T.C. ISTANBUL KÜLTÜR UNIVERSITY
INSTITUTE OF GRADUATE STUDIES

ENHANCING SMALL COSMETICS BUSINESSES WITH BIG COMPANIES INNOVATIONS: A SUSTANIABLE PRODUCTIVITY, AND LEAN MANUFACTURING JOURNEY

Master of Science Thesis

ABEER MUBARAK MUTAHAR

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Department: Industrial Engineering

Program: Engineering Management

Supervisor: Asst. Prof. İbrahim Ethem Tarhan

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LIST OF SYMBOLS

- **SME: Small** and Medium Enterprises
- **AHP**: Analytic Hierarchy Process
- **SWOT**: Strengths, Weaknesses, Opportunities, and Threats
- **IoT**: Internet of Things
- **AR**: Augmented Reality
- **VR**: Virtual Reality
- **AI**: Artificial Intelligence
- **CR**: Consistency Ratio, calculated as CR=RI / CI. (Used in AHP)
- **CI**: Consistency Index (Used in AHP)
- **RI**: Random Index (Used in AHP)
- **wi**: Weight of criterion i in AHP.
- **n**: Number of criteria or alternatives.
- **μ**: Mean of a data set.
- **σ:** Standard deviation of a data set.
- **λmax**: Maximum eigenvalue of a matrix.
- **CR<0.1**: Threshold indicating matrix consistency.
- **SO, Strategies**: Strengths–Opportunities Strategies
- **WO Strategies**: Weaknesses–Opportunities Strategies
- **ST Strategies**: Strengths–Threats Strategies

- **WT Strategies**: Weaknesses–Threats Strategies

LIST OF EQUATIONS

- **Consistence Index (CI):**

$$CI = \frac{(\lambda_{max} - n)}{(n-1)}$$

- **Consistency Ratio (CR):**

$$CR = \frac{CI}{RI}$$

- **Weight Calculation in AHP:**

$$w_i = \frac{\text{Sum of normalized matrix row } i}{n}$$

(Noureddine Motaki & Oualed Kamach, 2017)

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ÖZET

Kozmetik endüstrisi, geçmişteki gücüne ve sürekli gelişen bir sektör olarak tarih boyunca pek çok zorluğa maruz kalmıştır. Bu çalışmada, piyasa rekabetinin yoğunluğu, sermaye eksikliği ve eski yöntemlere bağlı kalma gibi üç temel sorun vurgulanmıştır. Bu sorunlar, işletme yapılarında yetki sorunlarına yol açmıştır.

Bu çalışmada, Endüstri 4.0 teknolojileri ve sürdürülebilir uygulaMELArın, küçük kozmetik işletmelerinin üretkenlik ve rekabet gücü üzerindeki etkileri değerlendirilmiştir.

Bu bağlamda, AHP ve SWOT analizi gibi araçlarla, İKAT'ın ihtiyaç duyduğu teknolojilerin değerlendirilmesi ve küçük ölçekli mimari çözümler sunulması amaçlanmıştır. Araştırma örneği, büyük şirketlerin sürdürülebilirlik süreçleri ve performansları baz alınarak, çalışmanın sonuçları, sürdürülebilirlik ile gelecekteki endüstriyel zorlukların küçük ölçekli kozmetik işletmelerinde nasıl aşılabileceğini göstermektedir.

- **Anahtar Kelimeler:**

Kozmetik Endüstrisi, Endüstri 4.0 Teknolojisi, Sürdürülebilir UygulaMELAr, SWOT Analizi, Analitik Hiyerarşi Süreci (AHP)

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ABSTRACT

The cosmetic industry, considering its onset from the events of far back civilizations, has a variety of contemporary issues at hand, making an impact on small companies. These obstacles as the hard battle in the market, restricted funds, and the delusions of the dated work methods. This project focuses on the important cross-roads of technology, namely Industry 4.0, and its role in sustainable practices within the small cosmetics industries.

The research, through the adoption of tools such as the Analytic Hierarchy Process (AHP) and SWOT analysis, seeks to give viable solutions to improve productivity and competitiveness of business while also increasing sustainability. Through analyzing successful players in the cosmetics industry like Big Companies the study aims to bridge the gap between theory and practice, providing tangible solutions directly to the needs of the small magnitude cosmetics businesses. The research will develop an in-depth analysis of industry trends to support small business owners thrive and prosper in the on-going complex cosmetic industry markets.

- **Keywords:**

Cosmetic Industry, Industry 4.0 Technology, Sustainable Practices , SWOT Analysis Analytic Hierarchy Process (AHP)

INTRODUCTION

1.1 Background and Context

The cosmetic industry holds a global significance that dates to ancient times among civilizations like the Egyptians, Greeks, and Romans. Cosmetics, perfumes, and hygiene products, since their very origin, are among the fundamentals of communicative practices, being capable of adapting to socially needed changes.

Such practices were clearly revealed by the ancient practices. Indeed, the Neanderthal man applied reddish, brownish, and yellowish pigments obtained from clay, muddy and arsenic for painting his face. They used bones in curling hair whereas the makeup, tattoos, among others communicated important social info. (Kumar, 2005)

Records of history expose fascinating examples in which makeup and perfumes were essential elements of different cultures. Ancient Greece had prominent physicians like Galen who advanced the industry with their innovations like cold cream. Oil-based perfumes were not for anointing only, because the Romans used them on their peoples, baths, fountains, and weaponry. The crossroad that started the interchange of fragrant cultures was the introduction of fragrances by crusaders returning from East Asia during the 13th century.

The rich historical basis of this industry points out to the fact that it has a great tendency for adaptation about its modes of production and ingredients throughout time. Formulations are today very sophisticated while clay-based cosmetics were symbolic of the evolving industry (Kumar, 2005).

The forecasted growth of the global cosmetics market, as of 2026, goes on to show that this is one industry whose prospects are skyrocketing. The market covers a wide variety of

products for skin care, body hair removal, antiperspirants, make-up, perfume, sunscreen as well as hair care goodies that cater for unique needs.

The recent trend of cosmetic hype has caught not only women but also men, with preference for women. Cosmetics do not just appeal to women due to beauty; they provide an easy means of self-expression that instills confidence. Remarkably, researches show that young group especially, people with higher educated and financially solvent enjoy cosmetic products so much and make this practice a part of daily life in order to give themselves more confidence and stylish appearance (Sweta Kumari , Biplab Pal , Devesh Tewari , Sanjeev Kumar Sahu , 2023).

Additionally, the growth to emerging markets such as China, Eastern Europe, and particularly South America is further indication of its global presence and economic footprint (Kumar, 2005). Nevertheless, as the cosmetics market continues expanding at an astronomical pace on the world stage, questions are raised about these developments' effect and resource usage in environmental terms. Expansion into different markets needs companies to focus on sustainable practices especially on production for them to adhere to global environment sustainability objectives (Tawalhathai Suphasomboon, Sujitra Vassanadumrongdee, 2023).

The last few decades have seen tremendous changes in the manner of consumption and creation to meet the SDGs (Sustainable Development goals) set for this year (2030) by the United Nations. It has forced many organizations to get involved in the sustainability initiatives. These include companies in the likes of cosmetic industries to appreciate the need to address climate change, resource management, recycling and environmentally responsible operations to mention a few.

Valued at US $500 billion in 2019 and being one of the fastest growing industries cosmetics sectors, it is challenged by negative consequences of significant need of natural resources to production and consumption which negatively impacts on environments. Sector's

production and especially among the supply chain are big in environmental degradation. As a result, many cosmetic companies have manufactured eco-friendly lines of products holding organic components.

Therefore, the global trend is towards safety, healthy and non-hazardous cosmetics products. Increasing demand for green formulations and organic cosmetics valued at approximately USD 30 billion as of 2021 is expected to exceed USD 50 billion by the end of the forecast period. The transformation of the industry towards Sustainability, as a matter of fact, is not driven by consumers' demand only, but it is a strategic move towards introducing ecological manufacturing processes in fashion and assurance and style (Tawalhathai Suphasomboon, Sujitra Vassanadumrongdee, 2023).

1.2 Statement of the problem

This article concentrates on the problems of small businesses like intense market competition, limited capital, and reliance on outdated methods. The case in which small businesses face inequality with assets and skill, is the main factor causing small businesses to not compete effectively with big businesses who have useful resources to power their business. Detailed analysis of the disadvantages as a problem of the leaders in the organization will follow towards construction of realizable alternatives that will facilitate proper decision-making processes during choosing the suitable technology. This research aims to analyze and provide detailed reviews of specific technologies in terms of their suit abilities level to meet small enterprises requirements and best practices that can help the latter establish a competitive advantage in the market after hard analysis of industry trends.

1.3 Research Questions:

Deciding the right type of technology for every small business in the cosmetic industry is the most confusing factor nowadays, as there are many changes and sustainability matters are of utmost importance. This paper entails dealing with the issues faced by small enterprises and discoveries from the big companies that have managed to solve these

challenges. The Goal is to offer practical suggestions that will help them surpass the competition and operate in an eco-friendly manner.

Consequently, the following research questions will serve as focal points for deeper exploration:

1. How can small cosmetic businesses pick the right tech in line with sustainability goals?

2. What factors help small cosmetic businesses be more efficient and competitive when using AHP and SWOT together?

3. What lessons can small cosmetic businesses learn from big companies' tech choices to manage resources better and stay eco-friendly in today's changing industry?

1.4 Objective of the Paper:

Small cosmetics manufactures face the challenge of identifying modern production technologies that are optimally focused on the sustainability concept among the numerous options of industry 4.0. The article focuses on two key aspects: a campaign case summary and step by step implementation plan of objectives. The AHP method considers the factors of costs and decision-making after thorough analysis. The study does external and internal factors in the SWOT analysis for ensuring positive decision making. The case study of companies that have successfully dealt with the issue can be divided into examples and instructions related to it.

These objectives can be summarized as follows:

1. Specify the participation of small cosmetic companies in Industry 4.0 technology.
2. Apply AHP for evaluating products based on factors like cost, security, innovation etc.
3. Merge SWOT into decision-making with inward strengths, weaknesses as well as external opportunities and threats.

4. Larger companies are role models on how to make resource management, sustainability, and Industry 4.0 adaptation successful, using them as an example.

1.5 Research Map

The exploration starts by following the historical development of computational techniques in Section 2, and traces back to two algorithms that dovetailed with McOwen's eventual AHP focus: the Analytic Hierarchy Process (AHP) introduced under Luce & Riffa and Strengths Weaknesses Opportunities Threat SWOT. Section 3 describes AHP and SWOT in considerable detail, explaining their basic methodologies as well as applications. In Section 4, attention is turned to the nucleus of manufacturing AHP and SWOT. Therein lies their crucial role in decision-making processes as well as operational efficiencies. In Section 5, issues concerning sustainable practices in the cosmetics industry are scrutinized: Environmental concerns and how companies can practice more environmentally friendly procedures. Section 6 then goes on to outline the implementation of Industry 4.0 technologies and features case studies such as that of Big Companies East Africa, stressing their profound impact upon manufacturing processes. Compared to Section 7, this section undertakes a comprehensive analysis of sustainability efforts between industry players including Beiersdorf and Big Companies and the successes they have achieved in areas as well where there is room for improvement. This gives way in Section 8 to a strategic analysis of Big Companies with SWOT and AHP method used for market positioning, competitiveness strategy, sustainability policies. In Section 9 there is a full-scale description of Big Companies 's experience using sustainable development principles to stimulate innovation, production, and social engagement. Section 10 covers the use of SWOT analysis to assist small businesses in growing strategically, major features, construction of the SWOT matrix, and the use of AHP for weighting and prioritization. Finally, Section 11 holds a conclusive summary. After reviewing the results of this in-depth study and based on collaborations across many fields active within China's industry with industrial capabilities to contribute whether used or not, but lacking regulation from experts elsewhere for high level unification hence lowly used and highly fragmentary, key findings are identified along with actionable.

