Guideline
Value Generation from Machine Data 4.0
Introduction and Motivation

in cooperation with

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VDMA Electrical Automation

Editorial

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Machines generate data and information which are becoming significantly valuable in the age of industry 4.0. Extracting the data from the depths of the machines and transfer them into useful information is an important value generating process. Above all, the IT industry has discovered this market for itself and the large companies are trying to occupy it in a leading role.

For machine manufacturers, plant operators and as well as manufacturers of automation components, the use of machine data means a lot more than just a promising new business segment: Without data sovereignty, they run the risk of losing their unique selling points and solution capabilities. Those who do not participate or try to seal themselves off will be overwhelmed by international competition. This counts for all involved parties, but in particular to plant operators and machine manufacturers. The competitive advantage of high-quality and more efficient machines with high output and availability only exists if the machines are used correctly. Machine data can create the solution.

Apart from that, self-administration may create severe challenges to small and mid-size companies: Which data usage scenario suits my company? How can I find help with the implementation but without revealing my data sovereignty? From the individually self-determined risk assessment to the contractual design, many questions need to be considered and clarified regarding one‘s regarding one’s own responsibility.

This is where the guideline comes in: Small and medium-sized companies in the mechanical engineering sector shall receive assistance with “generation of value from machine data”. An in-depth approach and concrete examples will follow.

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Management Summary

Creating profits by self-administration of the machine data is a big challenge. Plant operators, machine manufacturers and automation manufacturers can only realize maximum benefits from machine data together. This necessary close cooperation has not yet been established. This requires great trust and a joint approach based on partnership for all those involved in the value chain.

The concept: Partnership instead of customer-supplier relationship

Digital networking within the machine enables more and more detailed data to be collected from the automation components and about the process. This data must be converted into usable information for different users.

A project understanding based on partnership is the starting point of value generation.

This requires a wide range of know-how and expertise: about the machine process, the automation components used, the products and the use of the machine. This knowledge needs to be used co-operatively and has to be shared accross the value added chain and throughout the companies (Figure 1).

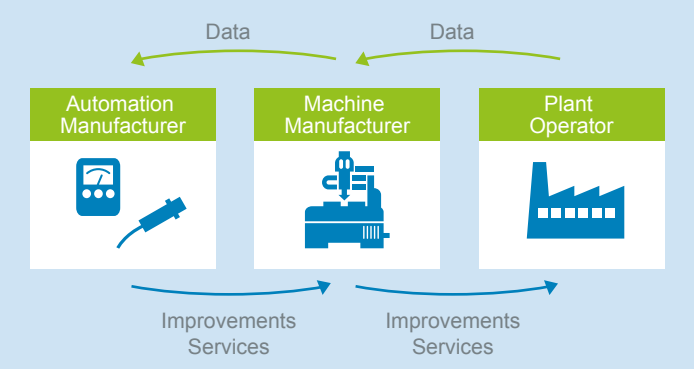

Figure 1: Win-win situation through partnership

The technologies for sharing data and know-how are available. However, this technologies alone are not enough. The companies and persons involved need a relationship of trust and clear rules for dealing with the common good. Every business partner must achieve a benefit and achieve a balanced cost-benefit ratio with a justifiable risk.

The way: from the idea to implementation

The efficient use of the machine data is only possible if all participating companies contribute to the conversion of said data into information. Since everyone receives as well as supplies data, an Added-Value-Circle will be created (Figure 1).

The guideline shows a way in which potential business partners in a joint project can generate value from machine data.

Joint advice on the basis of the guide:

1. **Selection of an application scenario**
2. **Determination of the relevant machine data**
3. **Assessment of benefits and efforts**
4. **Risk assessment**
5. **Implementation of the project = Fields of action**

As a result, the participants develop their own assessments and compare them. This gives them a basis for deciding which application scenarios can be meaningfully realized. The guideline provides a selection of possible application scenarios, suggestions for assessing benefit, effort and risk as well as support in the most important fields of action.

