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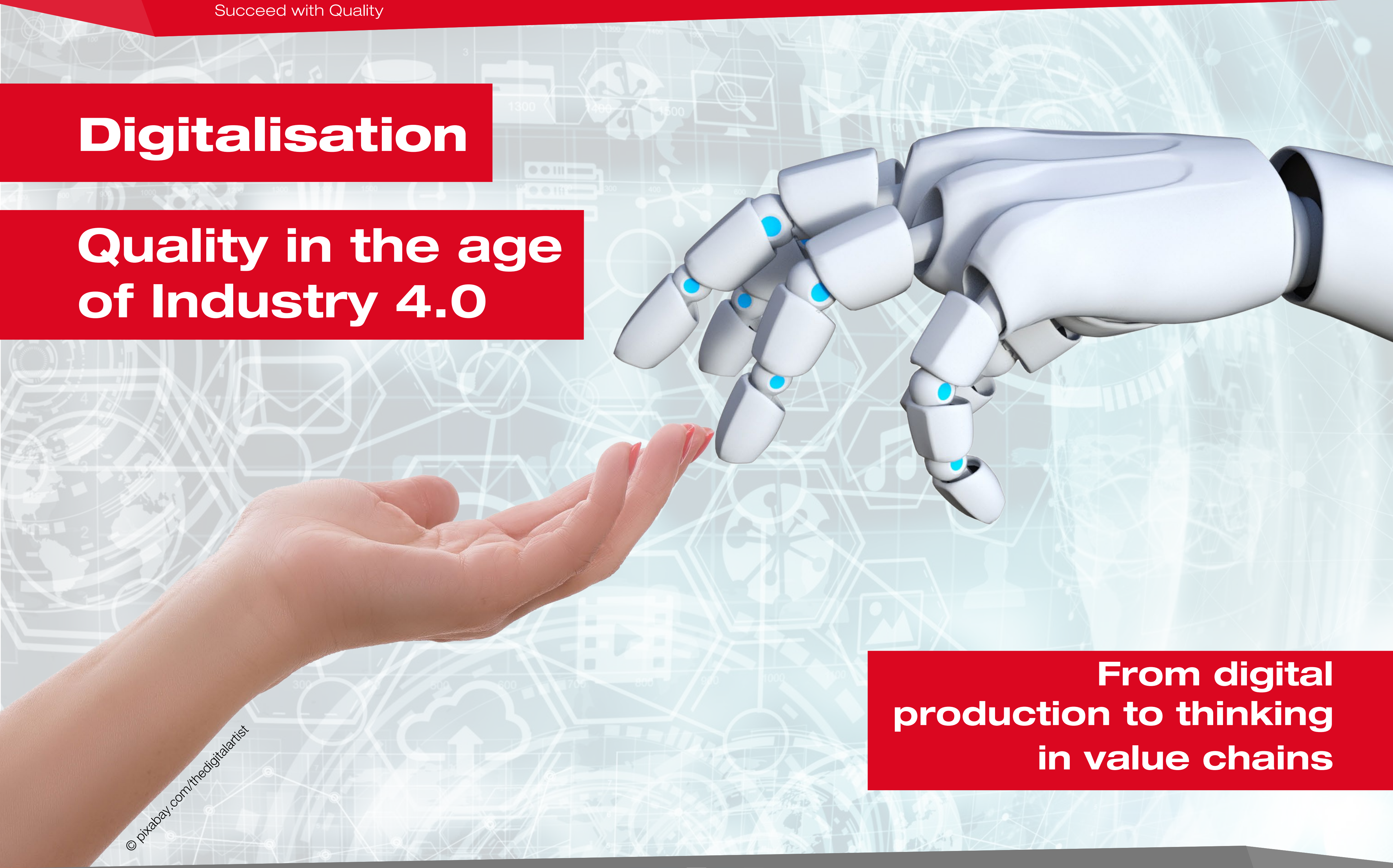
Succeed with Quality

Digitalisation

Quality in the age of Industry 4.0



From digital production to thinking in value chains

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A new environment for quality management

ISO 9001

The ISO 9001 is a universal approach for management systems. Relevant aspects for change projects include:

