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Metrology and sensors as dermo-cosmetic technology opportunities for a change of paradigm

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Abstract

Objective: Metrology and measures are changing the way patients and consumers behave and help find new, more effective solutions.

Methods: This Review and Prospective Paper identifies applications in the field of dermatology and beauty tech.

Results: The review of skincare as well as dermatological applications and analysis provides a comprehensive picture of the dynamics in the process of impacting the complete value chain in the field of dermo-cosmetics, as well as the opportunities offered by a strict approach around new and innovative measures, especially in the field of better patient/consumer knowledge, understanding, and personalized solution offering. It identifies the new business models or opportunities for the cosmetic industry.

Conclusion: Adapting metrology and measures to skincare is a significant opportunity to change the way things are done today.

KEYWORDS

beauty, dermatology, dermo-cosmetics, Internet of things, privacy, Safety testing, sensor, skin barrier, skin metrology, Skin physiology/structure

1 | INTRODUCTION

According to the International Bureau of Weights and Measurements, metrology, the study of measurement, is becoming an essential aspect of all industries today in creating value.[1] There are two technologies impacting metrology today: quantum and iot (Internet of things). Metrology is rapidly expanding in B2B industries and is now going to experience growth in consumer arenas, mainly through the channels of iot devices.[1] Expansion of metrology is particularly relevant in health care, as remote healthcare measurements and immediate data processing are bringing value to physicians and consumers to create more advanced and immediate preventative solutions.[2] This growth provides the opportunity to connect consumers to physicians remotely

and digitally as consumers regularly search for more information on their health and personal care. This expansion indicates that there is real value in metrology for the coming future, particularly for consumers, and this can extend to other areas of health and personal care such as skincare.

Putting in perspective a patient and consumer trend of self-monitoring and tailored-size products, we illustrate the multiple opportunities carried by the release of reliable sensors, iot, and artificial intelligence. A review of existing products and their influence on skin comprehension, skincare, skin clinical trials, and marketing and business is also provided. Taking the example dermo-cosmetic and beauty industry, this paper highlights the challenges and opportunities of digital business transformation through sensors, iot, and data generation.

Caroline Bollinger and Tu Anh Duong have equal contributions.

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2 | METROLOGY AS THE NEXT FRONTIER

2.1 | Internet of things for reliable measures

People from all industries, brands, physicians, and consumers are searching for new measurements and solutions that can bring convenience and value to their daily life. These solutions are already prevalent in some categories; consumers are receiving regular measurements on various aspects of their life, including heart rate, sleep, calories consumed and burned, and many other parameters.[3] Complementary to applications collecting declarative data, devices within the Internet of things are an essential factor in this growth of personal measurements and how it impacts consumers' lives. Bain and Company report that the combined Internet of things market is expected to grow to about $520 billion in 2021.[4] Consumers today are surrounded by connected devices spanning from the development of smart cities, smart homes, connected cars, wearable devices, and many more. We can, therefore, anticipate an opportunity for further innovation into more specific industry-targeted solutions via iot and new accurate measurements.[4]

Bain and Company in "Unlocking Opportunities in the Internet of Things," however, report that existing cloud service providers, such as Amazon and Microsoft, should focus less on expanding on broad services within iot and more on industry-targeted solutions.[4] These providers invented broad horizontal services with low barriers to iot adoption but lack industry-specific applications. Bain and Company mention that these cloud service providers are influential figures in iot analytics and services; however, their broad focus leaves opportunity for new providers in specific industries. Though these more specific solutions may take more significant investment and time to develop, it is still an essential opportunity for advancement right now in various industries.[4] The Internet of things has changed the outlook of many industries through the intersection of informational and operational technology and expanding consumer services; however, it still faces challenges and opportunities. Consumers identify security, ease of adaptation, and uncertain value and returns as primary barriers to adopting iot devices. To address these concerns, brands should focus on more targeted solutions to specific consumer problems and areas yet unaddressed by industry giants.[4]