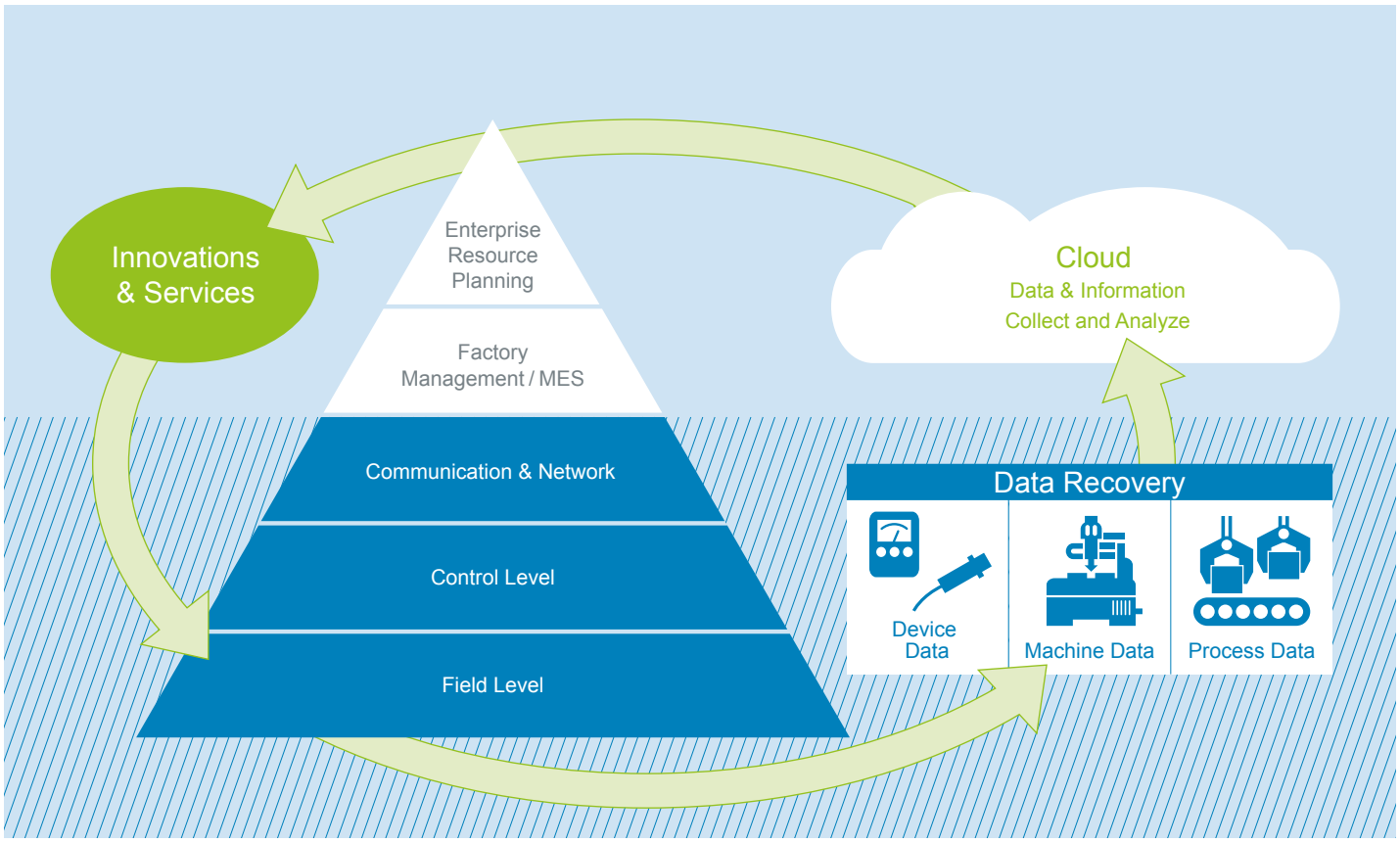

Figure 2: Data pyramid of automation technology - acquisition, transfer, processing, value generation from machine data

The Partners

In order to achieve value generation from machine data, all participants must make their contribution:

- The plant operator and the machine manufacturer jointly determine the application scenarios and the project implementation. They decide which data is used for which purpose.

