AI in Technical Service
Industry 4.0

Concept
Learning objectives – Curriculum
Training documents

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List of changes

Version 1.00	Description of the change(s)	Authors	Date
V1	Basic structure	Christine Neubauer	31.07.2021
V2	Learning objectives, module structure	Christine Neubauer	14.08.2021
V3	Adaptations	Hauke Timmermann	17.08.2021
V4	Realisation	External author	01.09.2021
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V14	Updates 3.4 Using digital business models	Ralf Schädel, Nils Klute	10.03.2022
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V16	Addition of the new ESW use case	Christine Neubauer	04.05.2023
V17	Check Translation	Christine Neubauer	02.10.2023

SERVICE MEISTER

Content

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The Curriculum

1 Concept

Some background information: The SME sector is quite diverse in terms of company sizes and industries, and the prerequisites for digitalisation vary greatly from company to company. Companies and employees are united by a common goal: to be successful in the market and in the company.

In the area of technical service, we want to enable you to make good use of current and future AI innovations – your ideas are expressly encouraged. Concrete company goals, motivations and solution competencies of the employees are closely interlinked here and offer a unique dynamic for joint success.

For some, they have long been “state of the art”; for others, specific approaches and terms are new and unknown.

The best place to start is with the technical service processes.

2 Target groups and requirements

The curriculum for users is aimed both at owners and service employees of small and medium-sized enterprises (SMEs).

The content of the AI-based Service-Meister service ecosystem is a focal point for technical service in the context of Industry 4.0. Although you have different responsibilities as technicians, engineers, managers and entrepreneurs, we presuppose that you are familiar with service processes.

Aspects of AI are explained in a practical way. Links are provided to more in-depth information and references to existing learning programmes covering the basics as well as specialised knowledge so that everyone can obtain further information according to their needs or level of expertise.

Recommendation:
Do you want to delve deeper into the subject and also learn about the basics of AI? Then one of the following courses might be of interest to you:

- Launchpad to AI – An Introduction to Applications, Risks, and Opportunities
- Elements of AI
- Stadt – Land – DatenFluss (German-language course on data)

Since there are already numerous courses on digitalisation, Industry 4.0 and the basics of AI, we will focus here on the aspects entrepreneurs need to know to make the best decisions for their business. We will also show service technicians what support is possible for their work. The chapters correspond to the three learning objectives.

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3 The learning objectives

In this course, you will learn the following:

1. How to assess the benefits of AI applications for technical service using a typified service process and practical examples
2. The technical principles of AI processes, operations, and their interaction
3. How to find starting points to develop your own ideas for your business and implement them

4 The modules and what you can expect in the three areas

1. **How to assess the benefits of AI applications for technical service using a typified service process and practical examples.**
   1.1. Get to know AI applications based on six typical activities in the service process.
   1.2. In practical examples, you will learn how these activities are implemented, including the respective benefits for companies and their employees.

2. **The technical principles of AI processes, operations and their interaction**
   2.1. We give you an overview of possible AI core functionalities in the service process.
   2.2. You will learn how these work and how they can interact.
   2.3. In addition, you will have the opportunity to delve deeper into functionalities and AI methods.

3. **How to find starting points to develop your own ideas for your business and implement them.**
   3.1. We present you with a tool with which you can quickly and easily identify the potential of your services.
   3.2. With the process map, you can learn more about the advantages of automation via AI applications, explained in an easy-to-understand way – including the data sources.
   3.3. Discover exciting options for your service in the Service-Meister catalogue and get in touch with the experts.

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Training documents

1 Assess the benefits of AI applications

1.1 Get to know AI applications based on six typical activities in the service process.

No. 1 – Service demand notification and pre-qualification via predictive analytics

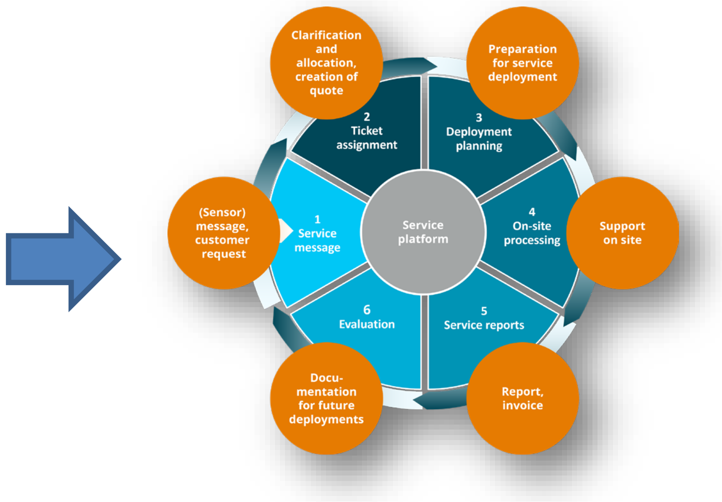

Figure 1: The first segment of the service lifecycle

Every technical service begins with an assessment of whether a service requirement exists at all. If this is present, it is necessary to find out what kind of service case it is. This is precisely the assessment that the first technical service module allows us to make.

Before automated solutions were available as a tool in the context of Industry 4.0, a team of specialised service employees first assessed whether or not there was a need for service. Their expertise and the significance of the requesting customer or their Service Level Agreement had a decisive influence on the classification of a qualified service case. If classified accordingly, it triggered the customer service: A service technician visited the customer to carry out repair or maintenance work on site. The service case continued in the same way.

In the Service-Meister service ecosystem, an AI-based application takes over the step of assessing a service need. In the process, information about a possible anomaly first enters the system via sensors. The application has a collection of AI techniques called 'predictive analytics'. It assists in deciding when service is needed and offers the advantage of being able to make predictions and probability calculations of specific events or people's behaviour.

1.1.1 No. 2 – Classification with AI-assisted ticket creation and allocation

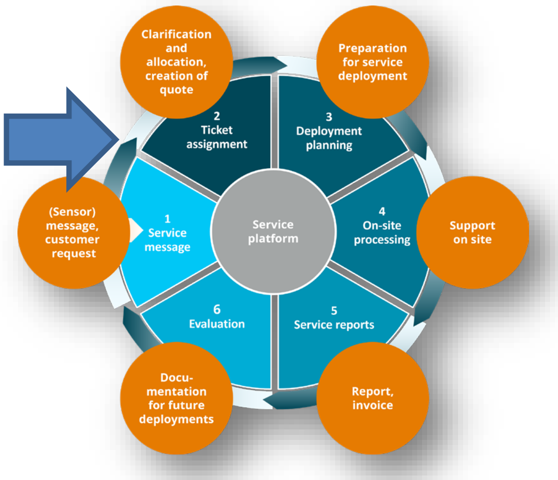

Figure 2: The second segment of the service lifecycle

In this step, the event that has been pre-qualified as a service case is clarified and assigned on the basis of the information provided. An AI application examines the category of problems and whether solutions are already known for them. The AI application also quickly provides information about the reaction the service case has triggered in the customer.