New, more accessible, miniaturized technologies are enabling measurement and data to bring new value to both consumers and brands. These smaller sensor technologies within iot devices are becoming more accessible and advanced but at a lower price. This growth allows companies to think about developing more user-friendly, consumer-ready, and possibly disposable devices to bring a return on investment. These smaller and portable devices enable consumers to conduct measurements remotely but gain instant access to data.[5] The new value brought to consumers through the expansion of iot devices to bring measurements is the next frontier in many industries.[6]

This innovation in smaller devices allows for large-scale monitoring, detection, and collection of data. Advances in real-time analytics and artificial intelligence make this shift in data from the personal device to large-scale analysis of big data for the benefits of brands and consumers more achievable. Gaining customer data in many fields of health and personal care enables insights creating added value for companies to personalize and adapt their solutions.[7] An example of this expansion into the health field is how Alphabet, Amazon, and Apple are all beginning to invest in the development of hardware devices for diabetes. Individually, Alphabet is working with Dexcom to bring hardware to the market that will provide continuous monitoring.

It is essential to note the sociological changes that result from iot devices and general technology so diffused into everyday life. The beauty industry is far advanced in digital consumer goods and services due to the way consumers engage with brands and seek out innovation.[8] There is constant innovation in the beauty industry concerning digitally native brands and new color cosmetics, affecting the way consumers and brands interact.[8] Many consumers today are more interested in trying various products, rather than merely purchasing. Part of this drive originates from the widespread ability to try products in stores or with subscription beauty boxes, as well as consumer motivation to know how well a product works for them before making a purchase.

Augmented reality applications are digitally bringing this experience to consumers as they can take a picture of their face and see themselves with various types of color cosmetics.[8] The skincare industry is also expanding into this category as multiple brands have created applications allowing consumers to receive feedback and advice based on how their skin looks in a picture.[9] There is, however, still a significant gap and opportunity for growth in bringing hardware (sensors and devices) and digital into skincare. Real measurements are an answer to the growing need to balance out the often used declarative-only product assessments. Bringing more fact-based, objective data, measures is more and more perceived as a way to strengthen the trust in the value chain.[10]

While this challenge of bringing iot hardware into skincare has been a focus of many large brands, however, it is so far limited. As consumers become further informed and experience measurement and data in other areas of their life such as exercise and diet, they are seeking out innovation and more precise, specific, and personal measurements within the dermo-cosmetic industry as well. The challenge of large industry giants attempting to keep up with evolving demand brings a fascinating new landscape to the dermo-cosmetic industry, as new players, with new sensors and devices, emerge (Table 1).

2.2 | Reliable measures: a challenge and an opportunity in dermatology

In health care, dermatology provides a good model for ICT (information and communication technology) integration and use for preventive diagnosis or follow-up strategies using mobile health or specific sensors for skin or environment monitoring. The visual nature of dermatology enables the use of images for diagnosis and makes this discipline a perfect model for telemedicine or remote

TABLE 1 Overview of a selection of innovative launched and to be launched Beauty Tech solutions

Device	Brand manufacturer	Measure method	Owned tech	Hardware	Software	Brand-specific	Product release/effect	Description/Providers commercial claim
Optune	Shiseido	App	×	×	×	×	×	Optune is an iot personalized skincare system that offers 80,000 skincare patterns matched with individual user's daily skin conditions and living environments which change day to day.
Perso	L'Oréal	App	×	×	×	×	×	This 6.5-inch beauty tech device, developed by our technology incubator, delivers personalized on-the-spot skincare and cosmetic formulas.
Clinique Clinical Reality	Lauder	App			×	×		Download your picture and get a skin diagnosis in a few minutes based on 50 years of dermatology expertise
MAPO Hydra	WB Technologies	Skin sensor	×	×	×		×	First beauty mask providing skin diagnosis and formulation booster.
YouCam	Perfect Corp	App	×		×			Beauty 3.0 AI + AR technology helps you know yourself better than before.
Lulu Lab Lumini Lab	Samsung	App	×		×	×		AI Skincare Assistant LUMINI analyzes a whole facial skin in a snap and recommends the skincare products for each user
Skin 360	Neutrogena	App			×	×	×	The free Neutrogena Skin360™ app brings together decades of Neutrogena® trusted expertise, innovative skincare technology, and personalized recommendations all in one place.
Opte Skin system	P&G	App	×	×	×	×	×	Opté beauty device for age spot removal and facial toning will target weak spots. Opte digitally scans your skin, analyzes your complexion, and camouflages age spots.
Iope	Amore Pacific	App	×	×	×	×	×	3D face mask printing system (IOPE Tailored 3D Mask) and flexible LED beauty device (MakeON Flexible LED Patch)
Poseidon	CareOS	App	×	×	×			CareOS is the first smart Health & Beauty Hub for devices and services in the bathroom. It connects them together to make them smarter.
MAPO Solaire	WB Technologies	Skin sensor	×	×	×			UV sensing wearable, in real time, in real life for better sun prevention and protection
Venus	Icon AI	App	×	×	×			ICON.AI, the smart beauty device maker behind the world's 1st All-in-one Multi-Function Smart Makeup Mirror Device,
My Skin Track US	L'Oréal	Skin sensor	×	×	×	×		My Skin Track UV is a wearable technology and app to measure your exposure to environmental aggresssors including UV, pollution, pollen, and humidity.