Automation manufacturers are partners in information retrieval

- Automation manufacturers must design their components in such a way that they supply the required data and can be appropriately networked. By analyzing the component data, the automation manufacturers can provide the information that allows machines and components to be optimized and better adapted to the application.

Data generation and dissemination

In order to achieve value generation from machine data, the existing automation of a machine can be maintained (Figure 2).
The raw data are generated in the components of the automation technology, are pre-processed if necessary and then passed on:

- Either via the control level
- or via new parallel communication channels directly into the digital world (e.g. a cloud).

Finding the right solution together and taking individual interests into account

The focus of the guide is on data generation and data transfer to the project partner(s). The procedure presented in the guideline is intended to create a win-win situation for all business partners involved if the cost-benefit ratio is positive and the risk is acceptable.

1 Application Scenarios

The following application scenarios are concrete examples from everyday business . Machine manufacturers and plant operators can orient themselves on these application scenarios and select meaningful and useful scenarios for a joint project.

Scenario
Condition Monitoring

Increase productivity

Attributes:
- Capture condition data and evaluate it against product quality and output
- Identifying and remedying causes of downtime

Typical challenges:
- Machine must report statuses and be easy to diagnose
- Data selection is crucial

Scenario
Predictive Maintenance

Reduce downtimes

Attributes:
- Perform scheduled maintenance at the forecasted time
- Determine ideal time for maintenance by comparison with order data and runtimes

Typical challenges:
- Customers expect highest machine availability (OEE)
- Risks if the database is not sufficient for predictions

Scenario
Smart Process Control

Increase efficiency

Attributes:
- Dynamic sequencing of orders with consideration of disturbance variables during process control and production control
- Production flexibility down to minimal quantities

Typical challenges:
- Seperation between local regulation and remote intervention
- Possibility of process control from outside the plant

Scenario
Intelligent Spare Parts and Maintenance Management

Additional value generation

Attributes:
- Continuous monitoring of firmware and hardware levels
- Plagiarism protection protects the plant operator as well as the machine manufacturer and the automation manufacturer from counterfeit spare parts and the resulting damage to the machine
- Automatic spare parts ordering reduces repair and maintenance costs and ensures timely availability

Typical challenges:
- Presentation of a win-win situation for all parties involved
- Finding a balance between dependencies and potentials

Scenario
Targeted Product Development

Increase reliability

Attributes:
- Environmental, wear and tear, and machine data are recorded in detail
- Decisions in development and design are derived from data-based down-time and specific user requirements

Typical challenges:
- Access to data of the plant operator
- Development of specific data analysis methods

Application scenarios as a pool of ideas for a joint project

Scenario
Digital Twin

Shorten development time by comparing model and reality

Attributes:
- Accurate recording of the output and result parameters of a real process
- Development of processes with simulation tests before implementation

Typical challenges:
- Expenditure in the implementation of the concept whereby the added value is often not directly apparent
- Fragmented systems along the life cycle of a machine

Scenario
Service Promise

Better hedging of warranty commitments

Attributes:
- Online logging of contractually agreed performance parameters
- Securing of claims, reduction of costs

Typical challenges:
- Balancing transparency and warranty claims
- Measurable benefit commitments

Scenario
Performance Benchmarking

Targeted measures to increase efficiency

Attributes:
- Cross-location comparison of production lines
- Check the effectiveness of improvement measures
- Derive optimization potential for the plant operator

Typical challenges:
- Data protection and transparency vis-à-vis third parties
- Comparability of the use of a machine in different contexts

Mutual trust and a jointly chosen application scenario are the basis for success

2 Assessment of Benefit, Effort and Risk

The application scenarios described in the first chapter form the basis for the assessments. The common approach is intended to achieve an assessment of the benefits in relation to effort and risk. The aim is to make decisions with equal consideration of the interests of all parties involved.