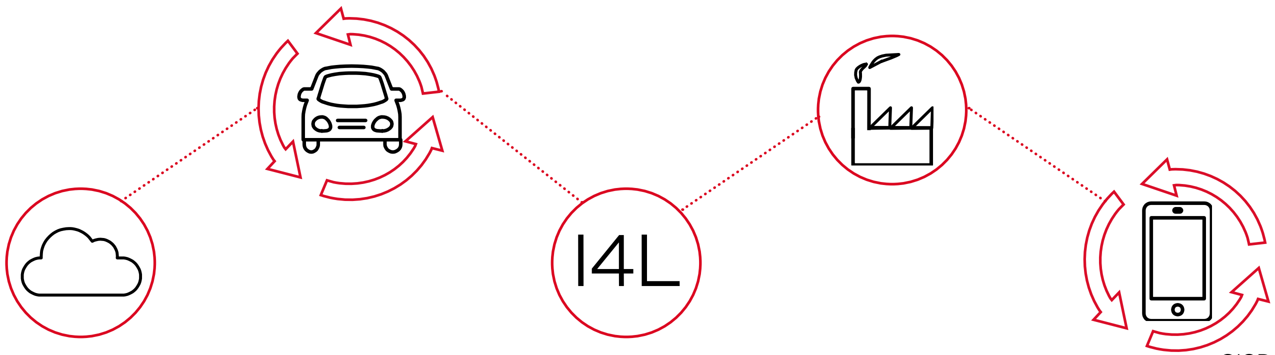
- Context of the organisation
- Systemic planning
- Evaluation of risks and opportunities
- Leadership
- Management of documented information
- Further development of the knowledge base of the organisation
- Monitoring, measuring, analysing and evaluating

Do these aspects apply within the scope of digitalisation?

Industry 4.0: A practical approach

The digital transformation represents a complex, dynamic and challenging environment for organisations. It affects almost every core function of a company and the main activities of the value chain. This results in opportunities and risks:

- For example, organisations might have outdated systems and a **lack of knowledge and skills for the digitalisation**. Their development is an important task for the near future.
- Organisations not only need data analysts and new software solutions, but also require an **IT strategy** that promotes a quality culture. A strategy for a 'World 4.0' should consider the interplay between digital and human capabilities to ensure the success of the organisation.
- The implementation of an IT strategy requires the **organisation's top management to play an active role**. Changing core processes necessitates changes to daily activities. A prerequisite for this is strong, goal-oriented leadership of the organisation.
- Modifications should be monitored with **performance indicators** in order to maintain focus on them. This helps the organisation to keep track of the cost/benefit relationship.
- Lastly, **systems need to be validated** and **implemented** in the daily operation. This also includes updating documentation and the necessary training of staff.
- New processes create new knowledge. For the continual development of newly introduced processes, it is important to create opportunities to **share** the **newly acquired knowledge**.



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Sources: 1,2

From smart production to smart products

Smart products, digital technologies in connection with Industry 4.0 and the connectivity brought about by the Internet of Things change companies and quality management. A few examples:

- The use of software as an alternative to hardware functions can enable dynamic product adaptations. For example, if customers need a more powerful machine, the company can simply remotely unlock the engine (as it was implemented in Tesla's 'Model S').
- Identification and location technologies enable the products or components to be traced in real-time.
- Companies can track the functionality and quality of a product after the sale and ensure quality over the entire lifetime of the product via remote monitoring.
- Smart products can collect usage information about the customer, and maintenance and repair activities. Moreover, the data collected can enable preventative detection of necessary maintenance processes and product defects. Quality managers can thereby expand the company's range of services through remote monitoring services and predictive maintenance.
- Smart products can also contain details about their own identity, components and materials, as it is being examined with the so-called digital product passports. This can increase the value and quality of recycled materials after take-back.

These examples show that quality does not lie in the individual production stages but in a holistic and integrated '**end-to-end quality**' approach along the entire value chain.

A silo mentality is not successful here. As can be seen in the illustration, innovative approaches to digitalisation of the value-chain include agile product development, the analysis of take-back data, and feedback from the online community. Sources: 2-4

