



# PERSONALISATION AS A STRATEGIC COMPETITIVE ADVANTAGE: A SURVEY

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**Abstract:** *The paper analyses the applications and trends of personalisation in the DACH region. Personalisation serves as the key to market differentiation and generates competitive advantages, with the integration of customers already taking place in the early development phases. This results in new requirements for the development of products and their production, as well as for the qualification of employees. For this reason, the »Leistungszentrum Mass Personalization« (LZMP) in Stuttgart conducted a survey on the challenges of personalisation. The development and manufacturing of personalised products and the need for corresponding skills are discussed.*

**Key Words:** *Personalisation, Customer Integration, Mass Personalisation, Industry 4.0, Industry Trends, Skill Development*

product development and production processes of personalised products, suitable interfaces to the customer are becoming increasingly important. These interfaces allow integrating customer needs and requirements into the product. With this in mind, an online survey was conducted to determine the current state of personalisation in the areas of product development and production processes and the associated skill requirements for employees. The survey targeted companies in the DACH region. The results were compared with a spin-off company, Skinmade GmbH, and its orientation towards personalisation was described. The actions in product development and production processes were identified, as well as the required skills that have led to the success of personalisation at Skinmade.

## 1. INTRODUCTION

The trend towards individualisation creates new challenges for businesses. Today's customers expect customised products and experiences, which forces companies to personalise their products (Würtz 2018, Bauernhansl et al. 2014; Kölmel et al. 2018). The growing demand for personalisation not only offers economic opportunities but also raises complex questions about production systems and employee skills (Bauernhansl et al. 2014; Gross et al. 2017). Companies use personalisation as a differentiation strategy to offer more customised products. Personalisation is becoming increasingly important, especially in product development (Kölmel et al. 2018). Companies recognise that involving customers early in the product development process can lead to greater customer loyalty, competitive advantage, and long-term success (Bauernhansl et al. 2023). Therefore, it is crucial for companies to understand their customers' needs and expectations and to incorporate them into the development process (Würtz 2018; Wecht 2008; Eversheim et al. 1999; Herrmann 2010). As a consequence, companies are forced to adapt their production processes to meet the increasing demands (Schimmelpfeng 2002; Engels et al. 2020). In the

## 2. SURVEY RESULTS

As part of an explorative study, first, qualitative interviews were conducted with 18 experts from the field of personalisation (Bauernhansl et al. 2023), and hypotheses for an online survey were formulated. The response options for the online survey were defined based on the expert statements. An online survey was then conducted with 73 participants from around 24 sectors. It was possible to skip questions so that not all questions were answered by all participants. The participants come from the cosmetics, metal, electrical, software, textile, orthopaedic, metrology, medical technology, automotive, mechanical, and plant engineering industries, as well as from consulting companies, research institutions, the construction industry, authorities, and associations. The results of the survey categories of product development, production process, and requirements for skills development are presented in the following and then compared with the experiences of Skinmade GmbH.

### 2.1. Personalisation in the early phases of product development

Companies that recognise the importance of personalisation can achieve competitive advantages through customer integration in the early phases of

product development. The survey shows that the decisions on personalisation are made at the beginning stages of product development. Fig. 1 shows the survey results, where multiple answers were possible.

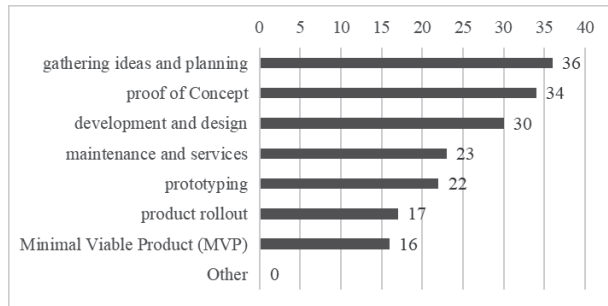


Fig. 1. Product development phase in which personalisation takes place (n=47)

Three quarters (36 out of 47 possible responses) of the responding companies see the greatest potential for personalisation during product development in the idea-collection and planning phase, for example, in market research/analysis and business analysis. Almost three quarters (34 responses) of the companies also see the proof-of-concept phase, including requirements analysis, as an important period for personalisation. This includes the listing and description of all functions to be implemented in the product. Thirdly, the respondents see the development and design phase, for example, in the definition of architecture, interfaces, and product features based on the requirements and their correlations. However, personalisation is also still seen in prototyping, as is the case in agile development processes, for example. In the later phases of the rollout or a minimum viable product (MVP), only around a third (16 responses) of the responding companies still see potential to consider personalisation aspects.

