Industry 4.0 Technologies and the Industrialisation of Beauty Industry Services

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Abstract: The study examines how digital technologies associated with the Fourth Industrial Revolution may be integrated into beauty-industry small and medium-sized enterprises, and how industrialisation may be interpreted in a service sector that remains strongly dependent on human expertise, trust and aesthetic judgement. A research-based digital maturity and industrialisation model is developed, through which five dimensions are assessed: digital presence, customer journey management, operational standardisation, data-driven decision-making and technological innovation. It is argued that beauty-industry industrialisation should not be understood as mass production or the displacement of professionals. Rather, it should be understood as the systematic stabilisation, measurability and scalable development of service processes. References have been inserted according to the order of first occurrence, and no citation group contains more than three references.

Keywords: beauty industry; digitalisation; industrialisation; artificial intelligence; SMEs; service innovation; customer journey; data-driven management

1 Introduction

The technologies associated with the Fourth Industrial Revolution have been introduced not only into manufacturing systems but also into service sectors in which personal interaction had previously been treated as the dominant source of value. The convergence of digital, physical and biological domains has been described as a defining characteristic of this transformation [1]. In parallel, automation and data-driven decision-making have been presented as mechanisms through which labour, knowledge and productivity are reorganised [2].

Beauty-industry services provide a particularly useful research field because customer choice is influenced by visible outcomes, reputation, trust, trend sensitivity and recurring interaction. A beauty salon is no longer encountered only as a physical location. It is searched for online, compared through reviews, evaluated through images, booked through digital channels and discussed through social media. Consequently, the service is increasingly initiated before the customer enters the salon, and it is continued after the physical intervention has been completed.

The present study is based on scientific research and is focused on the industrialisation of beauty-industry services. In this context, industrialisation is not defined as the mechanised production of identical services. It is defined as the structured organisation of recurring service processes, the technological support of background operations, and the systematic use of data for customer management, quality stabilisation and business development. Where literature from critical infrastructure, cybersecurity and safety-management research is cited, it is used as an analogical basis for process reliability, data protection and operational resilience, not as a claim that beauty salons have the same risk profile as critical infrastructure operators.

2 Literature and industry background

Digital transformation has been treated in public policy and management literature as a cross-sectoral change process through which organisations are required to develop basic digital capabilities, data literacy and platform-based interaction [3]. In consumer service industries, digital tools have been associated with improved convenience, personalised access and stronger customer retention. In the beauty sector, growth has also been connected with premiumisation, science-based products and the increasing integration of technology into consumer routines [4].

Marketing and customer relationship management have been reshaped by the transition from conventional promotion to digital, networked and platform-based interaction. Technology-oriented marketing has emphasised the importance of personalised customer value, while social media research has shown that online communities and user-generated content can become central components of brand trust [5, 6]. Platform theory has also demonstrated that value is increasingly generated through multi-sided ecosystems rather than through isolated firm-customer transactions [7].

For beauty-industry SMEs, these developments mean that a service cannot be evaluated only through technical professional skill. The full service experience includes online search, visual reference material, booking, reminders, payment, feedback, rebooking and after-care communication. The experience economy perspective is therefore relevant, because value is co-created through staged, memorable and repeatable interactions.

3 Artificial intelligence and intelligent service personalisation

Artificial intelligence has been increasingly used as a decision-support technology in service contexts. Core AI literature has defined intelligent systems through perception, reasoning, learning and action in complex environments [8]. In managerial practice, AI has been applied most effectively where well-defined tasks, sufficient data and clear decision rules are available [9]. In beauty-industry services, this logic is visible in AI-supported skin analysis, recommendation engines and customer segmentation.

Image-based diagnostics have particular relevance for the beauty sector. Dermatological image classification research demonstrated that deep learning can achieve high diagnostic performance in selected skin-related classification tasks [10]. Although such results cannot be directly transferred to commercial beauty services without validation, they justify the careful investigation of AI-assisted visual assessment. Augmented reality has also been analysed as a technology that alters consumer behaviour through interactivity, vividness and simulated product experience [11].