The advantage of the AI application is that it gathers all the information and documents it in a single ticket. This is like a secure "digital suggestion box" that manages, groups and prioritises all kinds of customer requests.

In an analogue case management process, information is collected in a floating file and then passed on to the service team.

1.1.2 No. 3 – Process planning via central AI-assisted case clarification

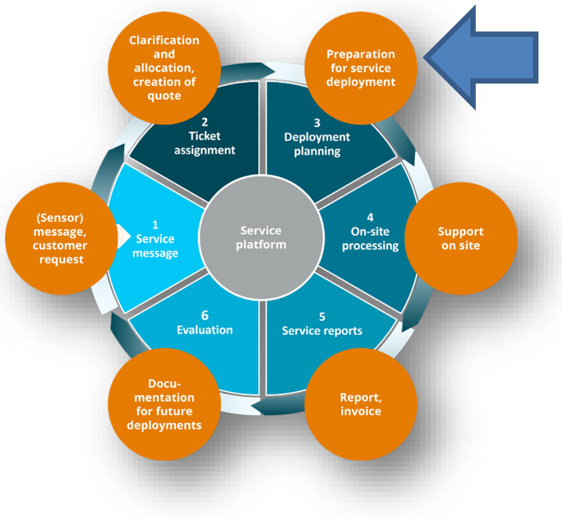

Figure 3: The third segment of the service lifecycle

In the following step, all necessary arrangements and preparations that need to be made for the upcoming visit to the customer are managed centrally. The AI application takes the information from the ticket compiled in advance and processes it in such a way that the customer receives an appointment, an appropriate team is scheduled, the route to the customer is calculated and the availability of the spare parts is checked. All relevant information for the successful completion of the service case is collected at the customer's premises, and the service staff can access it digitally on-site.

In the case of analogue process management, numerous internal agreements and complex coordination would have been required for the successful execution of the service case.

1.1.3 No. 4 – On-site servicing with the help of a service chatbot: Access of the technician to documentation, expert knowledge, histories and comparable processes

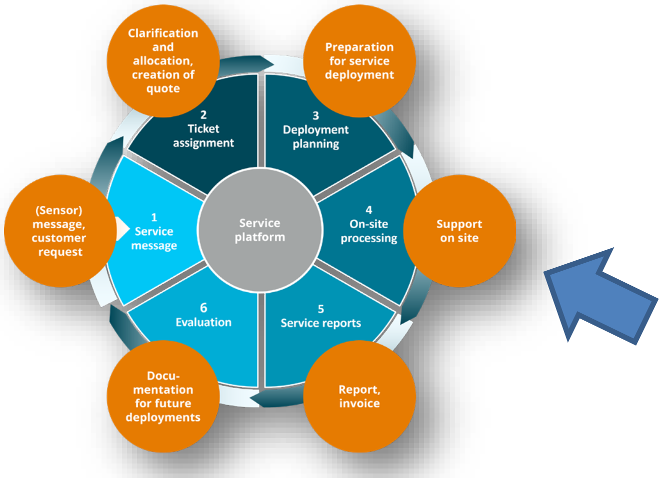

Figure 4: The fourth segment of the service lifecycle

This step deals with the on-site support of the technician for the client. The AI application has already collected all the necessary information on the service case in advance and uploaded it to the tablet. This means that the technician already knows which measures are required and have to be carried out upon arrival at the customer's premises. If the technician has access to, for example, the case history, documentation such as manuals or comparable processes, the best practice documents are directly available to them. If the service technicians need further support, a service chatbot can read out texts such as assembly instructions or excerpts from manuals on the tablet.

In the analogue planning, coordination and execution of a service case, on the other hand, comprehensive and time-intensive preparation and coordination of all parties involved would have been an absolute prerequisite for the successful execution of the service appointment.

1.1.4 No. 5 – AI-assisted service reports for documenting activities, with links to relevant contracts, parts, cost rates ...

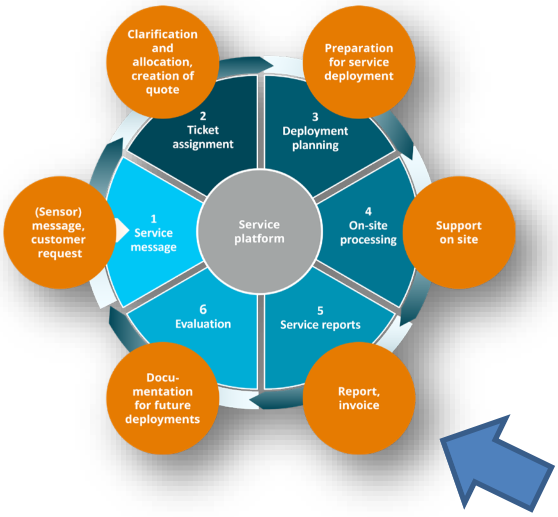

Figure 5: The fifth segment of the service lifecycle

The next step of the AI-supported service reports is the formal completion of the service case, the compilation of all necessary information in a summary report and the actual invoicing. The service technicians who have carried out the service case click through the form fields on their service tablets and select ready-made answers to the targeted questions for each point of the service case. Free-text fields are available for additional comments. By submitting these forms, the service case is operationally closed. Then, the AI application accesses this information, compiles it in a service report and produces an invoice, which goes to the customer.

In analogue times, this case processing step was characterised by many different system breaks: The technicians had to report how the case went, and a pre-qualification was generated from these reports, which finally ended up in the accounting department via the service area, where everything else was arranged.

1.1.5 No. 6 – AI-based report evaluation and feedback loop for continuous improvement

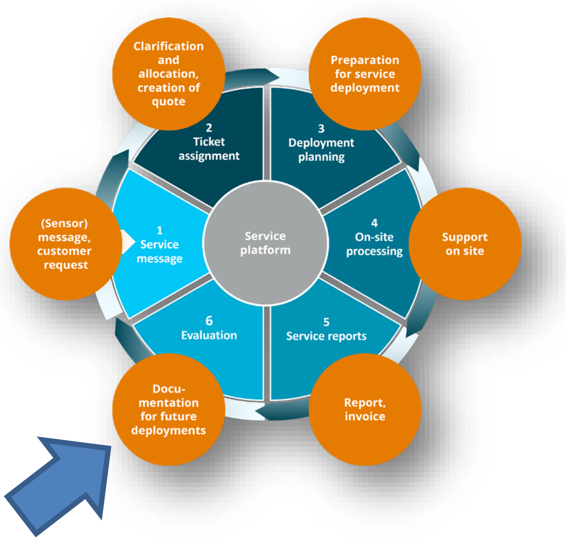

Figure 6: The sixth segment of the service lifecycle

Now, we have reached the step of AI-supported report evaluation – evaluation of the service report, updating of customer files, service databases and all necessary information collections. Furthermore, it elaborates on which new points of information might be relevant for future service cases. This is how the much-cited “lessons learned” are distilled.

