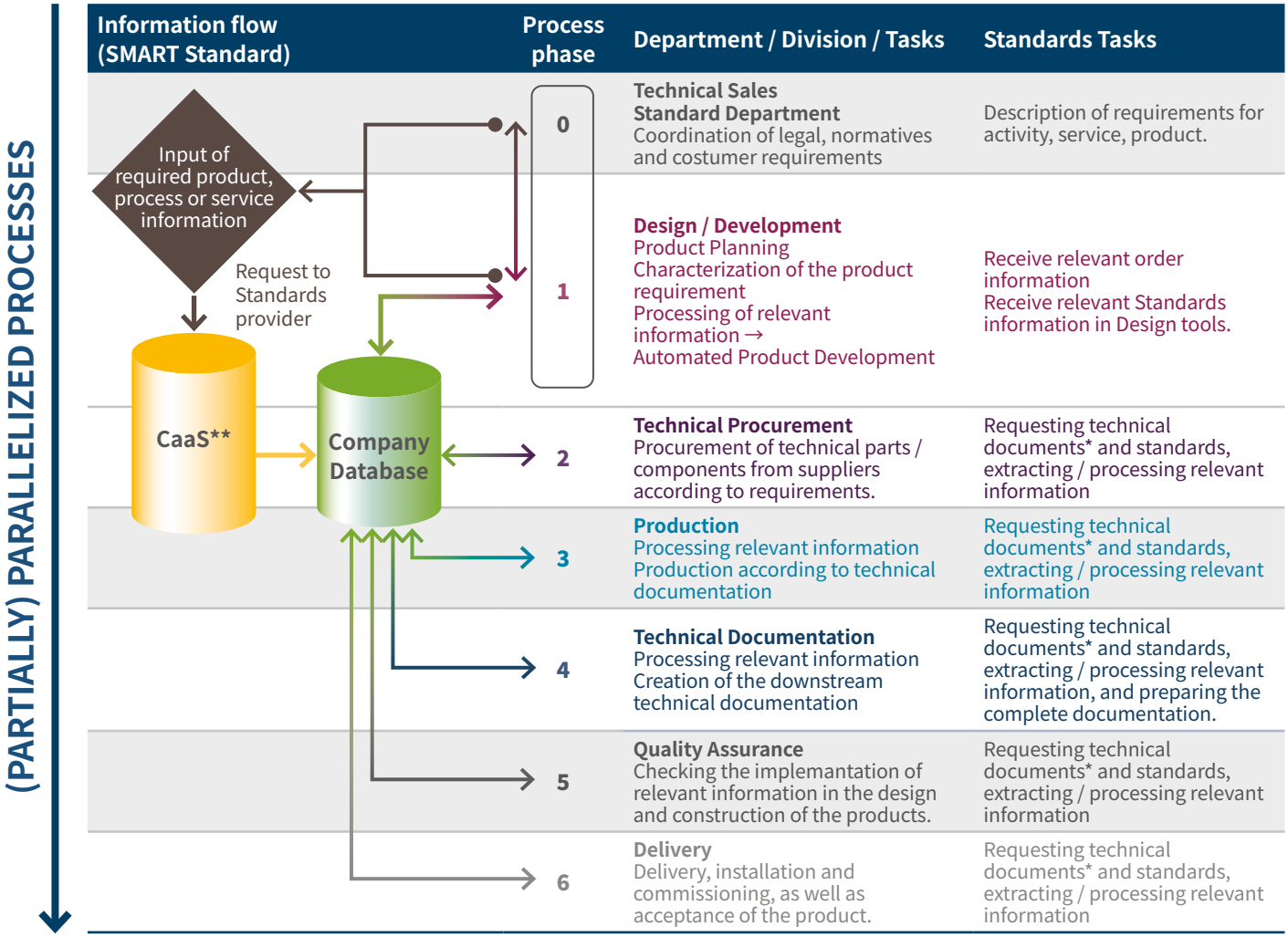
Possible information gaps in the value chain due to missing or insufficent information transfer.



Information flow (pdf)	Process phase	Department / Division / Tasks	Standards Tasks
	0	**Technical Sales** **Standard Department** Coordination of legal, normatives and Customer requirements	Standards research (meta data), request and provision (if the respective company owns a Standards Department).
	1	**Design / Development** Product planning	Standards research, request reading (relevance check).
	1	**Design / Development** Characterization of the product requirement	Extraction / Derivation of relevant information
	1	**Design / Development** Processing of relevant information → Manual Product Development	Manual transfer of the extracted information to design tools
	1	**Design / Development** Forwarding of processed information → Transmission of the design within the scope of the technical documentation to downstream departments / divisions	Derivation of results considering normative requirements for the design.
	2	**Technical Procurement** Procurement of technical parts / components from suppliers according to requirements.	Requesting technical documents* and standards, extracting / processing relevant information
	3	**Production** Processing of relevant information Production according to technical documentation	Requesting technical documents* and standards, extracting / processing relevant information
	4	**Technical Documentation** Processing relevant information Creation of the downstream technical documentation	Requesting technical documents* and standards, extracting / processing relevant information, and preparing the complete documentation.
	5	**Quality Assurance** Checking the implemantation of relevant information in the design and construction of the products.	Requesting technical documents* and standards, extracting / processing relevant information
	6	**Delivery** Delivery, installation and commissioning, as well as acceptance of the product	Requesting technical documents* and standards, extracting / processing relevant information

*Technical documents = process documents including relevant Standards information from **Design, Development** and **Technical Documentation** department.

Fig. 4-2: Information flow (SMART) within a product development and production process (Puppan, DKE)



*Technical documents = process documents including relevant Standards information from **Design, Development** and **Technical Documentation** department.

Fig 4-3: Information flow (SMART) within a product development and production process (Puppan, DKE)

The digital product development service references these requirements within the AAS of the product being developed, and the users can adapt the individual implementation significance of every requirement (Fig. 4-4):

CE requirements for example usually remain mandatory, while requirements from more extensive, specific standards can be deemed optional.

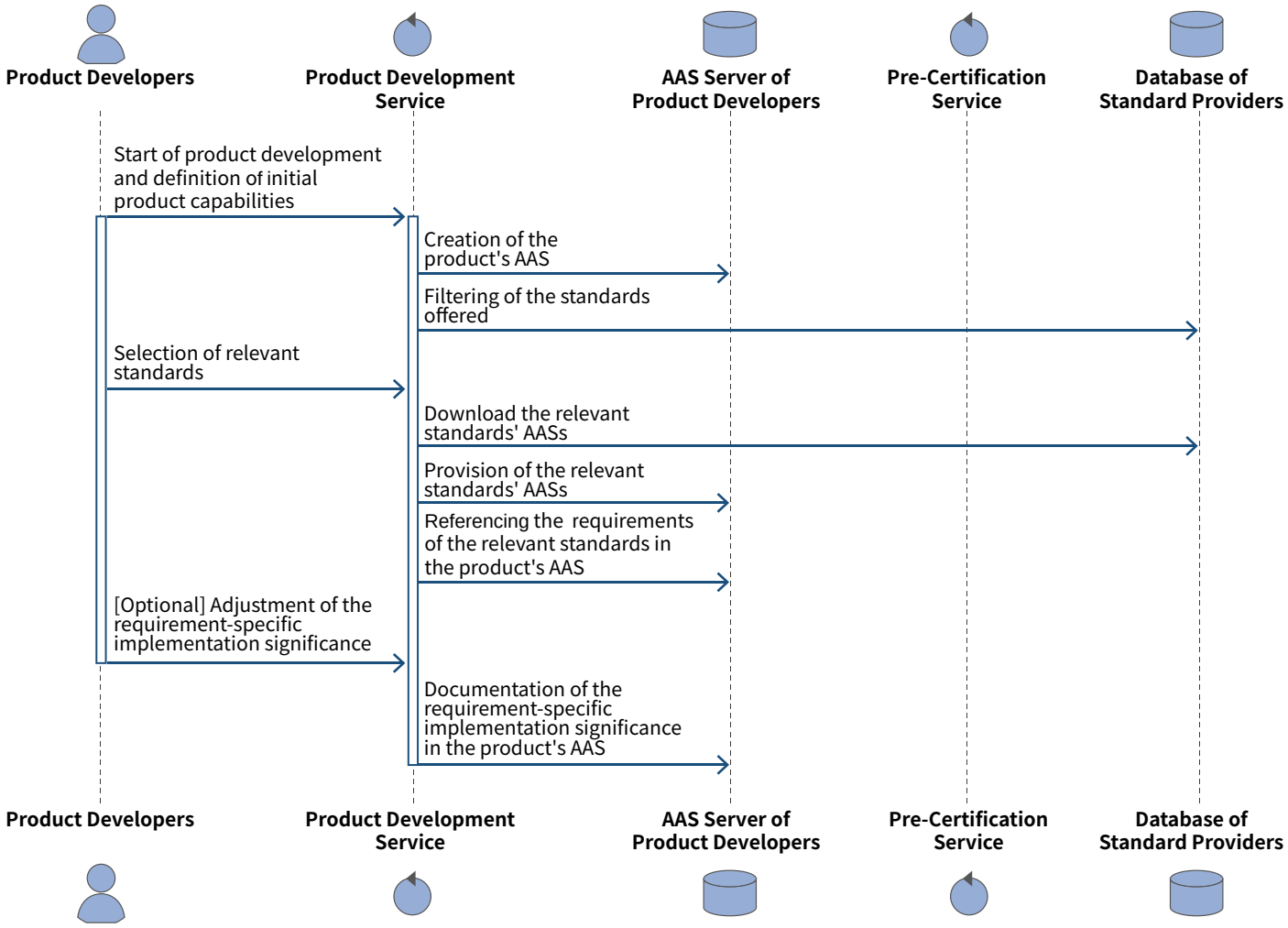


Fig. 4-4: SMART standards demonstration in the IDiS pilot NormAAS: Integrating the requirements of relevant standards into product development (Redeker, Fraunhofer IOSB-INA)

During the demonstrated product development (see also step 1 in Fig. 4-3), the product is developed in the product development service (Fig. 4-5). Capabilities and technical data are added to the product or go through further development according to the requirements. For every interim stage in product development, the users can for example book a digital pre-certification service that assesses compliance with the requirements of all selected standards as a whole, while looking at each individual standard and requirement, documenting the results in a testbook sub-model in the product AAS. The product development service adopts this assessment and shows the user which requirements are already fulfilled in the current stage of development, and where the product needs further tuning.

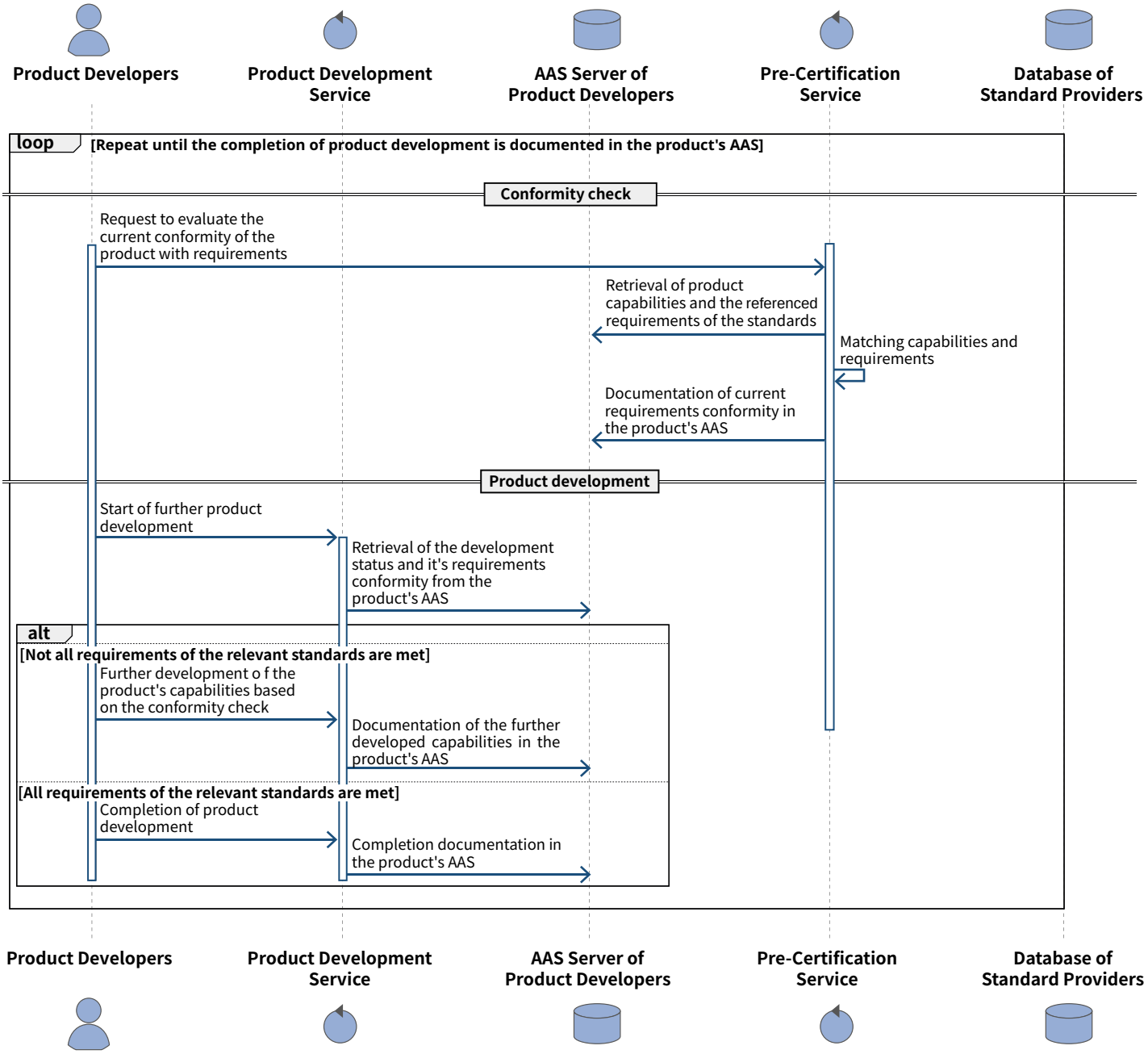


Fig. 4-5: SMART standards demonstration in the IDiS pilot NormAAS: Iterative product development ensuring conformity to standard requirements (Redeker, Fraunhofer IOSB-INA)

Such iterative use of the product development and precertification service in product development processes ensures that the products are developed in conformity with the standards deemed relevant in each case, producing early corresponding documentation.