Virtual try-on applications and immersive product testing illustrate how digital tools can reduce uncertainty before purchase. Retail studies of AR/VR have shown that interactive simulation may improve engagement and perceived usefulness [12, 13]. Nevertheless, the use of such tools in salons or cosmetic retail must be accompanied by transparent communication, because customer trust is easily damaged if algorithmic recommendations are treated as objective professional diagnoses without appropriate limits.

4 Employment, skills and the service workforce

The introduction of automation has often been discussed in relation to labour substitution. Employment research has shown that routine tasks are more exposed to computerisation, while tasks requiring creativity, social intelligence and complex perception remain more difficult to automate [14]. This distinction is particularly important in the beauty industry. Scheduling, reminders, stock alerts and customer data recording may be automated, but professional judgement, aesthetic taste, hygiene discipline and customer empathy remain human-centred.

From a development perspective, digitalisation should therefore be interpreted as a skill transition rather than as a simple labour-saving mechanism. Beauty-industry professionals are expected to combine technical craft knowledge with digital competence, data awareness and online communication ability. This requirement is consistent with European digitalisation policies that emphasise basic digital capacity in SMEs [15].

As personal images, contact details, preferences, health-related information and payment data may be processed during beauty services, compliance with data protection obligations must be treated as a strategic requirement. European data protection regulation requires lawful, fair and transparent processing of personal data [16]. Cybersecurity frameworks further indicate that even small organisations benefit from structured identification, protection, detection, response and recovery practices [17].

5 Research aim, questions and methodological approach

The research aim is to identify how digital technologies can be converted into an industrialised operating model in beauty-industry SMEs. The study is not based on the assumption that all salons should immediately implement advanced AI systems. Rather, it is assumed that digital development should be phased, proportionate and linked to the real operating problems of the enterprise.

Three research questions are addressed. First, which digital technologies may be treated as basic infrastructure for beauty-industry services? Second, how can online visibility and customer interaction be transformed into a data-driven service process? Third, under which conditions does technological development produce genuine industrialisation benefits instead of remaining an isolated tool purchase?

A qualitative, model-building approach is applied. Typical salon processes are analysed and mapped against digitalisation and automation opportunities. This method is supported by research on supply-chain resilience and data-driven strategies, because even micro-service providers depend on reliable flows of materials, information and customer commitments [18, 19]. These sources are therefore used to transfer general principles of resilience, process coordination and data-based planning to a small-service-provider setting.

6 The proposed digital maturity and industrialisation model

The central result of the study is a five-dimensional maturity and industrialisation model. The model assesses digital presence, customer journey management, operational standardisation, data-driven decision-making and technological innovation. Human-factor research in safety-critical environments suggests that technology alone cannot stabilise performance unless people, procedures and organisational routines are considered together [20]. This assumption was therefore built into the model. In the present model, this literature supports the assumption that stable service quality depends on the coordinated management of people, procedures and digital tools.

Advanced technologies can support resilience and efficiency when they are integrated into a broader operating logic [21]. In the beauty sector, an online booking system becomes industrially relevant only when it reduces errors, supports capacity planning, connects with customer history and improves follow-up. A similar logic applies to collaborative or automated technologies, where safety, interaction and process design must be addressed together [22]. The relevance for beauty services lies in the same organisational logic: technology creates value only when it is connected to a controlled workflow and to responsible human decision-making.

Industry 4.0 and 5G-related research highlights the significance of connectivity, integration and standardisation in modern service and production systems [23]. For a beauty salon, these principles are translated into accessible booking data, standard service durations, consistent documentation and structured marketing workflows. The reference is therefore interpreted at the level of connectivity and standardisation rather than at the level of industrial infrastructure scale.

7 Model dimensions

Digital presence is the first dimension. It includes the website, social media channels, online reviews, visual portfolio and local search visibility. Its industrialisation role lies in the conversion of informal recommendation into a measurable acquisition channel. Compliance-oriented research also suggests that visibility and control should be supported by clear rules and accountable routines (see the Table 1.) [24]. This compliance analogy is relevant because salon visibility increasingly depends on controlled platform access, accountable image use and consistent review management.