The AI application takes the service reports and checks them for their entries to gain insights. It checks the new notes of the service technicians to see whether relevant key terms appear and what its final assessment of the quality and possible special features of this service case is. Once this information is collected by the AI application, it is used to create documentation of relevant aspects for future work.

In analogous times, this step of the case processing involved systematically going through the corresponding documentation of the respective service cases in the area of service technology for their possible implications.

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1.2 In practical examples, you will learn how these activities are implemented, including the respective benefits for companies and their employees.

1.2.1 KROHNE/Inovex: NLP and Anomaly Detection in Wastewater Management

Keeping an eye on water levels remotely, determining discharge rates and identifying problems

Use case: KROHNE makes wastewater systems intelligent via the Internet of Things (IoT)

Climate change poses new challenges for water and wastewater management. Heavy rainfall events can lead to overloading of the combined sewers and uncontrolled pollution of water bodies. These heavy rainfall events are becoming more and more frequent and mean that rainwater retention basins and sewers can no longer absorb rainfall. The consequence of extreme weather: Deluges and floods.

In order to be able to react to such events in a timely and appropriate manner, smart real-time monitoring is needed that allows supply, sewer and pipeline networks to be reliably kept in view from a distance. **KROHNE** makes this possible for its customers by means of a comprehensive portfolio of Internet-of-Things-capable sensors, as well as a corresponding IoT platform. This IoT solution is now being further developed in Service-Meister together with the IT project house inovex smart.

For this purpose, KROHNE and inovex are collaborating on one of the six speedboat projects. Both partners want to implement AI functions in their use case and offer them to all users of the KROHNE platform. For example, the new modules are intended to visualise sensor data with AI methods, predict faults and optimise deployment planning—the result: more intelligent wastewater management systems for all users of the IoT platform.

About the two companies:

KROHNE measure the facts

inovex

inovex is an innovation and quality-driven IT project house with a service focus on “digital transformation”. More than 350 IT experts provide comprehensive support to companies in the digitalisation and agilisation of their core business and in the realisation of new digital use cases.

KROHNE is your reliable partner for process instrumentation and automation. As our customer, you benefit from our ability to find the right metrological solutions for your applications. We offer a complete product portfolio, industry-specific system solutions and complementary services.

The aspects at a glance:

1 Working title:	Combined Sewer Overflow
2 Concept:	Legal regulations require municipalities to notify authorities when water is discharged (i.e. overflows in the sewage system). The idea is to provide a sensor and an application as a data product that meets these obligations.
3 How has the problem been addressed so far?	Only selectively or not at all, measuring points have rarely been digitalised so far.
4.1 Business model	
4.2 Revenue model:	Subscription
5 Target group:	Municipalities, communities, associations, and wastewater treatment plants
6 Addressed problem of the target group:	A "discharge event" must be detected, and then a report must be sent to the authority. From 2024, there will be new legal requirements and specifications.
7 Advantages/added value for the target group:	The obligation to provide proof to the authorities requires minimal effort on the part of the customer.
8 How can success be measured?	The KPI is, therefore, the time that has to be spent on the proof.
9.1 Obstacles:	The sector is known, but applications have not yet been fitted out. Know-how in Sales is not available and needs to be nurtured.
9.2 Special challenges	
10 Resources needed for development:	Development and expansion of sensors and remote data transmission, platform development

1.2.2 WÜRTH/grandcentrix: Connection and AI for power tools

Accelerate service processes and detect faults remotely

Use case: Innovations for the individual that later benefit the general public

The Service-Meister concept also fits well with the idea behind the use case of assembly expert **WÜRTH** and digitalisation partner **grandcentrix**. The next-generation power tools from WÜRTH are tools that are connected for the first time and can, therefore, collect and transmit data. This information can be analysed to speed up service processes and detect faults remotely.

The use case relies on predictive maintenance: By evaluating machine data, future maintenance requirements can be predicted at an early stage. In this way, malfunctions and failures can be avoided, and the maintenance process can be made more efficient.

In addition to real and simulated device data, Würth's service organisation is a central data source: Whether received by phone, email or website – the service messages contain valuable information that can be used to optimise future repairs and maintenance.

About the two companies:

WÜRTH grand centrix

WÜRTH is the world market leader in the distribution of fastening and assembly technology products. The WÜRTH-GROUP currently consists of over 400 companies in more than 80 countries and employs over 77,000 people. In the 2018 financial year, the WÜRTH GROUP achieved a turnover of 13.6 billion Euros.

grandcentrix is an IoT solution provider for Smart Products, the Internet of Things, Smart Homes and Smart Energy. With more than 200 employees in Cologne and Dortmund, grandcentrix covers the complete technology and user experience expertise for future-proof large-scale IoT production.

The aspects at a glance:

1 Working title:	Power Tools Uptime Service

2 Concept:	**Core function 1:** The status of the machine is continuously recorded by various sensors. The user will be informed promptly of any anomalies that may indicate a defect. **Core function 2:** With the machine data collected from everyday use, we can draw conclusions about the customer’s application and mode of operation and thus suggest a more suitable machine model if necessary. **Core function 3:** Optimisation of the service process from the commissioning of the repair to the return of the repaired machine through the use of AI
3 How has the problem been addressed so far?	Service packages with coverage of repair costs
4.1 Business model	
4.2 Revenue model:	A pay-per-use model in the area of power tools is a future possibility. Otherwise, a subscription model will be used.
5 Target group:	Machine operators from the various divisions, service technicians, commercial office employees
6 Addressed problem of the target group:	• Fixed maintenance cycles that do not include individual use of the machine • Failures due to errors and malfunctions
7 Advantages/added value for the target group:	Reducing downtime of customer machines, always being able to supply the right machine for the right application, gaining transparency about machine use, and process cost reduction in the repair shop
8 How can success be measured?	• Number of users • Number of repairs • Reduction of down time for users • Proportion of unrepaired tools
9.1 Obstacles:	IT implementation (resources), customers’ willingness to use AI, reservations about AI
9.2 Special challenges	• The advantages of connected power tools must be worked out on a differentiated basis. • The connectivity of the machines is often problematic due to their flexible locations.
10 Resources needed for development:	Resources from a wide range of business areas, especially IT, are needed for development. The same applies to service, product management and sales.