LITERATURE REVIEW

1.6 Origin and history of AHP and SWOT

AHP was developed by Professor Thomas Saaty in the 1970's as a tool and is considered one of the foremost instruments used in multicriteria decision making. Dr. Saaty's quest began with a fundamental question: Is there a way of improving decision making by incorporating the facts and the preferences?

There have been old decision models that used mainly numbers ignoring the human part of decision-making processes, namely our gut, emotions and intuitions. Thus, it became apparent that Dr. Saaty needed a different, more integrated systemic way of thinking. (Saaty T. , 1987)

Initially, AHP was envisaged as a structured approach for handling complicated decision problems where the factors were both tangible and intangible. The goal was to establish a context within which key stakeholders could define multifarious issues in simple terms, break them down into manageable bits with an average value assigned per piece using the technique of binary comparative analysis.

According to (Saaty T. , 1987) By being flexible, this approach could be applied to a wide array of complex decisions problems facing such industries as business, engineering and social science. It has its basis on a process that develops criteria for simplification and prioritizing in an orderly manner which in turn is used to make comparisons and arrive at mathematical conclusions.

Based on research (Saaty T. L., Decision making with the analytic hierarchy process , 2008) that show with time, AHP transformed into a versatile tool for handling difficulties involved in combining contradictory attributes of different options as well as both qualitative and quantitative characteristics at once. Saaty's work and subsequent studies of scholars and experts made the AHP one of the most important approaches. It gives people and companies ways to make more whole decisions about aspects and location that are complicated or different sorts.

On the flipside, the SWOT analysis; a strategic planning strategy, dates to the sixties in the U.S. The SWOT (Strengths, Weaknesses, Opportunities, Threats) model originated from a study carried out on an institute called Stanford Research Institute by Mr. Albert S Humphrey , Originally built as an instrument of internal reflection, SWOT was created so that it allows companies to point out both their specific strong points and weak sides alongside the forces outside that may impact on those organizations' activities (Richard W. Puyt , Finn Birger Lie , Celeste P.M. Wilderom , 2023).

Furthermore, based on research (Danca, 2013) SWOT analysis as a structured technique of strategic decision making is a model that helped organizations to evaluate their situation at a given time in anticipation of possible future opportunities and threats from external sources.

With its simplicity, SWOT analysis soon became popular, separating complex business elements into four distinct categories. The use of business intelligence transcended the limits of corporations, being applicable on health care, education, marketing, and projects management. Although some complaints may relate to bias and simplification, SWOT analysis is still a particularly important tool in organizational practices. It's a straightforward framework for appraisal and strategy formulation (Richard W. Puyt , Finn Birger Lie , Celeste P.M. Wilderom , 2023).

1.7 Definition of AHP and SWOT

Omkarprasad. S. Vaidya and Sushil Kumar discussed AHP as an all-encompassing approach applicable for decisions in various activities. They highlighted its usefulness for planning purposes, conflict resolutions, resource allocations and optimization. Secondly, they provided a description of how AHP can work closely together with other tools to help in decision making like Linear Programming and Fuzzy Logic. From this point of view, AHP represents a numerical procedure for helping to make choice concerning alternative options (Omkarprasad S. Vaidya , Sushil Kumar , 2006).

(Triantaphyllou, 2000) conducted a study wherein he discussed different decision approaches which led him to conclude that AHP was one of the newer developments that had become common location while highlighting this approach's growing popularity. The definition of hierarchies as structured representation of complicated problems is contributed by Thomas L. Saaty. Hierarchies consist of various stages ranging from a general goal to elements, standards, sub-standards and options. These are helpful in terms of splitting up complex matters into a sequential chain of interruptions and resolutions. (Saaty T. L., Fundamentals of Decision Making and Priority Theory With the Analytic Hierarchy process, 1994) .On the other hand, The SWOT Analysis is a strategic tool in evaluating strengths, weaknesses, opportunities and threats associated with a given case or project. Using the analysis during early stages will help and guide the growth of OBIA as a developing field. A multidisciplinary team composed of different experts usually conducts this analysis once the goal is established and systematically records the results. These interested parties could be engaged in further deliberations as participants or even initiate a platform of common dialogue which could be mutually beneficial to them (Geoffrey J Hay , Guillermo Castilla, 2006).

Based on research (Sepehr Ghazinoory, Mansoureh Abdi, Mandana Azadegan-Mehr, 2009) ,Among the popular frameworks in strategic management is SWOT which helps to analyze a firm's internal strength and weaknesses compared with its external opportunity and threat. This entails an in-depth examination of the controllable aspects within the company, such as the state of finance, operation effectiveness, as well as marketing approaches. It looks at macro environment forces such as changes in the economy, politics, technology, competitors, and social development. SWOT is instrumental in helping formulate a strategic matrix that compares various internal abilities against related environmental conditions towards developing useful business plans.

1.8 Importance of AHP and SWOT in Manufacturing

In the context of the industries, SWOT coupled with AHP marks the winning move. The SWOT framework is a convenient tool for considering strengths, weaknesses, opportunities, and threats in a particular business environment. Yet, despite this, it fails to rank these issues as their top priorities leading to an important deficit in decision making. Thus, one enters the

Analytic Hierarchy Process (AHP), an advanced decision-making method. AHP is the most common technique that helps in enriching the SWOT analysis approach; it provides an orderly process for determining the significance of various issues. The strategic decision making in manufacturing is enhanced when this synergistic pairing is brought to use (Ali Görener, Kerem Toker, Korkmaz Uluçay, 2012).

Based on research (Ali Görener, Kerem Toker, Korkmaz Uluçay, 2012) , Manufacturing companies acquire a more profound perception of their internal scape while competently surmounting fluctuations of the environmental factors by means of adding AHP into SWOT. Integration does not just mean insight but acts like a guide to inform manufacturers to look at their strengths, weaknesses, operational opportunities, and threats.

In the manufacturing industry, using AHP and SWOT for the purpose of analysis is not just that; it's an instrument for making precise decisions. Through this double act, businesses can identify key priorities, refine tactics, and map enduring routes through changing manufacturing environments (Ali Görener, Kerem Toker, Korkmaz Uluçay, 2012).

The study (Vineet Jain, 2021) on industry 4.0 and its application in India's manufacturing sector. A major point here is that AHP and SWOT analyses are important. Twenty factors that influence the adoption of Industry 4.0 were identified by surveying manufacturing and IT professionals. The study ranked these factors using AHP and SWOT models for the revelation of essential information. Productivity in I4.0 requires specialized skills and at any time online trust is an option, however employee resistance can be a risk.

The proposed SWOT model for the manufacturing industry is ranked through AHP. By utilizing resources, strengths addressing weaknesses taking advantage of opportunities but minimizing threats of I4.0 terrain landscape (Vineet Jain, 2021).

In search from (Dan Bai , Pengbo Liu, 2019) The use of AHP combined with SWOT analysis is important especially in Pearl River Delta China towards manufacturing industry.

Subsection Describe how to handle a situation where an employee arrives late for work. Subsection brings together an in-depth examination of internal strengths and weaknesses and external opportunities and threats. This provides a better view of the direction and key drivers for any industry's sustainable development, which is useful information when making informed decisions for a long-time development.

SWOT analysis and the AHP play significant roles especially in Indonesia's manufacturing sector. These are important equipment for a company during uncertainness and complexity of the industry. The combination of swot analysis (strong, weak, opportunities, threat) to analyses the company strengths reveals actionable insights from AHP. What is more, these methodologies are not mere theoretical constructs, but have worked wonders in international industry, making the point of practice. Structured frameworks of SWOT analysis and AHP for Indonesian manufacturing companies overcoming market complexity. These are critical for understanding market complexity and taking valuable development decisions in a changing world of today (Arica Dwi Susanto, Nengah Putra Apriyanto, 2019).

Furthermore, according to (Fabio De Felice , Antonella Petrillo , Claudio Autorino ,Armando Carlomusto, 2013) , a SWOT-AHP tool is useful for dealing with the WEEE problems in this context. Such methods can be regarded as power tools leading to evaluation of the necessary parameters finding WEEE sustainability. S-AHP is the combination of integrating SWOT into AHP. This provides a way to gauge to what extent the WEEE management approaches are green friendly. The outlined model in this case makes it possible for one to understand the critical elements of efficient WEEE management. This is not about speculating, but rather about making wise choices for all people involved. S-AHP would improve the existing WEEE systems so that they suit different users' needs and preferences.

1.9 Enhancing Sustainability Practices in the Cosmetic Industry

The Body Shop and princes in Thailand Environment. Several of such firms have taken steps towards a green agenda and the improvement of its ecological prints. They have production

policies that entail limited resource consumption and little waste, and employable environmentally friendly substances and procedures for production. For instance, this includes more investment in renewable feedstock components, biodegradable and recyclable packaging as well as bio-based or nature identical materials for cosmetics applications. These moves ensure they lower their environmental impact both in their processes and with respect to products hence moving their production of cosmetics nearer to sustainability (Lalit M. Johri, Kanokthip Sahasakmontri, 1998).

Based on research from (Prothero, 1996) The world environment problem nowadays makes Sustainability as important as a paragraph that is considered for the future. The concept of sustainability as used here has encompassed governance, industries, consumers and marketing strategies within society. It shines into the changing mask of environmental perception molded by its audience and green marketing. This leads the corporates to accept these green strategies due to changes in the clients' outlook. Also, it shows how companies integrate sustainability into their policies that come about through eco-pressure for promotional activities. The paper examines different approaches through which an organization deals with environmental aspects such as environmental strategy, approach, perspective, decision making process.

1.10 Implementation of Industry 4.0 Technologies:

With Big Companies in East Africa as an example, these Industry 4.0 technologies have been implemented in several aspects of operations to improve the efficiency and quality of its manufacturing processes, among other items. Big data analytics, cloud computing and barcode scanners are among the ten technologies employed widely to improve efficiency. In terms of production itself, autonomous robots have speeded up many routine procedures such as feeding raw materials into machines. This not only improves efficiency but also reduces errors. By installing sensors on machinery and other equipment, managers can monitor machine performance in real time, enabling them to make decisions based on actual data (Juma Nasambu Anitah , Stephen Onserio Nyamwange ,Peterson Obara Magutu , Michael Chirchir , James Mauti Mose, 2019).

Based on research (Juma Nasambu Anitah , Stephen Onserio Nyamwange ,Peterson Obara Magutu , Michael Chirchir , James Mauti Mose, 2019) , Big Companies East Africa have successfully used big data and analytics to predict product demand in order proactively adjust production levels. Having this predictive ability streamlines inventory management, allowing a fine balance between supply and demand. With cloud computing, remote data storage and accessibility reduced the costs of information management while enhancing operational flexibility overall. In warehouse management, the incorporation of barcode scanners in data collection has greatly increased accuracy and reduced errors when materials are transferred from one workplace to another.

Moreover, the company has adopted IoT technologies for real-time data transmission between devices, helping to boost efficiency. Monitoring manufacturing progress, ensuring product quality and transport of raw materials on the production line have all used drones. These Industry 4.0 technologies have been cleverly applied and not only improved the process of production, it also increased transparency within in-house operations, providing a better customer focus and bringing down Big Companies East Africa' s operational costs (Juma Nasambu Anitah , Stephen Onserio Nyamwange ,Peterson Obara Magutu , Michael Chirchir , James Mauti Mose, 2019).