Furthermore, reducing interpretation variations minimizes the risk that deviating interpretations by customers and product developers may result in a product not being accepted, or quite simply not certified.

4.2 Added business values - Improvement of performance indicators

When assessing the added business value resulting from the application of SMART standards, a distinction is made from a management perspective between direct added value, which occurs in the short term (quick wins), and indirect added value, which is expected in the medium to long term (long term wins).

DIRECT ADDED VALUE – QUICK WINS

Optimizations in the standards workflow (see 4.1) lead directly to imporvements in process and and product quality (quick wins), which can be mapped in time or cost indicators.

In business-oriented terms, **process quality** includes both the degree of process standardization and efficiency together with process duration, and the degree of legal cerainty in identifying and implementing standards (compliance[11]), which in turn is associated with the level of liability risks.

By contrast, **product quality** indicates the degree to which a product fulfils the existing requirements. This refers to both regulatory requirements (conformity[12]) and also requirements stated by the customer, for instance in terms of functionality, safety, service life and economic efficiency (customer satisfaction).

INDIRECT ADDED VALUE – LONG TERM WINS

The Improvements in process and product quality in turn have a positive impact on the organizational and personnell structure, as well as additinal earnings potential (indirect added value from using SMART standards). The indirect added value is less obvious and quicker to generate than the direct added value and is only really relevant once the implementation of SMART standards has been completed, but is all the more effective and sustainable (long term wins).

Improvements in the operative processes for using standards indirectly relieves pressure on the **personell and organizational structures** on the level of the individual order, and also on the level of the whole company or individual business units.

SMART standards need fewer manpower resources, and the work can also be done by staff with less experience or qualifications. In other words, higher qualified skilled workers are less involved in standard usage processes and are freed up to focus more on their core activities. Furthermore, the use of SMART standards reduces the onboarding time for new employees. In addition, the know-how involved in using standards is shared out across several shoulders to avoid know-how monopolies and create feasible deputizing rules.

In turn, relieving pressure on the personell and organizational structures increases the **earnings potential** on the level of the individual order, and also on the level of the whole com-pany or individual business units.

In the product development process for instance, the use of SMART standards reduces personell requirements in both qualitative and quantitative terms, thus bringing down the personnel costs per order. With constant sales prices, this increases the margin per order or compensates for other cost increases (such as energy costs) which at least maintains the margin per order. On the other hand, cost savings in standards usage can be passed on to the customers by reducing the sales prices, thus generating a competitive advantage.

11 Compliance refers to the way companies abide by business and legal rules, i.e. complying with laws, regulations and voluntary codes (German Wikipedia 07.12.2023).

12 Conformity describes the way a product fulfils requirements.

In addition, the reduced resources required for each develop-ment order releases personell capacities for additi-onal orders. In future, it will therefore be possible to process more orders with the same manpower resources, thus creating additional turnover or earnings potential. Another possibility is to use the released **personell** capacities for strategic tasks such as progressive digitization of business processes or generating new business models to keep the company competitive and viable.

5 QUANTIFYING THE ADDED VALUE IN THE CALCULATION MODEL

While Section 3 presented the requirements and costs of applying standards in general and implementing SMART standards, Section 4 described the added value of SMART standards for the standard user, i.e. after successful implementation. However, an objectively comprehensible business decision to implement SMART standards can only be made if both the costs and the added value are quantified and compared in monetary terms.

The costs of implementing SMART standards can be regularly ascertained on the basis of a transformation plan for the individual company within a fixed period, featuring detailed milestones and specific internal and external resource requirements.

The added value of SMART standards on the other hand, arises after successful implementation.

→ in regular company operations
→ without any time limits,
→ have a monetary and also non-monetary character and
→ can only be ascertained in comparison with the status quo.

In order to be able to process the added value of SMART standards form a business management perspective, it must be avalible . Accordingly, the measurability and comparability of data form the basis for the SMART standards value-added model developed in IDiS.

5.1 Content Creation

To make the SMART standards added value model **measurable**, the measured data are reduced to a common denominator. In other words, non-monetary parameters are expressed in a monetary parameter as an appropriate representation of the identified added value.

When it comes to **comparability**, the SMART standards added value model always compares the business processes in the status quo of standards application (established processes) with the future business processes after implementing SMART standards (transformed processes).

The SMART Standards Value-Added Model also assumes that value can be created in multiple value dimensions. Currently – though not necessarily completely – the following value dimensions are distinguished:

→ **Performance value:** the added value is directly visible in the company's operative cost or success parameters.
→ **Risk value:** contribution to the company's compliance or legal conformity
→ **Future value:** contribution to the strategic development of the company.

The multi-dimensionality of the added value model is taken into account by using Rubik's cube.[13] to visualize the value attributes.

13 https://en.wikipedia.org/wiki/Rubik%27s_Cube

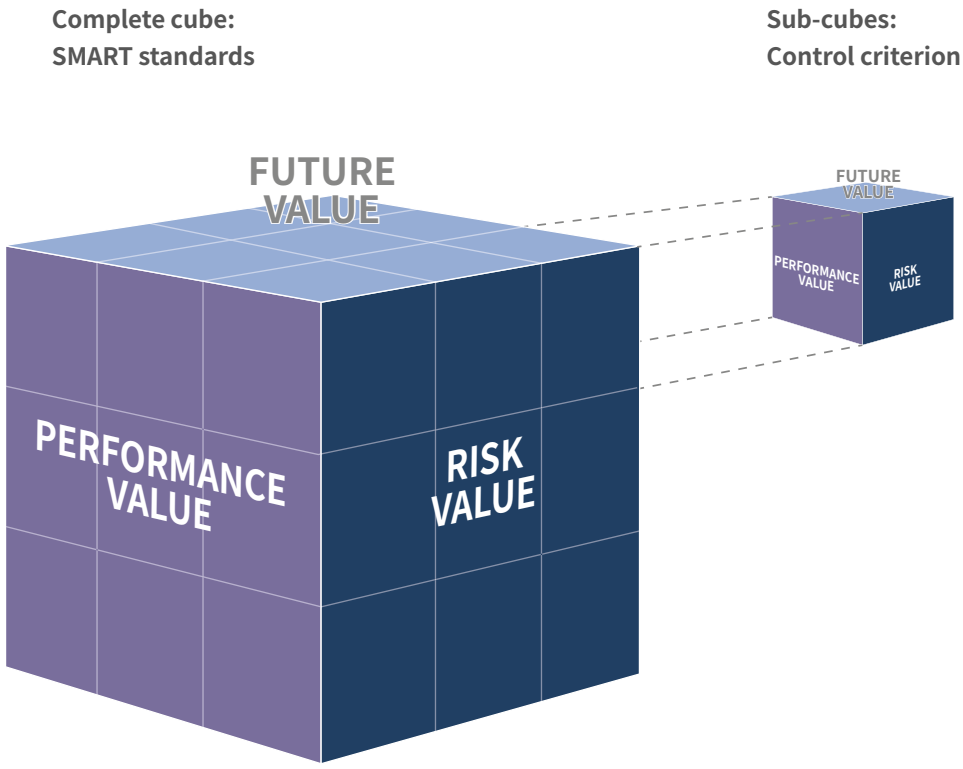


Fig. 6-1.1: Complete cube - SMART standards added value attributes (Voit, TS.advisory GbR)

The complete cube shows the SMART standards as a complete set of regulations with the corresponding value attributes, while the partial cubes represent the following control criteria (**stage 1 of the added value model**):

→ Process quality
→ Product quality
→ Personell and organization
→ Earnings potential

The valie-added model quantifies and compares established processes and transformed processes at the level of control criteria on the basis of parameters (stage 2), measurement indicators (stage 3) and key indicators (stage 4) (for details on the methodology of the SMART standards value-added mo-del, see Appendix A).

5.2 Usage restrictions and definitions in the added value model

General prerequisites

The SMART standards added value model can be basically used regardless of the size, sector or location of a company.

However, since the value-added model basically compares a company's business processes in the status quo of standards application (established processes) with the prospective business processes after implementation of SMART standards (transformed processes), a potential user of the value-added model should fulfill the following fulfill the following requirements.

→ Sufficient degree of digitalization:
- The company or business unit has an adequate digital infrastructure implemented in its product development processes.
- With the use of SMART standards, an improvement from level 0 - 2 to level 3 - 4 according to the IEC utility model (see white paper 1) can be implemented in the application of standards.

Level	Description
Level 0	Paper format. Not suitable for direct machine processing or use.
Level 1	Digital document. The document can be managed and displayed automatically (WORD, PDF).
Level 2	Machine-readable document. The structure of the document can be digitized and certain granular content can be exported (chapters, graphics, definitions etc.). Content and presentation are separated.
Level 3	Machine-readable content. All essential granular information units can be clearly identified, the relationships between them recorded and made available for further processing or partial execution.
Level 4	Machine-interpretable content. The information in a standard is linked to execution and application information so that it can be directly executed or interpreted by machines and combined with other sources of information so that complex actions and decision-making processes can be carried out automatically.

Fig 5-2: IEC classification and utility model

→ Homogeneity in the degree of digitalization and level assignment:
- An international company or corporate structure may be characterized by differences in the degree of digitalization and level assignment in standards (ACTUAL) and possibly also the target value (TARGET) per site (within domestic, abroad) or per Company unit (business unit, branch, subsidiary).

  If the added value model were to be applied to the company as a whole, the results for the individual markets or locations would be of little significance.

- It is better to take a differentiated view of the added value per market or location in order to be able to compare these added values with the transformati on costs per market or location in a business analy sis.

5.3 Calculation results of the added value calculator

Use case for calculation

For the purposes of this white paper, the added value from SMART standards are calculated for the example of a fictive company with the following framework criteria:

→ **Size = small or medium-sized company (SME):**
- It is assumed that for SMEs with an adequate level of digitalization but a low level of standard application, high economic added value effects are associated with the implementation of SMART standards.

→ **Sector = engineering:**
- In mechanical engineering, the processes of development, design and production can be easily differentiated and weighted.
- Counterexamples would be software companies where the product is actually created within the development phase; Design and manufacturing phases are eliminated.

→ **Stage assignment in standards application:**
- Status Quo (ACTUAL) = stage 1
- Zielniveau (TARGET) = stage 4

→ **Restricted to the core process of product development:**
- Although standards also need to be implemented in other processes, including procurement and design, which also have responsibility for standard conformity of the products, the added value calculation focuses on the product development process as part of an order. An order within the added value model refers to both single-part production and serial production.

The following section illustrates the procedure in the SMART standards added value model with exemplary calculation results.

Example 1: Temporal consideration

In the first example, the performance value (value attribute) is to be determined for the control criterion "process quality" (stage 1). A control parameter (stage 2) for this is "standardization and increased efficiency in the application the application of standards".

The control parameter "standardization and increased efficiency in the application of standards" can be defined with the measurement indicator (stage 3) "Time spent on activities related to the application of standards (time)".

The **time** required for standards application without and with SMART standards is calculated on the basis of the controlling indicators (stage 4):

→ "average number of working and project hours taken up with standards usage per order" and
→ "average number of working and project days taken up with standards usage altogether per business year."

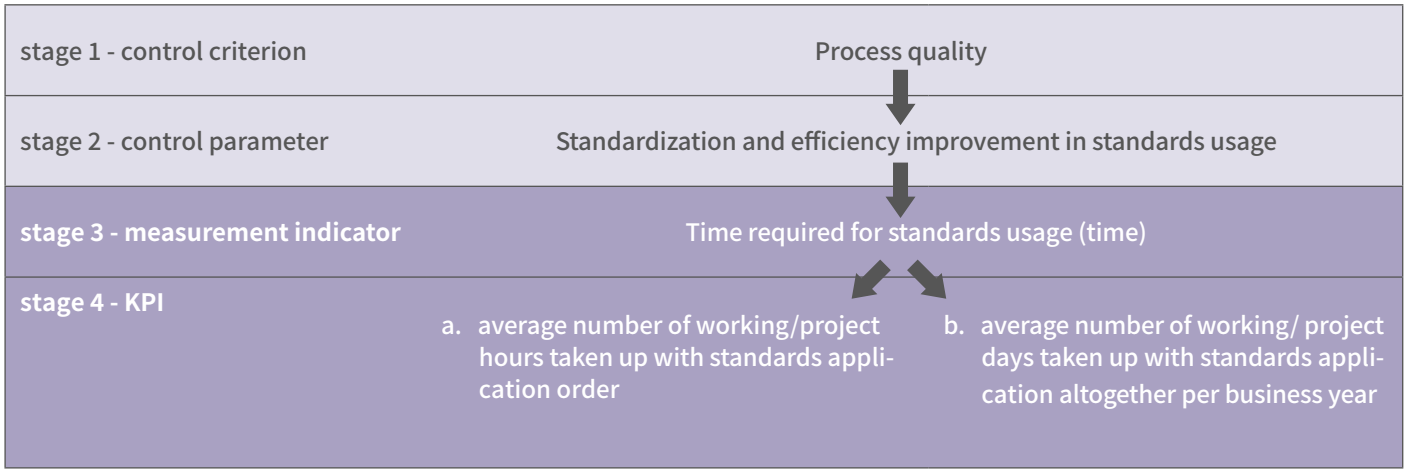


Fig. 5-3.1: Added value model – Increased efficiency - time (Voit, TS.advisory GbR)

To determine the key indicators a. and b. in the comparison "Status quo without SMART standards" and "Transformed status with SMART standards" the following initial data is required from the respective company:

Initial data			Unit	Current value			Change value	
				Initial value	Share	Sub-share	Alternative 1: value assumed for individual company	Alternative 2: fixed value from external source
Average time required for product development per order			h	50 h				
	Time share for standards research per order		%		35 %			
		incl share for research and reading	%			60 %	-50 %	-80 %
		incl share for checking relevance	%			20 %	-80 %	-100 %
		incl share for transferring to systems	%			20 %	-80 %	-100 %
	Time share for development per order		%		30 %		-10 %	-20 %
	Time share for documentation		%		35 %		-30 %	-40 %
Average number of orders per business year			ea.	240				

Fig. 5-3.2: Added value model – Value-added model - Input data "time required (Voit, TS.advisory GbR)

The fields marked in lighter color are basically company-specific input values ("Current value", "Change value, 1st alternative"). In the calculation examples shown here, assumptions have been made about the initial values in order to be able to show the calculation system.