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1.2.3 OGE/USU: Remote monitoring of and anomaly detection for gas pipelines

Detect anomalies, forecast service needs

Use case: Classify problems automatically and solve them remotely

Open Grid Europe transports natural gas through its 12,000-kilometre-long pipeline network. Grid operators are obliged to monitor their power plant identification systems remotely in a quality-assured manner. For this purpose, Open Grid Europe operates its own Competence Centre, which is supposed to detect anomalies in the data streams of all 850 sensors. Together with **USU Software,** the largest European provider of IT and knowledge management software, Open Grid Europe wants to further develop its monitoring with AI.

The aim is to improve service knowledge management, automatically detect anomalies and forecast maintenance needs. In addition, technicians will be able to solve complex problems with AI-based chatbots.

About the two companies:

OGE Open Grid Europe GmbH OGE (E.ON Gastransport GmbH up until the end of August 2010), based in Essen, is a transmission system operator for natural gas. OGE operates the largest transmission network in Germany with a length of about 12,000 kilometres, among others, through its shareholdings in the pipelines MEGAL, TENP, NETRA, DEUDAN, et cetera. OGE is part of the market area of NetConnect Germany.

The **USU Group** is the largest European provider of IT and enterprise service management solutions. USU is the only company on the market with ready-made solutions for all areas of technical service.

The aspects at a glance:

1 Working title:	Artificial intelligence for the identification and classification of anomalies in the monitoring of cathodic protection against corrosion (CCP)
2 Concept:	CCP systems transmit sensor signals to a central system at least once a day. With AI, this is to be enabled to recognise conspicuous progressions that indicate a service case related to the system. Ideally, the comparison with previous courses and, thus, the classification of the abnormality provides a first indication of the type of potential disorder. Two-step approach:

	1. Identification of false alarms with a first email to reduce the workload in the assessment of service needs: The sensors are then renewed and subsequently transmit values every five minutes, which then significantly increases the number of false alarms. The top priority is, therefore, to reduce false alarms. 2. Classification of real alarms to facilitate the creation of the corresponding service tickets: The classification of the disorder is only important in the second instance because, first of all, the workload in the assessment of the detected anomalies has to be reduced.
3 How has the problem been addressed so far?	The attainment of fixed threshold values is checked by statistically updating the historical data. When said thresholds are exceeded, alarms are generated that are submitted to a central specialised unit for analysis. These are either recognised as "false alarms", or the alarm is classified as a malfunction, and a service ticket is created for on-site maintenance at the asset.
4.1 Business model:	According to the German Association of Gas and Water Professionals (DVGW), network operators are obliged to regularly assure themselves of the effectiveness of their corrosion protection, also for hazard prevention. The collection and regular monitoring of cathodic protection sensor data via remote monitoring is the preferred way to implement this requirement (as opposed to on-site monitoring at the asset). With AI methods, this effort can be reduced considerably further and more efficiency achieved, as the experts only examine relevant cases with potentially real incidents instead of sifting through and evaluating "false alarms".
4.2 Revenue model:	The service is currently provided as a full service, which means that OGE connects customer installations to its own central system and monitors the customer installations in this way with its own staff. The maintenance process itself can remain with the customer.
5 Target group:	Operators of CCP-protected pipelines and buried assets with CCP protection
6 Addressed problem of the target group:	Carrying out the functional check of the CCP protection according to the 7.2.2 technical standard in the DVGW GW10 standards worksheet, as well as more precise and earlier identification of problems in the systems that endanger the protection status of the CCP.

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7 Advantages/added value for target group:	Time savings, reduced personnel deployment with consistent monitoring quality in accordance with DVGW regulations
8 How can success be measured?	The classification of the abnormalities can be assessed by the staff who carry out the monitoring today. The service orders carried out later reveal the actual nature of the fault and can confirm or falsify the classification.
9.1 Obstacles:	The AI task could be too difficult; the AI analysis could offer too little added value to the experts. The classification into real and false alarms is the most urgent task of AI to further reduce the workload in the control centre.
9.2 Special challenges:	The processing of past data in the current context model for the analysis of seasonal effects is particularly necessary in the case of weather influences. Changing the master data in the time histories without such processing makes older raw data unusable in terms of anomaly detection.
10 Resources needed for development:	Resources from the Cathodic Protection Competence Centre and from the development team of the central monitoring software have been secured.

1.2.4 TRUMPF/USU: Machine monitoring and diagnosis

Diagnose problems automatically, reduce maintenance costs

Use case: Plan service calls efficiently, diagnose machine data automatically

The goals of the **TRUMPF** and **USU Software** speedboat project are ambitious. TRUMPF machine tools are complex, and operating and maintenance costs influence the decisions of potential buyers. The solution is a combination of sensor technology, diagnostic procedures, and AI know-how. The machines should be able to independently diagnose and analyse problems and transfer the results to a cloud platform where they can be evaluated in a differentiated manner.

The result is that maintenance tickets can be automated and information used in a continuous learning and improvement process. This continuously increases system availability and reduces maintenance costs.

About TRUMPF:

TRUMPF. Developing production technology further, making it economical, precise, future-proof and connected – that is our task. We are the market and technology leader in machine tools and lasers for industrial manufacturing. Our innovations can be found in almost every industry.

The aspects at a glance:

1 Working title:	Error & Data Diagnosis
2 Concept:	Standardisation of diagnosis through the transmission of the data, but also evaluation of the data to enable proper predictive maintenance. We are working on the development of a web app for the technicians so that they can investigate the errors remotely. This displays the error events, including videos from inside the machines.
3 How has the problem been addressed so far?	Traditionally, a lot of implicit experiential knowledge is therefore not scalable and not with the level of automation technically possible today.
4.1 Business model:	We are working in the direction of EaaS (Equipment as a Service), where the machines are no longer sold to the customers, but the service of cutting parts is.

4.2 Revenue model:	Subscription, part of the maintenance contract, EaaS
5 Target group:	TRUMPF customers with 5+ machines and 25+ employees With EaaS: Customers where the EaaS business model is implemented so that TRUMPF can manufacture the machines remotely.
6 Addressed problem of the target group:	Reduction of unplanned downtime and better planning of necessary maintenance work (condition-based). Remote, which means that the errors are corrected more quickly.
7 Advantages/added value for the target group:	Higher customer satisfaction through reduction of unplanned down time, higher ROI
8 How can success be measured?	Whether the insight into the customers' problems can be made factually and objectively measurable and whether the right actions can be derived and then customer satisfaction positively influenced.
9.1 Obstacles:	Budgets, but also the change in how a business case is calculated. The ROI is uncertain (when/how much).
9.2 Special challenges:	Being able to detect a variety of different errors
10 Resources needed for development:	IT and SW resources: Availability depends on budget.

1.2.5 KEB/USU: Recommendation Engines and Chatbots in Service

Plan field operations and procure spare parts.

Use case: Efficiently collect service data, automatically evaluate it in real time and provide it contextually

The use case of drive expert **KEB** and **USU Software** relies on an extensive information pool. The speedboat project processes not only data from sales, service and customer communications but also error descriptions and live events such as alarm messages and machine statuses.