The individual evaluations of the application scenario form the basis for the joint assessment of benefit, effort and risk. The graphic representation of the ratings makes them visible. This allows corrections or a reconciliation of interests to be made.

The comparison of the assessments of the project partners creates a better understanding of the interests and requirements of the other participants. It is irrelevant whether the partners have the same benefit. A balanced overall benefit for each of the partners is important.

Figure 3 schematically shows the exemplary result of a joint assessment of the most important benefit aspects. Comparable tables for efforts and risks are required, but not shown here.

The graphical representation reveals imbalances and creates transparency

With the goal of a long-term, stable, win-win business relationship, it becomes possible to reach a compromise or an adequate balance (by means of material or monetary values) between the parties. The decision can thus also be conclusively documented in terms of internal company communication.

Different assessments can also reveal learning and improvement potentials if these are openly discussed and the reasons for the assessment are uncovered.

Application Scenario: Condition Monitoring

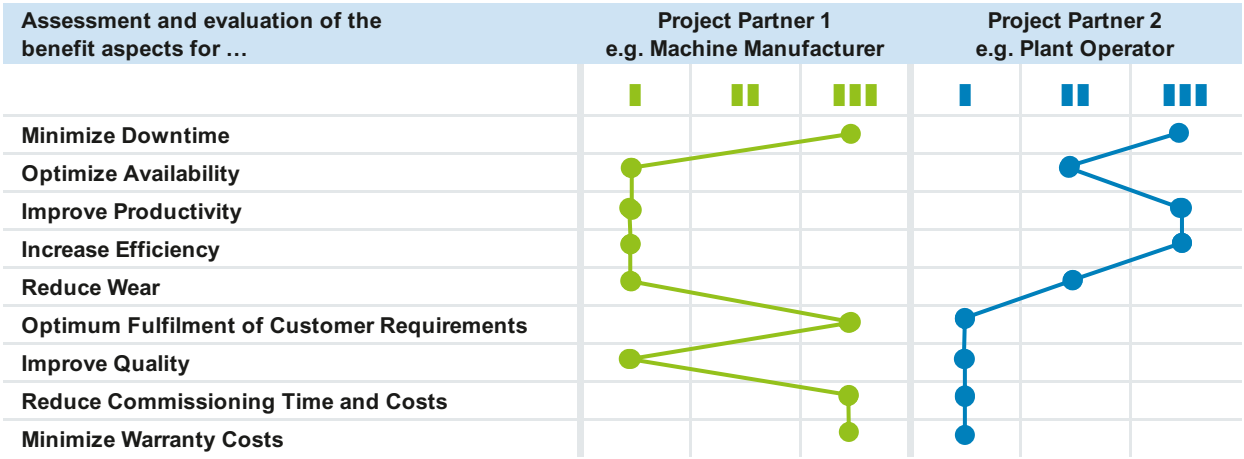

Figure 3: Exemplary representation of a joint assessment and comparison of the benefits for the project partners involved in a specific application scenario.

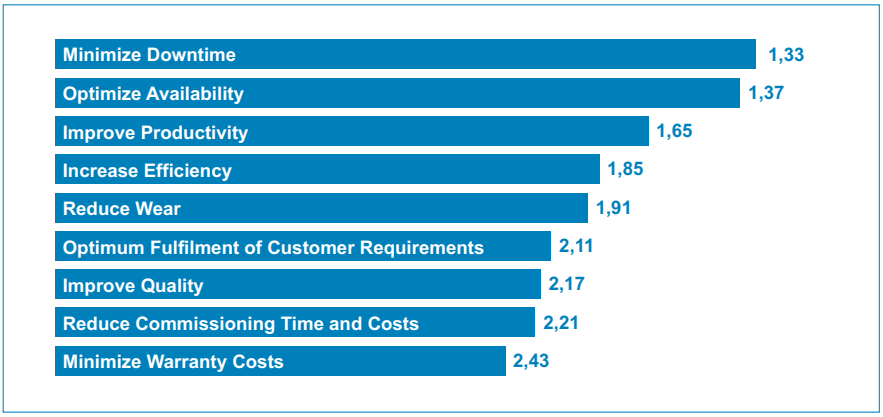

Figure 4: Average priority of benefit aspects,
source: VDMA Technik-im-Dialog “Value Generation from Machine Data” [1]

Benefit Aspects

Minimize Downtime

The reduction of downtimes and failures by early detection and elimination of problems offers the highest added value and savings potential. The plant operator can quantify the costs of unplanned shutdowns and calculate the return on investment against the costs.