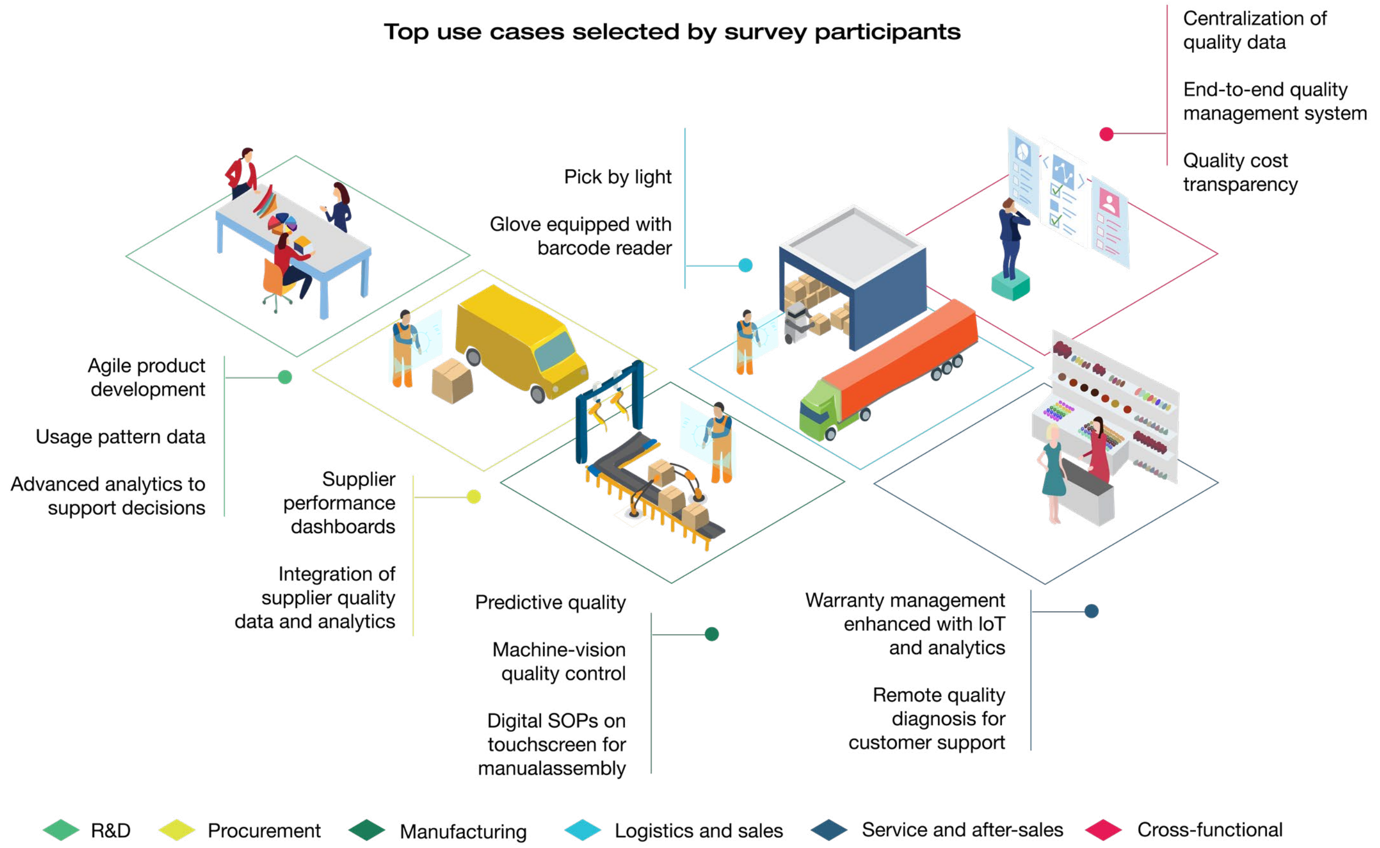


Figure 1: Boston Consulting Group study: Quality 4.0 along the entire value chain – own representation based on [2]

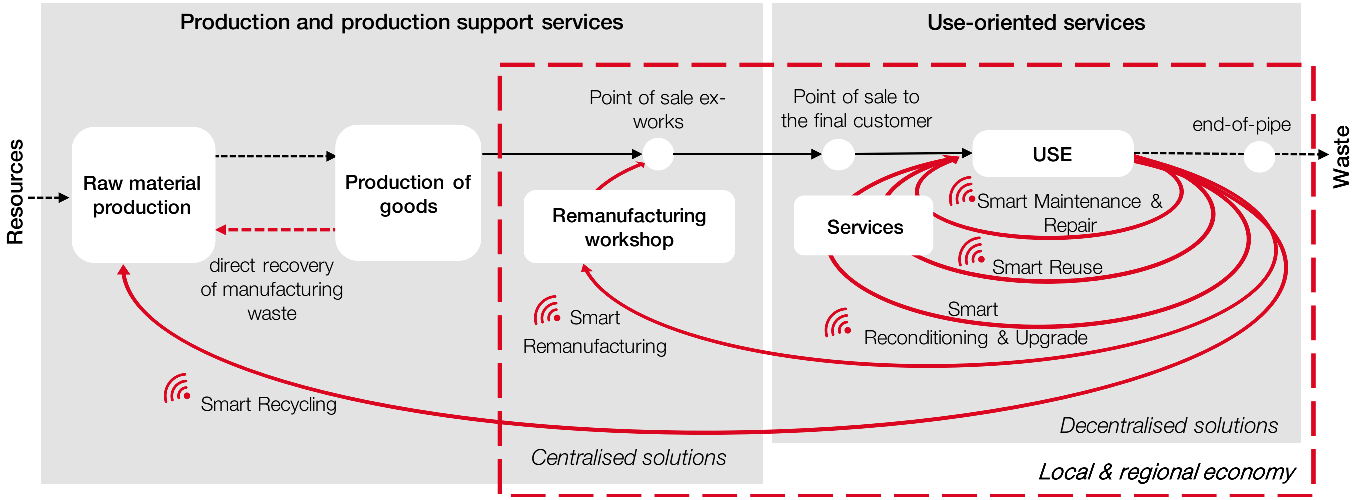
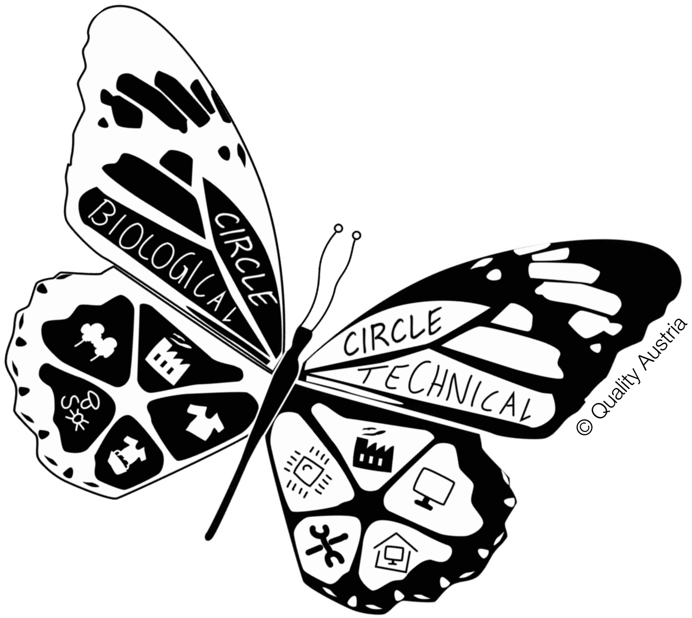