Whether video, augmented reality or chatbot – the results of the AI analyses should be able to be integrated into different tools, depending on the service application. Technicians should automatically receive support in this way. And recommendation engines are to help plan field service missions and procure spare parts.

About KEB:

Since its foundation in 1972, **KEB** has developed into a globally active medium-sized company with more than 1,400 employees – over 900 of whom work at the headquarters in Barntrup, Germany. KEB develops, produces and distributes a wide range of industrial automation technology components with a focus on electrical drive and control technology.

The aspects at a glance:

1 Working title:	Digital service management of the future
2 Concept:	Establishment of a technical service knowledge database for the provision of AI/ML-based assistance systems for service processes
3 How has the problem been addressed so far?	The problem has not been addressed at all so far.
4.1 Business model:	
4.2 Revenue model:	(not defined)
5 Target group:	Service organisation
6 Addressed problem of the target group:	Targeted digital knowledge management

7 Advantages/added value for the target group:	Efficiency, better quality, higher first-time fix rate
8 How can success be measured?	A first-time fix rate of over 95 per cent
9.1 Obstacles:	Previous documentation of current service cases
9.2 Special challenges	
10 Resources needed for development:	Knowledge management/IT/internal RD are secured.

1.2.6 ESW/inovex: Using NLP to create an intelligent service ticket system

Shortening of error-related machine downtimes through the use of maintenance data

Use case: esw shortens machine downtime with an AI system developed together with inovex

An important point in optimising manufacturing is better planning and execution of maintenance work. Machine breakdowns cause major losses in turnover. Therefore, there is great interest in keeping the error-related downtime of machines as short as possible.

In most manufacturing SMEs, service technicians are called when there is an error on the machine. The growing shortage of skilled workers can lead to long waiting times and, thus, longer machine downtimes. To solve this problem, esw GROUP is developing an intelligent service ticket system together with inovex, which provides manufacturing employees with possible solutions to a problem that has occurred. Natural Language Processing (NLP) is one of the methods used. In addition, the AI system supports the employee in determining the category (mechanical, electrical, ...) in case of problems that cannot be solved immediately in order to be able to call the right service technician.

By using the system, valuable data records are created over time that contain information about the frequency and type of error on a machine. This information is of great value to manufacturers of industrial machinery. In this way, manufacturers can gain information on the actual usage behaviour of customers and also increase their own product quality, as well as uncover quality gaps.

About the three companies

inovex | esw GROUP Beste Verbindungen | BHT Berliner Hochschule für Technik

inovex is an innovation and quality-driven IT project house with a service focus on "digital transformation". More than 450 IT experts provide comprehensive support to companies in the digitalisation and agilisation of their core business and in the realisation of new digital use cases.

The **esw GROUP** is a family-run, medium-sized group of companies specialising in the manufacture of safety-relevant components for various technical applications. With sophisticated and high-quality metal-plastic products, the esw GROUP has become a reliable partner in the automotive, commercial vehicle and construction industries over more than six decades.

The **Berlin University of Applied Sciences (BHT)** offers the largest range of engineering courses in Berlin and Brandenburg. With around 13,000 students, the BHT is one of the largest universities of applied sciences in Germany. The BHT stands for a career-oriented, future-proof course of study and focuses on the transfer of knowledge and technology between the university and companies.

The aspects at a glance:

1 Working title:	Intelligent Service Ticket System
2 Concept:	Employees detect a problem with a machine and open the app with the intelligent service ticket system. There, they enter several pieces of information, including a description of the problem. Based on the input, possible solutions to the problem and a category of the problem are suggested using NLP. If the proposed solution can be implemented by the employee, the machine can immediately continue to operate. Otherwise, a service technician is called based on the category (e.g. electrics), who can then fix the problem. In this way, the knowledge about occurring problems is persisted with the corresponding solutions. In addition, this knowledge can be transferred to machine manufacturers, who can use the information to improve their products.
3 How has the problem been addressed so far?	• System in which problems with the machines are entered by the employees • Problems are described as well as possible by the employees and assigned to a category (mechanical, electrical...) • The service technician is called based on the assigned category • The service technician solves the problem and enters the solution into the system
4.1 Business model:	
4.2 Revenue model:	
5 Target group:	SMEs that want to accelerate their maintenance of machines and persist knowledge. In addition, machine

	manufacturers that want to obtain data on common problems on their industrial machines in order to improve their products.
6 Addressed problem of the target group:	Machine down times in manufacturing due to error messages lead to high revenue losses. Therefore, there is an interest in keeping these machine downtimes as short as possible. Optimally, small errors can be solved directly by the employee without calling in a service technician. Due to the ever-increasing shortage of skilled workers, there may be delays in processing by the service technician. If the machine fault cannot be solved by the employee and, therefore, a service technician has to be called, there is great interest in calling the right service technician. If there is a mechanical problem but an electrician has been called, there will be further downtime and costs as another technician will have to be called in. This can be prevented by better categorisation of errors.
7 Advantages/added value for the target group:	Less downtime and, therefore, more turnover through better maintenance implementation.
8 How can success be measured?	Number of correctly classified categories (accuracy) and number of problems that could be solved with the help of the system.
9.1 Obstacles:	Manufacturing employees must be able to handle the system -> training courses.
9.2 Special challenges	Employees have to maintain the data, as the system does not work without a detailed data basis.
10 Resources needed for development:	Maintenance data

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2 Understanding of the technical principles of AI processes, operations and their interaction.

2.1 We give you an overview of possible AI core functionalities in the service process.

2.1.1 No. 1 Service requirement notification

Every technical service begins with an assessment of whether a service requirement exists at all. If this is the case, the type of service case must be identified. In this first module for the technical service, the assessment is made as to whether or not there is a need for service.

How exactly does the customer's report reach the service centre team that carries out such an initial assessment? This input information can be delivered analogue, for example by phone, or digitally, for example via a service message by email or even fax. It is also not uncommon for certain more modern types of machines that originate from the manufacturing industry to trigger a message on their own. This will then either first appear to representatives of the internal service team (for example, via email, push message, as a text message or on a connected display board) or can also be routed directly to the service provider on digital channels. When this information has reached the service provider, they will then decide on the next steps.

In summary, the analogous procedure can be depicted in the following reporting chain:

1. The customer/machine perceives a suspected malfunction and reports it to the service centre.
2. Service centre employees assess the extent to which there is actually a malfunction and, if so, what exactly it is.
3. The service technician receives this information and travels to the customer or machine to carry out the service process.

This reporting chain has now been converted in that it functions completely digitally: Sensors on the machine sense an unusual reading. An algorithm, i.e. a calculation rule consisting of individual steps, analyses the sensor message and comes to a decision as to whether a malfunction has occurred. The processed information about the malfunction is forwarded to the service centre in the next step.