(Continues)

TABLE 1 (Continued)

Device	Brand manufacturer	Measure method	Owned tech	Hardware	Software	Brand-specific	Product release/effect	Description/Providers commercial claim
Hylab	Romy	App	x	x	x	x	x	To create everyday in 1 min a dose of fresh, clean, tailor-made skincare
Duolab	L'Occitane	App	x	x	x	x	x	A home device which blends and warms a personalized face cream product.
Ultraviolet	Ultra.inc	Skin sensor	x	x	x	x		Now there is a better way to enjoy the sun while taking care of the skin.
Wayskin	Amore Pacific	Skin sensor	x	x	x	x	x	Brings clinic quality care, matched to your life and your skin.
Shade	Shade	Skin sensor	x	x	x	x		The Shade sensor solves this by correctly weighting UVB and UVA and behaves just like your skin.
SalonLab	Henkel	Hair sensor	x	x	x	x		Digital ecosystem allowing the professional hair care experience personalization

management.[11] A wide literature points the benefit of remote image transfer for skin condition management improvement or consultation triage.[12] This digital perspective in dermatology also raises the ability for non-specialist or non-doctor to participate in a new care process with a dermatologist at a distance.[12] The scientific literature identified up to 500 hundred apps related to the dermatology field. The expansion of applications has grown with the number of smartphone users and the trends of increasing patient-centric approaches to improve healthcare efficiency.[13,14] Among the identified apps targeting both patients/individuals and healthcare providers, ten categories are identified: general dermatology reference, self-surveillance/diagnosis, disease guide, educational aids, sunscreen/UV recommendation, calculator, teledermatology, personal images storage/sharing, conference, or journal.[13,14]

The ability of using a smartphone to gather self-pictures enables patients with skin conditions to actively participate in their disease monitoring or management, including or not their physician.[15,16]

Combining apps and non-invasive wearable sensors is raised as a challenge to better monitor or understand chronic skin conditions.[2,17,18] The development of sensors monitoring itch, sleep, and physical parameters opens widely the opportunity to correlate disease activity, that is, eczema to the environment but also the possibility to combine metric outcomes to declarative data filled in apps. In modern epidemiology, ICT offers the opportunity to give physicians an improved comprehension of patient behaviors or the environment. Taking the example of sun protection, apps may provide the combination of intrinsic and extrinsic factors that influence sun protection including season, geo-localized UV index, individuals' characteristics (male/female/infant), activity, or phototype (Figure 1). Based on these data, one could hypothesize an increased efficacy or efficiency of sun protection using the knowledge gained. In randomized control trial, despite some promising approach, sunscreen app combined to UV dosimeters failed to display a difference regarding sun exposure, sunscreen use, sunburn, or suntan for young adults in comparison with non-electronic intervention.[19] Thus, after these disappointing results, the authors pointed out the interest of this ICT approach to improve individuals' education with possible long-term effect that could not be identified through short trials.[19] Finally, the development to specific skin biosensors providing new data or collecting new skin parameter, may carry the most exciting perspective by improving skin physiology comprehension particularly if combined to environmental sensors monitoring pollution or UV exposures (2, 18-20). This could open a new frontier, especially by connecting up- and downstream of the value chain, R&D, and laboratories directly to patients and consumers.