Figure 2: Smart quality services in a local and regional economy – own representation based on [5,6]

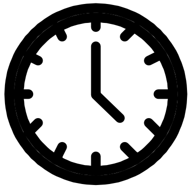


A new quality focus: Quality matters along the entire product life cycle

To date, primary production has been the focus of quality assurance. Will this be the same in the future?
Services that have only been made possible thanks to digitalisation will play an increasingly important role in customer satisfaction and in terms of the resulting sales generated for the manufacturer. This will be further strengthened by recent political and regulatory developments (i.e. the circular economy).[7-10] The focus of quality assurance will thereby increasingly be expanded or shifted to include these services.
This is a challenge from a practical point of view.

Both decentralised and centralised activities will need to be coordinated by the manufacturers, sometimes in partnership with third-party providers (see Figure 2). Whilst the majority of production and associated remanufacturing activities will continue to be centralised, new maintenance, repair, reuse and upgrade services will often be carried out closer to the final customer.[5]

Time – the third dimension



Industrial processes and business practices currently concentrate on 'optimising the technical system' in terms of the following two factors:

1. Resource efficiency (or simply 'efficiency') to reduce production costs;
2. an engineering approach for risk reduction and the assurance of statutory product warranties.

Both approaches together have led to a rather short-term orientation and transactional customer relationships. Particularly in business-to-consumer operations, manufacturers are increasingly targeting fast repeat purchases of lower-quality goods instead of managing quality during the use phase of the customer.[5]

How could the new understanding of quality change this?

Considering the time factor in the concepts of quality and the business model may lead to a new perspective. The focus on technical efficiency of the production process and short-term product sales is then combined with a focus on the long-term use of products, components and materials.[11,12]
Customer requirements during the use phase and the associated after-sales revenues are better recognised.
Opportunities to reduce costs are exploited by recovering and reusing resources (which would otherwise be lost, as most products end up incinerated or in landfills).
This results in innovation potential as information flows through feedback channels from the use and end-of-life phases to the development department (or product design).