1.11 Sustainability Initiatives Comparison:

Today, the beauty industry estimated to reach US $ 571 billion in 2023 is increasingly plagued with questions about its environmental and social impact. Resource depletion, pollution and social responsibility have all focused the industry's attention on questions of sustainability. With consumers casting about ecological products, companies must follow in their wake. Some shine, however, other flounder. The problem of greenwashing comes up frequently. A case study in response compared the sustainability reports of two industry leaders, Beiersdorf and Big Companies, to see what they were doing right--and perhaps

wrong. This research employed a mixed-methods approach, looking at economic, environmental, and social aspects. In terms of economics and environment, acting better than others was probably Beiersdorf's forte. Especially prominent in this regard were anti-corruption efforts and environmental compliance. On the other hand, Big Companies had strengths in social areas and customer safety (Bhujel, 2023).

In search from (Bhujel, 2023) Both companies are also committed to sustainability, advocating for the use of renewable energy and transparent reporting. But there were differences in their sustainability agendas, stakeholder engagement work, reporting standards and form of data presentation. Beiersdorf (owner of Nivea and Eucerin) emphasizes reporting that is transparent, along the lines mandated by GRI guidelines, as well compatibly conducive to achievement of all 17 SDGs. Big Companies do not explicitly mention such standards.

According to (Bhujel, 2023) across all categories, including environmental performance in which Beiersdorf scored 87 % as against Big Companies 's mere 75 %, the German firm beat its French competitor. Although they take different paths, both companies are committed to addressing climate change and promoting the development of sustainable beauty. Such findings provide valuable clues to what is being done and not in the way of sustainable development, as well as how much effort it takes ultimately to pass on value, Scores were calculated in several different categories for Beiersdorf and Big Companies , using a radar chart (Figure 1) and (Table 1),There was an economic category as well as environmental and social ones, The following chart provides an easy-to-understand visual representation of their comparative positions on various sustainability indicators.

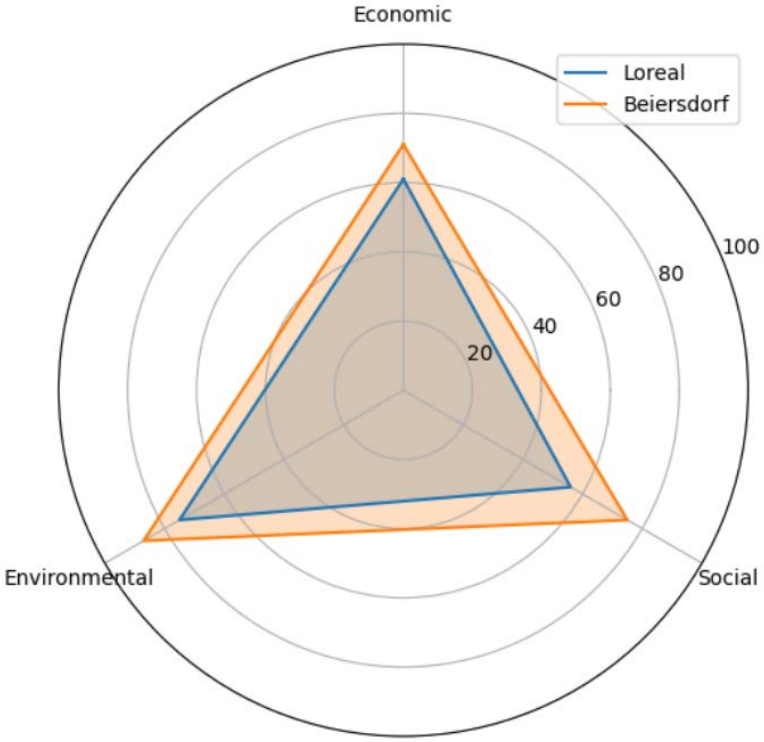


Figure 1 Beiersdorf and Big Companies 's scores in each parameter are shown on a radar chart.

Dimensions	L'Oréal	Beiersdorf
Economic	13 (61%)	15 (71%)
Environmental	18 (75%)	21 (87%)
Social	32 (56%)	43 (75%)
Total	63 (61%)	79 (77%)

Table 1 shows the total scores obtained by Beiersdorf and Big Companies in each dimension.

1.12 Big Companies Strategic Analysis:

Based on search (Xusheng Chen , Haonan Yan, 2021) ,The value of the U.S. cosmetics market has grown rapidly, accounting for sales of 90 billion yuan in retail terms as early as 2020; but together with expanding demand there are also increased risks due to counterfeit

products promoted and introduced through social media or networks established by word-of-mouth advertising (WAB), which can easily end up leaving Scholars have different concepts of the role that advertising plays, dividing it into persuasive and informative functions. The following analysis examines Big Companies advertising and marketing strategies in the North American market, a research area neglected to date. With brand loyalty building as one objective and reputation improvement as another success. Big Companies rank as the world's largest cosmetics company in terms of data, turning out large sales figures and extending a wide variety of products into extensive distribution paths. The methodological approach includes SWOT analysis and AHP, as well as an assessment of the market positioning and competitiveness of Big Companies.

The SWOT analysis points out the company's strengths in its broad product mix but also glosses over some weaknesses such as an often-redundant structure and fierce competition in the market. Seizing opportunities involves concentrating on active health products and seeking out new channels. Threats range from competitor challenges to the operational impacts of COVID-19. The AHP-SWOT approach employed here attempts to plot Big Companies ‘s development strategy because of brand strategies and evaluation indices, providing an overall grasp of its direction, Figure 2 shows the conventional system's hierarchical structure model. (Xusheng Chen , Haonan Yan, 2021).

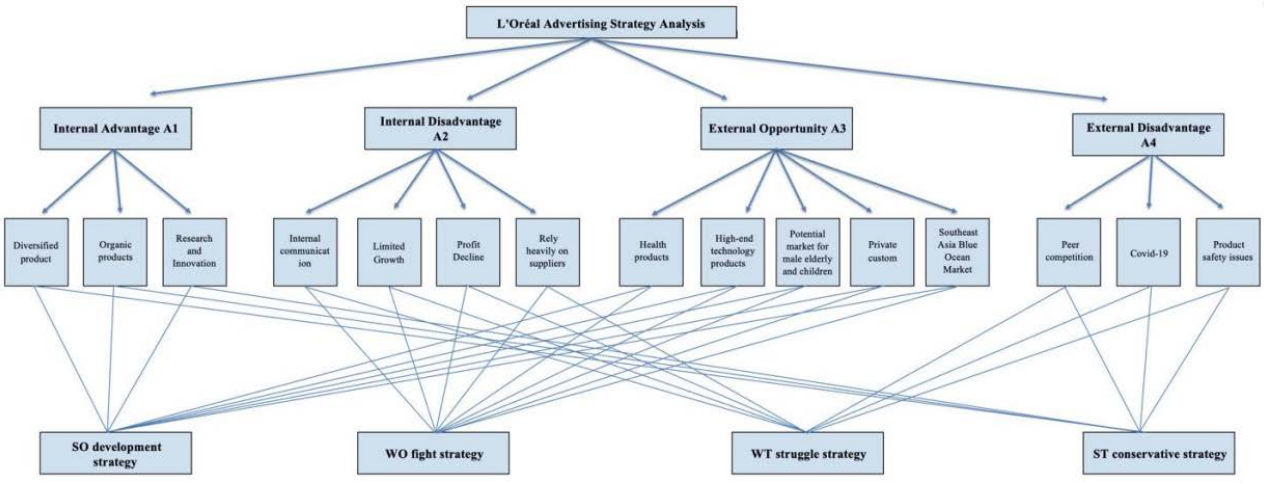


Figure 2 Model of the AHP Hierarchy

1.12.1 SWOT Evaluation in Manufacturing

SWOT analysis is among the most basic strategy tools that can be used to evaluate the inside and outside conditions. It divides these factors into four categories: SWOT analysis that stands for strengths, weaknesses, opportunities and threats. SWOT analysis is simple, flexible, and comprehensive as it allows the development of radical strategic plans considering all the strengths, weaknesses, opportunities and threats of a particular company.

decision makers come up with better decisions for their current state and the future state they desire. In a bigger space called business analysis, figure 3 sees where SWOT stands (Ali Görener, Kerem Toker, Korkmaz Uluçay, 2012).

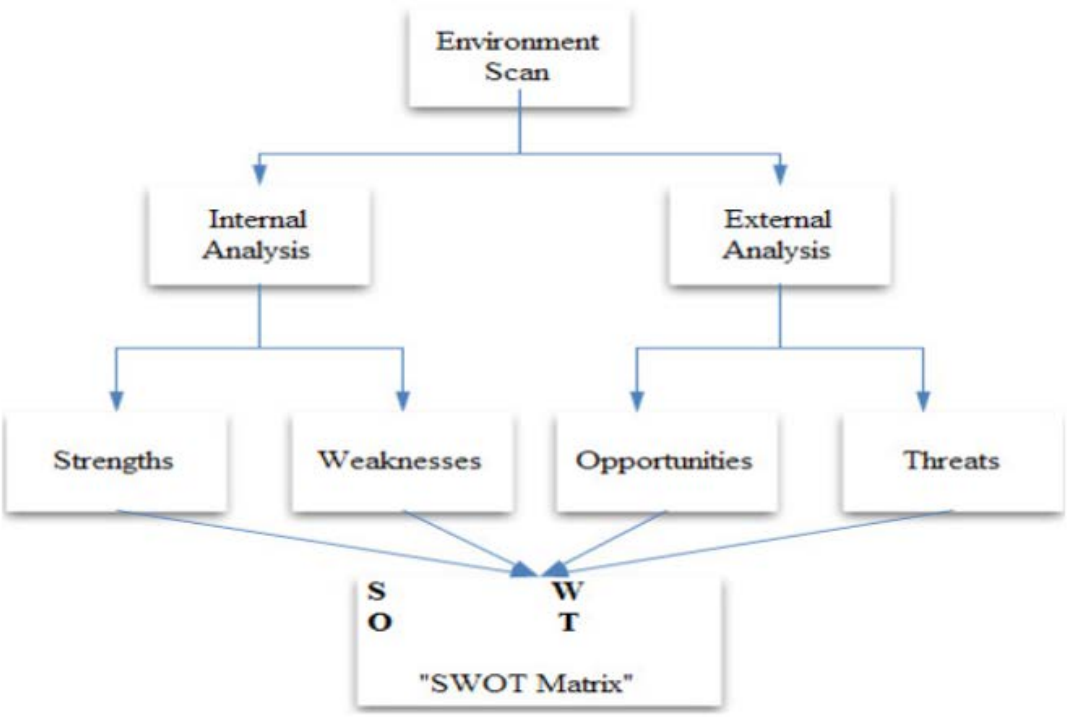


Figure 3 Framework for SWOT analysis

According to (Ali Görener, Kerem Toker, Korkmaz Uluçay, 2012) , SWOT analysis covering strengths, weaknesses, opportunities and threats are presented for the manufacturing function. In the strength dimension, such factors as innovation capability,

skilled human resource and expert management give confidence to the market. On the flip side, problems like high energy and labor costs and, most importantly, absence of a concrete performance measurement system can slow the company down. Concerning the strength, increased living standards and globalization create growth opportunities while weaknesses as economic instabilities and competition are threats. Indeed, the following matrix (Table 3) synthesizes the critical elements that affect the manufacturing industry.