3 | CONNECTING CONSUMERS TO THE LABORATORY THROUGH DATA

3.1 | Applying measurement to new markers

Today, we can measure parameters in a new and innovative way. Rather than invasive and time-consuming experiments, new

measurements focus on distinct parameters by a simple measurement of various endpoints. The development of new, smaller biosensors enables this advancement in measurement and correlations. This technology creates the measurement of factors related to various wellness and health in a non-invasive and continuous way. The combination of a real-time collection of quantitative parameters along with the input of qualitative information precipitates a better understanding of various factors affecting the skin.[20-24] Related to the skin, new measurements focus on distinct skin parameters by a simple measurement of the external skin.[20-24] This technology creates the measurement of factors related to hydration and oxidative stress in the same non-invasive and continuous way. It precipitates a better understanding of various factors affecting aging, oxidative stress, and other skin issues.

3.2 | Creating value in dermo-cosmetics technology through the internet of things

As seen above, large-scale expansion of iot devices in everyday life is, most importantly, providing value to consumers. Measuring the efficacy of treatment is an essential application of this technology. Users of connected objects can receive immediate measurements on various health parameters through these devices. Based on measurements provided, consumers can begin to adapt their lifestyle and habits and test product and treatment efficacy. There are now several examples, from weight tracking to new insights about more severe health topics.[25] For example, a survey in 2016 showed promising results in promoting public access through digital monitoring and personalized feedback to support physical activity assessment, counseling, and interventions for cardiovascular disease risk reduction.[26]

Similarly, in 2017, a survey confirmed the first assessments for the Fitbit Charge HR, Apple Watch, and Garmin Forerunner 225. Establishing the efficiency of wearable devices is of particular interest as they are being used in weight loss interventions.[27] In 2017, a pilot study surveyed the intervention of a Fitbit and Facebook MHealth for promoting physical activity among adolescent and adult childhood cancer patients.[28] Similarly, a survey confirmed encouragement of regular physical activity for hormone receptor–positive breast cancer patients as a way to improve mental and physical health during treatment and survivorship.[29]

Skincare consumers, for example, can take measurements of their skin on various parameters and then adapt their lifestyle, the amount of sunlight they take in, their diet, or products they are using, and regularly measure the impact of these changes. These objective and accurate measurements can be made in someone's everyday life, without the regular consultation and cost of a specialist.

Data gathering will not only provide consumers with regular measurements specified to their health and solutions but will also provide brands with the opportunity to collect comprehensive data and better develop products and treatments for these users. As mentioned in the previous section, the skin is greatly influenced by where and how individuals live. However, remote skin measurements enable product manufacturers to develop products, specifically for people living in any condition. Some brands have begun testing the idea of a skin measurement in store, in real time, and real life, to provide consumers with actionable insights.[30] These measurements, however, are limited by the fact that they are not continuous. The skin changes each day and can significantly benefit from remote, real-time, real-life monitoring that is continuously taking place each day (Figure 2).