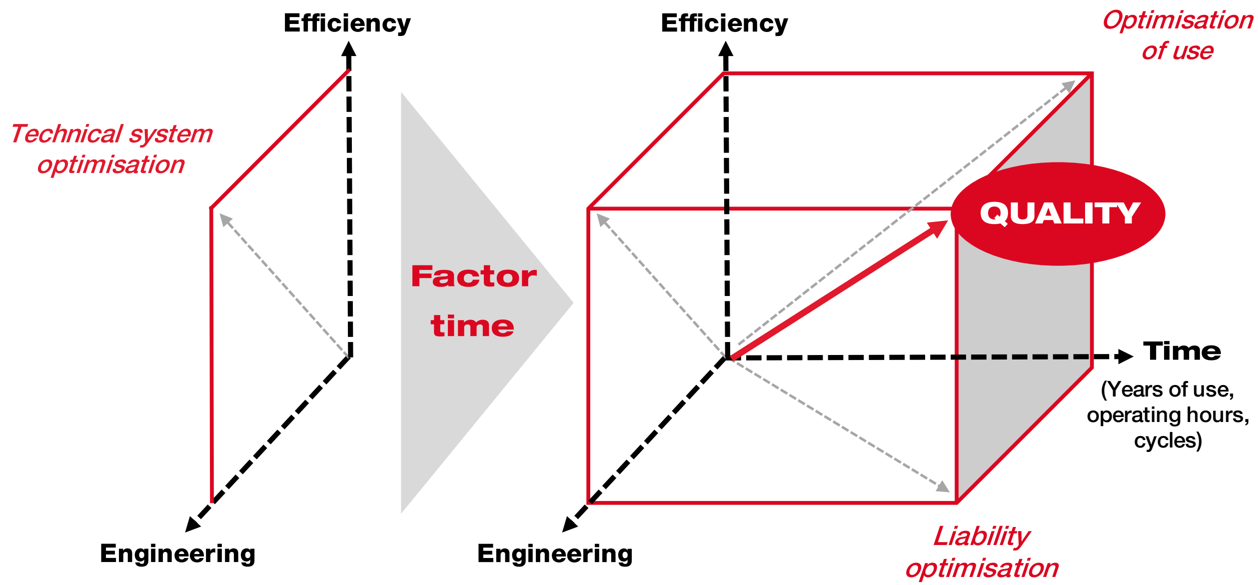


Figure 3: The time factor as the basis of an overarching value-added quality concept – own representation based on [11,12]

... a new vision of quality

Within the scope of the long-term utilisation of products, components, and materials, quality managers shall continue to guarantee the best possible technical system performance. However, they now have increased room for manoeuvre. In addition, they shall also ensure the performance of the products during their use and minimise potential liability risks over the entire service life.
This new understanding of the concept of quality implies that activities which were typically seen as outside the scope of quality function are now emerging as new areas of action and opportunities. For example, improvements of new product designs and the implementation of changes to logistics or sales processes are paramount to guaranteeing long-term quality.
As explained in the previous section, such a quality management approach, which covers the entire value chain, is in line with the latest developments regarding international standards, digital technologies and customer requirements.[11]

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Quality 4.0: How does it work in practice?

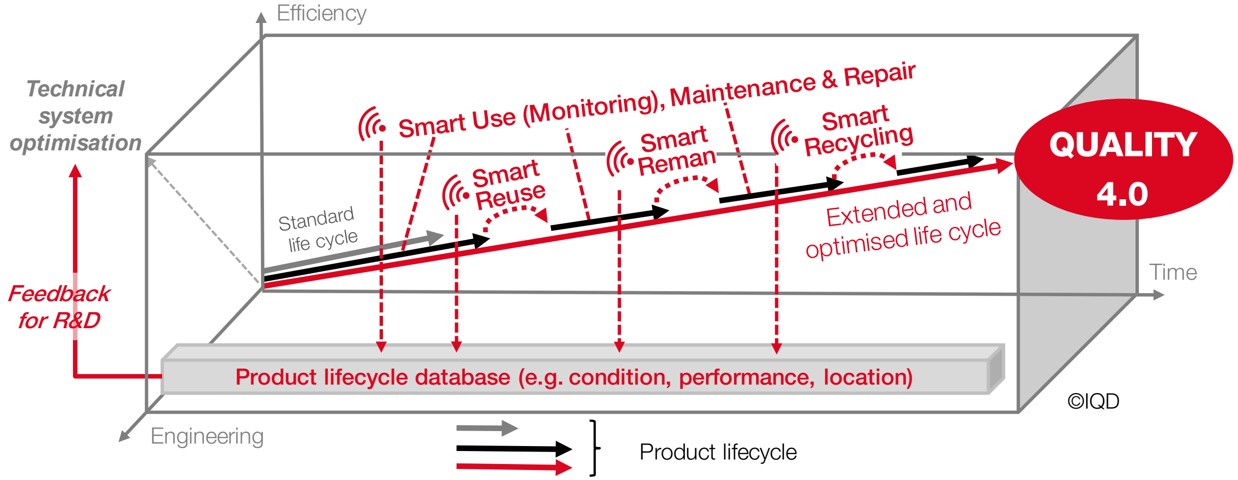

Figure 4: Implementation of Quality 4.0

A few examples:

Smart Use	Includes remote monitoring and data collection with a focus on product use and performance. Databases, data analytics and remote control capabilities support both the business and the customer.
Smart Maintenance & Repair	Focuses on a) *condition-based* (i.e. monitoring) and b) *predictive* maintenance. The former is implemented adaptively to avoid downtime or failures and to reduce the unnecessary replacement of parts. Predictive maintenance additionally uses prognostics and machine learning algorithms to improve the predictive capabilities for future behaviour. A product lifecycle database is updated to keep the product information up-to-date, even if maintenance or repairs are carried out manually.
Smart Reuse	Deals with tracking, early identification and the classification of products, which leads to an improvement in inventory management, take-back and reuse in secondary markets.
Smart Remanufacturing	The use of status indicators and product history facilitates decision-making after product take-back and the preparation of returned products and components, thereby increasing the quality of reconditioned products. Collection data enables better planning of future deliveries. Sorting and identification technologies facilitate dismantling and thereby reduce costs.
Smart Recycling	Sorting and disassembly are costly processes, the economic benefit of which is partially unclear. Digital product passports or related product registers can considerably increase the potentials of recycling, as the quality and quantity of the constituent parts are known, which improves planning processes and enables the use of more specific material recovery processes to obtain high-quality materials. Location tracking can potentially support the recycling logistics.