## 2.2. Need for specific data to create personalised products

To be able to manufacture personalised products, customer and user-specific data are required. This data allows to customise products to the customers' individual needs. For this reason, the companies were asked what types of data they need to manufacture personalised products. They could name several types of data, see Fig. 2.

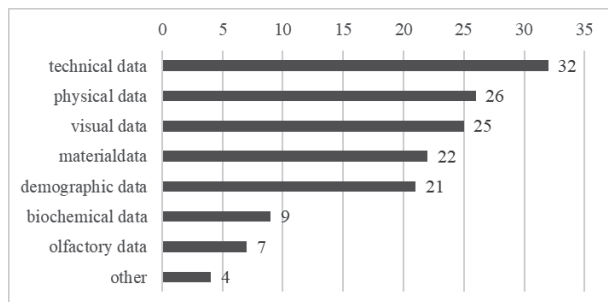


Fig. 2. Specific data required for the manufacture of personalised products (n=46)

Nearly three-quarters (32 out of 46 possible responses) of the responding companies need technical data, such as dimensions, performance, consumption, or mechanical data, to manufacture personalised products. However, more than half of the companies (26 responses) also require information on customised interfaces and interrelationships ('physical data'). Data on the visual appearance of products is also important for more than half (25 responses) of those companies surveyed. Material data, such as certifications or international labelling, are important for just under half (22 responses) of the responding companies. Demographic data, such as age or gender, are also important for just under half (21 responses) of the responding companies. Biochemical and olfactory data, on the other hand, barely play a role in product individualisation.

## 2.3. Requirement profile for personalised products

In the product development phase, product-specific data is required to create a requirements profile for personalised products. For this reason, we asked which data the participants used to create the requirements in the product development process for personalised products - multiple answers were also possible here, see Fig. 3.



Fig. 3. Data collected for the creation of a requirements profile for personalised products (n=47)

More than-three quarters (38 out of 47 possible responses) of the responding companies use customer surveys and workshops as sources to identify the requirements for their personalised products. Historical data and experience play an important role for three-quarters (37 responses) of the companies and are used in the product development process. Another important source named by more than half (30 responses) of the companies is customer feedback. The companies, therefore, use both forward-looking and backwards-looking sources to record requirements. This indicates that most companies use prospective and retrospective sources to identify the requirements for their personalised products.

## 2.4. Flexibilisation of production

Therefore, personalisation itself and development processes have an impact on production structures. More than 90% (43 out of 47 responses) of the responding companies see individualisation as the driving force behind the development of new production infrastructures. A precondition for the personalisation of products is a flexible production process enabling all product variants in line with customer requirements. Two-thirds (32 out of 48 possible responses) of the responding companies see flexibilisation through flexible production planning, followed by the factors of production technology (28 responses) and software (26 responses).

Employee skills (22 mentions) and production set-up (19 mentions) are also important. A high level of automation (11 mentions) and the size of production (8 mentions) are less important for the companies, see Fig. 4.

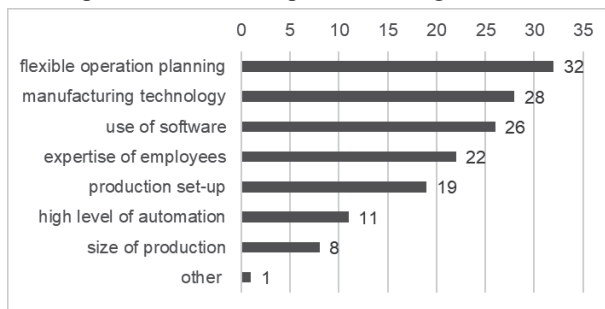


Fig. 4. Important production factors for mass personalisation (n=48)

### 2.5. Connection between personalisation and the cost structure

Due to the requirements for the development and production of personalised products, it is obvious that personalisation initially increases costs and only later leads to added value, which is then reflected in price increases. Of the 48 companies that responded, 27 agreed with this statement. However, 14 responding companies disagreed. Five companies were unable to evaluate this, and two saw other reasons. This means that the chain of reasoning cannot be clearly confirmed by the survey, but neither can it be rejected, see Fig. 5.