Data generated from various sources, particularly big and unstructured data from iot devices, are a significant factor in business
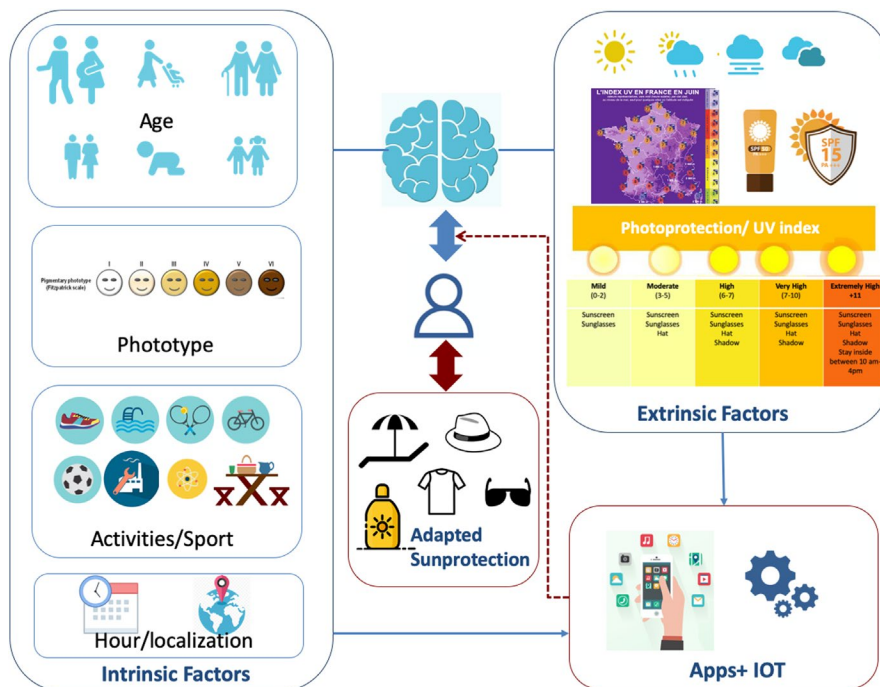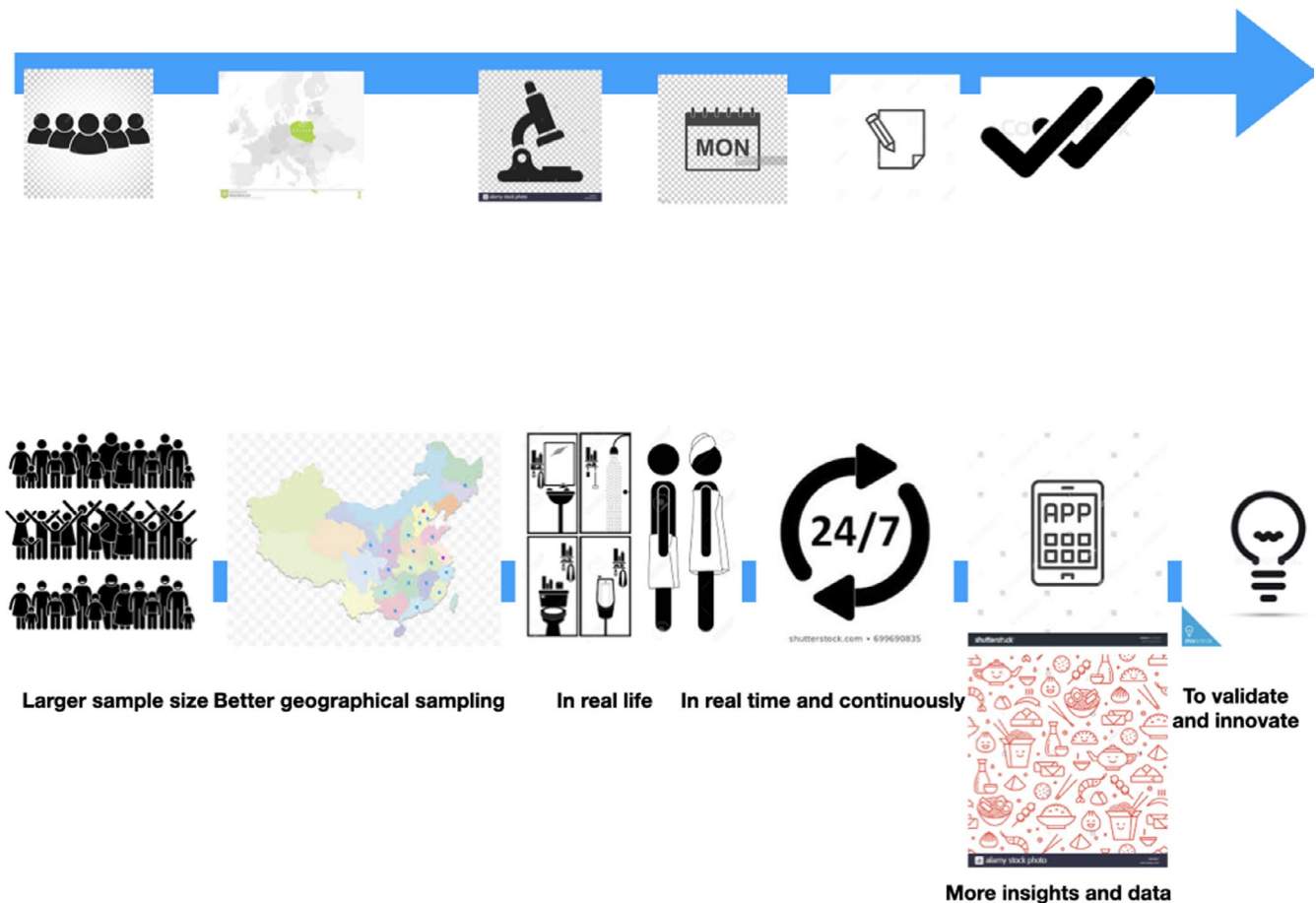