Sources: 6, 11, 12

Service business models for Quality 4.0

Merely changing the processes is not enough. It is only by adapting the business model that the possibilities of the Internet of Things (IoT) are able to deliver new competitive advantages.
Here is a comparison:

	'Product' business models (and quality services)	'Use' business models (e. g. rental, leasing, sharing)	'Performance' business models (e. g. outsourcing, pay-per-use, results)
Description	The focus is on selling products and after-sales service. The customer buys a certain product and its features. The price applies per product unit sold plus various service plans.	The focus is on the customer's use of the product. The customer chooses a specific product and its features. The price applies per unit used over a certain period (normally product units).	The focus is on the continuous availability of the product and personalised solutions. The business partners agree on a level of performance (the specific product is not relevant). The customer pays a fee within the scope of a long-term contract.
Quality 4.0 Enablers	**R&D:** Only interactions with the customer when selling and during the after-sales service and remote monitoring services allow collecting feedback. **Purchasing:** Data on product quality and take-back information are limited. Rather reactive supplier management. **Production:** Optimisation of the production process and subsequent estimation of demand. **Logistics & sales:** Access to data on the product location is limited. Only remote monitoring services enable gathering product and usage data. **Service & after-sales management:** Remote monitoring, predictive maintenance and data-based remanufacturing are only introduced after an agreement with the customer. **Cross-functional:** The data remain decentralised and end-to-end-quality is limited due to poor access to the product.	**R&D:** Regular interactions with customers and remote data collection enable gathering feedback more frequently. **Purchasing:** Data on product quality are retrieved remotely or after take-back. Data enable a proactive supplier management. **Production:** Optimisation of the production process and demand assessment on the basis of customer usage data. **Logistics & sales:** Data on the product location streamline product circulation. Product histories and usage data guide future sales and enable quality assurance. **Service & after-sales management:** Remote monitoring, predictive maintenance and data-based remanufacturing minimise errors and reduce costs. **Cross-functional:** Remote monitoring and control enable data centralisation and end-to-end quality management.	**R&D:** Permanent product monitoring and interaction with customers enable feedback and data to be collected practically in real time. **Purchasing:** Data on product quality and take-back information are part of the business model. Proactive and faster supplier management. **Production:** Optimisation of production processes and estimation of demand, based on data and knowledge acquired from the customer. **Logistics & sales:** Data on the product location streamline the take-back process. Product histories and usage data inform sales, enable quality assurance, and improve the overall service. **Service & after-sales management:** Remote monitoring, predictive maintenance and data-based remanufacturing prevent product failures at the customer site and reduce costs. **Cross-functional:** Full access to customer data enables comprehensive quality management and the use of dashboards with complete product life cycles.

A best practice rental business model

Salesianer Miettex GmbH:

The company Salesianer rents out smart textiles and is a pioneer in the use of Radio Frequency Identification (RFID) technologies in the services segment of rental textiles. Intelligent textiles are rented to customers from different industries and 'circulate' in a closed-loop between Salesianer and its customers. The company takes back used textiles and treats them hygienically for reuse by its customers. Clean textiles are delivered to the customers in defined intervals according to customer requirements. In the case of the healthcare sector (hospitals and care homes), the company supplies textiles which are either equipped with RFID chips only or with RFID chips and barcodes.[13]