Technically, the algorithm mentioned above is embedded in an AI application, i.e. in a mini-application that can record, process and forward information. The algorithms, i.e. the calculation rules used for this purpose, often come from the large group of anomaly detection algorithms. This can be used to recognise whether a measured value is "normal", i.e. whether it belongs to the group of measured values that are known from this context. This type of AI analytics is called predictive analytics.

In summary, this is what is done here:

4. Information about unusual measured values arrives via connected sensors.
5. The AI application analyses the values to see whether it is actually a so-called anomaly.

6. If so, this information is forwarded in the service lifecycle.

2.1.2 No. 2 Ticket creation and allocation

Now that the service demand request has been triggered by the AI-based assessment in the first service segment, a ticket is created automatically and AI-based in the second segment of the service lifecycle. What are ticket systems? These are software systems that can, for example, store customer enquiries, support messages, complaints and so on in digital index cards and sort them according to processing priorities. Another name for a ticket system is a case management system, which makes it immediately clear that service cases are created, catalogued and prioritised here. Classically, the customer calls the service provider, is put through to the call centre, and the case is recorded, written on a digital card and managed from there. Alternatively, the message can be sent by email, for example. All of these steps are omitted here because the AI application performs all of this automatically by processing the information fed in by AI segment No. 1 on its own. For this purpose, procedures from the AI field of Natural Language Processing (NLP, see chapter 2.3.3) are used, with which language can be analysed. The AI application now has three process parts to execute:

1. It must recognise what kind of service case it is; to do this, the AI must discover key terms such as "roller bearing", "paper feed", "broken", "rattles", and so on. When this is done, it compiles a service case based on probabilities and the known fault cases, which could read like this:
   "ERROR: Press ABC-123
   - Roller bearing broken
   - Paper feed rattling"
2. If this is the case, it can directly suggest solutions if information is available, which could look like this:
   "SOLUTION: Possible solutions:
   - Replace roller bearing
   - Replace paper feed".
3. It tries to identify which sentiment, i.e. which emotional attitude (positive or negative), was given to the ticket text. For this purpose, key terms are searched for that provide clues to the customer's attitude; for example, the AI could find the terms "again" and "annoyed" and thereupon assert a negative attitude on the part of the customer, i.e. for example:
   "SENTIMENT: Customer expressed negative sentiment
   Terms used:
   <again> <annoyed>"

After these qualifications have been made, the ticket is passed on to the next segment.

In summary, this is what is done here:

1. The ticket system recognises key terms in the ticket, which it uses to determine error categories.
2. The ticket system finds possible solutions for the error categories in the available data.
3. The ticket system finds indications of negative sentiment from the customer.
4. The ticket system updates the ticket with the new information.

2.1.3 No. 3 Technician deployment planning with a 360-degree view

The third segment of the service lifecycle is the central case support, also called a 360-degree view. The ticket that has received a pre-qualification via SLC segment 2 now arrives here. Based on the information available here, further information is compiled so that the service case can be carried out on site at the customer's by service personnel.

Date: 2021-10-14, Time: 15:15
Customer: XYZ
"ERROR: Press ABC-123
- Roller bearing broken
- Paper feed rattling."
"SOLUTION:
- Replace roller bearing
- Replace paper feed"
"SENTIMENT: Customer expressed negative sentiment terms used:
-<again>
-<annoyed>"

Figure 7: Possible created service ticket with the existing assessments of the service case

Using the terms in the ticket, the system now looks up customer XYZ in the databases to see whether or which service cases already exist. If there is documentation on this, a copy is made of it in the current client directory. In addition, the machine database is searched for the specific machine type ABC-123 to see if there are any entries in the error history for "roller bearing broken" or "paper feed rattles". If so, a copy of this is also made. Now, the existing manuals and best practices documentation are looked at to see if there are entries to solve the two types of errors. If these are available, the system creates a section of a manual showing a screenshot of the modules to be changed and attaches the section of the manual from the best practices explaining how exactly to change both modules. In the next step, the AI application searches the team database for technicians who have a high level of experience in the two service parts. Two qualified persons can be found: Luke and Julia. The application looks at their work calendar and finds a four-hour free time slot on Wednesday of the current week. The application uses the customer database to locate customer XYZ 89 kilometres away, plans the route and schedules the journey for 07:15 on Wednesday. Lukas and Julia are informed that they have a service case with customer XYZ in the team on Wednesday. The collected information, i.e. the copies of the service cases of machine ABC-123, as well as the manual extracts and the best practice extracts, are made available to the team on their tablets. Spare parts are ordered from the warehouse. The customer will be notified of the service appointment by automated email, with a copy going to the service team.

In summary, this is what is done here:

1. The known error histories for the customer's machine and the machine type are compiled, as are the known solution procedures and spare parts.
2. A qualified service team is selected.
3. An appointment is entered in their calendars.
4. A route to the customer is planned.
5. The customer is informed.
6. A package of information and solutions is made available on the team's tablet computers.

2.1.4 No. 4 Service chatbot

The fourth segment of the service lifecycle is the so-called on-site service: Chatbots.

It is now Wednesday, 8:30 a.m., Lukas and Julia are in the tool shop at customer XYZ and have been shown the ABC-123 machine by workshop manager Robert. They have already had a coffee with Robert and reassured him, as they knew about the negative sentiment assessment. They get to work, their smartphones connected to the tablets via the data line. While Julia sets about dismantling the old paper feeder, Lukas devotes himself to the roller bearing. This module is located on an outer area of the machine that is difficult to access. During the outward journey, Lukas (the passenger) takes another look at the work processes for changing the roller bearing, but he cannot use the best-practice cut-out on the tablet because of the awkward positioning. He calls up the chatbot app on the tablet computer, enters the case ID and immediately hears the voice of the bot on the Bluetooth headset, asking how it can help. Luke says the bot should read him the eight action steps from the best practice guide. The default setting here is that the chatbot waits after each step until the interlocutor says the key phrase "Service bot: next!". Lukas can change the roller bearing in half an hour. The bot terminates. In the meantime, Julia has also finished with the paper feed. The workshop manager inspects and approves their work, brings them to reception, they check out, go to the company car and drive back to their company. It's Wednesday, 11:30 a.m.

In summary, this is what is done here:

1. The service team packs the necessary spare parts and technical items into the company car, sets off for the customer and checks in.
2. The assessment of the AI application proves to be accurate: Both modules are successfully changed. The replacement of the roller bearing is carried out with the support of the service bot.

2.1.5 No. 5 Service reports

In the fifth segment of the service lifecycle, AI-supported service reports are compiled.