FIGURE 1 Intrinsic factor or extrinsic factor for sun protection which can be combined in an app

Today's clinical trials

Larger sample size Better geographical sampling | In real life | In real time and continuously | More insights and data | To validate and innovate

FIGURE 2 Today's clinical trial and the perspective of new trial design using widespread sensors

today. Big data impacts every industry and generates via every consumer interaction with technology. These data are created at record velocity and are so large, and it cannot be processed by traditional methods. While a visible link exists between data and insights, this does not mean that all data produce actionable insights and value. This extensive creation of data and rapid analysis takes place mainly through the channel of iot devices within the current Industry 4.0 and the digital transformation of industrial markets. The constant innovation of new technologies by companies is taking place to create information streams based on data across the entire value chain and realize new business models.[31]

Without the convergence of informational and operational technology revolving around data, there is genuinely not a digital revolution and industrial transformation. iot, in this sense, is the primary tool for data collection and begins with the capture, analysis, and then leveraging of big data. The focus here for the production of iot devices should be on the end-to-end value chain, in which information and value are flowing through all systems and finally to the consumer. In the end, everything is about the data, how it is collected, why it is collected, and where it is used. The real-time collection of data, in the right place, and for the right reasons is the essential way to gain value in this digital transformation and integrating this data through iot. The

collection of big data allows for organization and control of products across the entire value chain. Cloud computing and information technology, however, are essential aspects of this move toward the use of data for creating more consumer-centric products and services.

The main goal in the growth of big data and real-time analysis is to make industries faster, more efficient, and consumer-centric while detecting new business models and opportunities. The increased velocity of data collection and processing for value creation purposes is not just a competitive advantage and consumer expectation but a growing necessity for companies to keep up with the evolving outlook of digital today. The real value may be created by developing new, data-intensive, revenue sources that focus on a consumer-centric business strategy in all industries.[31] This value can be achieved through horizontal integration of data across the entire value and supply chain. The real-time collection of fast and actionable data and analysis to obtain desired insights are necessary for a return on investment in this field.[31]

4 | NEW BUSINESS MODELS

There are currently various iot devices, data collection and analysis methods, and cloud service providers making advancements within

this field. However, there is yet to be a clear definition of strategy in dealing with big data. To maximize outcomes and resources, there must be a rethinking of business organizations and processes in how they develop devices, use, and protect their data.[31] Many challenges exist in this field, such as cybersecurity, the integration of IT (Information Technology) and OT (Operational Technology), and managing risks while lowering costs.[31] The true goal of these digital developments is to create new business models based on data and new ways to provide goods and services to consumers, meeting demand in completely personalized ways.