Optimize Availability

The required machine availability can often only be achieved through targeted monitoring and immediate reaction to emerging problems. Passing on machine data to the manufacturer or third parties for analysis can improve responsiveness to problems and save costs through targeted rather than regular maintenance.

Improve Productivity

The use of machines by the plant operator is often not optimal. Data from running machines must be recorded and analyzed in order to reduce rejects, reduce set-up and downtimes, and optimize machine processes.

Increase Efficiency

Machine data provide the input for the plant operator‘s process control software (digitization of production). With the help of this information, he can use his machines in a targeted manner.

Reduce Wear

The data from already existing sensors and the analysis of changes (motor currents, temporal courses, etc.) can provide timely information about wear and tear and enable condition-oriented maintenance.

Optimum Fulfilment of Customer Requirements

Targeted use analyses of the customer‘s machines can anticipate or technically concretize requirements. Suggestions for improvement by automation manufacturers increase customer loyalty and partnership.

Improve Quality

The quality of the products produced increases when tolerance parameters of the machine are monitored and reacted to in good time.

Reduce Commissioning Time and Costs

The recording of machine data during commissioning enables the simple and fast integration of experts from all parties involved. The comparison of real data with simulation results simplifies troubleshooting.

Minimize Warranty Costs

The recording of machine data simplifies the identification of causes of problems and enables proof of the fulfilment of contractually agreed targets.

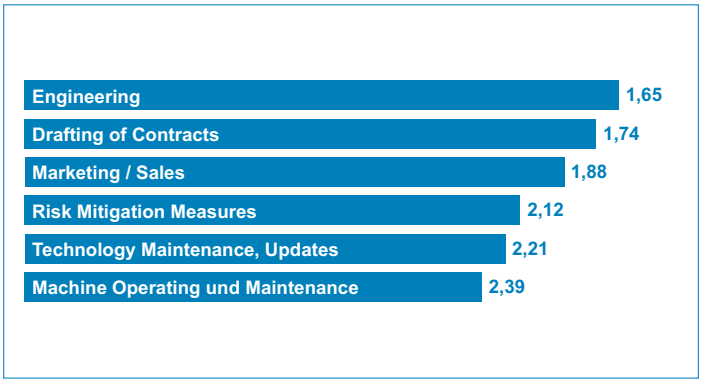

Figure 5: Average priority of efforts,
source: VDMA Technik-im-Dialog “Value Generation from Machine Data” [1]

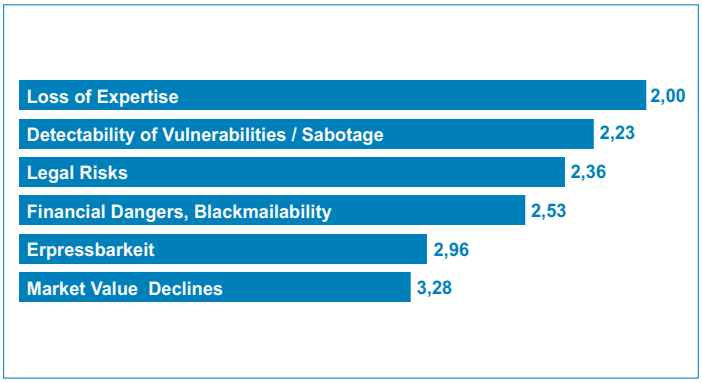

Figure 6: Average priority of hazards,
source: VDMA Technik-im-Dialog “Value Generation from Machine Data” [1]

Efforts

Engineering
Existing machine software must be extended, interfaces must be created, an infrastructure must be established, security measures must be taken and new know-how and the qualification of new suppliers must be built up.