→ The "baseline values" are preferably real data from the order and from company controlling and could be supplied by the company's ERP system to the SMART standards added value calculator via an automated interface.
→ The ERP system probably only provides the details given in the "Shares" and "Sub-shares" columns in exceptional cases. In other words, they must be estimated on the basis of the company's individual level of digitalization and level assignment in standards, together with corresponding empirical values in the product development process.
→ The "Change value" in the 1st alternative shows the company's individual estimate of the expected percentage time savings in the individual process steps in the "transformed status with SMART standards" compared to the "status quo without SMART standards".

Instead of or in addition to the company's individual assumptions, the "change value" on the 2nd alternative (column with a darker color) shows statistical assumptions from external sources.

As a general rule, the change values from external sources (2nd alternative) are only used in the added value calculation if no individual company values (1st alternative) are stated (= "alternative" calculation). However, for the purposes of this white paper, the added value calculation has taken account of both alternatives. The change values in the 2nd alternative are based on empirical values provided by experts at DIN and DKE, while the company's individual change values (1st alternative) were based on rather conservative assumptions to show a range of results (= scenario calculation). The values shown are exemplary assumed values to illustrate the calculation methodology. This results in the following values for the Key indicators stage 4:

Key indicator (stage 4)	Value without SMART standards	Value with SMART standards			Value with SMART standards		
		Alternative 1			Alternative 2		
	Quantity	Quantity	Change		Quantity	Change	
			absolute	in %		absolute	in %
Average number of working/project hours taken up with standards application per order	35,0	18,9	-16,1	-46,0	12,6	-22,4	-64,0
Number of working/project days (8h/d) taken up with standards application altogether per business year	1.050,00	567,0	-483,0	-46,0	378,0	-672,0	-64,0

Fig. 5-3.3: Added value model – results for time savings in standards application. (Voit, TS.advisory GbR)

On the level of the individual order and on the company level, this simple calculation shows for both alternatives the mount of time or resources taken up with standards application in he product development process in the status quo in level 1, and how much savings potential is associated with a transformation to SMART standards in level 4.

Referred to the complete order with 50 hours, this results in the following changes:

Example 2: Cost calculation

Example 2 defines the measurement indicator (stage 3) "Total costs for activities in standards application (AMOUNT)" for the con-trol parameter "Standardization and efficiency improvement in standards application".

Key indicator (stage 4)	Value without SMART standards	Value with SMART standards			Value with SMART standards		
		Alternative 1			Alternative 2		
	Quantity	Quantity	Change		Quantity	Change	
			absolut	in %		absolut	as a %
Average number of working/project hours per order	50.0	32,4	-17,6	-35,2	24,6	-25,4	-50,8
Number of working/project days (8h/d) taken up with product development processes altogether per business year	1.500,00	972,0	-528,0	-35,2	738,0	-762,0	-50,8

Fig. 5-3.4: Added value model – results for time savings per order (Voit, TS.advisory GbR)

Given the same workforce resources, this means that from around 50% (alternative 1 = 17.6/32.4) to nearly 100 % (alternative 2 = 25.4/24.6) more orders could be processed with SMART standards compared to the status quo, and this in the long term.

The **amount** required for standards usage without and with SMART standards is calculated on the basis of the controlling indicators (stage 4):

→ "average costs for standards application in the development and manufacturing process per order",
→ "total costs for standards application in the development and manufacturing process per business year", and
→ "total costs for standards application in the development and manufacturing process per business year in relation to income (cost-income ratio)".

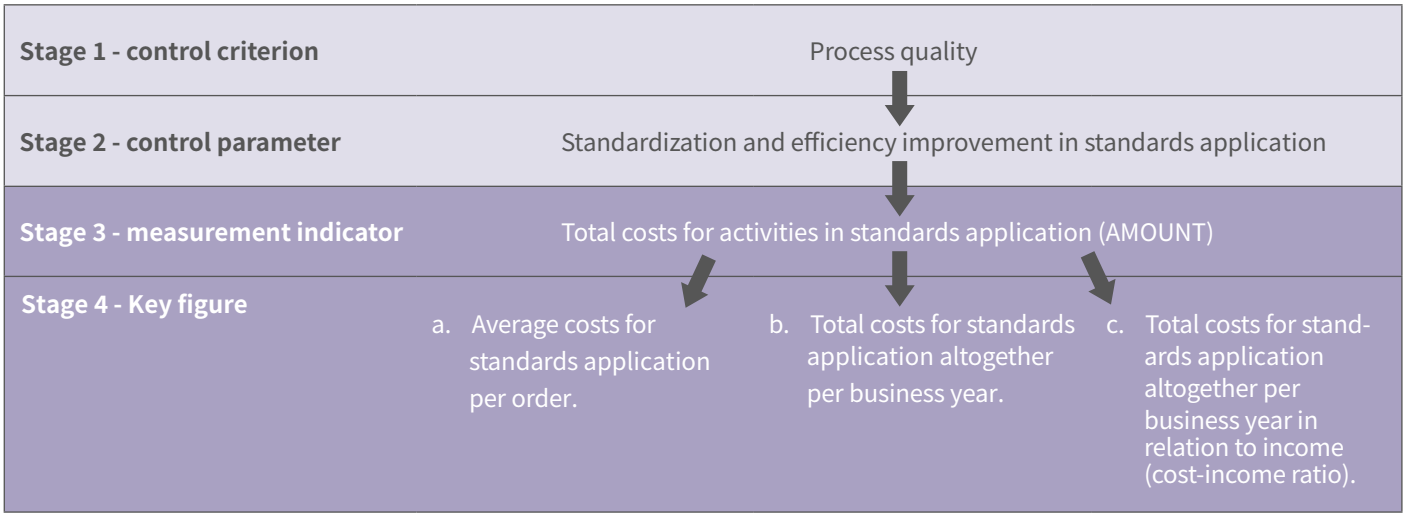


Fig. 5-3.5: Added value model – efficiency improvement: cost (Voit, TS.advisory GbR)

To determine the Key figures a., b. and c., the following initial data data is required from the respective company – in addition to the data in Example 1:

Initial data	Unit	Current value	Change value	
		Initial value	Alternative 1: company's individual assumed value	Alternative 2: fixed value from external source
Calculated cost rate per hour for internal staff	€/h	100	-5 %	-10 %
Calculated material costs for standards applicationper business year	€	10.000	500 %	300 %
Company's income per business year	€	3.600.000		

Fig. 5-3.6: Added value model – Initial values: costs (Voit, TS.advisory GbR)

To determine the total costs of applying the standard in the status quo, an assumption was made as to how high the average personnel costs per hour and internal employee are and what material costs are incurred for the procurement of the relevant standards per year.

Two assumptions were made for the transformed status with SMART standards:

→ The personnel costs per hour and internal employee costs are reduced by 5% (alternative 1) or 10% (alternative 2), as a lower qualification level is sufficient for the employees involved in the product development process with SMART standards in the application of standards.

→ The material costs for the standards application increase 5-fold (alternative 1) or 3-fold (alternative 2), as the standards are no longer obtained once as PDF files, but with SMART Standards access authorizations are required for tool applications and costs for updates and maintenance measures must also be taken into account.

This results in the following values for the controlling indicators in stage 4:

Key figures (stage 4)	Value without SMART standards		Value with SMART standards				Value with SMART standards			
			Alternative 1				Alternative 2			
	in €	in %	in €	in %	Change		in €	in %	Change	
					absolute	in %			absolute	in %
Average costs for standards application in the product development process per order	3.542		1.826		-1.716	-48,4	1.259		-2.283	-64,5
Total costs for standards application in the product development process per business year	850.000		438.240		-411.760	-48,4	302.160		-547.840	-64,5
Total costs for standards application in the product development process per business year in relation to income (cost-income ratio)		23,61 %		12,17 %	-11,44 %	-48,4 %		8,39 %	-15,22 %	-64,5 %

Fig. 5-3.7: Added value model – Results Cost savings Application of standards (Voit, TS.advisory GbR)

The cost analysis clearly shows the volume of personnel and the annual volume of personnel and material costs in the company associated with the application of standards and that that a transformation to Level 4 would result in an annual costreduction of between 48.4 % (alternative 1) and 64.5 % (alternative 2).

Example 3: Earnings calculation

Deviating from examples 1 and 2, example 3 defines the performance value (value attribute) for the control criterion "Earnings potential" (stage 1). One control parameter (stage 2) in this respect consists of "Increasing and securing the earnings potential".

This control parameter can be defined with the measurement indicator (stage 3)"Target margin per order or per business year". The target margin is calculated without and with SMART standards on the basis of the Key figures (stage 4):

→ "average target margin per order with consistent order volume"
→ "turnover per business year with consistent target margin"

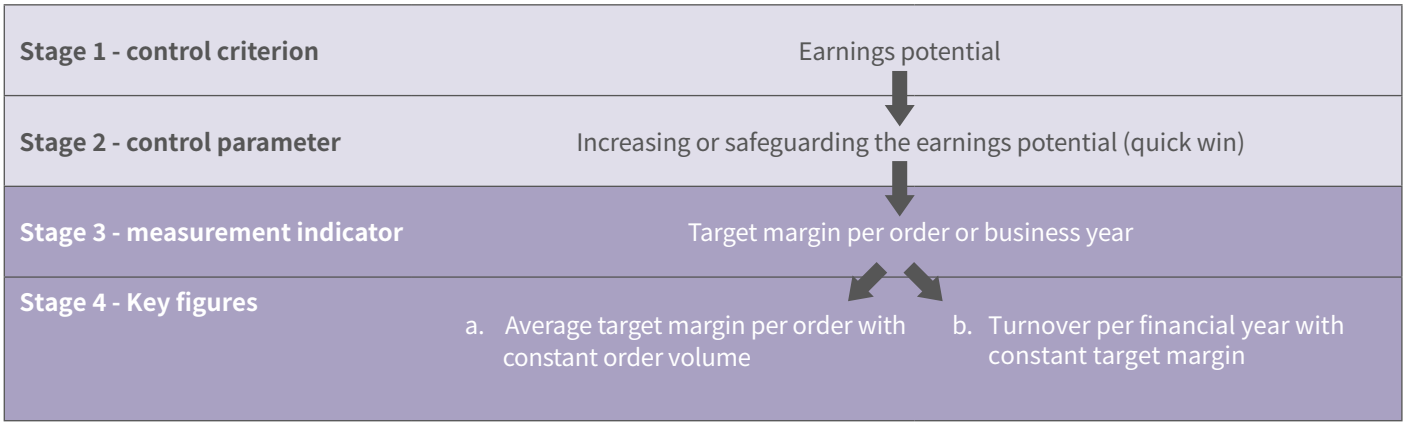


Fig. 5-3.8: Added value model – increasing the earnings potential (Voit, TS.advisory GbR)

To determine the key figures a. and b., the following initial data is required from the company:

Initial data	Unit	Current value	Change value	
		Initial value	Alternative 1: company's individual assumed value	Alternative2 : fixed value from external source
Average time required for product development per order	h	50		
Average number of orders per business year	pcs.	240		
Calculated cost rate per hour for internal staff	€/h	100	-5 %	-10 %
Company's income per business year	€	3.600.000		
Target margin per order	%	20		

Fig. 5-3.9: Added value model – Initial values: earnings (Voit, TS.advisory GbR)

To determine the earnings potential in the status quo - analogous to example 1 - the average time required per order and the average number of orders per financial year and - analogous to example 2 - the assumption regarding the average level of of personnel costs per hour and internal employee was used.

Furthermore, information is required about the company's turnover per financial year, preferably via automated ERP interface, referring for instance to the last business year (CURRENT value) or the current business year (PLAN value), as well as an indication of the target margin per order (PLAN value).

This results in the following values for the Key figures in stage 4:

Key figures (stage 4)	Value without SMART standards	Value with SMART standards			Value with SMART standards		
		Alternative 1			Alternative 2		
	in €	in €	Change		in €	Change	
			absolut	in %		absolut	in %
Average margin per order with constant order volume	3.000	4.760	1.760	58,7	5.540	2.540	84,7
Income per business year with constant target margin	3.600.000	4.740.741	1.140.741	31,7	5.768.293	2.168.293	60,2

Fig. 5-3.10: Added value model – results for the earnings potential (Voit, TS.advisory GbR)

Based on the earnings parameters, it becomes apparent that a company with SMART standards in level 4

→ can generate an increase in the order margin of between around 60% and 85% on the level of the individual order, with constant order volumes and sales prices, and
→ can generate an increase in turnover of between around 32% and 60% with a constant percentage target margin.