Dimension	Analysed content	Industrialisation relevance
Digital presence	Website, social media, reviews, portfolio	Converts informal visibility into a repeatable acquisition channel.
Customer journey management	Booking, reminders, payment, feedback	Makes customer interaction measurable and manageable.
Operational standardisation	Stock, hygiene, documentation, service steps	Reduces errors and stabilises service quality.
Data-driven decision-making	Customer frequency, service popularity, revenue and stock data	Supports pricing, procurement and capacity planning.
Technological innovation	AI analysis, AR/VR, smart devices	Enables differentiation and premium positioning.

Table 1.
The digital maturity and industrialisation model for beauty-industry SMEs. By authors.

Customer journey management is the second dimension. Booking, reminders, payment, feedback and rebooking are treated as linked steps rather than separate activities. Cloud service orchestration research is relevant here because it illustrates how distributed services may be coordinated to create more reliable and scalable functionality [25]. The analogy helps to justify the integration of separate customer-contact points into one manageable service flow.

Operational standardisation is the third dimension. It includes service descriptions, hygiene documentation, stock routines, equipment maintenance and customer records. Blockchain and manufacturing-integration research is indirectly relevant because traceability, transparency and verifiable process history are increasingly expected in digitally supported operations [26]. In this study, traceability is interpreted in a service-specific sense, namely as the ability to reconstruct service steps, product use and customer-related decisions when quality or safety questions arise.

Data-driven decision-making is the fourth dimension. Customer frequency, service popularity, material usage, average service time and campaign results can be analysed to support pricing, procurement and staffing decisions. IoT security research also underlines that connected systems must be designed with appropriate security controls when operational data are collected [27]. This is particularly relevant where customer records, online booking data and device-generated information are processed together.

Technological innovation is the fifth dimension. AI skin analysis, AR product testing, intelligent devices and automated stock alerts may support differentiation. However, web-system security testing research indicates that application-based services require systematic verification, because digital customer interaction may introduce new vulnerabilities [28]. The cited security-testing perspective is therefore used to support careful tool selection and periodic verification of customer-facing digital applications.

8 Industrialised customer journey

The customer journey begins with digital discovery. The salon is found through search engines, maps, social media posts or recommendations. At this stage, credibility is built through consistent visual presentation, transparent service information and trustworthy reviews. Research on OT network defence confirms that digital networks must be protected both at the operational point and through the surrounding IT environment [29]. Although a salon is not a critical infrastructure operator, the same logic supports the protection of booking platforms, social media accounts and customer databases. The citation is used to justify a basic cyber-hygiene perspective for digitally dependent customer interaction rather than to suggest that salon operations are equivalent to OT systems.

The booking stage creates the first structured data point. An online booking system records the selected service, time, duration and sometimes customer preferences. Research on operational technology networks is useful by analogy because it emphasises that local operations and surrounding IT environments should be treated as connected systems [30]. If booking, customer history and reminders are disconnected, much of the digital value is lost. For beauty SMEs, the transferable lesson is that disconnected digital tools reduce both service efficiency and data reliability.

During service delivery, digital tools should be used as support rather than as substitutes for professional competence. Cyber-defence research has noted the limits of detection technologies and the need for combined technical and organisational solutions [31]. In a salon context, the same principle means that AI analysis, image documentation and product suggestions should be interpreted by trained professionals. This strengthens the argument that digital support must remain embedded in professional judgement.

After the service, feedback, rebooking and personalised after-care may be managed digitally. Data-minimisation research is relevant because only necessary data should be collected and disclosed, particularly where personal images and sensitive preferences are involved [32]. A legally and ethically sound customer journey is therefore a precondition of sustainable digital growth. The reference therefore directly supports the proportionate handling of customer images, preferences and contact data in salon practice.

9 Development levels for beauty-industry SMEs

Three development levels may be distinguished. The first level is basic digitalisation. This includes social media, online portfolio, searchable location data, clear digital service lists and electronic payment. At this level, digital tools primarily increase visibility and convenience (see the Table 2.).

Development level	Main objective	Typical tools	Expected business effect
Basic digitalisation	Visibility and access	Social media, web page, portfolio, electronic payment	Improved discovery and customer convenience.
Operational automation	Administrative simplification	Online booking, reminders, digital customer card, stock records	Reduced errors and more predictable capacity.
Intelligent service development	Personalisation and differentiation	AI analysis, recommender systems, AR/VR, predictive analytics	Premium positioning and data-driven growth.