When Julia and Lukas arrive at their company car park at 12:30, they go straight to the workshop office, where they finish documenting their service assignment at customer XYZ. On their service tablets, they click through a list of questions where they have to answer many yes-no questions. At 13:10, they can finish the process in the workshop office after declining the option to add more comments in free text fields. Their involvement in this service case is over for the day, so Lukas and Julia go to the canteen for lunch.

The completed digital forms are forwarded from their tablets via the company network and processed automatically. To do this, the data from the forms is first blended with information from the customer administration. First, the application reads the customer master data, which also includes the customer's service level agreement. Together with the service report about the concrete assignment on this Wednesday from 07:30 to 12:30 (according to the boss, the 40 minutes in the workshop office are not charged to this customer!), a billing category is determined, and a final invoice is created, which is sent to the customer by email at 14:45.

In summary, this is what is done here:

1. The service team finishes their tour of duty by completing the documentation of the service process in the workshop office, clicking through a list of questions on their tablets and answering yes-no questions.
2. Now, the automated invoicing takes place on the basis of the information from the completed forms and the customer database.
3. The end product, the invoice, goes to the customer by email and is also sent to the accounting department.

2.1.6 No. 6 Report evaluation and feedback loop

In the sixth segment of the service lifecycle, the service reports created in SLC segment no. 5 are evaluated with the support of AI. For this purpose, the service reports clicked together by Lukas and Julia are retrieved from the server. The AI application takes note of the confirmation of the apparently correctly classified problem categories. While replacing the paper feed module, Julia made an observation: The cassette was broken at the bottom, which may have caused the module to no longer sit firmly in its rail, which in turn may have caused the paper feed to rattle. Since the paper feeder was delivered with the original machine two years ago and the average life of the module is six years according to the manual, the AI application concludes from this that there may have been unauthorised third-party interference. A new entry is made in the service history of machine ABC-13 at customer XYZ with the wording: “During the service call on Wednesday from 08:30 to 11:30 at the customer’s, the roller bearing and paper feed modules were changed. A break in the retaining rail was detected on the paper feed module, which may have been the cause of the customer complaints about this module. Unauthorised third-party interference is possible.” Finally, the application makes the suggestion to address this in conversation with the customer. The data is updated, and the service procedure is finished.

In summary, this is what is done here:

1. The information from the service call that Lukas and Julia carried out is scanned for anomalies. The entry that the paper feed cassette is broken is found.
2. A check with the service manual will most likely rule out the possibility of material fatigue.
3. The application concludes that there may have been unauthorised third-party interference.
4. The application proposes bringing this up with the customer.

2.2 You will learn how these work and how they can interact.

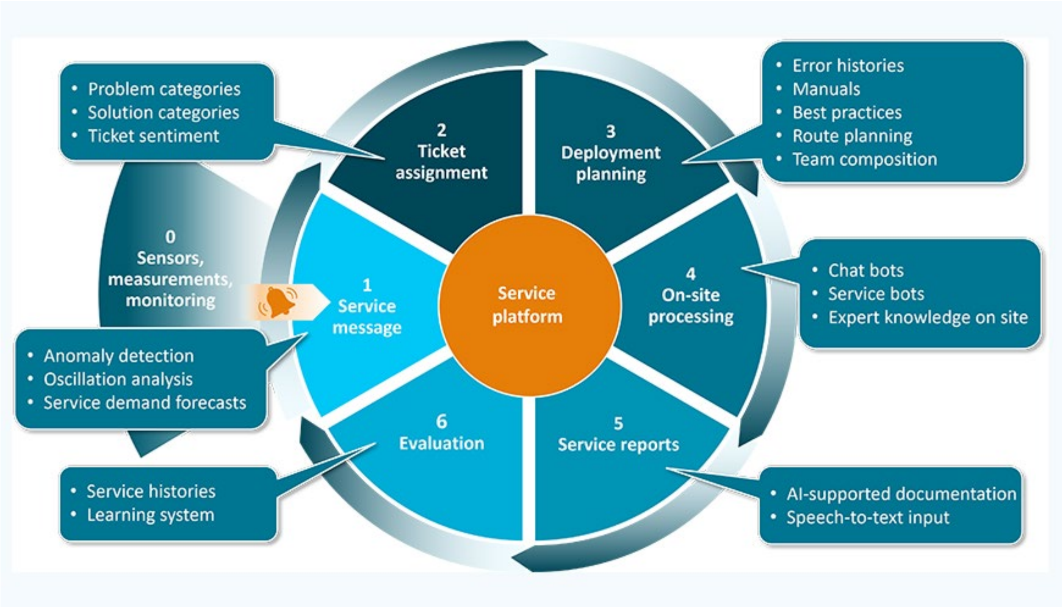

Figure 8: The service lifecycle

2.2.1 Finding the right AI applications and data sources

Learn how AI can be integrated into your chosen services or even into the full Technical Service. Using the service lifecycle, we will show you practical application possibilities, techniques and prerequisites with which you can improve your known processes. This allows you, for example, to see for yourself which data sources you need and which you already have. You have the option of integrating them either via standardised interfaces in your own IT environment or in a special AI platform with the corresponding prerequisites and open standards.

Service message:

Is there a service requirement at all? This initial question is at the beginning of every process in the field of technical service. If this is present, it is necessary to find out what kind of service case it is. This initial module for the technical service is where this first assessment is made.

Analogue process: In the event of a suspected malfunction of a machine, the service centre is informed. Service centre staff assess the fault on the basis of further details and, if necessary, instruct a service technician. The technician drives to the customer or machine with the information to carry out the service.

AI-assisted process: Connected sensors record the measured values of a machine precisely, quickly and reliably. If these deviate from the standard, the AI application analyses the values for this and checks whether it is actually an anomaly. Only then will this information on the deviating values be added to the service lifecycle. The application also has the advantage that it or a so-called predictive analytic can be used to make predictions and calculate the probability of certain events or the behaviour of people.

Ticket assignment:

In the days of analogue processes, people used to talk about a case management system, but today, they only talk about ticket systems. Service cases are digitally created, catalogued and prioritised there. Either the customer calls the service provider and is transferred from there to the call centre so that the case can be recorded and managed. Or a message arrives by email.

AI-assisted process: These entire steps of a digital service case recording are omitted with an AI application, as processes are carried out automatically, and information is processed autonomously. For this purpose, AI-supported methods, so-called Natural Language Processing (NLP), are used, and language is analysed with them.

Typical advantages of a ticket system with AI application:

1. Recognition of key terms on the basis of which error categories are determined
2. Finding possible solutions in the existing data
3. Localise, e.g. negative customer reactions, and prioritise them
4. Updating a ticket by always generating new information

Deployment planning:

A dispatcher has to think of many things so that the service case can be carried out smoothly and to the customer's satisfaction:
Schedules, travel routes, technicians with appropriate skills, required spare parts, etc. An AI system enables efficient pre-qualification.