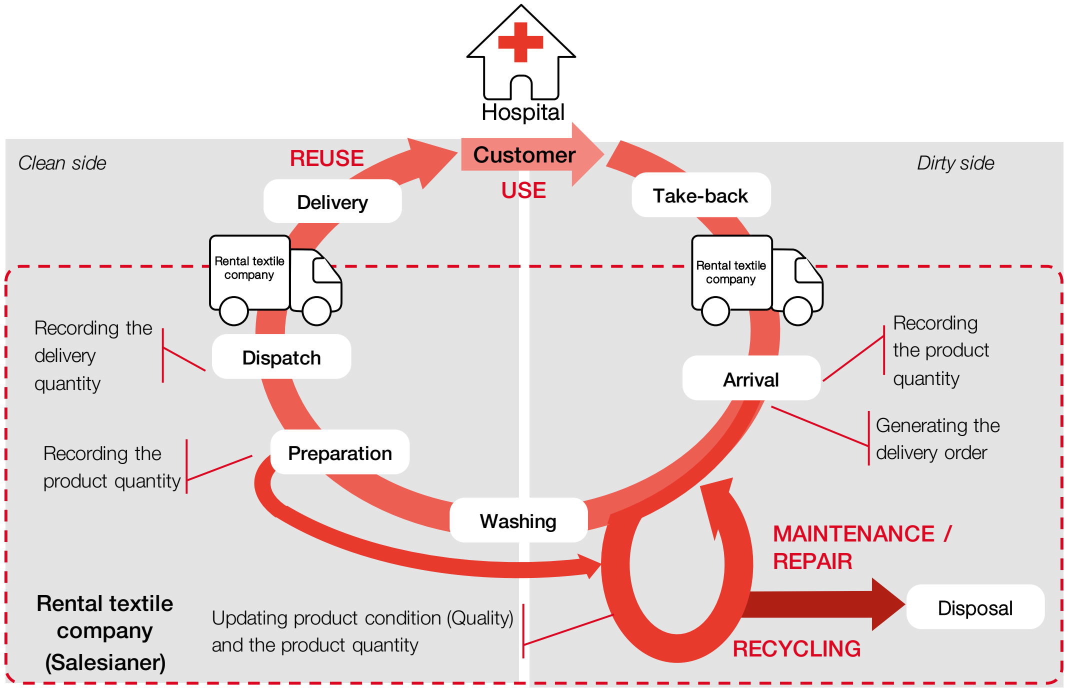

Figure 5: Reuse of smart rental textiles - own representation based on [13]

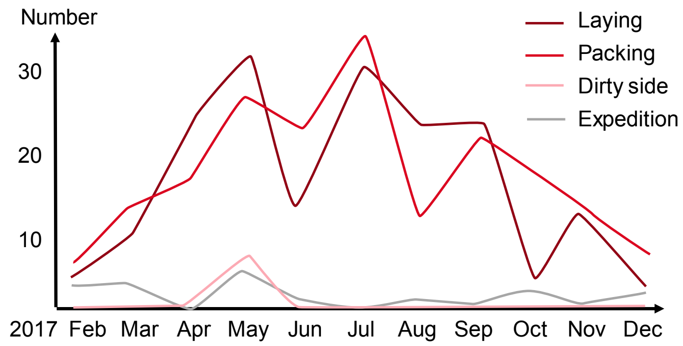

Figure 6: Complaints by department - own representation based on Salesianer

Mastering Quality 4.0

Prior to the implementation of RFID technology, the fast-cycling nature of rental textiles coupled with their large quantity (several tonnes per day) made it impossible for Salesianer to capture the quantities of the various items which were actually available. In this respect, the technology has allowed Salesianer to gather more precise data about the condition, the available quantities of each item and the location of its textiles. This information has enabled analyses of the speed of circulation, losses within the reuse system, the quality of various product lines, and the quality of internal processes (e.g. Figure 6). For this reason, the gains in transparency are the most remarkable benefit for Salesianer of smart textiles. This improvement in data analysis and transparency enables an smart and circular business model.

The Quality department at Salesianer carries out the data analysis, drafting of regular quality reports and resulting recommendations for top management. The information gained from smart textiles has enabled the Quality department to implement process improvements along the entire value chain. The company uses product life data to raise customer awareness of losses and damage to rental textiles. A reduction in losses at customer locations contributes to cost savings on both sides. Information about the product quality during use enables an improved negotiation and decision-making in procurement and thereby proactive supplier management. The business model is constantly improved through continuous optimisation along the value chain.[13]

A best practice performance business model

AB SKF

The company SKF is a leading manufacturer of rolling bearings. SKF has developed 'Rotation For Life' - a long-term, performance-oriented business model that is based on a monthly fee. It combines bearings technology, detectability of malfunctions and reliability services in a comprehensive package. SKF includes the lubrication management, condition monitoring services, root cause analysis, routine checks, customer training and bearing remanufacturing as part of their business model.[14,15]