Drafting of Contracts
Who owns the machine data? Who may use which machine data and how?
Clear agreements and contractual regulations must be created so that every participant can act in a legally secure manner.

Marketing / Sales
Trust has to be built up with the customers and the added value has to be communicated. Sales and Marketing of the machine manufacturer must work together with the plant operator to create the value from machine data.

Risk Mitigation Measures
Data and interfaces must be protected. Personal data may not be collected.

Maintenance, Technology Improvement, Updates
More software means more maintenance and updates, especially for IT security.

Dangers !

Loss of Expertise
Machines contain, for example, recipes, process sequences and quality data that are of interest to competitors. All data must be evaluated together at the risk of loss of know-how.

Detectability of Vulnerabilities / Sabotage
The release of data and the existence of online interfaces could unintentionally give third parties the opportunity to analyse weak points and sabotage.

Legal Risks
Data protection is regulated by law, and varies from country to country. In the event of improper or agreed use or inadequate data protection, there is a risk of legal action.

Financial Dangers, Blackmailability
If third parties gain access to the data, for example hackers, the danger of extortion and a resulting negative reputation is possible.

Market Value of Participating Companies Declines
So-called data leaks usually lead to headlines. This is a particular concern for large companies. The rating of companies may also fall.

Decisive Questions

In order to assess the risk potential of passing on machine data, it is necessary to examine the following questions (Figure 7). Questions 1 to 3 are knockout criteria. If one of these questions is answered negatively, this limits the possibilities for data exchange and thus the scope for value generation.

Data exchange and data sharing yes, but not at any price

The project may need to be modified in favour of security. For example, data could be anonymized or the application scenario could be changed. The positive answer to the fourth question is particularly important for medium-sized machine manufacturers:

This maximizes the benefits and ensures that small and medium-sized machine manufacturers are also competitive when it comes to new services for their customers.

Medium-sized machine manufacturers are often unable to cope with data analysis and informa- tion generation. These companies in particular must then use the services of third parties, such as data analysts or automation suppliers, in order to remain competitive. Therefore the final goal must be to answer all questions in a positive way.

In order to remain competitive, data must often also be passed on to third parties for processing.