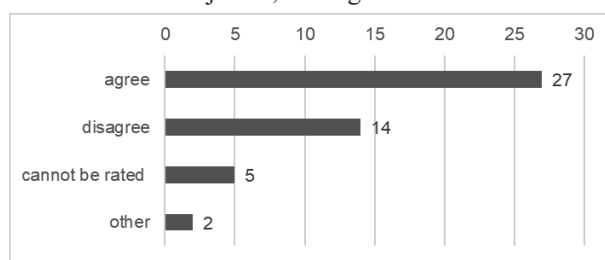


Fig. 5. Personalisation leads to an increase in manufacturing and production costs (n=48)

### 2.6. Integration of personalisation into the production process

Personalisation can take place in different phases of the production process. For example, it can affect the entire production process right from the start or only the final steps, for example, in the case of software-defined products. The hypothesis that personalisation in the company only takes place in the final stages of production was agreed to by 30.4% (14 of 46 responses) of the responding companies, 21.7% were neutral, and 47.8% (22 responses) disagreed or strongly disagreed. This suggests that personalisation represents a deep involvement in production for companies and that an economic optimum of variant creation in the assembly process (Engels et al. 2020; Große-Heitmeyer et al. 2004) or through software has not yet been achieved. Personalisation, therefore, often does not only take place in the final production steps, rather it is embedded much deeper and more complex in production, as the answers of the companies show.

### 2.7. Requirements and competencies for the realisation of personalised products

The above findings, the increasing user-centredness as a basis for the personalisation of products and services, and the new, highly complex product requirements resulting from personalisation require new professional and operational skills in companies. Given the accelerating pace of technological development, it can be assumed that the development and expansion of transformative skills, such as the ability to change and innovate, will be key competitive factors for companies in the future (Future Skills 2021). In addition to digital skills such as data analysis and AI combined with user-centred design, the focus here is on expanded awareness processes with regard to sustainable production, objective judgement, innovation skills and the ability to communicate. The results of the online survey confirm this thesis: the need for further training in the context of personalisation was primarily identified in the development of personal skills (business empathy, analytical skills, problem-solving skills).

Only 21% of respondents identified the development of IT skills as a need for training in companies, although almost 80% of respondents see flexible development structures, such as the integration of customer requirements into their products, the integration of customers into the development process or the integration of customer feedback into personalisation processes, as a key requirement for the establishment of personalisation in companies. In summary, the survey results confirm the findings of the expert interviews [5]:

- Companies that are new to the personalisation industry need to develop internal skills.
- Employees must have industry-specific knowledge of the increasingly complex manufacturing and analysis process.
- The skills to be developed range from social to specialist skills, especially in the area of digitalisation.

These skills must be integrated into existing production processes to achieve a common value orientation in line with the Sustainable Development Goals (SDGs).

## 3. EXPERIENCE WITH THE REALISATION

This section aims to analyse the challenges of implementing personalisation using skincare as an example and present successful solutions. For this purpose, the results of the online survey will be compared with Skinmade's experiences.

### 3.1. Introduction of Skinmade

The personalisation of products and services on the market is becoming increasingly important. The personalisation of products is particularly important in the skincare industry. Skinmade is an example of how customer feedback and information can be integrated into product development and the production process to develop and manufacture customised skincare products. The company is a pioneer in personalised skincare and produces personalised skincare products under its own brand. Based on a biomarker analysis carried out at the

point of sale, each order placed by a consumer is produced with a unique, personalised formula tailored to their needs. Fig. 6 illustrates the personalised production process at Skinmade.