Strengths (S)	Weaknesses (W)
(S1) Innovative capacity **(S2)** Availability of resources and skills **(S3)** Quality of the product **(S4)** Expert management staff **(S5)** Reliability in marketplace	**(W1)**Lack of performance measurement systems **(W2)**Non flexible organizational structure **(W3)** Energy costs **(W4)** Labor costs **(W5)** Lack of accurate forecasting capability **(W6)** High logistics costs **(W7)** Lack of well-known own brands
Opportunities (O)	**Threats (T)**
(O1) Rising living standarts and increasing modern buildings **(O2)** Globalization and the decreased trade barrier **(O3)** New foreign markets	**(T1)**Macroeconomic instability in Turkey **(T2)**Competition **(T3)**Political instability and possible problems in regional geographical area, especially Middle East **(T4)**Different and changing international market mechanisms **(T5)** Strengthening environmental pressures **(T6)**Different standardization request of international customers **(T7)** Low income per unit

Figure 4 SWOT Matrix

The relative weights produced by the Analytic Hierarchy Process (AHP) in conjunction with the SWOT matrix are used to evaluate inequality. First, as shown in table four below, Saaty's 1–9 scale is used to compare the SWOT categories pairwise. The next step is to compare the components in each SWOT analysis tool category. In this regard, we possess: The three department managers and the company's competent employees conducted all the comparisons with the paper's authors (Ali Görener, Kerem Toker, Korkmaz Uluçay, 2012).

The results will be presented in several tables: The Comparison Matrix for Strengths group is presented in Figure 5, the Improvement Matrix for Weaknesses group is given in Table 6, Improvement Matrix for Opportunities group in Figure 7 and Comparison Matrix for Threats group in Figure 8. Next, Figure 9 will indicate the Overall Priority Scores of all the SWOT factors identified. Lastly, the SWOT components' total priority scores are determined. Figure 9 displays overall priorities.

SWOT Groups	S	W	O	T	Importance Degrees of SWOT Groups
Strengths (S)	1.000	3.000	1.000	3.000	0.367
Weaknesses (W)	0.333	1.000	0.250	2.000	0.146
Opportunities (O)	1.000	4.000	1.000	2.000	0.365
Threats (T)	0.333	0.500	0.500	1.000	0.123
CR = 0.06					

Figure 5 Comparisons of SWOT factors in pairs

Strengths	S1	S2	S3	S4	S5	Importance Degrees
(S1) Innovative capacity	1.000	0.500	0.200	0.500	0.167	0.057
(S2) Availability of resources and skills	2.000	1.000	0.167	0.200	0.167	0.065
(S3) Quality of the product	5.000	6.000	1.000	3.000	2.000	0.400
(S4) Expert management staff	2.000	5.000	0.333	1.000	0.200	0.144
(S5) Reliability in marketplace	6.000	6.000	0.500	4.000	1.000	0.334
CR = 0.08						

Figure 6 Comparative Strengths Group Matrix

Weaknesses	W1	W2	W3	W4	W5	W6	W7	Importance Degrees
(W1)Lack of performance measurement systems	1.000	3.000	0.200	0.200	0.500	0.250	0.500	0.055
(W2)Non flexible organizational structure	0.333	1.000	0.167	0.167	0.500	0.200	0.500	0.035
(W3) Energy costs	5.000	6.000	1.000	1.000	6.000	2.000	7.000	0.294
(W4) Labor costs	5.000	6.000	1.000	1.000	6.000	2.000	7.000	0.294
(W5) Lack of accurate forecasting capability	2.000	2.000	0.167	0.167	1.000	0.200	0.500	0.056
(W6) High logistics costs	4.000	5.000	0.500	0.500	5.000	1.000	7.000	0.204
(W7) Lack of well-known own brands	2.000	2.000	0.143	0.143	2.000	0.143	1.000	0.062
CR = 0.06								

Figure 7 Comparative Weakness Group Matrix

Opportunities	O1	O2	O3	Importance Degrees
(O1) Rising living standarts and increasing modern buildings	1.000	2.000	3.000	0.539
(O2) Globalization and the decreased trade barrier	0.500	1.000	2.000	0.297
(O3) New foreign markets	0.333	0.500	1.000	0.164
CR = 0.08				

Figure 8 Comparative Opportunities Group Matrix

Threats	T1	T2	T3	T4	T5	T6	T7	Importance Degrees
(T1)Macroeconomic instability in Turkey	1.000	0.333	2.000	1.000	0.333	0.500	0.500	0.0946
(T2)Competition	3.000	1.000	1.000	2.000	4.000	3.000	1.000	0.2389
(T3)Political instability and possible problems in regional geographical area, especially Middle East	0.500	1.000	1.000	1.000	0.500	1.000	0.333	0.1006
(T4)Different and changing international market mechanisms	1.000	0.500	1.000	1.000	3.000	1.000	0.500	0.1240
(T5) Strengthening environmental pressures	3.000	0.250	2.000	0.333	1.000	0.250	0.250	0.0980
(T6)Different standardization request of international customers	2.000	0.333	1.000	1.000	2.000	1.000	0.333	0.1128
(T7) Low Income per Unit	2.000	1.000	3.000	2.000	2.000	3.000	1.000	0.2311
CR = 0.08								

Figure 9 Group Comparison Matrix of Threats

Swot Group	Group Priority	Swot Factors	Factor Priority within the Group	Overall Priority of Factor
Strengths	0.367	Innovative capacity	0.057	0.021
		Availability of resources and skills	0.065	0.024
		Quality of the product	**0.400**	**0.147**
		Expert management staff	0.144	0.053
		Reliability in marketplace	0.334	0.122
Weaknesses	0.146	Lack of performance measurement systems	0.055	0.008
		Non flexible organizational structure	0.035	0.005
		Energy costs	**0.294**	**0.043**
		Labor costs	**0.294**	**0.043**
		Lack of accurate forecasting capability	0.056	0.008
		High logistics costs	0.204	0.030
		Lack of well-known own brands	0.062	0.009
Opportunities	0.365	**Rising living standarts and increasing modern buildings**	**0.539**	**0.197**
		Globalization and the decreased trade barrier	0.297	0.108
		New foreign markets	0.164	0.060
Threats	0.123	Macroeconomic instability in Turkey	0.095	0.012
		Competition	**0.239**	**0.029**
		Political instability and possible problems in regional geographical area, especially Middle East	0.101	0.012
		Different and changing international market mechanisms	0.124	0.015
		Strengthening environmental pressures	0.098	0.012
		Different standardization request of international customers	0.113	0.014
		Low Income per Unit	0.231	0.028

Figure 10 Overall SWOT Factor Priority Scores

The findings of this study integrate SWOT analysis with AHP to determine strategic factors in a manufacturing firm. The priority rankings are Michael Porter's four forces are the most recognized competitive forces and implemented in 90% of the organizations Strengths (36.7%), Opportunities (36.5%), Weaknesses (14.6%), and Threats (12.3%). The highest value belongs to the opportunity factor, which is 'Rising living standards and increasing modern buildings. Such insights can be useful to management for decision making a devising management strategy. It shall be the subject of future research to employ a more refined methods of analysis, for instance, the fuzzy logic or other (Ali Görener, Kerem Toker, Korkmaz Uluçay, 2012).

1.13 Case Study on Sustainable Development at Big Companies

A case study on sustainable development at Big Companies shows the firm has focused sustainably across its lifetime, and now in its current stage puts energy behind a focus upon it. Big Companies define their sustainable development program as including the areas of innovation, production, consumption, and progress. Since it was launched in 2013, the sustainability program has affected carbon footprint reduction, waste handling, deforestation prevention and water management. Not only that but employment generation and social development can be credited to this initiative too (Pradit Withisuphakorn ,Ishita Batra , Nakul Parameswar ,Sanjay Dhir , 2019).

According to (Pradit Withisuphakorn ,Ishita Batra , Nakul Parameswar ,Sanjay Dhir , 2019) Big Companies Innovating Sustainably is one of our key initiatives, encompassing actions to reduce the environmental footprint, respect biodiversity and optimize packaging to prevent deforestation. For example, it is enhancing product biodegradability and using renewable raw materials; optimizing packaging by incorporating recycled material components; developing the responsible sourcing of its own raw materials in ways that both avoid deforestation and contribute to community development.

Producing Sustainably The concept involves CO2 emission reductions, water conservation and waste reduction throughout the manufacturing units themselves through distribution. But in this area, Big Companies has made quite a headway. They have already reached carbon neutrality for several of their units and slashed greenhouse gas emissions considerably. With efforts in water management the total consumption has fallen, and an attempt is being made to change manufacturing units into dry factories. Living Sustainably focuses on teaching consumers about the environmental and social impact of various products. Tools like the Sustainable Product Optimization Tool (SPOT) enable evaluation of product performance and can help consumers make better choices (Pradit Withisuphakorn ,Ishita Batra , Nakul Parameswar ,Sanjay Dhir , 2019).

In search from (Francisco Waldilon Da Silva , Anabela Carvalho Alves ,Manuel Figueiredo, 2019) , Sustainable Development means inclusiveness, not only for society at large but also internal and external stakeholders from all the relevant communities. For example, it includes underprivileged groups, people with disabilities or suppliers even. Collective Growth: Big Companies has sourced in the communities of local farmers, run training programs for them and have also made efforts to increase inclusivity across the supply chain. Big Companies shown how companies can care for the environment and people while making some profit for their business. However, for everyone to accomplish this, companies must include it in their daily operations.

1.14 The Future of Cosmetics Industry 4.0 Innovation

The digital technology under Industry 4.0 for cosmetic industries encompasses mechanisms of various systems that advanced to modernize procedures of product development, manufacturing, supply chain management, marketing, and collaboration (Gianpaolo Di Bona, Vittorio Cesarotti, Gabriella Arcese,and Tommaso Gallo, 2021). For example, cloud computing makes data storage secure and convenient, giving cosmetic companies a chance to store vast information without worrying about collab among the different stakes who are in some parts of the world different. This contributes to better communication and decision-making procedures, which result in more flexible and effective operational performance (Osvaldo Ferreira & Fernando Moreira[a], 2012), developing a way of using communication and information technologies to increase output in organizations is a complicated task because for every technology feature that is explored, the company has a new chance for improved results. Here are some technologies that are used in the Cosmetic industry: 3D Printing, IoT, AR & VR, Cybersecurity, AI, Robotics, and Cloud Computing are among the prevailing technology trends of this generation. Furthermore Manufacturing, product, supply chain management, marketing and branding campaigns, and collaboration and partnership initiatives are the five crucial areas in which the company has used such technologies. The next paragraph will comprehensively examine these technologies giving a pictorial representation and applicability and the possible ramifications (Gianpaolo Di Bona, Vittorio Cesarotti, Gabriella Arcese,and Tommaso Gallo, 2021).

1.14.1 3D Printing

As the 3D printing has been introduced as a new technology in the cosmetic industry, companies have the chance to better prompt prototyping and to produce custom design products more quickly. This technology greatly cuts the time needed for coming up with new formulations and for designing the packaging, hence driving companies' sensitivity to fashion trends and bettering the customer design. Moreover, 3D printing grants designers have such unlimited freedom with design since their work is not inhibited by the constraints of physical manufacturing. 3D printing allows producers to create complex geometries, intra cavities, as well as complicated details that in the past were hard to produce by traditional

manufacturing techniques. As a case in point, rather than manufacturing sunglasses' separate components, like the earpieces, and assembling them without further ado, 3D printing circumstantiates the production of sunglasses, with earpieces featuring soft and flexible materials, and rims that are hard and part supporting the lens. This tunability is then helpful in a wide variety of applications ranging from aircraft engines to audio assistance for the hearing impaired. An example of GE Aviation through 3D printing includes fuel nozzles for next-generation turbofan engines, while most hearing aids around the world are created this way too, each specific to a user's distinctive ear shape. Besides, 3D printing makes product development faster due to the reduced time between the invention and the product needed locally, which shortens time to address local issues. In other words, there was a joint venture of the Canadian organizations with Comprehensive Rehabilitation Services in Kisubi, Uganda, to pilot 3D printing of artificial limbs for amputees with better fitting and production process very quick in comparison to the traditional ones. Once more, in Togo, prints produced from repaired 3D printer highlight the possibilities of green manufacturing within a tech framework (GADZALA, 2018). Additionally, the subsequent discussion will explore how 3D printing impacts the five key aspects of company operations: Product innovation, lean manufacturing, Supply Chain, Marketing and Branding as well as Collaboration and Partnerships, and how they are involved in the various stages of business development.