Furthermore, an increase in the order margin or sales leads ceteris paribus to higher company results and improved corporate creditworthiness.

Excursus:

If the internal employee resources saved by SMART standards in the application of standards are not "reinvested" in the processing of more orders, but in further internal transformation or digitalization projects, this can reduce project costs (replacement of external resources with internal resources) or increase the speed of transformation (supplementation of existing project resources).

6 NEXT STEP – SELF ASSESSMENT

SMART standards can parallelize sub-processes at certain points, with potential savings in time and resources by accelerating the processes. This has relevant impacts on process quality, product quality, earnings potential, personell and organization.

For example, SMART standards eliminate the need for research and manual follow-up activities, which can free up time to expand a company's product range and motivate employees to work closer to their core activities.

The SMART standards added value model was developed to work out the economic added value and make the future of standards application transparent and monetarily tangible for companies. Knowing that a change in corporate strategy, the introduction of change processes, takes many months or even years, now is the time to focus on SMART Standards.

In this sense, the calculation model provides the basis for each company to create its own calculation to decide in a timely manner when to switch to SMART standards and wether the company has already met the conditions are already in place or still need to be established.

In order to raise awareness of the importance of the topic of standards application and monitoring in the company, which units and persons are currently dealing with this issue and how the associated processes are designed, a self-assessment questionnaire was developed.

You can use this questionnaire to determine generically, but on a company or location-specific basis, which level classification of standards application is implemented in the status quo in your company, which cost factors are associated with this and what fundamental upside potential is likely to be involved in the implementation of SMART standards.

Based on this generic classification, relevant control criteria and parameters can then be identified for each individual ompany or location and depending on the stakeholder erspective (e.g. management or contract manager), and the specific added value can be determined using SMART standards with the help of the added value calculator (see next page).

Outlook:

SMART standards make business processes much more efficient and are more stable due to direct input into customer systems, as manual transmission errors are eliminated.

In order to meet the requirements for conformity assessment and the state of the art, all information must be complete, up-to-date and correct during product development. Due to the increasing digitalization of standardization processes, the standards themselves and - above all - the standardization of digitalization, the availability and timeliness within the framework of the aforementioned requirements is taken into account more than ever before. Since SMART standards are fragmented, redundant information is eliminated and the use of standards is simplified.

Using the business considerations based on the SMART Standards added value model, each company can calculate (or have calculated) how great the benefits will be from converting the standards apllication processes to SMART standards.

Heading	Basic question	Details	
PRIORITY in the company	→ What is the basic priority of standards usage in product development? → Are activities relating to the application of standards perceived solely as an "unavoidable obligation" or cost factor? → Or do the affected stakeholders already recognize added values?	<u>Viewing level</u> → In the management ("tone from the top")? → Lower management levels? → Among the order/product owners? → Among the affected staff?	→ Does the "minimum principle" apply to the applicationof standards? – Legal compliance with lowest possible costs? ("minimum jump height") → Is standards usage associated with making a contribution to operative product quality/ safety? – Creating a quality standard → Is standards application seen as a future/competitive factor? – Contribution to achieving strategic targets
HOW? – compliance process	→ What is the current current process for applying standards in product development? → How do you ensure that the application of standards is complete, up-to-date and objectively correct?	→ <u>Standards application:</u> → Highly manual and individual? → Standardized and checklist / application / tool-based? → Automated?	<u>Standards monitoring:</u> → How are innovations, amendments and changes to the standards communicated and taken into account in project development? → Are there checks in place for the application of standards?

Fig. 6-4.1: Self-assessment – part 1 (Voit, TS.advisory GbR)

Heading	Basic question	Details	
WHO? - responsibilities	Which units / functions / personnel are involved in the application of standards and, if applicable, the review of standards?	→ Centralized vs decentralized processes? Distribution of tasks? → Who has final responsibility for standards application? → Who takes product decisions in conjunction with standards usage?	→ How many personnel (in persons) are responsible for the application of standards in the company? → What level of qualification / experience (junior, senior, professional) do the personnel involved in the application of standards have? → How can the proper application of standards be ensured even when individuals are on vacation or sick?
HOW MUCH? – costs of standards application		How high are the average direct costs (material and personnel costs) for standards application in the current process through to the end of an order/delivery of a product (possibly estimated in % per case) → Per order/project in relation to the order volume? → Per business unit in relation to the allocated revenue of the business unit? In the company in relation to total revenue?	HHow high are the average indirect costs of improper application of standards (complaints, rework, compensation, premiums for liability insurance, etc.) (estimates in % where applicable)? → Per business unit in relation to the attributable revenue of of the business unit? → In the company in relation to total turnover?

Fig. 6-4.2: Self-assessment – part 2 (Voit, TS.advisory GbR)

ANNEX A:
DIGITALIZATION POTENTIAL OF COMPANIES

Digital transformation of companies in the status quo (initial picture)

For a representative analysis of digitalization processes in SMEs, the following section is based on a study "**IfM Materials Digitalization Processes of SMEs in Manufacturing – follow-up survey**" dated February 2022 by the Institut für Mittelstandsforschung (IfM - Institute for SME Research) in Bonn.

Interrelations within companies and on the cross-company level can be broken down as follows:

a. In-house digitalization
   i. Intra-departmental networking
   ii. Cross-departmental networking
b. Cross-company digitalization

Fig. 6-1 shows strong growth in intra-departmental networking in the course of digitalization between 2016 and 2021 in various departments of companies. The study attributes this development to the consequences of the pandemic in order to compensate for staff being physically separated.

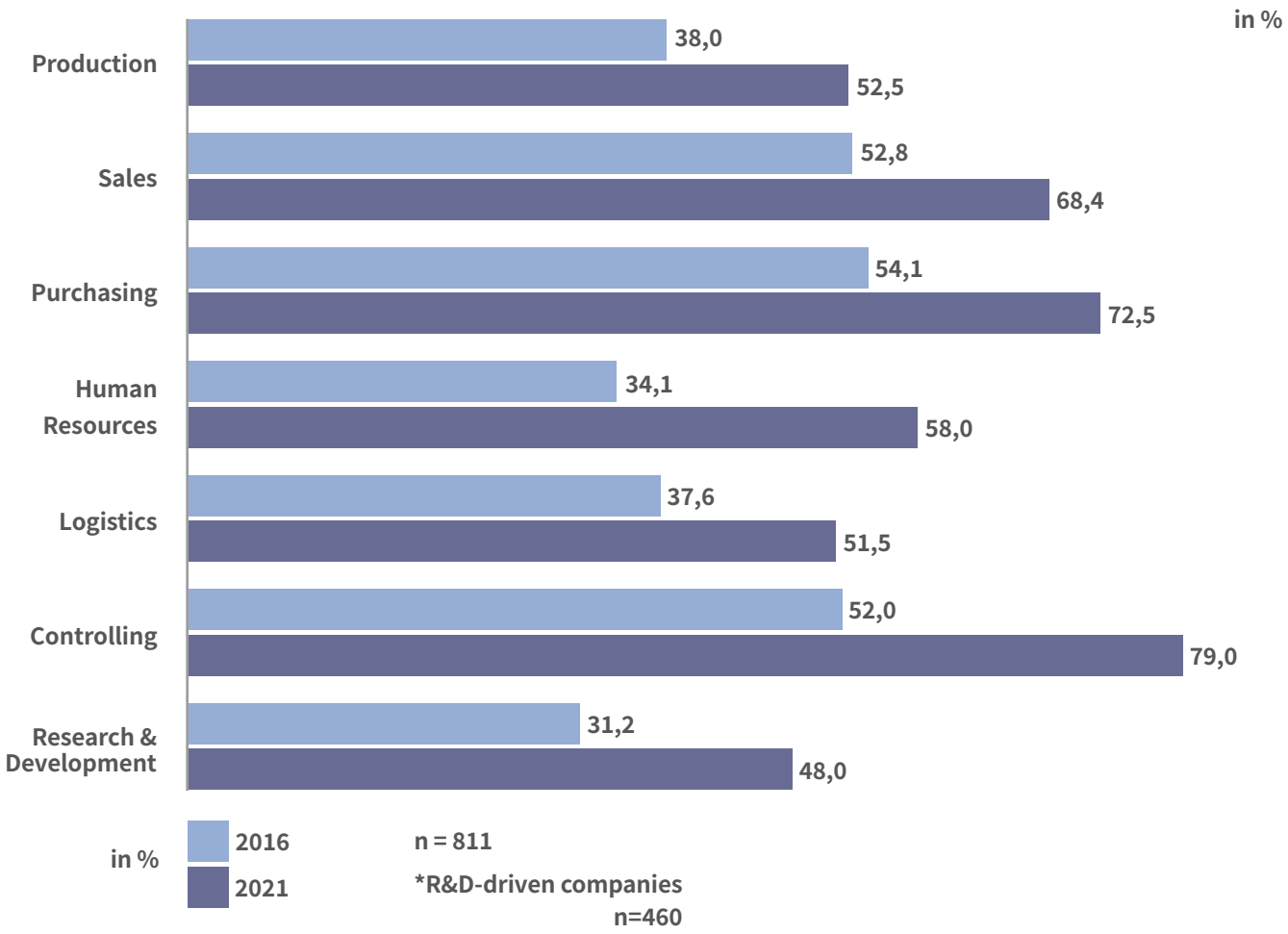


Fig. 6-1: Intra-departmental networking 2016 versus 2021 (source: IfM Bonn 2022)

What are the driving forces and constraints of inner-company networking?

The study also indicates that there was already a strong trend towards more efficient production and business processes in 2016. There is also an increasing focus on using digital technologies to improve products and services (Fig. 6-2).

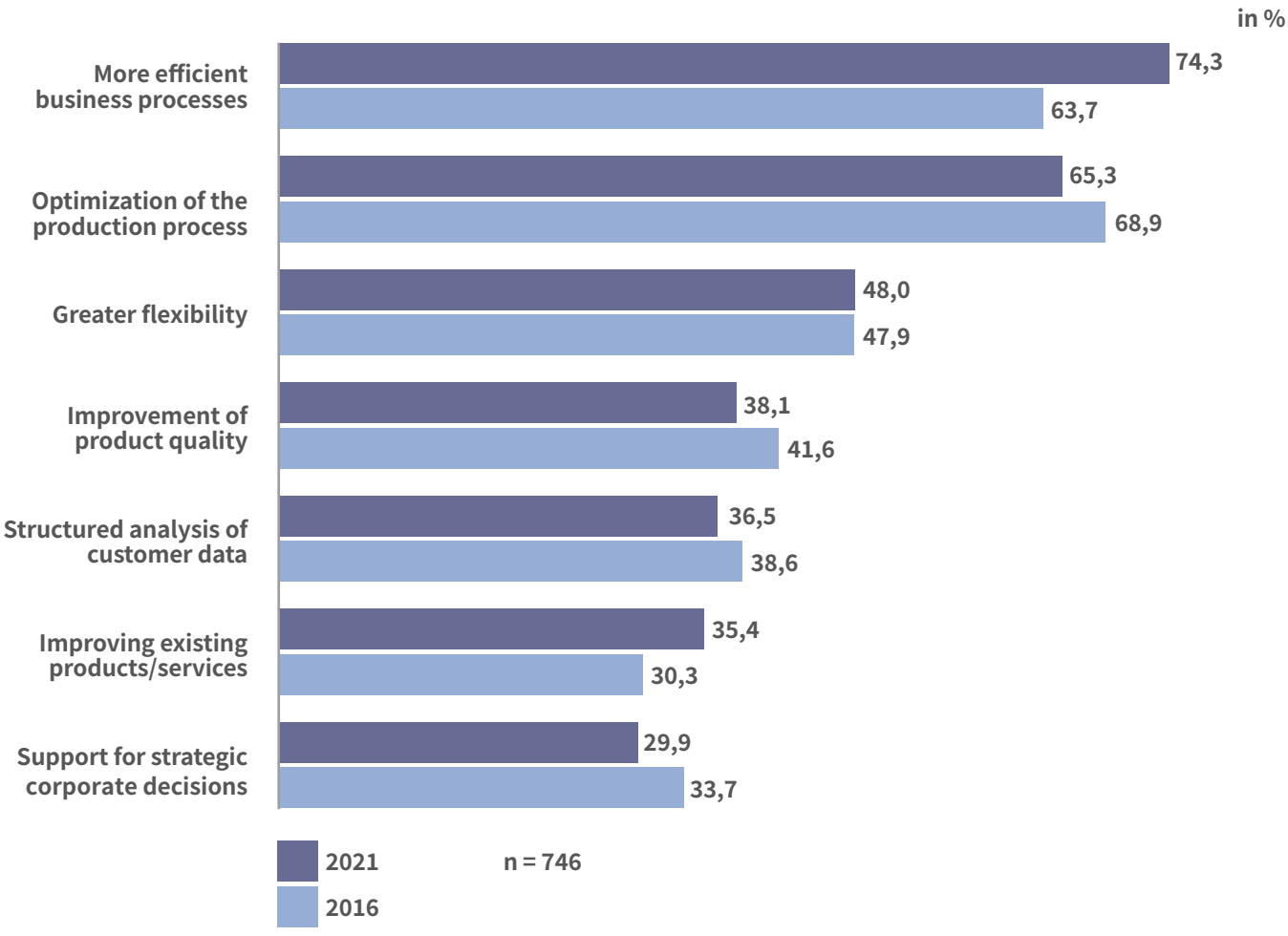


Fig. 6-2: Main driving forces behind internal networking 2016 versus 2021 (source: IfM Bonn 2022)

In terms of opening up new business area, however, digitalization as a driver of inovation has barely arrived in companies, Strategic considerations tend to be of a subordinate nature here.