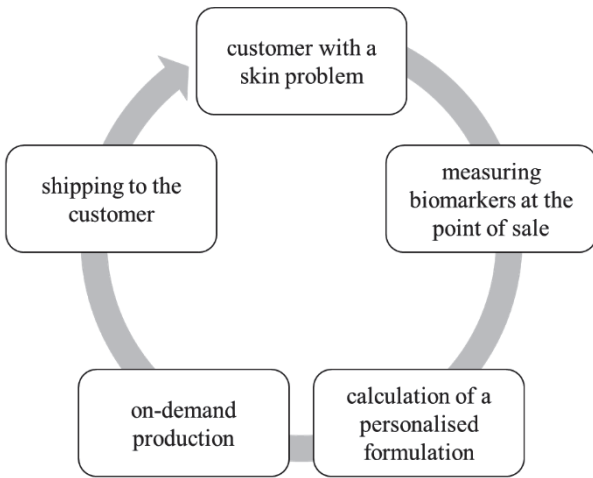


Fig. 6. Personalised production at Skinmade GmbH

### 3.2. Personalisation in product development at Skinmade

Skinmade always develops its products in a customer-centric way, together with its community. This community consists of customers and beauty institutes who know the market, the target group and their needs very well. Ideas and inspiration for innovative products and concepts come from a close dialogue with the community. An example of this idea generation and planning process is the successful implementation of a product idea from a beauty salon. This idea was fully implemented and also launched as co-branding (Becker 2023).

Proof of concept, development and prototyping are carried out in close iteration loops with customers, experts (e.g., beauty institutes) and testimonials. Requirements are gathered, translated into product features, implemented and tested. The iteration loops, and thus the customer-centric development process, are integrated into the launch and are part of a marketing campaign. Data collection is an integral and iterative part of all phases of product development. In the proof of concept and development phases, technical, physical, demographic and visual data is collected through community surveys and supplemented with biophysical historical data and experience. In the development and prototyping phase, sensor-based information is obtained through iterative feedback loops in product testing with the community and implemented directly into the product.

### 3.3. Elements of flexible production at Skinmade

The enabler for the production of personalised products at Skinmade is a cyber-physical production system (CPPS) enabling real-time communication between skin analysis (hyperspectral measurement of biomarkers using a measuring device) and production. Fig. 7 shows Skinmade's CPPS. The data required for personalised production (biomarkers and demographic data) is collected via a frontend (web application) that runs

on a dedicated end device. The measuring device is connected to the end device as a human-machine interface (HMI) for the transmission of the skin analysis measurement data, and the web application is essential for the user experience of the skin measurement and the ordering process. The frontend communicates with the backend using the https protocol. The architecture between the frontend and the backend is implemented as a REST (Representational State Transfer) interface. This allows a centralised backend to communicate with multiple distributed measurement systems. The backend consists of a database system and the algorithms for calculating the individual recipes. Microsoft Azure is used as a Platform as a Service (PaaS) to implement the backend. Data transfer from the backend to the programmable logic controller (PLC) is based on an OPC UA client-server model. The backend transfers the customer and order-specific production data to the PLC, which controls the corresponding process modules for personalised production. The CPPS developed by Skinmade enables a continuous flow of information along the described communication levels (HMI, frontend, backend, PLC). The continuous flow of information is a key factor for the feasibility of personalised production. Personalised production is also made possible by a production technology developed by Skinmade. The use of the CPPS, the developed software and architecture, the manufacturing technology and a high degree of digitalisation and automation are, therefore, the enablers of personalised production at Skinmade.