1.14.1.1 Product Innovation & 3D printing:

Making use of 3D printing during manufacturing processes allows for new products invention. In this regard, a skincare brand embraces the new 3D printing technology that helps in the prototype of the packaging designs in a relatively short period because of the advanced way by which the design can be tested and the product offerings that are tailored according to preferences of the consumers (Thomas Campbell, Christopher Williams, Olga Ivanova and ,Banning Garrett, 2011).

1.14.1.2 Leaning Manufacturing & 3D printing:

Redundant manufacturing infrastructure is trimmed down by the integration of 3D printing thereby stimulating lean practices. Conceive how a baby-cosmetics company could enhance or create the production lines it uses by applying 3D printing technology that allows for customizable components. While this lean process results in reducing the rate of waste, shortening the time of queuing, and improves overall effectiveness (Simon Véronneau, Geoffrey Torrington and ,Jakub P. Hlávka, 2017).

1.14.1.3 Supply Chain Optimization & 3D printing:

The introduction of 3D printing is one of the recent innovations in boosting the effectiveness of supply chains. Try to picture a cosmetic company, which is using 3D printing ability of its equipment to develop components for products right on its spot without any dependence on 3rd party suppliers or transportation limitations. This one-process approach increases the velocity of execution, interpretability, as well as improves the system's agility and reliability in the availability of the product and meeting customer expectations (Simon Véronneau, Geoffrey Torrington and ,Jakub P. Hlávka, 2017).

1.14.1.4 Marketing and Branding & 3D printing:

Product marketing commonly takes a walk down the lane of 3D printing; one of the most profitable industries. Thus, consumers are now able to stand around the new world of creation and communication made by them in the brand that they hope for. It seems you were in the shoes of a fake beauty company impressing the audience with 3D printing emerging technology to create magnificent product exhibitions and exclusive packaging services. This new branding approach as well as generating distinctions as it also plants in the minds of customers strong relationships, which thence comes out as loyalty and ultimately yields a boost in the market share. This popularity is mostly because of the DIY (Do It Yourself) revolution, where people are on the driving seat and that they are creating or customizing products by using the technology of 3D printing for experimentation or by starting up small-scale manufacturing enterprises (Russell, 2017).

1.14.1.5 Collaboration and Partnerships & 3D printing:

As soon as the 3D printing technology incorporates theaters that exhibit maximum collaboration, the technology takes root. Differentiate among those collaborations of a cosmetics company that can join designers and research institutions to coproduce formulas and package reputation using 3D digital printing. Such a collaboration of expertise is a great opportunity for creating and developing innovations which in turn create top global industry competitiveness (Russell, 2017). In Figure 3 a 3D printer meticulously builds layer upon layer of material, illustrating the innovative technology's capability to produce intricate and customized objects with precision (Peitersen, 2021).

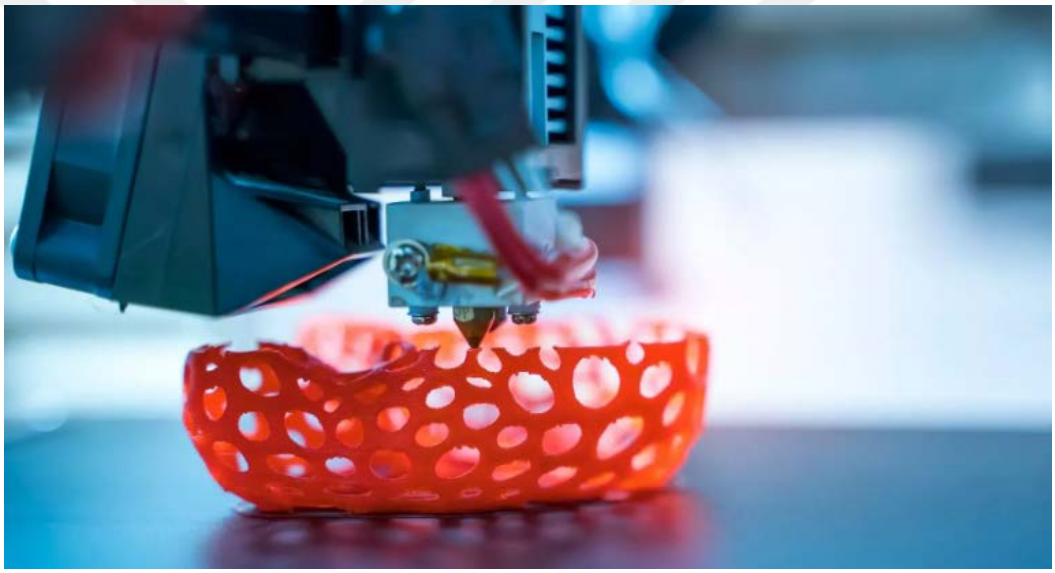


Figure 11 3D printer building a very detailed shape

1.14.2 Internet of Things (IoT)

Compared to traditional cosmetic goods, the embedded IoT technology and innovative approach acts as a banner for the new concepts about consumer interaction and innovation in the cosmetic industry. Locating a sensor in the packaging equipped with connectivity element will allow companies to get accurate data of the usage of a product and the actions of the consumer. Besides the many garments offered, it also includes a campaign system where advertisers help identify the genuine customers. The product is customized and hence the customers like the product and create brand loyalty. This radical metamorphosis belongs to the broader movement called the ominous Fourth Industrial Revolution, which features the utilization of super-advanced digital technologies and smart automation (Chou, 2018).. This close example has been proven with the industry 4.0 program which has been adopted by the German government. All these schemes have a “cognitive touch” which is expressed in the transition from the physical to the digital and heavily relies on the software than on the hardware. The core of this disruption is the new forms of linkage that will be created by the "Internet of Things" (IoT) technology. It is a logical continuation of the association among the levels of net connectivity that were already achieved through the Internet and World Wide Web (WWW) to involve ordinary physical objects and systems. IoT is a combination of a set of digital exertion components such as sensors, communication modules, and various program apps (Chou, 2018). The subsequent discussion will delve into how Internet of Things (IoT) influences the five key aspects of company operations.

1.14.2.1 Product Innovation & IoT :

The Internet of things (IoT) is generating a deep and momentous change for the cosmetics industry. It is a true manifestation of digital transformation. That IoT can even exist, is proof to the convergence of several technologies. Progress in the different areas of the microprocessors, sensors, and communication hardware which will improve availability of the IoT devices combined with big data analytic functions, the cloud and algorithms that allow automation or streamline ordinary processes, have expanded the possible use of the

IoT. Developing IoT evolves within the context of new communication networks linking all devices which can be easily managed from a distance, new Internet communication protocol (IPv6), and more accurate satellite GPS technology. The sensor family, which includes cameras, thermometers, and pedometers, is the central factor in IoT, it being able to collect a rich variety of information from the environment by mechanical, thermal, chemical or biological means. Sensors and actuators perform harmoniously possessing the function to read the signals and produce the response respectively. This may mean sensors picking up external temperature and actuators adjusting the jacket's temperature, as seen on a smart e-jacket. Sensors can alternatively be deployed as a composite unit bringing in other sister programs. In addition to that, micro-electronic components in cosmetic packaging would also be useful since it can also give a live data update on product usage and consumer behavior. Since nowadays consumers have easy access to seemingly infinite amounts of data, it is possible to make custom products, which potentially will satisfy every individual's explicit taste and they will remain wedded to the brand (Kshetri, 2023).

1.14.2.2 Lean Manufacturing & IoT:

IoT has connected pallets, bricks, elements and people together, leading to lean manufacturing in the cosmetics industry. A governed world, IoT system will be an integral part working. This will go on to streamline production processes and reduce the amount of waste and therefore improve operational efficiency. Real-time monitoring of equipment performance and inventory levels in the background helps regularly maintain the equipment and managing the inventory efficiently which will result in cost saving and higher productivity (Kshetri, 2023).

1.14.2.3 Supply Chain Optimization & IoT:

Multiplication by Internet of Things (IoT) in supply chain management provides merited transparency and efficiency that is not common. Incorporating wireless sensors of the IOT type allows companies to know the direction of raw materials and finished products movement, to monitor shipment tracking, inventory level management and reorganization of logistics process by optimizing this. Now overview by the management, all the processes

of supply chain management will be controlled adequately. Processes will be streamlined, and lead times reduced. Consequently, the company will become more responsive to the market demands (Chou, 2018).

1.14.2.4 Marketing and Branding & IoT:

The Internet of Things IoT reshapes marketing and advertising strategy of cosmetics sector. With data derived through advanced IoT analytics, enterprises can explore consumer tendencies thereby executing individualized marketing and brand activities. IoT fitted smart packaging, and interactive displays allow brand experience that involves consumers which result in their engagement and loyalty (Chou, 2018).

1.14.2.5 Collaboration and Partnerships & IoT:

According to (Vaughan Turekian ,Taehee Jeong ,Gigi Kwik Geonvall ,E lizabeth Prescott ,Gwanhoo Lee , Rebekah Lewis ,and Beau Woods, 2018) The IoT (Internet of Things) serve to complement people and ally the health care industry by making the cosmetics business more people centered and partnered. By making use of internet-enabled systems and technological tools, companies have been able to promote interdisciplinary collaboration with supply chain partners, distributors, and other important players in the business community thereby driving innovation and achieving a common business agenda. With round-the-clock and sources for information, businesses can improve their decisions, prioritize allocation of resources, and introduce contributions through partnerships that improve the business. International standards should be taken as the lowest priority since the world is still experiencing the first configurations of IoT standardization. In turn, such standards can clear the path for a universal protocol amongst IoT systems that will ensure economies of scale and provide a higher level of cybersecurity standards. On the other hand, the government should provide some support, however; the major efforts should concentrate on teaming up with related industries to develop IoT standards rather than control what the standards should be.

1.14.3 Augmented Reality and Virtual Reality (AR&VR)

According to (deLahunta, 2002) ,Blending AR and VR technologies is shaking up both the marketing of and customer experience of beauty products, at the same time. Utilizing the augmented reality approaches, phone owners and other users can also do a makeup test on their devices. This, hence, builds immersive and highly realistic experiences situation. In the same way, VR technology creates viewing virtual beauty businesses where consumers can respond to the items and methods therein. This thus leads to brand awareness raise and multifaceted contact between consumers and the companies.

There is an immersion of audiences in virtual reality and performance arts into the very real experience, with open and direct manner of participation and interaction. This is a kind of art that takes its roots in various past traditions such as, performativity, participation, interactivity, and communication, expressed through several media. The reality of virtual reality and interactive artworks where viewers can move wherever they like in the three-dimensional environment of their computers is a very interesting concept (deLahunta, 2002). These simulations exploit sensors as well as input devices to receive and process corresponding movements and gestures which in turn represent virtual existence appreciated by users. Many virtual reality and performance art forms share the use of custom input devices type, therefore making the real time rendering and projection of virtual environments possible on individual holographic displays or VR headsets via projection devices (deLahunta, 2002). The influence of Augmented Reality (AR) and Virtual Reality (VR) on the five key business domains will be examined in the upcoming debate.

1.14.3.1 Product Innovation & AR/VR:

The novel technologies of augmented reality (AR) & virtual reality (VR) are all the years of the established route product innovation in the cosmetics industry. Today the customers can virtually try on makeup, test different shades and review the shade that will match with them using visual technologies of businesses. This adds a near enjoyable shopping experience to the customers, and comes along with constructive feedback, which is worthwhile for marketing new formulations and designs (Ross, 1992).