As a result, companies are much more likely to drive digitization measures if they see immediate operational and economic added value.

Cross-company networking and digitalization with subsequent communication forms the basis towards Industry 4.0.

Because of this, further efficiencies and a more flexible alignment of the value chain will arise, although the dependencies of a characteristic value chain will no longer exist in their previous form.

As far as the supply chain is concerned, cross-company digitalization will in future trigger a contractual commitment between companies, thus increasing the probability of more small and medium-sized companies being drawn into digitalization.

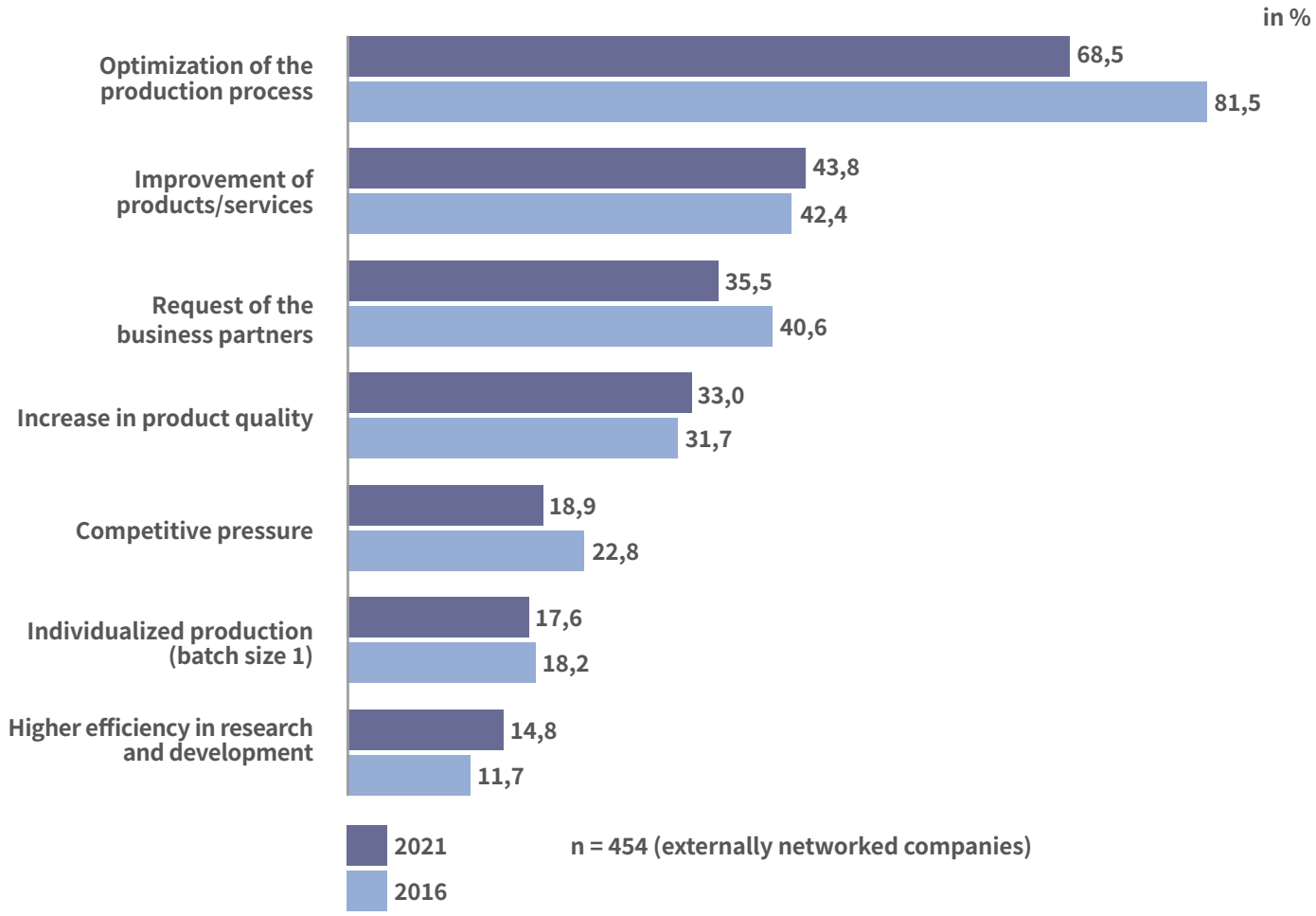


Fig. 6-3: Most important reasons for companies to network with external partners (Source: IfM Bonn 2022)

To summarize, the wish for fundamentally stronger networking leads to the need for standards as future means of communication to secure cross-company networking even more than before; this can only be done in a digitalized environment when made available to all interested stakeholders as SMART standards.

Finally, the larger the size of the company, the higher the number of companies that see great potential in further digitalization. Around seven in ten companies are convinced of the need to further digitalize the development and manufacturing of products and services (Fig. 6-3).

Accordingly, both internal and external digitalization are seen to be highly dynamic.

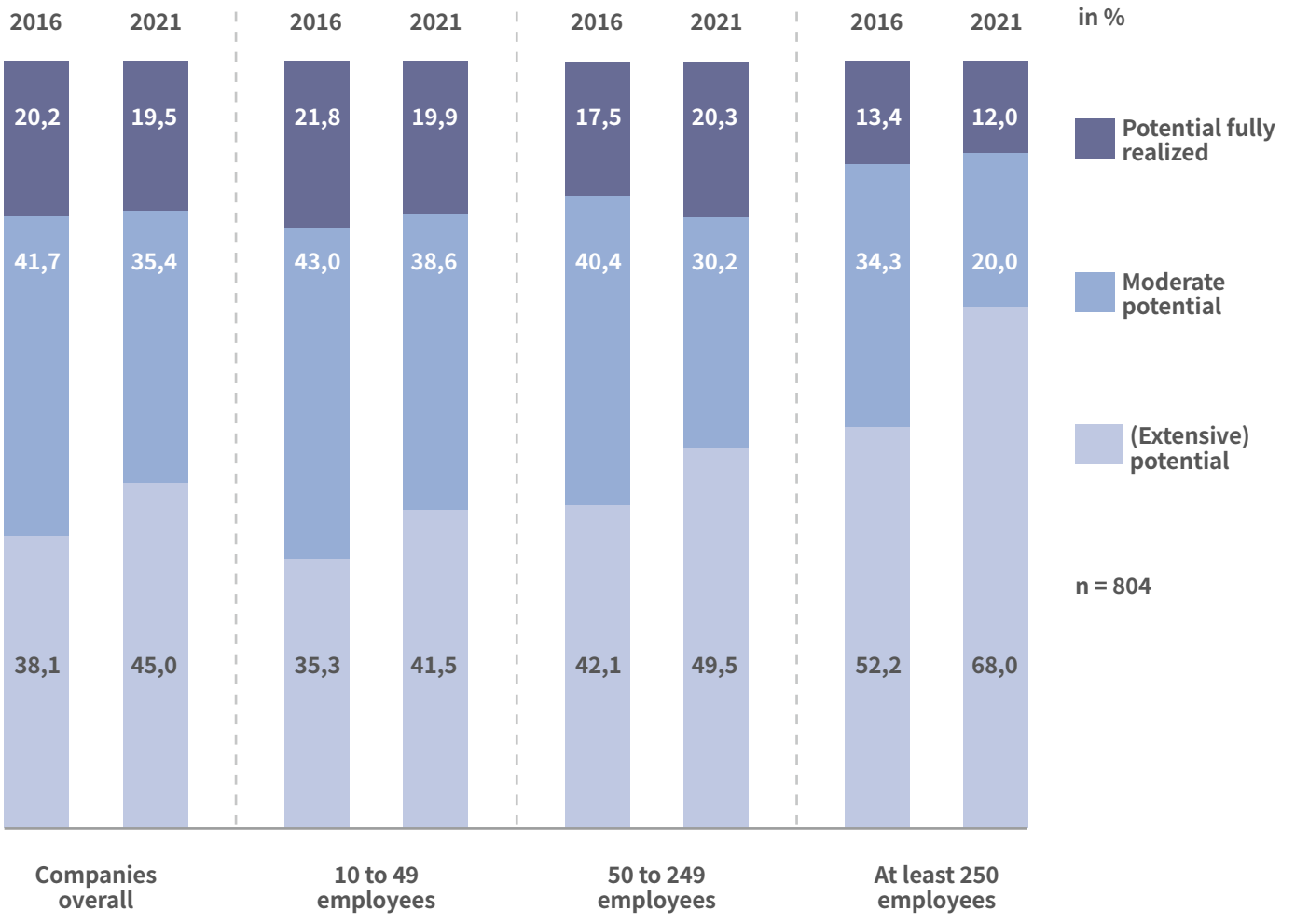


Fig. 6-4: Comparison of digitalization potential in companies (source: IfM Bonn 2022)

Transformation to SMART standards (with levels of maturity the target image)

Based on the results of the IfM study, the degree of digitalization in companies can be broken down as follows.

Level of maturity	1. "Paper tiger"	2. "Paperless versus digitized"	3: "Early Adopter"
Characteristics	→ Have no IT infrastructure → Work with paper	→ Electronic document management → Meta data are already processed and distributed in the organization. → If appropriate, IT department available to manage the growing tool landscape.	→ The organization creates, executes and transfers information within automated processes. → Is capable of extracting fragmented information from existing standards and defines its own databases.
Digital enabler versus workload	→ High cultural and technical workload → Building IT infrastructure or service provider → Implementing new processes and work methods	→ Comes under the category of inner-company networking → The procurement of tools is easily possible in existing IT landscapes and systems.	→ Driving force behind digitalization → Marginal workload – nearly 100% value creation → Probably larger organization (> 250 employees)
Transformation costs[14]	→ External consultants → IT outsourcing → Data communication → Migration, architecture, training → Storage → Licenses (?) → Installation, audit, risk management → Support	→ External consultants → Architecture → Training → Support	→ External consultants → Architecture → Support
Conclusion	Transformation depends on the branch and the business environment. Accordingly, now at the latest the time has come to build an IT infrastructure.	The initial workload is low as new systems can be implemented in the existing IT landscape. Greater workload may be expected just in the short term for adapting the processes and work methods.	The workload consists above all in adapting new data formats and APIs to the existing architecture.

Table 1: The three maturity levels in the digitalization of companies

14 Consulting depends on the extent to which the services are requested according to the degree of digitalization in the company.

Not only the transformation effort, but also the type of transformation depends on the size of the company:

→ **Larger companies (>250 employees)** tend to opt for **insourcing**, in other words, the content provided by the standardization organizations is processed within their own IT infrastructure.
→ **Smaller companies (< 250 employees)** are more likely to proceed with **outsourcing** and use external IT (service providing) systems for their processes.

What influence could SMART standards have?

In fundamental terms, SMART standards would simply eliminate the reasons mentioned in the previously processed IfM study (organizational effort, cost-benefit analysis), which have so far prevented the development of new services or products.

How? By direct, targeted and automated implementation of SMART standards in the product creation development. This can already be determined in advance withwith the cost/ ben-efit considerations, using the added value calculator of the SMART standards added value model.

Fortunately, there are only a few companies corresponding to maturity level 1 "paper tiger" (Table 1) that would not be ready to introduce SMART standards.

Consequently, the further considerations of the SMART standard added value calculator assume at least level 2 of the utility model and a correspondingly completed digital transformation of a company that is already targeting level 4 according to the utility model as part of a digitalization strategy.

The way to digital value creation

The increasing digitalization of companies (Table 1) reveals which possibilities are conceivable in terms of standards application in the framework of transformation.

While standards can be characterized by five different levels using the extended utility model (see Figure 1-2), a closer look at the type of information provided by standards with increasing levels can be easily illustrated using the example of black, grey and white box tests.

What are the differences between black, grey and white box tests and how do they compare with standards on the basis of their transformation levels from level 1 to level 4?

Comparisons are usually appropriate when made on a level of abstraction that is easy to understand and also appropriate. The aim is to help readers understand the changes in the standards application processes at a glance and show them the incremental advantages.

Black box test[15]

The tests take place **without** knowledge about what is inside the system being tested. Only externally visible behavior is included in the test. This test is not a guarantee for correctness.

→ **Abstraction TXT:** Compare with a level 1 standard → The contents are not known, nor are any meta data provided with the document. Relevant information has to be extracted manually from the standard and entered in a system. Errors in manual recording, extraction and transfer of information cannot be ruled out as there is no machine readability.

15 https://en.wikipedia.org/wiki/Black-box_testing

→ **Abstraction PDF:** Abstraction TXT + meta data. It is now possible to reference the specific document for identification. From the point of view of application practice, there are no differences in the manual transfer of relevant information.

Grey box test[16]

This kind of test comprises a combination of black and white box tests in terms of insights for an unsuitable structure or inappropriate usage form of a software application.

→ **Abstraction XML:** The standard is broken down into individual sections for automated, targeted assignment of information. Similarly, the respective standard sections can be augmented in terms of data due to being paragraphcentered.

White box test[17]

The tests take place with knowledge about the inner functionality and possibly also with insight into the source code. An error analysis of certain components is possible, as is identification of the component causing the error through insight into the mode of operation and can be well aligned with the detectability of SMART standards in levels 4 and 5.

→ **Abstraction:** Determination centering with known semantics in level 4 means that partial information is available that can be fragmented with subsequent targeted forwarding to the addressee. The detailed ascertainability of information in this form makes it possible to avoid errors for example, because no manual tasks are necessary, from standards research and registering relevant information through to transmission into other systems.