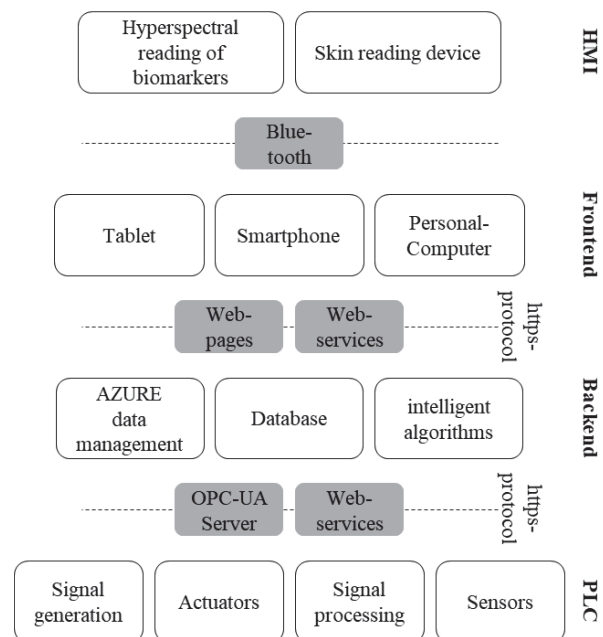


Fig. 7. Skinmade-cyber-physical production system for the production of personalized products

### 3.4. Lessons learned during implementation

For Skinmade, customer-centric product development has become a successful approach to reducing time-to-market. This requires direct contact with the customer and an efficient dialogue. Integrating customer requirements into the development process leads to products that are

more in tune with the market, increases customer satisfaction and minimises the risk of misdevelopments. Although personalised production results in higher unit costs, it enables a differentiated value proposition and higher prices, thus securing a competitive advantage in the long term. Economies of scope result from production structure and flexible production. For example, development and production orders for small batch sizes can also be offered as white labels. Economies of scope enable lower development and production costs within different variants and are increased by linking different processes and systematically exploiting development and production synergies.

However, this leads to increasing complexity in production due to the high variance. This complexity must be overcome through the use of suitable software and the digitalisation of the value chain. One hurdle for Skinmade, for example, is the lack of suitable software tools that enable the seamless implementation of personalised production. As a result, Skinmade has to do much in-house development, affecting the return on investment (ROI). This can lead to the failure of a successful implementation of personalised production, even though a competitive advantage can be achieved in the long term. For example, Skinmade had to change its strategy to increase economies of scale, moving away from the original decentralisation in the form of mini-factories (Weik 2023) at the point of sale, see Fig. 8.



Fig. 8. Decentralised mini-factories at Skinmade GmbH (Weik 2023)

This has been achieved by physically separating skin analysis and production. Skin analysis remains

decentralised at the point of sale, while personalised production has been centralised. This reorganisation of the production structures has improved the business metrics without negatively impacting the level of personalisation or the value proposition. The conditions and enablers for this were a high degree of digitalisation and integrated value creation. The findings from the practical example agree with the results of the survey that the successful implementation of personalised production is already influenced by the development of the product system, as this defines the factors and degrees of freedom of personalised production.

#### 4. RECOMMENDATIONS FOR ACTION

This section focuses on the recommendations regarding action for product development, production design, and future skills requirements for employees. The results of the expert survey, the online survey, and the experiences of Skinmade are integrated into the recommendations for action.

##### 4.1. Systematic data collection

Understanding customer groups requires targeted and consistent data collection. This enables the behaviour, preferences and needs of each customer group to be better identified and understood. Various data sources such as technical information, individual interfaces and requirement profiles can be used to make decisions on the development of personalised products.

To achieve this, potential customers must be involved in the product development process at an early stage. Thus, their needs are better understood and taken into account. For example, focus groups or other market research methods can be used to gain relevant insights for developing personalised products. It can also be used to gather customer requirements and feedback on product ideas at an early stage of product development. For example, prototypes or mock-ups can gather feedback during the development phases. This allows the functionality and acceptance of personalised products to be tested with customer groups at an early stage.

##### 4.2. Monitoring and analysis

Personalised products should be continuously analysed and evaluated to measure their customer effectiveness. Not only the products themselves but also the processes for gathering customer data need to be constantly analysed and evaluated. The effectiveness of personalised solutions can be assessed using appropriate metrics and performance indicators, and by continuously comparing values over time. This way, adjustments can be made based on insights and a robust database to improve personalised products continuously.

Companies should, therefore, consider personalised approaches in the planning of products and services from the beginning to be able to produce flexible and user-centred products in the long term. Suitable data sources must be identified and considered early on so that customer data can be gathered and analysed. Structured data collection then enables the implementation of technologies such as AI.