According to (Ross, 1992) , vivid illustration of virtual reality is the fact that it eliminates the consequences of failure while joining creative and productive segments together. This measure helps reinforce the money flow, expands the market and trains staff better. Building an actual product prototype before creating a product can be completely avoided by humans having interactions with the virtual designs, when they can explore a simulated reality. This cut is time-consuming testing of experiences before products and procedures are launched and there will be no need for costly revisions or re-remolding.

What is more, virtual reality has marketing tools, such as demolishing the products customers might be willing to purchase soon. For example, VPL is among the companies designing virtual reality systems that let users map their apartment layouts and then visualize the placing of new appliances in those room layouts inside virtual showrooms. When building virtual reality, it permits the purchasers to make educated choices about the purchases (Ross, 1992).

Virtual reality goes beyond simulation for it could also revolutionize new product design methodologies, thus ensuring that sharing skills between teams, even remote ones, will not be an issue. While some VR scenarios must be as realistic as possible to achieve their purpose, there are situations where merely going beyond reality is necessary to activate the imagery. Cyber worlds that stimulate imagination rather than record reality are built and people become more engaged due to the implication. Finally, as for as user's autonomy to create their own virtual environments using programming language tools increases the scope gets wide and sky opened for the innovation and discovery in alternate paradigms (Ross, 1992).

1.14.3.2 Lean Manufacturing & AR/VR:

Lean manufacturing in different businesses lines such as cosmetics nowadays is offered a variety of innovative solutions by augmented reality (AR) and virtual reality (VR) technologies. A business may achieve these benefits by blending AR/VR tech with production processes: replacing human production processes with virtual ones, reducing errors and boosting worker productivity. As an instance, establishment of the AR system for assembly processes could guide workers through difficult procedures with minimum

training, thus make operation processes efficient. As VR can create a common and uniform vision, VR-based training and quality control features can ensure identical production quality and safety standards among all producers (Peter Balco,Peter Bajzík and ,Klára Škovierová, 2022).

Parallel with the technological developments and the reason for equipment being at a low cost in the market, numerous areas have also started applying VR. Although VR is considered as a gaming and entertainment tool, there are prospects of its other uses in manufacturing to different fields. in the future, VR will be used for industrial engineering, such as for production and design control processes. The engineers will be able to interact in a 3D setting with all details of data. These are interrelated and used for collaborative work from the early stage and consider factors like ergonomics and product lifecycle.

Also, VR provides a training ground, in both structure and operations, for students to explore in the immersive virtual environment. Instead of using real equipment and elements, virtual training emulates them. This helps to save resources and enhance security. Advances in AR and VR technologies open new possibilities for developing a streamlined production process and improving welfare among sectors (Peter Balco,Peter Bajzík and ,Klára Škovierová, 2022).

1.14.3.3 Supply Chain Optimization & AR/VR:

Immersive technologies, namely AR and VR are being employed to optimize the supply chain processes in the cosmetics industry. They are a complete virtual environment with the help of which they can display items in a 3D way so the customers can understand the beauty products better. Companies can run their equipment efficiently and safely with the help of AR/VR technology. It can automate inventory management processes, optimize logistic and distribution flows. One of such AR features, smart glasses powered by computers can view what workers need to find out in the warehouse and whereabouts tracking operations to increase the efficiency of the warehouse. VR simulations are applicable for virtual inspections and audits, thus saves time for staffs and faces, thus join in the decision-making process promptly (Peter Balco,Peter Bajzík and ,Klára Škovierová, 2022).

1.14.3.4 Marketing and Branding & AR/VR:

Tutorials, infographics, and virtual try-ons powered by augmented reality (AR) and virtual reality (VR) redefine marketing and branding approaches in the cosmetics industry. They can rejuvenate interactions with customers, applying attractive and intriguing approaches that would never have been possible before. Such applications of AR can be exemplified by makeup try-on apps which provide users with the ability to virtually and apply various products of cosmetics and styles, making their shopping amusing and influencing them to take purchase decisions. This way VR can have customers experience products as if they are virtually at beauty events and pop-up stores, increasing brands' popularity as well as purchase involvement (Ross, 1992).

1.14.3.5 Collaboration and Partnerships & AR/VR:

Based on (Peter Balco,Peter Bajzík and ,Klára Škovierová, 2022) ,Cosmetics industry leverage Augmented Reality (AR) and Virtual Reality (VR) in helping colleagues build partnerships. It is precisely the technology that serves to bridge the gap between people by providing a channel for remote communication. Thus, it is very much a source of ideas. For instance, bringing upcoming product designs to life and packaging concepts can be done without leaving the virtual space in front of your eyes and with AR/VR-powered collaboration platforms. Fast decision-making process, which has never been faster, reduces the time-to-market. Also, these simulations as well as presentations, training and product demonstrations could be used in virtually, for cross-team meetings or sharing of knowledge

1.14.4 Cybersecurity

Based on (Natasha Cohen, Rachel Hulvey, Jittip Mongkolnchaiarunya, Anne Novak, Robert Morgus, and Adam Segal, 2017) ,In the age of digitals, we can only make sure strong and reliable security measures, this is very essential to help customers protect their sensitive data as well as intellectual property, especially when it’s coupled with the increased digitalization in industries like plastic surgery. Firstly, improving the cybersecurity practices is, and secondly, maintaining standards for the privacy of data will be crucial for this purpose. Alongside utilizing the latest security technologies investments, organizations generate trust

amongst their clients, also security and reputation in the market. Also, the increasing executing processes of mimicking illustrated plastic surgery online threatens the need for applying cybersecurity implementations and following the data privacy stipulations that must be complied with.

Cybercrime has been a concern of equal concern in both the private and public sectors, and the recent past has seen a massive rise of high-profile cyberattacks across the world. People, using those tactics not only for stealing or disclosing classified information but for disturbing critical infrastructure, demonstrate the greater requirement for cybersecurity services and skill. These investments in cybersecurity have been, as a result, consistently on the rise, with a notable jump in the technology sector being observed since 2013. The cybersecurity sector displays its clustering, with Britain, the United States, and Germany as the most pronounced clusters and there are many other countries which join this club (Natasha Cohen, Rachel Hulvey, Jittip Mongkolnchaiarunya, Anne Novak, Robert Morgus, and Adam Segal, 2017).

Governments raise money to enhance protective and attack cyber capabilities aimed at quelling emerging cyber dangers. For instance, the United States' appropriation for the cyber defense to rise by more than 35% by the end of 2017 and more budgets are being devotes to the enhancement of the cyber security. Rising from private business, consumer groups and the governmental sector the cybersecurity market is expecting to rake up to $125 billion by 2020. This path highlights the role of cybersecurity as the main tool that can fight the dynamic cyber threats which affect different sectors increasingly .In the next debate, the effect of cybersecurity on the five main business domains will be discussed (Natasha Cohen, Rachel Hulvey, Jittip Mongkolnchaiarunya, Anne Novak, Robert Morgus, and Adam Segal, 2017).

1.14.4.1 Product Innovation & Cybersecurity:

An epoch of technological development or digital transformation has made solid cybersecurity practices a must for protecting credit card holders and the company's intellectual property. Placing cyber security at the top of the priorities list will enable companies to ensure the confidentiality and integrity of their unique product designs and

formulations and gain more trust from their customers and partners (Valentin Mullet , Patrich Sondi , and Eric Ramat, 2021).

1.14.4.2 Lean Manufacturing & Cybersecurity:

As far as lean manufacturing is concerned, cybersecurity is a key factor in providing protection against operational risks and corruption of data. With the advent of lean cyber manufacturing processes which are highly automated and dependent on interconnections, having resilient cyber defenses becomes a must because this makes the environment less prone to security threats and reduces the probability of data breaches. Through the inclusion of cybersecurity solutions into an overall lean production plan, corporations develop means to build more resilient systems and respond briskly to potential cyber-attacks that would be targeting highly sensitive data. This in turn secures both efficiency and stability in production. (Valentin Mullet , Patrich Sondi , and Eric Ramat, 2021)

1.14.4.3 Supply Chain Optimization & Cybersecurity:

Cybersecurity plays a vital role in shielding the active supply chain networks from malicious cyber-attacks that can otherwise be used for disrupting both system integrity and data integrity. By setting top-of-the-line cybersecurity rules for the processes of supply chain, companies can neutralize the possibility of supply chain disruptions and data breaches and in such way protect the assets of the supply chain ecosystem (Valentin Mullet , Patrich Sondi , and Eric Ramat, 2021).

1.14.4.4 Marketing and Branding & Cybersecurity:

One of the most important factors in cybersecurity is to have a world-class technological intervention which will help in building trustworthy brand image and integrity in the digital area. The key task for companies is to make cybersecurity an integral element of their marketing activities and to build trust with customers. It can be done by showing customers that data and privacy of consumers are their top priority. This approach will increase brand reputation and thus attract more customers (Valentin Mullet , Patrich Sondi , and Eric Ramat, 2021).

1.14.4.5 Collaboration and Partnerships & Cybersecurity:

In the industry of cosmetics, one of the core cybersecurity functions is to create a safe space free of cyberthreats for all the stakeholders. It allows making secure networks and business relations between cosmetics enterprises and significant stakeholders. Through an effective cybersecurity architecture, which comprises an assortment of opportune controls, companies can hinder unauthorized access to the information passing along from partner to partner, to guarantee that privacy is not breached, and collaboration efforts are not leaked. Rules regarding data privacy and security of systems stay not only cyber-bullying away but also protect the present business relationships, creating an atmosphere of integrity and honest communication between the participants and other people.

The national and bilateral level policy and criminal regulation reforms should aim at the cybersecurity increase of the internet of things devices but not just to hinder innovation and adoption. Of particular importance is the cooperation between government and industry officials to pinpoint the homogeneous key issues in the field of cybersecurity with respect to IoT and to define the most effective practices for addressing them. A comprehensive and harmonized level of effect on concentrated issues of policy would thereby drive forward existing best practices and avoid dictatorial non-uniformed rules, regulations and stipulations that pose as challenges for fledgling initiatives. (Vaughan Turekian ,Taehee Jeong ,Gigi Kwik Geonvall ,E lizabeth Prescott ,Gwanhoo Lee , Rebekah Lewis ,and Beau Woods, 2018)

1.14.5 Artificial Intelligence (AI)

Artificial Intelligence (AI) proved its life changing among the cosmetics industry in the way it not only helped develop the products but also made supply chain more efficient. AI algorithms surf various consuming data and market trends to look for and identify different patterns and tastes of clients that guide numerous techniques to produce attractive and innovative goods that may cater to the needs of customers. On top of this, AI-powered data analysis software can predict stock management, and transportation efficiency at optimal levels minimizing waste and streamlining workflow process. In the section that follows, not

only will the effect of AI on the said categories of business operation but also the impact of AI be discussed in detail (Kavanagh, 2019).

According to (Kavanagh, 2019) , AI research can be traced back more than five decades. However, the increased interest of the public in this field is before the twilight of the 20th century. Indeed, the idea is platformed in computer science and AI can be defined as building machines that optimize their operations by being as intelligent as humans. It involves different subfields such as natural language processing, machine learning, and robotics that collaborate in bringing about taking on responses and intelligent functionality. In recent years, these breakthroughs in AI have led to an array of possibilities in improving healthcare, mobility, and entertainment sectors.

Though AI could possibly bring a bunch of benefits too it contains several dangers and problems. One of them is cybersecurity threats spillover into vital AIs, which are dependent on them, unintended consequences of AI confluence with other technologies, biases of algorithms and lack of transparency in the policies, followed by risk of digital surveillance. Resolving these challenges will in effect pave the way for an effective utilization of AI to realize the maximum efficiency without putting into danger the grave associated risks. The impact of artificial intelligence (AI) on the five key business categories will be covered in detail in the upcoming debate. (Kavanagh, 2019).