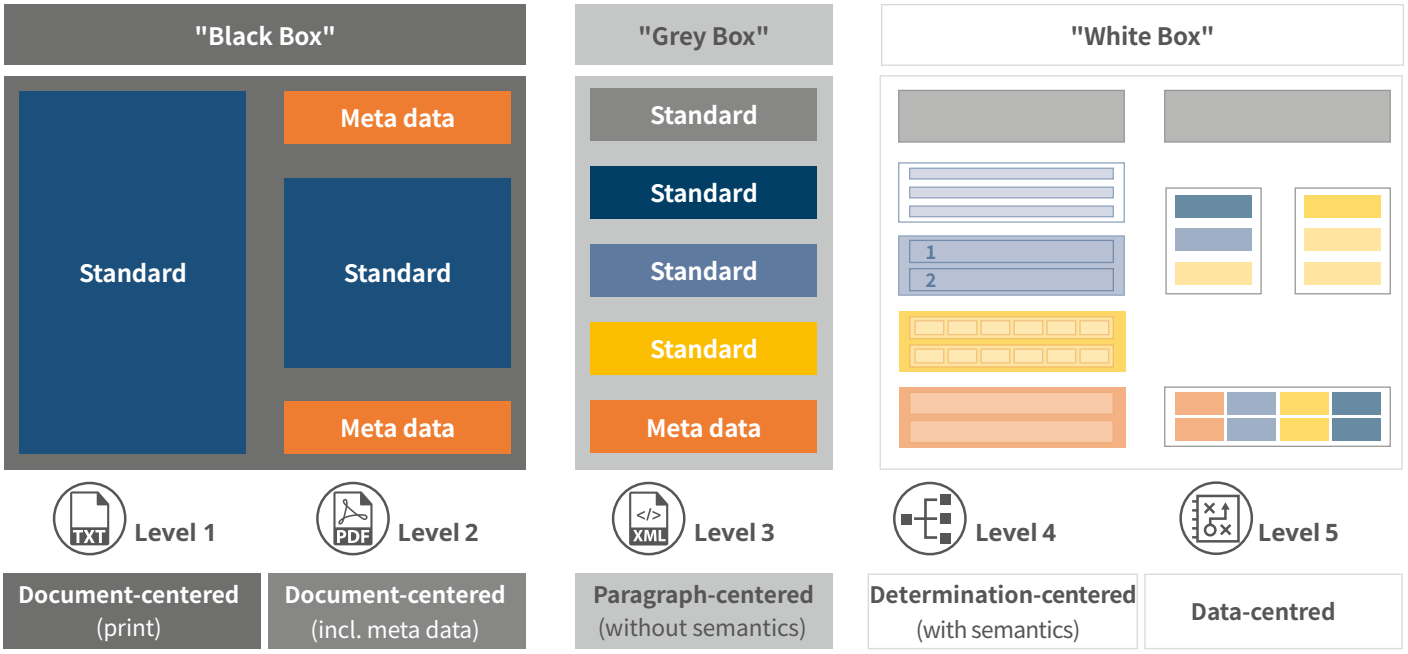


Fig. 6-5: Transformation levels from standards to SMART standards with incremental advantages (Puppan, DKE)

16 https://en.wikipedia.org/wiki/Gray-box_testing
17 https://en.wikipedia.org/wiki/White-box_testing

How does the benefit in using normative information change with ascending transformation level?

The following illustrations showing the example of a tractor with trailer (Figure 6-6) compares information staging for the status quo with future SMART information staging of normative information. The three silos symbolize the information sources for a standard, which could supply different areas of activity. But in many cases, differing information will be relevant in a certain mixture related to a specific usage for one department (e.g. design), while other departments profit from a deviating mixture of information.

While on the left side of Figure 6-6 information staging for the tractor with trailer is separated and sequential (tedious supply and loading in individual manual steps), the staging and supply flow is possibly not upto- date (because time-consuming), not complete (because different loading types) and possibly not correct (Information reaches the addressee only incompletely or not at all), to describe just a few but certainly not all challenges.

On the right-hand side of the illustration, we again see the targeted supply of information that is provided to a specific addressee in the right "mix", corresponding to relevance at the right time. For instances, during the design and development of a product, valuable information on safety requirements, implementation within the design, the resulting requirements for the quality of purchased components and production can be reliably provided and implemented.

Summary:

The presentation in three levels illustrates the transformation of a standard from a PDF document that cannot be assessed from the outside (black box) into an information model that enables a detailed view of its information content (white box) and uninterrupted digital value creation.

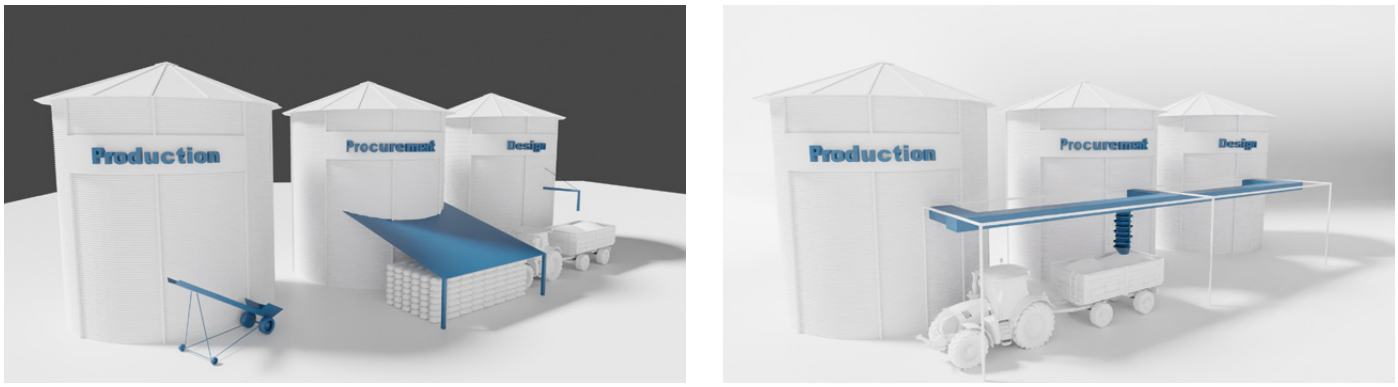


Fig. 6-6: Status quo (left) versus SMART information staging of normative information (right) (Rüther, CLAAS KGaA)

The three levels of provision and application of a standard make it particularly easy to explain the real advantages and also why it is only from Level 3 onwards that human beings and machines obtain relevant, processable and reliable information more quickly than at Levels 1 to 2.

Methodologies for digital transformation

Digital transformation – with SMART standards as an integral component – represents the matching of two previously successive but not necessarily coupled worlds. This is the world of business processes on the one hand, and the IT world on the other. One approach that already offers exemplary implementation of this link is SCRUM (www.scrum.org). This method could be a role model for implementing SMART standards for product development.

Firstly an organization needs to identify who will use standards in which processes and how.

This results in the following questions:

→ In which business processes are standards applied explicitly today?
→ In which business processes are they not yet applied today, although this would be possible? Who uses the standards regularly in these business processes?
→ Which interfaces can be expected from one process stage to the next?

Already digitized interfaces will draw particular attention.

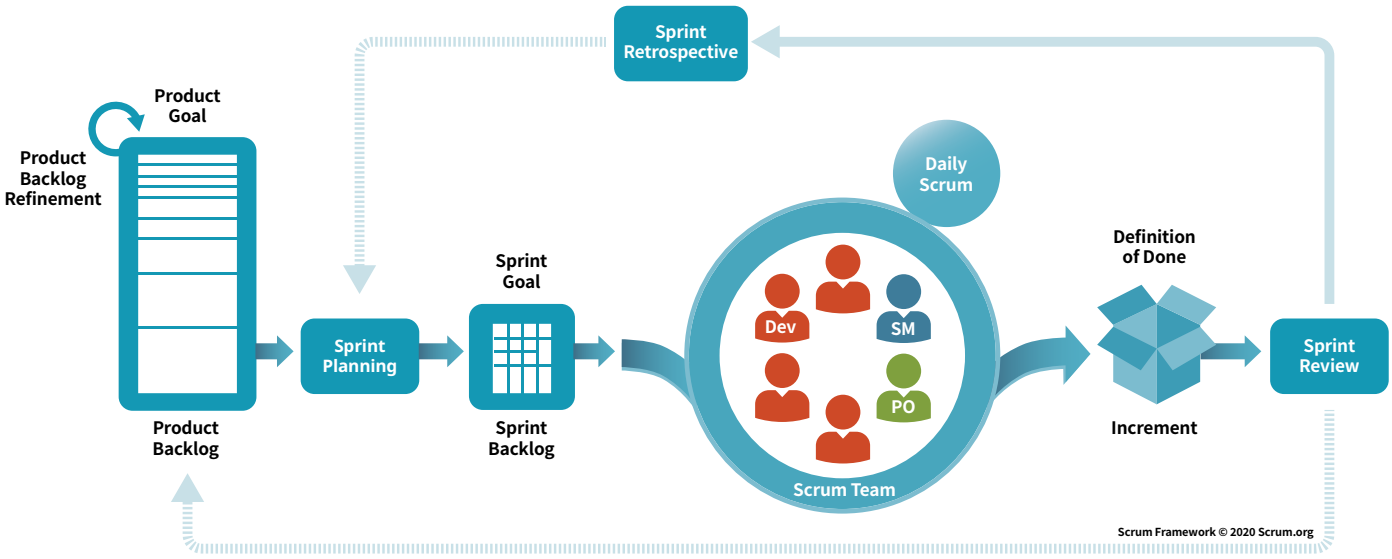


Fig. 6-7: Example of SCRUM as methodology for digital transformation (source: Scrum Framework)

Here SMART standards offer the potential of being adapted directly to these interfaces.

Remark: The cost of interface adaptation is negligible if this is a one-off adaptation and any subsequent parameterization required for operation.

However, a further increase in efficiency through SMART standards is likely to result from the process steps that have not yet been digitized. Altogether, SMART standards will need to provide all details about the infor-mation spectrum, the structure of information storage and its usability together with an interface description for corresponding use, in the interests of efficiency analysis. This information must also be supplied in standardized form (external meta data (SMART type) or immanent document data, such as a digital AMD or retrieval address) to keep the workload efficient for the user (human or AI) and, above all, unambiguously interpretable, in other words, usable at all within the meaning of SMART standards.

Table 2 presents exemplary processes and how these could match with the GUS. Detailed explanations are provided for the product development and technical procurement processes.

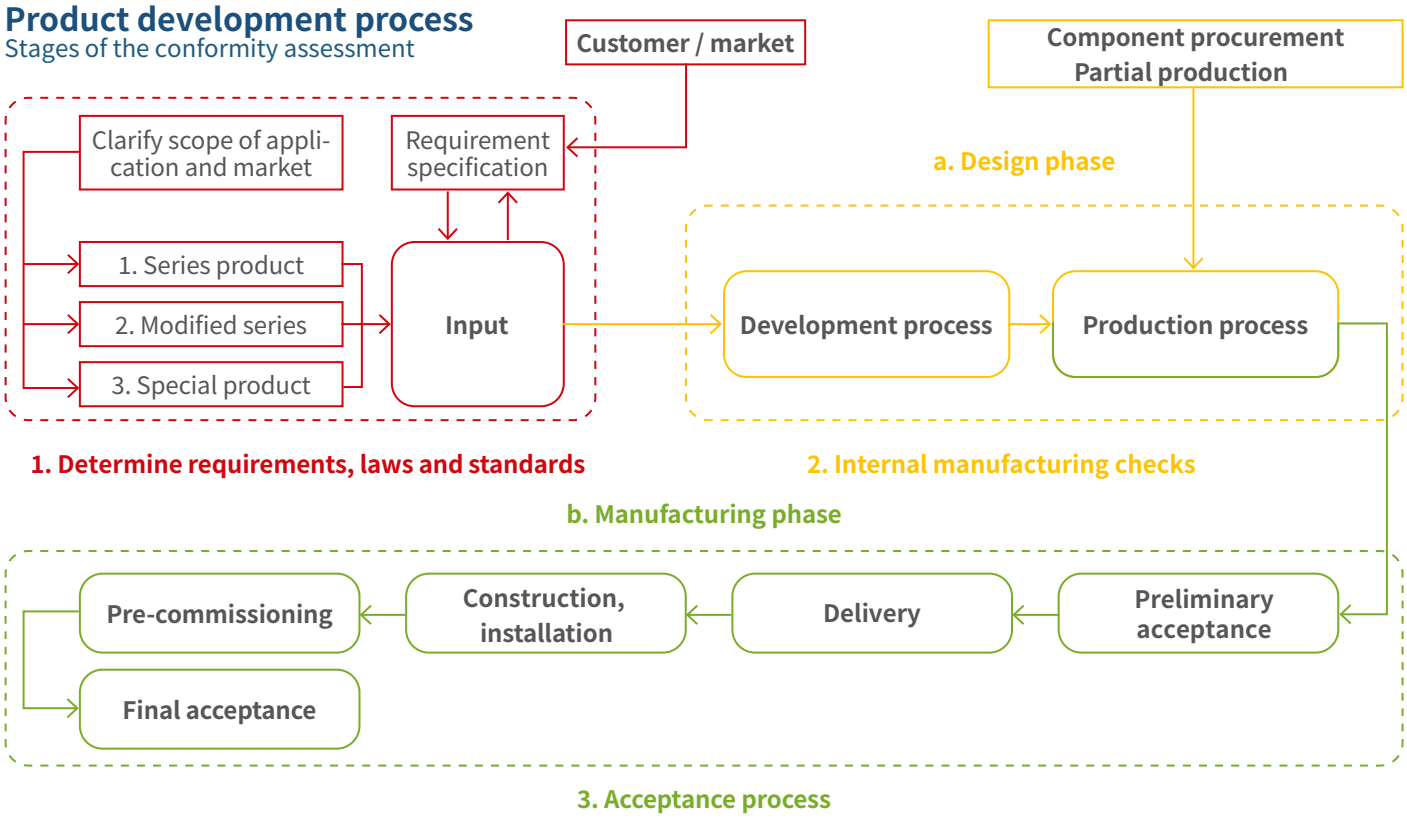
User story	Affected company processes
GUS #1: References [References]	Product development, procurement, compliance, service design, service delivery
GUS #2: Notifications [Notifications]	Technical procurement Technical procurement, e.g. for ongoing tenders
GUS #3: Search [Search]	Technical procurement, e.g. for ascertaining demand
GUS #4: Change record [Change and variant management]	Production process, product design, adjustment, requirements engineering, service delivery Technical procurement, e.g. for comparing bids
GUS #5: Standards matching [Linking standards to products]	Production process, product design, adjustment, requirements engineering, service delivery Technical procurement, e.g. for comparing bids
GUS #6: Information unit matching [Management of standards content]	Technical procurement (e.g. bid phase)
GUS #7: Regulation matching [Linking standard content with regulations]	Technical procurement (e.g. bid phase)
GUS #8: Standard and system integration [Standards and System Integration]	Change management, requirements engineering, service design, service delivery
GUS #9: Export of Information Units [Interchange formats]	Production process, product design[Technical procurement (e.g. bid phase but also contractor selection)
GUS #10: Use case matching [Use case matching]	Product design, production process Technical procurement (e.g. bid phase, comparisons)
GUS #11: Decision support [Decision support]	Production process, compliance