Today, there are developments to create solutions for consumers across many industries based on iot, artificial intelligence, data, and other technologies.[31] Such developments include Optune by Shiseido, Neutrogena Skin360, Apple watch applications, and many others. Optune is an iot skincare system that analyzes user skin conditions and environment and then creates personalized skincare based on conditions at home.[32] Neutrogena Skin360 is a face-scanning application using artificial intelligence to provide feedback on the state of your skin and then suggest Neutrogena products as a treatment.[9] The goal of this technology in skincare is to make skincare. Other brands such as Atolla and Procter & Gamble are also expanding into technology-based skincare.[33] While the Apple watch contains applications such as one to monitor and assess patients with major depressive disorder.[34]

While these are significant advances within devices and technology for personalized consumer-centric care, there are still limitations in technological development and business model. The proper business model for these types of products and services may still need to be determined and developed. The major challenge today is how companies can leverage opportunities from new data delivered by iot devices and build a business model based on this.[35] With more and more innovation in technology for skincare, there are increasing amounts of data. Companies must find a way to grow within this field while also building return on investment for consumers and brands. Rich data that were non-existent in the past provide an excellent opportunity for companies to develop new solutions and business models.

5 | DERMO-COSMETICS AND PERSONAL CARE MARKET EVOLUTION

5.1 | Growing skincare market

The beauty industry is growing faster than ever before, currently valued at $532 billion. The most substantial growth in the beauty industry, however, has taken place within skincare. Euromonitor reports that interest in skincare is growing as consumers' values have shifted to more meaningful consumption.[36] To find more meaningful product use, consumers are focusing on health benefits and positive intentions from new and existing brands. This intersection of dermo-cosmetics and health is one of the most critical aspects leading to innovation in the industry. Trends impacting skincare for the coming years include health and wellness-inspired beauty along with products with green, clean, and natural features. This interest in clean dermo-cosmetics has grown mainly among millennials but also to all skincare consumers.[36] There are, however, contradictions in the industry of what constitutes as clean as many sources and brands have differing opinions. A product that some may say is "clean" or beneficial to the skin, such as essential oils, may also be reported as damaging by others. This question of clean dermo-cosmetics and product ingredients, more generally, is an essential catalyst for consumers looking for more innovation and transparency in skincare.[36]

Current skincare consumers value natural beauty, looking healthy, and cleanliness most within their routine. Increased education is an impactful reason for the growth of the skincare market. Consumers now have an increased awareness of anti-aging and long-term damage to the skin caused by internal and external factors. Brands are now focusing more on this consumer education even in store, such as at Oh My Cream.[37] Growth of skincare brands such as Oh My Cream that offer a more tailored experience is evidence of prosperity in skincare as they have raised millions of euros in funding. The brand has successfully focused on skincare with expert consultation in their stores, which have premium locations. This increase in consumer education has led to a demand for targeted solutions that are consumer-centric and allow for personalized skincare. These previously mentioned trends within the industry are what consumers want to see a change in, resulting from long-term shifts in consumer behaviors and values. Though consumer trends for products are changing, consumers consistently value efficacy and quality as top factors when choosing what products to buy.[36]

Consumer trends tend to be moving toward a simpler routine, particularly in Asian markets. Lisa Payne, of global trends company Stylus, reported that while Korea had previously influenced the world with their ten-step skincare, they are now cutting back on this for "Skip-care" (March 2018). Asia, specifically Korea, initially spread some of the major skincare trends seen in the Western world. Through this Korean influence, the market is now seeing a more minimalist approach to dermo-cosmetics, specifically through the use of hybrid products that provide multiple benefits in one. This is a more thought-out and personalized approach to skincare in which "less is more." The practice essentially relies on finding a few key products that do the job of many and focusing on what the individuals' skin really needs.

5.2 | Brand adapting

There are continued renovation and innovation of brands attempting to stay current and to continue growth through various efforts. Brand renovation focuses on brands repositioning themselves to better align with consumer values such as using products with botanically derived ingredients, without animal testing, and transparency in ingredients. Brand innovation is primarily through brands creating new benefits and opportunities within existing spaces. Though brands are setting new precedents, such as expanding makeup lines

to be more inclusive for all races, for the industry to truly evolve, there needs to be a change in the brand proposition, delivering, in a more personalized way, what consumers are demanding. To enact new models, brands must focus on varying values from consumers; however, one of the main interests lies in engagement with consumers and personalization of routines and products. The real disruption cannot be immediate and should seek to reinvent consumer behavior and impact what they do to achieve their goals and values. As consumer interests change, brands must develop an effective way of delivering their message that can inform consumer decision making.[36]