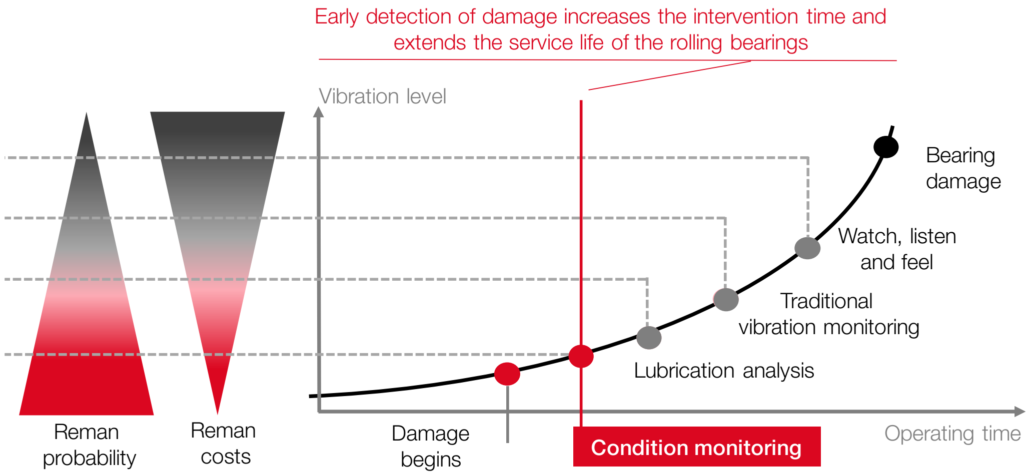

Figure 7: Smart remanufacturing at SKF – own representation based on [14,15]

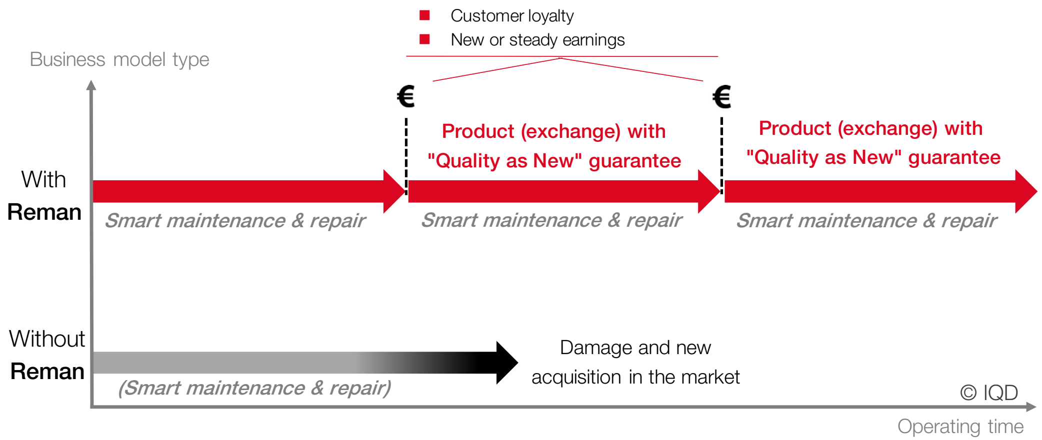

Figure 8: Product exchange with 'quality as new' guarantee

Mastering Quality 4.0

One of the main advantages of this business model is the use of condition monitoring to enable and improve bearing remanufacturing. With the aid of smart components, SKF can detect faults in advance and replace the bearings long before severe failures occur. This permits a reduction in remanufacturing costs and increases the likelihood of remanufacturing.
Bearings can be remanufactured several times and become therefore considerably cheaper. This enables attractive pricing in the performance business model. Product replacement and the associated remanufacturing are becoming a central competitive advantage for the company. This model also enables the development of close and long-lasting customer relationships. Additional sources of income are generated by taking on additional services, such as the overall maintenance of the bearings. A performance business model with intelligent technologies permits the remanufacturing and replacement of old bearings at the best possible time. In this respect, the combination of technology and service orientation enables a 'Quality as new' guarantee (Figure 8).[14,15]

Conclusion

Quality 4.0 - Conclusion in 5 points

1. Quality 4.0 - understood as an overarching cross-value-chain concept based on smart products and the Internet of Things - leads to new opportunities and challenges for companies and their quality managers, particularly with the integration of the time factor and the entire product life cycle.
2. A strategy and roadmap for Quality 4.0 require a foundation consisting of the development of soft skills, the enticement of suitably talented people, and the creation of a quality-based corporate culture. Communication, teamwork and management of change processes seem to be particularly important skills for quality managers.
3. The development of a digitalised value chain requires better coordination between functional areas within the company and external value creation partners. Only then can manufacturers, for example, receive usage data, monitor their products remotely, or use maintenance data to improve the design of newer product generations.
4. The use of information about the product life cycle offers the opportunity to acquire knowledge about the condition, location and performance of products in use – even if they are installed as components of other products. Smart products or components provide quality managers with direct information about their use, material flows and customer requirements. Based on this information, quality managers can use advanced quality methods and thereby facilitate either lower costs or higher customer benefit.
5. Many companies are trying to generate advantages with smart products but are too often caught up in transactional business models aimed at product sales. Whereas if quality is designed over longer periods, the use of new information technology should accompany the further development of the business model towards the intensification of of the service offer. It is only then that a competitive advantages arising from digital technologies or smart products can be achieved.

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"Nature's most raw beauty is the circle: perfect in its continuance, with no break between death and life."

From the card game 'Magic' by Wizards of the Coast

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