Table 2: GUS and use cases[18]

18 https://www.dke.de/idis/medien/idis-whitepaper-2_en

Overview Product development processes

The following diagram illustrates the relationships between product development, manufacturing development and technical procurement. This is based on the Decision No. 768/2008/EU which describes the corresponding (sub-) activities between a. design phase and b. manufacturing phase in the context of the conformity assessment procedures in Community law, thus supporting a causal context between the company's central workflow processes.



1. + 2. + 3. = Conformity assessment procedures
3. = conformity assessment

Fig. 6-8: Product development process and its stations (Puppan, DKE)

19 https://eur-lex.europa.eu/legal-content/DE/TXT/?uri=celex%3A32008D0768#d1e32-98-1

Example 1: Product development process:

Remarks: The product development process shown in Fig. 6-8 PE process diagram and GUS assumes a high degree of digitalization. The aim is to show how SMART standards can adjusted in line with digital product development.

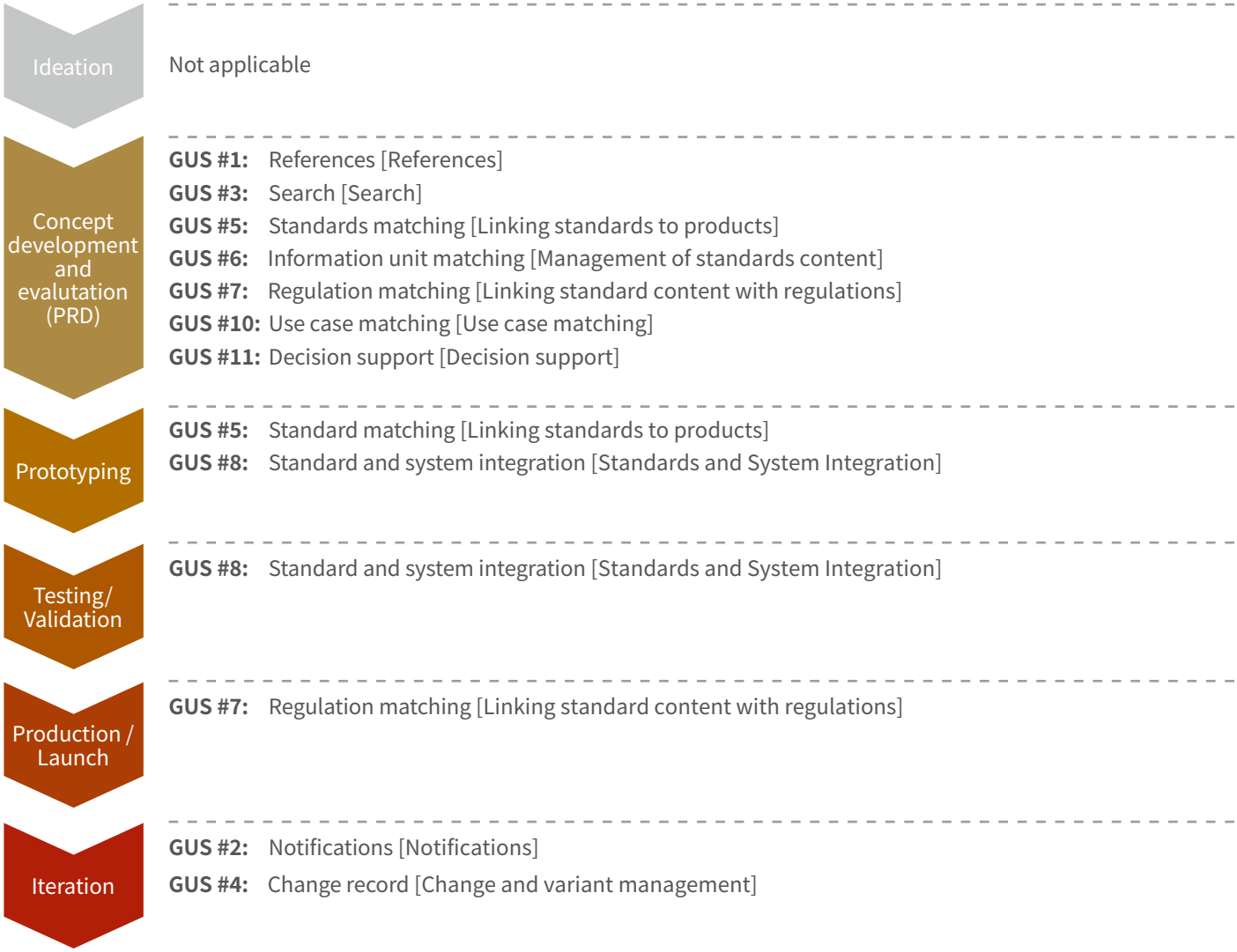


Fig. 6-9: PE process diagram and GUS

CONCEPT DEVELOPMENT UND EVALUATION	
TARGET	Proof of concept and evaluation (partly connected already with the prototyping process stage of an intended product, Go or Stop decision).
BASIS	Product or requirements specifications, market research, business analysis
Applicable GUS:	
GUS #3:	Search [Search]: Standards available?
GUS #5:	Standards matching [Linking standards to products]: Does the standard match the intended product?
GUS #6:	Information unit matching [Management of standards content]: Transfer the requirements to the proof of concept.
GUS #7:	Regulation matching [Linking standard content with regulations]: Which standard contents identified as being relevant or requirements match which regulation?
GUS #10:	Use case matching [Use case matching]
GUS #11:	Decision support [Decision support]: How high are the OPEX in view of the obtained matches or requirements and regulations?

PROTOTYPING	
TARGET	Understanding and testing whether the product is a viable way of solving the defined problem.
BASIS	Requirements specification, backlog
Applicable GUS:	
GUS #5:	Standards matching [Linking standards to products]: Reviewing the insights gained from the previous stage. Possible product adjustments are to be carried out.
GUS #8:	Standards and System Integration [Standards and System Integration]: Product versions with integrated requirements are installed into test systems.

TESTING AND VALIDATION	
TARGET	Check whether the product is fit-for-purpose and complies with the customer's requirements.
BASIS	Prototype(s), backlog or requirements specifications
Applicable GUS:	
GUS #8:	Standard and system integration [Standards and System Integration]: Product versions with integrated requirements are installed in test

PRODUCTION UND LAUNCH	
TARGET	Product is placed on the market or in its defined context.
BASIS	Compliance assessments, market requirements
Applicable GUS:	
GUS #1:	References [References]
GUS #7:	Regulation Matching [Linking standard content with regulations]
Iteration	
GUS #2:	**Notifications [Notifications]**: How have the used standards or requirements changed?
GUS #4:	**Change Record [Change and variant management]:** How have the standards or requirements applied changed? How should the product therefore be adapted?

Example 2: Technical procurement: see Fig. 6-10 Procurement process and GUS

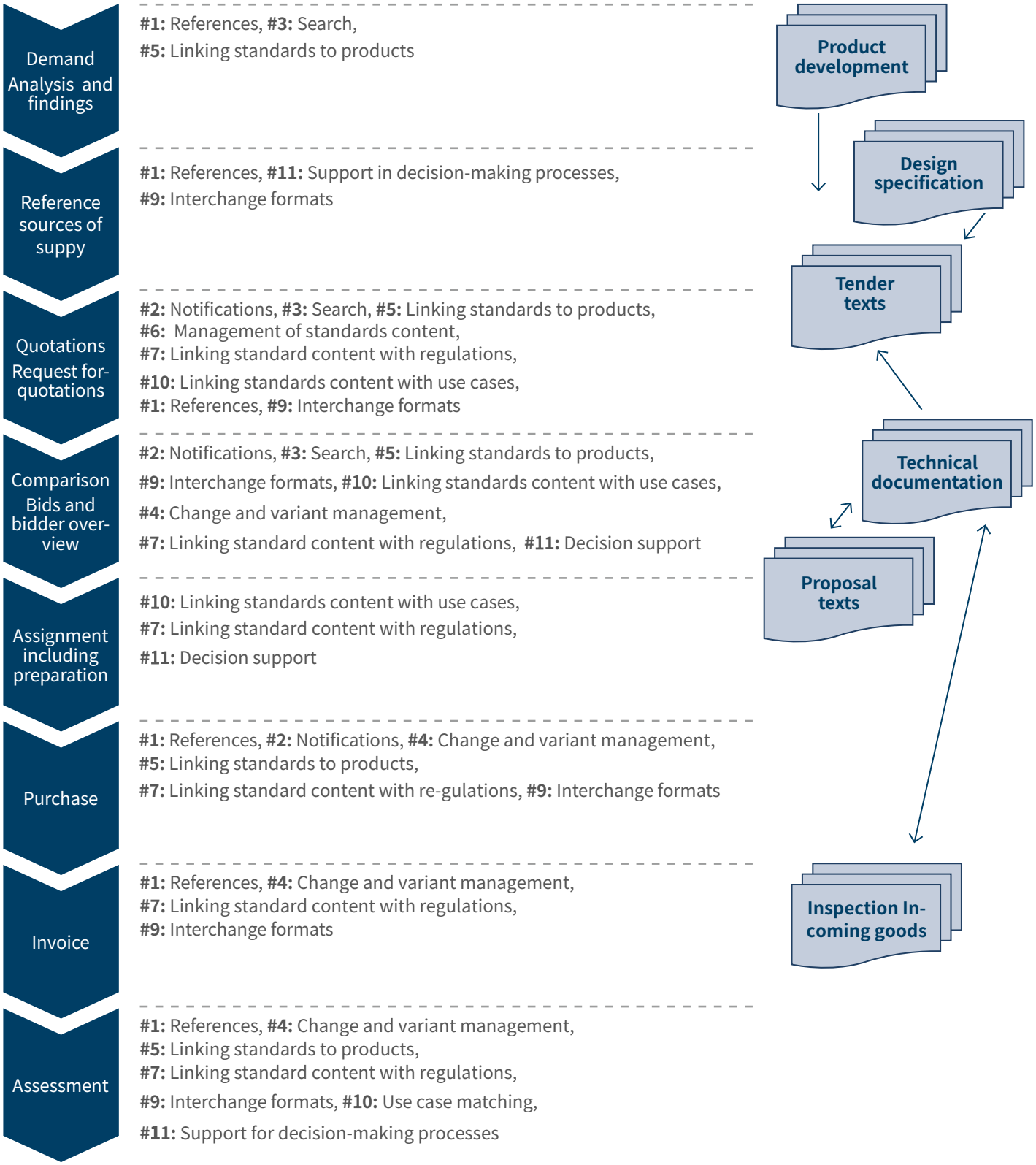


Fig. 6-10: Procurement process and GUS

Description for example 2:

DEMAND – ANALYSIS AND DETERMINATION	
TARGET	Documentation of the required item in the form of tender texts.
BASIS	Manufacturer information, in-house documents (both commercial and technical information).
Applicable GUS:	
#1:	Digital references are used to compare information from the market (raw materials, manufacturers etc.) and companies. Ideally, any missing references will become obvious, for example incomplete formulation of company or general safety requirements.
#3:	The usability of the search for references is a basic prerequisite for evaluation of #1.
#5 (optional):	Possible matching between production factors and standards will increase both information penetration (quality) and information density (security). While causing the required computing capacity to grow, this will make it controllable. The company itself decides how deep data research should go.

PROCUREMENT – IDENTIFICATION OF SOURCES OF SUPPLY	
TARGET	Projecting the required item onto the market and selecting suitable bidders.
BASIS	Documented demand and resulting information (so-called "market know-how).
Applicable GUS:	
#1:	Digital references are used to compare information from the market (raw materials, manufacturers etc.) and companies. Ideally, any missing references will become obvious, for example incomplete formulation of company or general safety requirements.
#9 (optional):	Existing interchange formats with standardized requirements (such as ReqIF) simplify the search. Remarks: If the level of digitalization is too high, this could leave smaller, less expensive bidders (such as SME) out of the picture as they are not able to operate a SMART system.
#11:	The decision to be taken about a suitable selection of potential bidders means that GUS #11 has to be applied here. The decision algorithms to be used can be supported with AI.