AI-assisted process:

1. The error history of the customer machine and the machine type are compiled
2. Known solution procedures and measures are clearly summarised
3. Necessary spare parts are listed
4. The service team is selected according to the requirements of the service case
5. The appointment is automatically entered in the calendar
6. A route to the customer is planned.
7. The customer is informed.
8. A package of information and solutions is added to the service team's tablet computers

On-site processing:

Having all the right information at hand during a service appointment on site is not only very helpful, but it also saves time and money and is customer-friendly. If there isn't a free hand to view documents at work, the support of an AI application is worth its weight in gold.

AI-assisted process using the chatbot as an example: Any technician who has already replaced a roller bearing knows the complications that can arise. The module is located on the outer edge of the machine and is, therefore, difficult to access. Even looking at the assembly in advance on the tablet as a best practice is not helpful, as the unfavourable positioning of the roller bearing allows little insight.

In this specific case, it is helpful to be able to call up the chatbot app as a technician via tablet and enter the case ID. The bot immediately checks in via Bluetooth headphones, asking how it can help. One option is to have the technician read out the action steps from the best practice guide. The default setting here is that the chatbot waits after each step until the interlocutor says the key phrase "Service bot: next!". This allows the technician to change the roller bearing in just half an hour.

Service Report:

Preparing a service report is a chore and time-consuming. The most time-consuming variant of this documentation is to record everything on paper, enter it into a system and compare it with price lists or orders. Even though many companies have already made this process easier for their technicians with online forms, only an AI application brings real benefits.

AI-supported process using the example of the service report:

1. The service team finishes the service case with the pre-configured documentation directly online.
2. Based on the completed or only confirmed forms, the application automatically creates an invoice by independently linking the necessary information from the customer database, technician hourly rates, spare parts database or other connected sources.
3. The end product, i.e. the report or the invoice, is simultaneously sent to the client by email and transmitted to the accounting department.

Evaluation:

Evaluations not only have a statistical value but also a business-relevant value. In this way, expert knowledge, new and particularly efficient solutions, incidents concerning product characteristics and warranty cases can be recorded and made visible to all employees and departments. The immediate evaluation and transfer to a knowledge database helps to derive implications for further cases or, for example, for future contract design or product development.

3 How to find starting points to develop your own ideas for your business and implement them.

3.1 Potential analysis by assessment

You can obtain the assessment here: https://www.servicemeister.org/en/the-assessment/

The assessment will give you some inspiration for your service: Assess the six areas of your service with just a few questions and create a meaningful overall profile on service notification, ticket assignment, deployment planning, on-site processing, service report and evaluation.

You can become clear about your own possible starting points and prerequisites and then dive into the process map according to your goals and priorities.

3.2 Orientation via the process map

You can obtain the process map here: https://www.servicemeister.org/en/the-process-map/

The process map gives you a comprehensive insight into the individual process steps to learn more about the benefits of AI applications. Discover the practical applications, techniques and prerequisites relevant to AI applications.

This allows you, for example, to see for yourself which data sources you need and which you already have.

3.3 Learning via the service catalogue

You can find the current service catalogue here: https://www.servicemeister.org/en/the-service-catalogue/

The service catalogue offers you an overview of the AI applications developed within the framework of ServiceMeister for known process steps. In the following, you will find use cases assigned to the respective process steps:

Module 1:
Service message

- Krohne/Inovex:
  Automated detection of defect classes in measuring instruments
- Trumpf:
  Automatic detection of faulty processes remotely

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- OGE/USU:
  AI for the identification of anomalies in cathodic corrosion protection (CP)

- USU:
  IT monitoring by means of adaptive thresholds / smart baselining

- Würth/grandcentrix:
  Predictive maintenance for optimal maintenance and maximum machine availability

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Module 2:
Ticket assignment

- Würth/grandcentrix:
  Automatic assignment of service tickets with free text error descriptions

- USU:
  Intelligent and automated assignment of text-based service tickets

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Module 3:
Deployment planning

- KEB/USU:
  AI document analyses for effective search and creation of a knowledge pool

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Module 4:
On-site processing

- Krohne/Inovex:
  Visual recognition of KROHNE products and intelligent search for relevant documents

- Uni Stuttgart:
  Question answering over knowledge graphs (KGQA)

Module 6:
Evaluation

- Würth/grandcentrix:
  Service cockpit for the analysis and monitoring of service operations

3.4 Using Digital Business Models

The use cases in the service catalogue have shown you how your path to the future 4.0 with AI-based approaches can look in practice. The added value that can be generated for companies is common to all these use cases. In this way, the automation of problem solutions and processes leads to an increase in efficiency from which both the customer and the company itself benefit:

- The customer saves time, costs and resources
- The company generates continuous, scalable micro-revenues and has satisfied customers who are retained for the long term

As studies show, there is a direct correlation between the degree of digitalisation and the relevance of AI in companies. And while less digitalised companies see AI primarily as a means to speed up processes, more digitalised companies are realising the true value of the technology: AI is giving rise to new business models.

3.4.1 Why digital business models are necessary

Digitalisation has led to a paradigm shift that has had a significant impact on the relationship between companies and customers. Whereas manufacturers and service providers used to determine supply, today's markets are shaped by customer demand. The Internet, in particular, has turned customers into well-connected and informed actors who are challenging companies to rethink and question the logic of value creation. Key requirements that arise in digital business models: How can value be generated for customers by using digital tools such as platforms, chatbots, apps, websites and more?

Digital business models offer companies new growth opportunities as well as the possibility to tap into revenue streams. In doing so, the model uses digital technologies to

- Improve products and services
- Create a personalised customer experience
- Develop subscription and performance-based services

3.4.2 The digital business models available on the market

The range of digital business models for you is extensive and varied. Which one is ultimately the right one cannot be answered across the board – especially because the business models can also be combined. What matters is what kind of services you are planning, where you want to optimise the business model and what value proposition you want to make to the customer. It also matters whether you are looking for a quick monetisation or a long-term and network-driven solution, such as a digital ecosystem. Below, you will find a small selection:

Free business model (advertising-supported): A company offers a product or service free of charge. In return, the company receives the user's data, which it can monetise.

Freemium business model: The user receives free access to a basic version (Free) of the product, which is often limited in scope. If the user needs more functions or resources, they can buy or subscribe to the premium version.

Open-source business model: In the open-source model, the software is freely accessible to all users, who also have the possibility to further develop the product. With an open-source product, money is earned from premium subscriptions, which are due for training or services, for example.

On-demand business model: In the on-demand business model, the user does not have a physical product or service but a virtual one. Payment is made for the duration of use and the service used.

Peer-to-peer (P2P) business model: This is a decentralised platform that two users can access simultaneously and participate in a transaction. Products and services are bought or sold, and it is possible to communicate about this transaction.

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