1.14.5.1 Product Innovation & AI:

AI is driving the fundamental changes that are occurring in the cosmetics industry by marketing data processing and analysis of market patterns and customers' behavior to propose innovative and trending beauty items. This shift towards ongoing innovation powered by artificial intelligence and digital craftsmanship is reflected in the increasing demand for green cosmetic products, wherever consumers are turning to safer and more eco-friendly alternatives. A close collaboration between government undertaking and private firms is a must if the development of the market and consumer cognizance of natural or herbal based cosmetic goods is to be driven. In the wake of the COVID-19 epidemic, AI and machine learning technologies have become critical instruments in handling the extended

consumer demands. AI-focused vendors are providing software systems which are being applied to AI-powered systems that use machine learning algorithms to customize skincare advice considering the individual conditions of the skins (Singh, 2023).

1.14.5.2 Leaning Manufacturing & AI:

An implement of the lean manufacturing is to have AI operated predictive analysis introduce correct inventory management and production processes. Through examining historical information as well as current trends forecasts for the future, AI techniques are capable to estimate how much is needed or not needed and to define where to keep these stocks without being wasteful. Moreover, AI-assisted predictive maintenance improves equipment functionality and reduces downtime which is one of the factors distinguishing seamless manufacturing (Singh, 2023).

1.14.5.3 Supply Chain Optimization & AI:

Artificial Intelligence is a leading tool of supply chain management which provides up-to-date information and predictive analysis. The AI algorithm filters through data provided from suppliers, logistics partners and market conditions to ensure the stock keeping units are just an optimum, the route of transportation for delivery is just optimum and the distribution channels are optimized. This optimization enables us to cut down production waste, to decrease related expenses, and improve capacity of resisting harmful supply chain disruptions. During the technological advancement of AI, it invaded the area of beauty industry, contributing to leaps of the innovation which also partake the industrial revolution 4.0. AI promises individuals automated processes, as well as enhanced decision making and digital networked systems, before human intelligence. AI and machine learning allow brands to provide cutting-edge operations and serve the customers in a fast-track manner in a customized manner. Via these technologies, customers can engage online with beauty specialists if they are in doubt; at the same time, they are able to maintain the social distancing requirement and prevent diseases from spreading. Moreover, with technology, augments reality acts as revolution by letting you have a virtual "try-on" experience for various products like apparel, make-up, fashion accessories, and many others. AR improves positive customer interactions and reduces the risk of disease transmission as it does not

require physical trials which is the sole need of a fitting room (Neelam Mangtani,Dr. Nibha Bajpai ,Dr. Sangeeta Sahasrabudhe and Dr. Deepak Wasule, 2020).

1.14.5.4 Marketing and Branding & AI:

AI plays a major role in creation of brand awareness and affinity of brands by means of utilizing personalized and targeted campaigns at the end of the long process with the aid of AI algorithms, a sizable amount of consumer and scientific data including demographics, surfing behavior and previous purchases can be analyzed which helps AI algorithms detect individual choices. AI algorithms use their capabilities to offer customized brand messages and product offerings that fit an end-user profile perfectly. With the assistance of AI-based marketing automation, companies do not only conduct but also respond to customers, which are very important. In this way, the companies will reach customers' needs and stay relevant to them. As a result, the customers will be loyal to them and increase the sales of the companies. AI is applied in the interaction sphere, where it deals with voice and text processing, image recognition, and decision making. Also, AI can run automated assemblies of robots and vehicles. With such apps marketers will engage their clients more by developing and monitoring brand awareness and personalizing client relationships. AI also helps create a better market mix when it comes to improving attractiveness, affordability, accessibility, and knowing of products and services. (Vrublevskaia, 2021).

1.14.5.5 Collaboration and Partnerships & AI:

Ai makes it possible to work together and create partnerships with the help of smart algorithms and AI-driven data for decision-making. Ways that AIs discover strategic partnering opportunities and optimize collaborative efforts include using data from multiple sources such as internal operations, market trends and consumers' behavior to perform analysis. Moreover, AI-enhanced collaboration platforms have all the ability to establish communication and the knowledge supplying among the partners, which leads to increase the innovations and business growth commonly (Vrublevskaia, 2021).

1.14.6 robotics

Industrial sector robotics, particularly in the cosmetic realm, is essential to maximize production and higher efficiency. Developing AI robots for repetitive tasks increases efficiency, as well as productivity, hence, fewer errors at larger scale which may result in a reduction of labor cost and more satisfactory quality. The efficiency thus provided gives manufacturers a chance to devote the other resources to factors that are rather significant like research and product design. The vast influence of robotics upon numerous business segments will be the heart of discussion.

The path of industrial automation has been driven for decades by robots that now act as projectors, like the likes of control towers in the 70s and process drive controllers in the 80s. The International Federation of Robotics (IFR) reported a rising number of robot sales worldwide these years, especially, the production systems in industries like China, Japan, South Korea, USA, and Germany are up to high level. Although economic complications exist, the robotization process will not be stopped, and on the contrary, this will show an increasing amount of robotics importance in the productivity of modern businesses. The tremendous effect of robotics on the five main business fields will be explored in detail in the upcoming discussion (Olszewski, 2020).

1.14.6.1 Product Innovation & Robotics:

As a cosmetics sector, automation embraces robots to address the issue of tedious tasks through the exacting of process automation. Being able to select robots for their exact manufacturing purpose is leading to the enhancement of the accuracy and effectiveness as well as speeding up the production process and enabling innovation in response to dynamic customer requirements (Timothy DeStefano,Koen De Backer,and Jung Ran Suh, 2019).

Based on (Timothy DeStefano,Koen De Backer,and Jung Ran Suh, 2019) the empirical results indicate that economies specialize not only in industries but also in varieties of product within those industries, with developed markets preferring higher quality goods. The use of industrial robotics as a tool result in the improvement of product quality's within-product feature, which is based on the concept of accuracy and productivity.

Agriculture robotics frequently uses higher-grade inputs, a significant part of which comes from other countries due to pure production accuracy. The case of generally well-established economies shows a positive correlation between robotics adoption and higher standard imports, but that is less true in most cases for emerging economies, thus suggesting that there is an underlying intricate machinery at play in the interactions between robotics and export quality (Timothy DeStefano,Koen De Backer,and Jung Ran Suh, 2019).

1.14.6.2 Lean Manufacturing & Robotics:

Lean manufacturing robotics is a key element in improving efficiency and decreasing costs and it does this by utilizing robotics. Automation thereby increases the speed of repetitive tasks such as packing and assembly and thus reduces the chance of any errors. It follows that automation implies increased productivity, labor costs reduction, and increased production efficiency, which brings the lean into the light through wasting elimination and continuous progress (Timothy DeStefano,Koen De Backer,and Jung Ran Suh, 2019) .

1.14.6.3 Supply Chain Optimization & Robotics:

Robots are driving the evolution of supply-chain optimization in the cosmetic business, which can be considered as an innovation able to reach a very high level of automation. Applying tools, including AGVs and robotic arms, makes navigation, handling, and inventory management at spatially distributed warehouses and logistic hubs easier. No wonder that instances of improved warehouse space optimization, reduced handling time, and more apparent supply chain systems translate into great time-advantages of order fulfillment, decreased transportation costs, and increased efficiency in the supply logistics system.

Innovations such as Angie’s list serve to build a structure within which the supply network can expand and grow. In addition, providers of assets and services can subscribe to the Network and be displayed as process robots on the robot distribution channel. It is a cutting-edge cloud-based platform that ensures a real-time match between supply and demand along

with automating business operations to achieve frictionless operations on a single platform. Different to traditional automation, which is a divided program, wherein human beings are needed for connectivity to effectively work robotics-based processes are more intelligent and versatile. These can act autonomously to cover for errors, modify the parameters' scale and cause a better result with the supply (Jain, 2019).

1.14.6.4 Marketing and Branding & Robotics:

AI and robotics have become inseparable factors that chained cosmetic companies with their marketing and branding strategies through one-to-one interaction and holistic approach. Currently, it is a designation for Strong AI which incorporates consciousness, awareness, and an ability to think on multiple levels and Weak AI whose purpose is to achieve goals like self-driving cars. Research can be divided into humanities which is about past and present, and into robotics which is the field of study that concerns robots' design, development, and applications (Keng Siau & Yin Yang, 2017)..

According to (Keng Siau & Yin Yang, 2017) , The cosmetics sector utilizes interactive kiosks and robotics experiment space which allow the people to experience the product in a customized manner like 3D product previewing and render virtual testing. Through such activities you can achieve a more positive brand image and additionally, augment sales volumes. Robotics, along with that, creates a significant part of customized packaging solutions through which companies can offer a great variety of packs with different designs and products according to consumer's personal preferences.

AI, robotics, and machine learning join forces to reconfigure the marketing and selling environment, where bots have been destined to immerse the activities of customer attraction. AI-loaded sites can edit content dynamically and form layouts according to users' behaviors, which means one can segment customers' preferences. As these technologies keep on developing, even the research questions in marketing research will be altered, and professionals will need to keep updated by embracing lifelong learning and working in collaboration with robots and AIs. Nevertheless, the spaces for creativity, designs utilization, and innovation are worthwhile, there is no doubt, which may make the human professionals to be effective with the current swift faced reality (Keng Siau & Yin Yang, 2017).

1.14.6.5 Collaboration and Partnerships & Robotics:

Robotics makes it possible for collaboration and partnership on the cosmetic chains by developing automation and labor-efficient components of production line. With the application of robotic automation technologies, the companies will not only collaborate with their receiving suppliers and partners but also renovate the way they are doing the production process thereby promoting growth for mutual business interests. Besides, robotics can provide the required adaptive and scalable production processes that may encourage networking and commission partnerships for new product developments and business strategic operations (Keng Siau & Yin Yang, 2017).Figure 4 shows robotic arm that is working in cosmetic sector.

Figure 12 The image shows robotic arms in operation, emphasizing their crucial function in streamlining manufacturing procedures in the cosmetics sector (IAV, 2024).

1.14.7 cloud computing

The concept of cloud computing has totally changed data storage and accessibility in the cosmetic industry. For instance, it enables firms to be safe while keeping large volumes of records. It also simplifies teamwork among all parties working with different

locations. With the help of cloud-based platforms cosmetic companies not only are able to improve their information exchange and decision-making processes thus increasing the speed and agility of the operations but also turn big data collected from their clients into actionable insights to forecast and plan their business strategies. On the one hand, this digital infrastructure helps company owners obtain paramount information any time they want and wherever they are, which, in turn, leads to well-informed decisions and fast reactions to any market changes. Cloud computing has become a big data cosmetic industry tool for real- time data analysis as well as an ambitious strategy to meet the dynamic beauty market needs. In the upcoming discussion, cloud computing's influence on the five main aspects of business operations will be explored (Osvaldo Ferreira & Fernando Moreira[a], 2012).

1.14.7.1 Product Innovation & Cloud Computing:

Cloud computing is determined by equitable and expansible storage on cosmetic products. Using the cloud platform companies can manage the data from both sides' security wise and resolution wise, permitting collaboration and innovation process. Via aggregation of product development resources and facilitation of real-time collaboration between the teams, cloud computing increases the speed of innovation and elevate the quality of new product offerings (Keng-Boon Ooi ,Voon-Hsien Lee ,Garry Wei-Han Tan ,Teck-Soon Hew ,and Jun-Jie Hew, 2017), .