BIDS	
TARGET	Specification of the object of requirements by obtaining offers from the previously identified potential suppliers.
BASIS	Anonymized request for proposals. Identical specifications (interfaces) to the providers are decisive in each case, with the objective of obtaining comparable offers in detail.
Applicable GUS:	
#2 (If required):	a) If standards are updated during the offering phase, it should be possible to take this into account. b) If offers with deviations from the standard content are offered, this should lead to a report.
#3, #5, #6, #7:	The search function, management and linking of standards content with products, laws and regulations are crucial for the provider and speed up the process overall. The technical system requirements, which are ideally synchronized with those of the provider, are particularly crucial here.
#10:	In the digital age, previous "market know-how" will have to be represented increasingly by "collections of transactions". It must be possible to trace these transactions back to real situations (acceptance of quotations, delivery, complaints, invoicing, etc.). In this context, matching standard contents to use cases is certainly one module of the anticipated system requirements.
#1, #9 (optional):	Both references and interchange formats will be part of the interface description. It is up to the trading partners to decide whether to focus on #1 ("specific definition") or #9 ("framework parameters of the exchange format are fixed, exchange options remain variable").

COMPARISON	
TARGET	The comparison and evaluation of quotations must be carried out on a neutral basis (independent and non-discriminatory in accordance with legal requirements). The decision to award the contract should result directly from this.
BASIS	Anonymized request for proposals. Identical specifications (interfaces) to the providers are decisive in each case, with the objective of obtaining comparable offers in detail.
Applicable GUS: Optional: #7 + #11	
#1 (If required):	References must be verifiable. This applies, for example, when checking inconsistent results.
#3:	As the standards selected by the provider will not be fully known in advance, the option of searching for the specifically selected standards should be used.
#5 + #10:	Linking the standards to products or use cases will be needed to verify the offer.
# 4 (optional):	Quotations will regularly contain suggestions for optimization. This must be mapped analyzed in the process mechanism.

CONTRACTING	
TARGET	Preparation, purchase order and contracting.
BASIS	Compilation of the specific order documents based on the comparison results.
Applicable GUS:	
#10:	Compilation of the required standards on the basis of the offer, which itself consists of a composition of use cases.
#7 (optional):	Compilation of the standards with reference to regulations.
#11 (optional):	The specific applicability of standard content in connection with the existing use cases must be decided - this forms the offer.

PURCHASE ORDER	
TARGET	Purchase order.
BASIS	The comprehensive procurement is to be triggered on the basis of the order documentation.
Applicable GUS:	
#1, #5, #7:	Compilation of the pre-selected standards and naming of the references, referenced products or regulations contained therein, if explicitly necessary.
#2:	If any updates have occurred, the standard must provide a possibility for checking ("notification").
#4:	Adjustments occur regularly during offers evaluation, for example, due to availability.
#9 (optional):	If not already specified from previous orders, it is essential to define the exchange formats to be used (e.g. ReqIF).

INVOICE	
TARGET	Payment procedure.
BASIS	The comprehensive procurement is to be triggered on the basis of the order documentation.
Applicable GUS:	
#1, #4, #7:	Checking the invoice, taking account of deviations from the tender or offer text. Besides the actual material and service costs, the standard references, changes and regulations are also essential quality indicators.
#9 (optional):	If the standards should result in any direct billing items (for example DIN 276, material specifics, restrictions on tolerances, other accounting keys, etc.), then these should be replaced.

REVIEW	
TARGET	Supplier evaluation, cost adjustment if necessary.
BASIS	A process and supplier evaluation must be carried out on the basis of the order and completion.
Applicable GUS:	
#1, #4, #5, #7, #9, #10:	Review of the delivery, taking account of deviations from the purchase order text. Among others: Checking the contents and references, giving due consideration to any changes in process workflow, linking with products and use cases, including necessary regulations, such as commercial or technical test specifications. The previously used interchange formats must be considered to ensure consistency in the review process.
#11 (optional):	Standard contents that can be used as support in decision processes (e. g. in the event of deviations) are particularly valuable, primarily because of the expected neutrality.

ANNEX B:
DETAILS ABOUT THE METHODOLOGY OF THE ADDED VALUE MODEL

The overall cube shows the SMART standards as a full set of rules with the following value attributes:

- → **Performance value:** The added value is directly visible in the company's operative cost or success parameters.
- → **Risk value:** Contribution made to the company's compliance or regulatory conformity.
- → **Future value:** Contribution to the strategic development of the company.

The partial cubes represents the following control criteria (**stage 1 of the added value model**), where by each control criterion in turn has the above mentioned value attributes:

- → Process quality
- → Product quality
- → Personnel and organization
- → Earnings potential

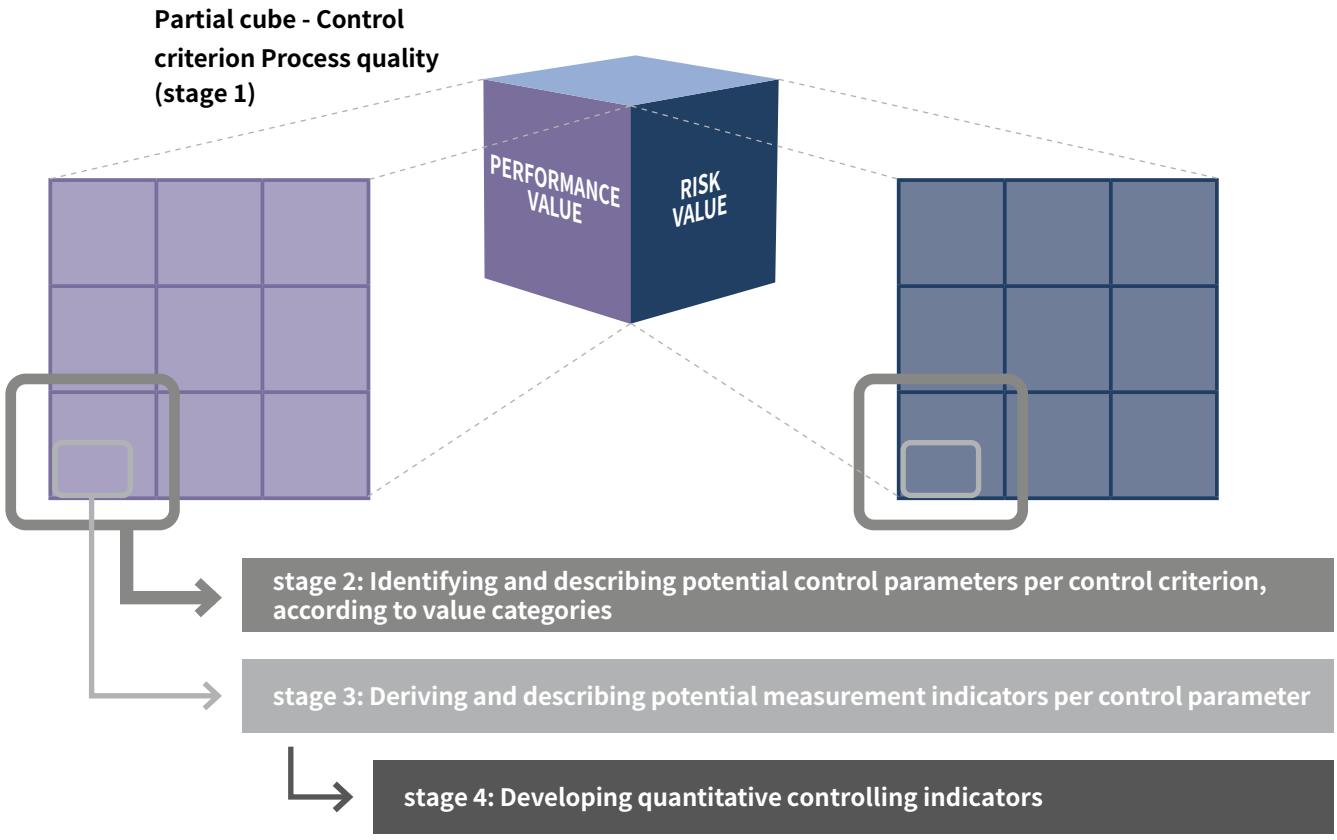


Fig. 6-11: Partial cube – SMART standards added value attributes (Voit, TS.advisory GbR)

In the next step, potential control parameters (level 2 of the value-added model) were identified and described for each control criterion ("partial cube", level 1), differentiated according to the value attributes (sides of the cube).

stage 1 - control criterion	**PROCESS QUALITY**	**PRODUCT QUALITY**	**EARNING POTENTIAL**	**PERSONELL / ORGANIZATION**
Added value effect	direct	direct	indirect	indirect
stage 2 - control para-meter				
PERFORMANCE VALUE	Standardization/Increasing efficiency in the development and manufacturing process	Product safety (standards conformity)	Increasing/securing of the earnings potential per order	Control capacity/ deployment of skilled personell
	Accelerating the development and production process	Level of fulfilling customer requirements (customer satisfaction)	Increasing/safeguarding the earning potential of the business unit/company	Know-how monopolies ("bottle-neck problem")
				Satisfaction / acceptance / responsibility
RISK VALUE	Legal certainty in standards identification			
	Legal certainty in standards implementation			
FUTURE VALUE		Added value from customer perspective	Future viability / transformation	
		Feedback Standards development		

Fig. 6-12: Overview added value model (Voit, TS.advisory GbR)

Potential measurement indicators were then derived and described for each control parameter (**stage 3 of the value-added model**) and a quantitative controlling indicator (**stage 4 of the value-added model**).

Given that the focus will be on different added values depending on the standard user's point of view and period of use, the measurement indicators (level 3) are also differentiated according to stakeholder or aggregation level and indicator valuation.

Stage 1 - control criterion	Stage 2 - control parameter	Stage 3 - measurement indicator	Stage 4 - key figure
PROCESS QUALITY			
PERFORMANCE VALUE	Standardization/ Increasing efficiency in the development and manufacturing process	Time required for standards application per order (TIME)	■ Number of work/project days spent ■ Costs = Number of project days x calculated personnel cost rate per day
Effect of SMART standards	Reduction of time spent on activities for the application of standards	Tim comparison with and without the application of SMART standards	
Stakeholders		■ CM = company management/board (aggregation level: company as a whole) ■ BU-M = management of business unit (aggregation level: business area) ■ OO = order owner (aggregation level: individual order) ■ WS = workplace supervisor (aggregation level: individual)	
Indicator evaluation		■ L = Performance indicator (contribution to operational or short-term achievement): - Guarantee of time specifications in individual order ■ B = basic indicator (contribution to achieving strategic or long-term target) ■ M = motivation indicator (= contribution to identity development): - No more justification for exceeding time limits any more - Reduction of deadline pressure, overtime, etc.	

Fig. 6-13: Details added value model (Voit, TS.advisory GbR)

A distinction is made between the following stakeholders:

Stakeholders	Aggregation level
Company management (CM)/ board	Company as a whole
Management (BU-M) of the business unit	Business unit
Order owner (OO)	Order / product
Employee/ workplace (WP)	Individual person

Fig. 6-14: Stakeholders added value model (Voit, TS.advisory GbR)

And the following indicator ratings are differentiated:

Indicator valuation	Description
Performance indicator (P)	→ Contribution to achieving operative or short-term target; → Stakeholder expectations.
Basic indicator (B)	→ Contribution to achieving strategic or long-term target; → No explicit corresponding expectations; → Stakeholder awareness in the event of nonfulfilment.
Motivation indicator (M)	→ Contribution to identity development of stakeholders and the company.

Fig. 6-15: Indicator valuation added value model (Voit, TS.advisory GbR)

The following classification is based on exemples of stakeholder value factors:

Stakeholders	Indicator valuation	Relevant value factor (example)
Company management (CM) and board	Performance indicator (P)	Company result
	Basic indicator (B)	Future and competition capability of the company
	Motivation indicator (M)	Quality standard and reputation of the company
Management (BU-M) of the business unit	Performance indicator (P)	Compliance with cost targets in the business unit
		Compliance with turnover and margin targets in the business unit
	Basic indicator (B)	Process development and optimization
	Motivation indicator (M)	Efficiency standard in the company or business unit
Order owner	Performance indicator (P)	Compliance with application and usage specifications
		Compliance with order specification (time, budget)
	Basic indicator (B)	Product development and optimization
	Motivation indicator (M)	Efficiency standard in the order
Employee and workplace (WP)	Performance indicator (P)	Complience with order specification per workplace (time, budget)
		Product compliance
	Basic indicator (B)	Workplace optimization
	Motivation indicator (M)	Efficiency in the workplace

Abbildung 6-16: Stakeholders added value model (Voit, TS.advisory GbR)

ANNEX C: ABBREVIATIONS

Abbreviation	Meaning
AAS	Asset Administration Shell
WO	Workplace owner
API[20]	Application programming interface
OO	Order Owner
BU-M	Management (M) of a business unit
CaaS	Content as a Service
ERP	Enterprise Resource Planning
CM	Company management
GUS[21]	Generic User Stories
IfM	Institute for SME Research
SME	Small or medium-sized enterprise
MA	Employee(s)
OPEX	Operational Expenditure
ReqIF[22]	Requirements Interchange Format

20 https://en.wikipedia.org/wiki/API
21 https://www.dke.de/idis-piloten-2022-en
22 https://en.wikipedia.org/wiki/Requirements_Interchange_Format

DIN e. V.

Burggrafenstraße 6
10787 Berlin
Germany
Phone: +49 30 2601-0
E-Mail: presse@din.de
Internet: www.din.de/en

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE
Merianstraße 28
63069 Offenbach am Main
Germany
Phone: +49 69 6308-0
Fax: +49 69 08-9863
E-Mail: standardisierung@vde.com
Internet: www.dke.de/en

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