The push from brands of skincare products onto consumers is also a growing pain point in the industry. As brands push more products, not always genuinely suited to consumers, consumers look for more innovation and better solutions within skincare. This push of products onto consumers comes from many angles, such as brand marketing, influencers, and media. Consumers are losing trust in many information sources as they might be promoting products they have never honestly tried or do not use. To enact more of a pull from consumers, brands need to obtain more clear and representative data from real consumers to know what products are necessary on the market. Many of the most recent product releases have relied on data to bring more personalized skincare. Companies need to truly include their clients in the product development process, in the all value chain experience.[36] Adapting products to consumer needs and having consumers demand these products create a new skincare industry that is more consumer-centric. Consumers are not looking for more products, but rather the right product.

5.3 | Digital in dermo-cosmetics

The way consumers purchase and learn about skincare products is also evolving. The digital revolution has an impact on all sectors and is redefining the brand-consumer relationship. Brands are now more often originating online rather than in-store. Digitally native vertical brands such as Dollar Shave Club, Glossier, and Function of Beauty are evidence of this switch to online consumption and success in the beauty industry.[38] As consumers move toward online shopping, brands can collect consumer data, bringing consumers a personalized and unique experience. Data are focusing on consumers' buying behavior, allowing brands to customize their offers per customer. This online engagement drives consumers to purchase products suitable for them immediately when shopping online. Another great example of this is the development of applications like INCI Beauty, with which consumers download and which they contribute to developing, enriching, and delivering information about product ingredients.[39] Brands are including this new kind of data in their product development and transparency strategies.

6 | CONCLUSION

There is still room, however, for more rich data collection: data collection focusing not just on online consumer buying behavior but also

on consumer skin parameters. Suggesting products to consumers based on real-time, real-life measurements of their skin can be the next frontier of rich data collection for the dermo-cosmetic sector. This collection of richer data should start with clinical trials to open the laboratory to consumers and connect consumers to more personalized solutions. New technologies, as seen above, and a growing interest from consumers and brands for objective and innovative measures offer a large room for further product testing, answering numerous issues facing current product testing and development, as one can see from the graph below. Today, products are tested on a limited number of patients or users, who have to come to the laboratory for measurements to be made, and most often, panels only include standard skin types, creating a non-representative sample (Figure 2). Very often as well, besides some scientific measures run in the laboratory, testing is made based on declarative assessment from users themselves, raising doubts from those reading the tests. Digital trials as described in the paper will allow some real-life measures to be made, with the same reliability as laboratory measures, and connected to a large number of variables related to one unique consumer or patient. They will be made on an almost unlimited number of patients/consumers, allowing to reach pertinence levels much higher than today. As a result, connecting this new type of laboratory, digital clinical trial measures with real-time, real-life consumer information will lead to a new type of data and offer a new perspective for the study of quantitative and qualitative effects of products on the skin: an augmented data. Aside to providing the cosmetic business industry a better comprehension of users'/consumers' skin owing to feedbacks and usage collection, beauty tech expansion relying on sensors and app use is also a great opportunity for dermatologists and scientists to increase their knowledge of skin parameters or individuals' behaviors or compliance regarding skincare. Building and validating accurate new wearable electrochemical biosensors for a non-invasive skin parameter monitoring highlights the convergences of prospects for wellness/well-being and healthcare industries, and therefore converging different objectives and the challenge to combine preventive or curative strategies for skin using iot.

AUTHOR CONTRIBUTIONS
SV and TAD conceived the study and contributed to methodology. All authors validated the study. CB, SV, and TAD performed formal analysis. CB, SV, and TAD participated in investigation. CB, SV, and TAD collected the resources. CB, SV, and TAD wrote the original draft of the manuscript. All authors wrote, reviewed, and edited the manuscript. SV and TAD supervised the study. SV, TAD, and AM administered the project. SV, TAD, and AM acquired the funding.

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