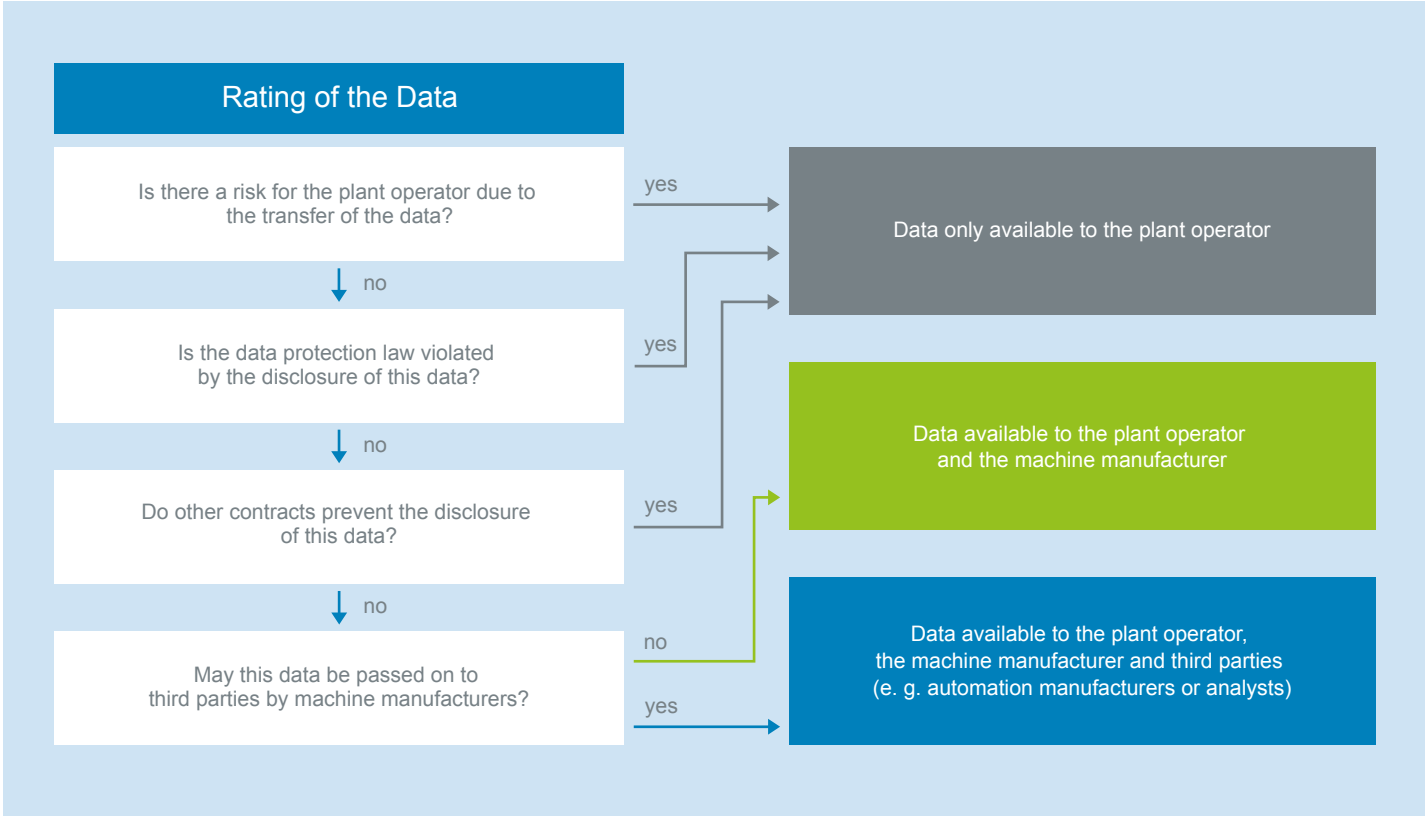

Figure 7: These questions determine the use of the data. The last question is decisive for the competitiveness of small and medium-sized machine manufacturers, as they need cooperation partners for data processing.

3 Fields of Action

From the idea to the implementation.

The application scenarios described in the first chapter and the tools introduced in chapter 2 to assess benefit, effort and risk form the basis for starting a project to generate value from machine data. Chapter 3 takes a first look at the issues to be considered in implementation. They serve to determine the current situation and offer practical assistance in self-determined implementation.

Field of Action: Contractual Regulations

Machine data is non-personal data. It is created during the productive operation of machines in the respective automation components used, such as sensors, actuators, controllers and PCs. Machine data is legally only subject to fragmentary protection.

It is therefore essential to regulate the use and recovery by contract. The VDMA guideline "Data Use - An Orientation Aid for the Drafting of Contracts for SMEs" provides the basis for this. Machine and plant manufacturers and their business partners are supported in the development and negotiation of agreements on the use of machine data.

The "Fields of Action" serve to determine the current situation and offer practical assistance

Contractual regulations on data sovereignty are important from an industry perspective and enable a fair reconciliation of interests. For this purpose, a practice-oriented approach was chosen which covers the main areas of regulation characteristic of a data usage agreement and provides formulation proposals for the core area of the allocation and use of machine data.

The objectives of contractual regulations on data sovereignty are:

- promoting the development of best practice standards,
- an orientation aid through clear parameters,
- the development of a strategy and
- the establishment of structured processes for the use of data

and to implement them in a legally compliant manner.

Field of Action: Industrial Security View

At the beginning of the security analysis there is the risk analysis, optimally as an integral part of the development process.

The early integration of risk analysis into the design and development process often means an unusual initial additional expense. This can, however, be reduced to a manageable level through structured, repeatable procedures.