Table 2.
Development levels of digital industrialisation in beauty-industry services. By authors.

The second level is operational automation. Online booking, automated reminders, digital customer cards and simple inventory systems reduce administrative work and prevent avoidable errors. Innovative education and skill-development approaches, including hackathons, have been proposed as ways to strengthen applied digital learning [33]. Such approaches are relevant because salon employees often require practical, scenario-based training rather than abstract software instruction. The relevance of this literature is practical: digital competence should be developed through short, applied and work-process-based learning activities.

The third level is intelligent service development. AI-supported recommendations, predictive analytics, AR/VR and diagnostic tools can create premium value. Research on AI-supported knowledge assessment demonstrates how intelligent systems may support structured evaluation processes [34]. VR-based training studies also indicate that immersive technologies can simplify learning and recognition tasks in complex environments [35]. For salon SMEs, these sources support the introduction of intelligent tools only after employees understand their limits, outputs and customer-facing implications.

10 Case-based analysis of a nail salon

A nail salon was selected as an illustrative case because the service is visual, recurring, material-dependent and strongly influenced by online trends. The work requires manual skill and creativity, but the background process can be highly standardised. AI-enabled organisational monitoring research shows that machine learning may be used to identify patterns and support proactive management [36]. In a nail salon, similar principles can be applied at a modest level through service-frequency analysis, material consumption monitoring and no-show tracking. The analogy is deliberately limited to pattern recognition and proactive management, which are relevant even when the available dataset is small.

The first development step is the systematic management of the online portfolio. Finished work should be photographed under consistent conditions, categorised by technique and linked to service information. This transforms visual evidence into a structured marketing asset rather than an occasional social media post.

The second step is digital booking and customer record management. The duration of each service type should be standardised, and exceptions should be recorded. Allergies, material preferences, nail condition and previous designs may be stored only when lawful and necessary. This creates continuity between appointments and reduces the risk of service inconsistency.

Systems approaches used in water safety planning demonstrate the value of documented processes, monitoring and corrective action [37]. The same principle can be adapted to salon hygiene and stock reliability. This addition clarifies why a safety-planning reference is useful for a salon case: both contexts require documented routines, monitoring and corrective action.

11 Data, safety and sustainability considerations

Digitalisation generates operational data, and the value of such data depends on accuracy, relevance and responsible processing. Sensor-placement research in water-quality monitoring shows that data collection must be planned according to the decision that it is expected to support [38]. For beauty-industry SMEs, this means that data should not be collected merely because it is available; it should be linked to booking reliability, customer retention, stock planning or service quality. The cited monitoring logic is therefore transferred to service-management indicators, such as appointment reliability, material use and customer-retention data.

Systems standards used in safety planning underline the need for repeatable processes and continuous improvement [39]. In salon management, this logic can be translated into documented hygiene routines, scheduled equipment maintenance, recorded complaints and periodic review of customer satisfaction. Security standards applied to drinking-water systems also demonstrate that service continuity and trust depend on controlled procedures [40]. The drinking-water example is used only as a process-control analogy, because both areas depend on documented routines and customer trust.

Sustainability is also connected to industrialisation. Improved stock management can reduce waste, while digital documentation can reduce paper use. Responsible procurement and transparent product information can support customer trust. In this sense, beauty-industry industrialisation includes not only efficiency, but also accountability and environmental awareness.

12 Security-related advanced technologies and their relevance

Although the references in this section originate mainly from critical infrastructure and security research, they are used here as transferable principles for proportionate risk management in digitally mediated beauty services. Research on the human factor in critical infrastructure protection has shown that technological development must be accompanied by security-aware implementation and organisational responsibility [41]. For beauty-industry services, this is important because online booking, payment, cloud storage and social media accounts expose even small businesses to operational and reputational risk.