### **4.3. Flexibilisation of production**

Flexible manufacturing is one of the key requirements for the efficient production of personalised products. A flexible manufacturing process allows the company to meet customer needs better through personalised solutions. Although the initial investment in flexible manufacturing is costly, it pays for itself over time through economies of scale, such as white labelling, or other synergies within a company's own product range, such as production networks and more flexible capacity utilisation across different production locations.

### **4.4. Establishing flexibility in the development process**

Companies, therefore, must establish flexible development structures to enable personalised development processes. This adaptability of development structures enables companies to respond quickly to individual needs and develop innovative solutions. To achieve this, employees need to be trained to work closely with customers in the early stages of development. This can further strengthen the company-customer relationship and create differentiation and competitive advantage.

### **4.5. Necessary skills for personalisation**

Organisations need to consider the multi-dimensionality of the term »user«. User-centricity focuses not only on customers but also on all stakeholders involved in the relevant processes, including employees. It is, therefore, important to involve employees in personalisation-related processes from the outset and to train them accordingly. This also means that employees must be actively involved in the change management processes associated with implementing personalisation from the outset. In this way, companies can use their employees' experience and skills to optimise the processes of personalised products. This also aligns with the holistic, user-centric approach to personalisation and builds trust and acceptance within the organisation.

This means that implementing personalisation requires a radical change of perspective and a high degree of flexibility from specialists and managers. The development of transformational skills within the organisation, such as judgement, willingness to change, innovation, communication and conflict skills, and mission orientation, is, therefore, essential. For this purpose, companies need to offer appropriate training programmes so that employees can develop and strengthen their skills as needed.

### **4.6. Legal aspects and solutions**

Companies need to find practical solutions to legal challenges, particularly in data protection. This requires regular engagement with policymakers on data protection, as well as reviewing and complying with current regulations. To this end, companies need to develop and implement their own data protection strategies to implement personalised approaches ethically and in compliance with the law.

This will enable the use of technologies such as AI and machine learning. In the future, companies will need to invest in appropriate technology and build expertise in

dealing with AI and using personalised data. Only through the strategic use of AI will companies be able to develop and offer personalised services and products efficiently.

### **4.7. Use cross-sector training collaborations**

Small and medium-sized enterprises often do not have the resources to train employees on their own. In this case, it is advisable to use or establish cross-industry training partnerships, for example, with other companies, universities, colleges or other educational institutions. This can provide companies with access to relevant training resources and transdisciplinary skills. In this way, companies can proactively address the growing skills shortage.

## **5. CONCLUSION**

The results highlight the challenges of personalisation. In particular, the link between product development and production requires new skills. Participants' responses show that the early stages of the development process are very important for data collection. Targeted data collection, early customer involvement, flexible production, and the use of prototypes are key aspects of efficiently producing personalised products and maximising customer value. This requires continuous monitoring and analysis of customer requirements and their implementation in development and production to evaluate the effectiveness of personalisation and make continuous improvements. It has become clear that the early involvement of customers in development processes means that production also needs to be flexible and that development, therefore, influences the design of production processes. This illustrates the interaction between development and production to produce personalised products economically. Employees also must acquire new skills in handling personal data to meet ethical and legal requirements.

These findings are in line with the practical experience of Skinmade GmbH. However, the scaling of Skinmade's business model has shown that although user-related data can be collected decentrally, production must take place centrally at Skinmade for economic reasons. This once again underlines the complexity of implementing and operating flexible production systems for the manufacturing of personalised products.

From the results of the online survey and the comparison with Skinmade, it is clear that personalisation offers not only competitive advantages but also the potential for achieving sustainability goals. Personalised production is more costly. However, it allows for a differentiated value proposition, higher selling prices, and less waste. This approach contributes to economic, social, and environmental sustainability. Personalisation allows the development of new (sustainable) business models, such as selling services based on customer-specific data sets. In this context, further questions must be answered, such as how companies can use personalisation within ethical and legal requirements to achieve their sustainability goals and create new business models at the same time. Organisational structures also play an important role and must be considered in the context of personalisation.

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