Above all, however, the early additional expense in the further course of development pays off if security is a functional component of the machine and therefore does not have to be retrofitted at an extra cost.

The protective goals for the transmission of machine data are:

- privacy
- availability
- integrity
- authenticity

Appropriate measures must be implemented to achieve the protection goals. For example, they offer assistance:

- VDMA “Industry Guide 4.0 Security – Recommendations for action for small and medium sized enterprises”
- VDMA Guideline “Information Security Part 3” (German)
- DIN IEC 62443-3-3: System requirements for IT security and security levels

The early integration of security is essential and is beneficial later

Field of Action: Description of the Data

In order for machine data to be usable by third parties, it must be comprehensible and clearly described: What kind of data is it? What is the data format?

The VDMA guideline “Interoperability through standardized features for industry 4.0” deals with this topic and provides information on a meaningful description of the data. The guide- line presents the essential prerequisites for horizontal and vertical data integration based on the Industry 4.0 concept.

Aspects of the description:

- Unique identification of an asset
- Unique identification of an asset with regard to its structural classification
- Unique description of an asset’s characteristics and properties

Field of Action: Value of the Data

The value of machine data is reflected, for example, in an increase in productivity or quality, which a plant operator can gain from the machine data, or in the product improvements of machine manufacturers and automation manufacturers.

Only clearly described data can be processed into information

The VDMA guideline “Investment Calculation for Digitisation Projects and Industry 4.0 Projects” provides guidance for individual and bilateral consideration. Together with indus- try partners and experts from the capital market, the VDMA has developed an online tool in the “Investment Calculation 4.0” working group, which provides key information on the payback period and costs of concrete digitisation projects as a result.

Field of Action: Business Models

Value generation from machine data can mean establishing new services and thus also new business models. Various VDMA guidelines offer assistance, such as:

VDMA Guideline “Industrie 4.0 – Guiding principles for the implementation of Industrie 4.0 in small and medium sized businesses”. Indus- try 4.0’s solutions offer the potential to establish new business models through digitization and networking of products and production.

VDMA White Paper “Platform Economics in Mechanical Engineering - Practical Tips and Experiences from Users”. Opportunities and possibilities as well as type, scope and the right time to enter platform-based applications are described.

Further fields of Action: Communication Architectures and Requirements for Transfer Technologies

How should the data be transferred? Which protocols and mechanisms are future-proof? These questions are answered in the VDMA guideline “Industry 4.0 Communication with OPC UA”. He describes in detail the migration steps towards an industry 4.0-capable communication.

The VDMA guideline “Sensor Technology for Industry 4.0” shows ways to cost-effective sensor systems. He supports users and manufacturers in requirements definition and development by means of guiding questions and toolboxes.

The project understanding based on partnership is the starting point of value generation

Summary and Outlook

At a glance

What must be taken into account in a project for the generation of value from machine data?

- Joint, partnership-based approach for machine operators, machine manufacturers and automation manufacturers
- Creating win-win for all parties involved
- Selection of the Application Scenario
- Assessment of Benefit, Effort and Risk
- Implementation of the Fields of Action, for example: Creating a contractual basis, security as an integral component

Questions, suggestions, interest in cooperation? Talk to us.

The present guideline part “Introduction and Motivation” gives a first insight into the “Value Generation from Machine Data”. In further editions, the topic will be concretized with a detailed step-by-step guide and the presentation of “Best Practices” will be dealt with.

VDMA Working Group Control Technology

The Automation Technology 4.0 Interest Group is developing a guideline to ensure fair and legally sound handling of machine data. It is a spin-off of the control engineering working group in the VDMA Electrical Automation Association on the subject of “Value Generation from Machine Data”.

Cross-industry cooperation is a key success factor for all participants in the value chain. The focus is on factual and technical discussions and constructive dialogue in mechanical engineering.

The VDMA platform is used by machine manufacturers, machine operators and automation manufacturers to work together for mutual benefit as partners in the value chain.

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