Human-factor research in critical infrastructure has shown that people remain a central source of both resilience and vulnerability [42]. Machine-learning research on network and firewall data also indicates that digital systems produce patterns that may be analysed for threat detection and operational understanding [43]. Although the scale is different, a salon that relies on online systems should adopt basic cyber hygiene, strong passwords, access control and backup routines.

AI assessment in financial institutions has highlighted the need for risk awareness when algorithmic systems are used in decision environments [44]. Intrusion-detection research for IoT cybersecurity and studies on the need for cybersecurity solutions in IoT systems further show that connected devices should not be treated as neutral tools [45, 46]. Beauty devices, booking platforms and customer databases should therefore be selected with security, vendor reliability and data protection in mind. This clarifies the sectoral relevance of the cited cybersecurity literature: its practical value is in vendor selection, secure configuration and responsible handling of connected service devices.

Information security in smart nations and digital competence research both indicate that technological maturity depends on user awareness and organisational culture [47, 48]. In a beauty salon, this means that employees should understand not only how to use digital tools, but also why customer data, images and online accounts must be protected. The connection to the beauty sector is therefore made through employee behaviour, customer-data awareness and everyday digital discipline.

Collaborative robot research has shown that automation should be evaluated through safety, interaction and usability requirements [49]. While most beauty-industry SMEs will not use industrial robots, the principle is transferable: any automated or intelligent device must be integrated into a safe, comprehensible and professionally controlled workflow. This supports the cautious adoption of automated beauty devices, diagnostic tools and smart equipment.

13 Practical implementation framework

A practical implementation framework should begin with a process audit. The current customer journey, booking practice, data handling, stock management and after-care communication should be documented. Only after this mapping has been completed should software or equipment be selected.

The second phase should introduce low-risk, high-value improvements. These may include a structured service list, standardised durations, online booking, electronic payment and automated reminders. Cybersecurity and privacy guidance recommends that risk management should be proportionate, documented and embedded into ordinary organisational practice [50, 51]. In this context, the practical implication is not complex enterprise certification, but a simple and documented approach to passwords, backups, customer consent, access rights and supplier selection.

The third phase should establish measurement. Useful indicators include booking volume, cancellation rate, no-show rate, returning-customer ratio, average service value, stock-out events and online review quality. These indicators create the evidence base for further industrialisation. Cosmetic good manufacturing practice standards also demonstrate that documented quality processes are essential where product use and hygiene are central [52].

14 Discussion

The findings suggest that the industrialisation of beauty-industry services is primarily a managerial and organisational phenomenon. Technology enables the change, but it does not guarantee it. An online platform may improve service quality only if service categories, time allocation and customer communication have been defined. AI may support personalisation only if its outputs are interpreted responsibly. Data may support decision-making only if it is accurate, lawful and regularly reviewed.

The proposed model contributes to the literature by connecting digital maturity with industrialisation potential. Instead of treating digital tools as isolated innovations, the model evaluates whether tools are embedded into the service process. This is particularly important for SMEs, where limited resources require prioritisation and where poorly selected technology may create cost without strategic benefit. The critical-infrastructure and cybersecurity references are therefore used selectively as sources of transferable principles, especially resilience, traceability, privacy and secure operation, rather than as direct sectoral comparisons.

The model also has practical value. It allows a salon owner to identify whether the next development step should be marketing visibility, booking automation, stock control, customer data analysis or advanced innovation. The same logic can be adapted to cosmetics, nail services, hairdressing, make-up, beauty retail and skin-care consultation.

Conclusions

The study has shown that beauty-industry digitalisation can be interpreted as a service-centred form of industrialisation. This form of industrialisation does not remove the personal character of beauty services. Instead, it professionalises the background processes that support personal service delivery.

The five-dimensional model demonstrates that digital presence, customer journey management, operational standardisation, data-driven decision-making and technological innovation should be developed together. If one dimension is neglected, the benefits of the other dimensions may be reduced. For example, AI-based diagnosis will not create sustainable value if customer data are poorly protected or if basic booking processes remain chaotic.

For beauty-industry SMEs, phased implementation is recommended. Basic digitalisation should be followed by operational automation, and only then should advanced AI or AR/VR solutions be introduced. This pathway reduces financial risk, supports learning and ensures that innovation remains connected to customer value and business sustainability.

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