1.14.7.2 Lean Manufacturing & Cloud Computing:

Cloud technologies take the lead cosmetics companies use them to resolve their manufacturing issues by improving operational efficiency and identifying the data pattern. Via the employing of cloud computer programs and analytics tools, firms are not only able to improve their productivity rates, decrease waste and use of the resources more efficiently. This indicates that they can adopt decisions faster and reduce the downstream processes which are a major source of waste. This change is just an element of a wider process that is affecting the realm of businesses all around the world, which is powered by technologies like IoT and cloud computing. Cloud computing provides companies with a way to access

shared technology without having to pay to own it themselves, which is cheaper and eliminates any need for the IT department of the company. In addition, it contributes to the effectiveness and efficiency what businesses can offer (Keng-Boon Ooi ,Voon-Hsien Lee ,Garry Wei-Han Tan ,Teck-Soon Hew ,and Jun-Jie Hew, 2017),.

In line with (Keng-Boon Ooi ,Voon-Hsien Lee ,Garry Wei-Han Tan ,Teck-Soon Hew ,and Jun-Jie Hew, 2017),The merging of the concept of cloud computing with the manufacturing field is referred to as "cloud manufacturing", which allows manufacturing companies to innovate and rapidly respond to the constantly changing global market. This alteration is in parallel with studies yesterday digital age which helped extensively in computerizing manufacturing processes, known as industries 4,0. Therefore, these innovations are bringing new intelligence to the factory floors and improving the entirety of the production cycles with less waste and better operations

1.14.7.3 Supply Chain Optimization & Cloud Computing:

The importance of cloud computing in the cosmetic industry cannot be overstated because it allows visibility and collaboration on the cloud across the entire supply chain in real time. Platforms, cloud-based supply chain management help facilitate a seamless share of information and data exchange between the suppliers, manufacturers, and distributors ensuring excellent workflow and smooth inventory management, logistics planning and order fulfillment. The transparency and collaboration generated by the collaborative supply network results in a supply chain that is more agile and responsive, ready to adapt anytime to the changing trends (Keng-Boon Ooi ,Voon-Hsien Lee ,Garry Wei-Han Tan ,Teck-Soon Hew ,and Jun-Jie Hew, 2017),.

1.14.7.4 Marketing and Branding & Cloud Computing:

Cloud computing is an item that triggered off the revolution in the field of marketing and branding in the cosmetic sector through collection and utilization of data- driven insights and personalized experiences. Various cloud-based analytics platforms interpret large data about customers and trends in real-time to allow companies to make accurate decisions on what to offer customers according to individual preferences. Moreover, cloud marketing

automation tools allow for the consolidation of sprout business operations which in turn improves campaign budget utilization thereby ensuring that the right audience is reached efficiently and effective (Keng-Boon Ooi ,Voon-Hsien Lee ,Garry Wei-Han Tan ,Teck-Soon Hew ,and Jun-Jie Hew, 2017),y.

1.14.7.5 Collaboration and Partnerships & Cloud Computing:

Cloud computing helps the cosmetic industry gain partnerships and collaborative networking with a data sharing and collaboration hub in its centralized flagship. A shared cloud provides prompt relationships and collaboration among internal teams, partners, suppliers, therefore fostering the production and invention process. Meanwhile, cloud project management and automation of workflows generate synergies in collaboration processes, thus companies can significantly harness external knowledge and experience and further advance their businesses (Keng-Boon Ooi ,Voon-Hsien Lee ,Garry Wei-Han Tan ,Teck-Soon Hew ,and Jun-Jie Hew, 2017),

METHODLOGY

1.15 Industry 4.0 Innovations for Small Cosmetic Companies Customized Approaches

The brand MELA BEAUTY, Egyptian cosmetics company created by the group of people in the year 2020 is experiencing a quick rise in rate of popularity primarily in the cosmetics sector. It produces an assortment of cosmetics from tints and lipsticks to foundations, concealers, primers, makeup removers, and even a highlighter. Therefore, it has gained a reputation as a brand that suits almost every woman. The brand has achieved significant presence on Instagram having more than 60k followers. Social media marketing has been the factor through which the brand has successfully led to collaboration with renowned Egyptian influencers, thus, reaching a wider audience. MELA BEAUTY has a goal of becoming popular around the world but also encourages eco-friendly production which will minimize waste. The brand introduces improved, eco-friendly formulations and packaging

that help create less environmental impact on the planet, at the same time as delighting customers with uniquely attractive products from all over the world.

Implementation of Industry 4.0 tools and techniques by MELA BEAUTY will be the main factor in revealing and using its inherent advantages; while the implementation will provide an opportunity to be in the offensive mood and move forward towards finding new business cases. Such a strategic development which is greatly impacted by the way large corporations work, has "7 technologies of innovation" as the aim, which includes separate technologies such as cloud computing, 3D printing, AR, VR, robots, cybersecurity, and AI. By merging the high-tech innovations and the highly sophisticated analytical approaches into their practice, MELA BEAUTY intends to pursue its goals efficiently.
The company will, subsequently, embrace the Analytic Hierarchy Process (AHP) method to pick the top four from the list of technologies available which are in line with MELA BEAUTY's goals and budget constraints. Secondly, the process will fully take on matrices like swot, if, and space matrices, among others, to guide us through the challenges and the evaluations. They will assist in internal analysis of strengths and weaknesses, external analysis of opportunities and threats and positioning the cosmetics business where the needs are, in the cosmetics marketing context.

Additionally, through this research, MELA BEAUTY can derive useful implications which will help the company formulate better business tactics for future steps. This is not only to help MELA BEAUTY but also to offer current entrepreneurs of the makeup industry appropriate advice to shape the future generation of leaders in the realm of the skin care industry. It is the main goal of this academic project to popularize successful entrepreneurial processes, as an effective tool to direct the future path of aspiring youth, ensuring their continuous growth and the industry's overall stability and durability.

1.16 Data Collection

The very first moment of the data collection process is about gathering information which is closely connected to the AHP (Analytic Hierarchy Process) for selecting the most effective solution from the wide spectrum of technologies. Respondents are given a questionnaire and presented with a list of criteria to indicate which criteria should remain in the final product development. During this study, 5 factors will be considered such as Cost, Scalability, Security, Validity, and Reliability

The second phase is the process of choosing the options, for this consideration, there are technological alternatives that are on the table. For these technological options such as cloud computing, 3D printing, augmented reality (AR), virtual reality (VR), artificial intelligence (AI), cybersecurity, and internet of things (IoT), which are current trends that are relevant in the cosmetic industry environment, are chosen.

The amount of savings generated by each technology scenario can be estimated by using various sources, including market research reports and industry papers. Environmental criteria like Creation of Jobs, Impact on Global Warming, Scalability, Operational Ease, Security, Innovation and Reliability are accessed through expert ratings. Experts are scored either on poor or excellent markings using Likert scale ratings where the lowest score is 1 and highest mark stands for 9. The all-embracing process of data collection helps to obtain an inexpensive analysis of each of the technical option’s performance according to the criteria stated (Hamidah Maidinsah & Raja Nurul Aisyah Raja Aziz, 2020).

1.17 Using AHP for Technology Selection in Small Businesses

- **Step 1: Identify the issue.**

Choosing the best technology to support MELA BEAUTY's business operations is the decision.

- **Step 2: Define the Objective**

Select the most suitable technology for MELA Beauty’s

- **Step 3: List the options and criteria**:
  - **Criteria:**

1. Cost
2. Scalability
3. Security
4. Validity
5. Reliability

  - **The 7-technology option:**

1. Cloud Computing
2. 3D Printing
3. Augmented Reality (AR)
4. Virtual Reality (VR)
5. Artificial Intelligence (AI)
6. Cybersecurity
7. Internet of Things (IoT)

- **Step 4. Establish a Hierarchy.**

AHP (Analytical Hierarchy Process) arranges the structure of the decision-making process based on hierarchy. At level 0, the main objective of the process is deciding the most basic technology associated with Industry 4.0. Level 1 shows the weight which indicates the importance of each expert's opinion about the criteria and alternatives and is shown in Figure 5 they are all equally important with a weight of 1/3. Level 2 is the study of the criteria that affect the choice of technology. In level 3, a variety of technological types are described.

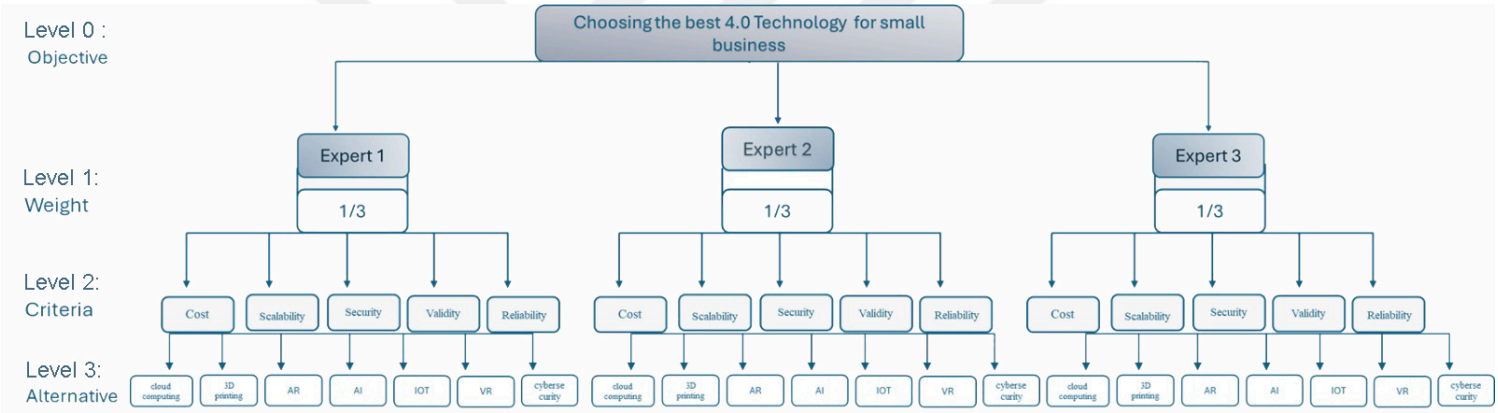


Figure 13 Hierarchy Structure

Step 5: Compare the Criteria:

Using a scale of 1 to 5, where 1 represents equal relevance and 5 signifies significantly greater importance, compare each criterion to determine its relative value (Sahar Pouya, Handan Turkoglu,and Umit Arpacioglu, 2020).

Criteria's Pairwise Comparison Matrix					
	Cost	Scalability	Security	Validity	Reliability
Cost	1	4	2	3	1
Scalability	1/4	1	1/3	1/2	1/2
Security	1/2	3	1	2	3
Validity	1/3	2	1/2	1	2
Reliability	1	2	1/3	1/2	1
sum	3.08	12.00	4.17	7.00	7.50

Table 2 Criteria's Pairwise Comparison Matrix for expert 1

- **Step 6: matrix of pairwise comparisons**

A paired comparison rating scale table is created to determine the weight of the assessment for each variable. Subsequently, the total value of every element in every column is calculated. Normalization of the matrix is done by dividing each element value from the column by the total number of columns in question, after the acquisition of the result of the matrix comparison and the sum of each element value (Ilka Zufria , M. Fakhriza , and , Nur Nofrizal Agustina Srg, 2021). Divide the total number of items by the value of each element. like the table that follows:

Normalized Matrix						
	Cost	Scalability	Security	Validity	Reliability	**Weight**
Cost	0.32	0.33	0.48	0.43	0.13	**0.34**
Scalability	0.08	0.08	0.08	0.07	0.07	**0.08**
Security	0.16	0.25	0.24	0.29	0.40	**0.27**
Validity	0.11	0.17	0.12	0.14	0.27	**0.16**
Reliability	0.32	0.17	0.08	0.07	0.13	**0.16**

Table 3 Normalized Matrix for expert 1

- **Step 7: Using a pairwise comparison matrix to find Consistency index**

Table 4 Criteria's Pairwise Comparison Matrix for expert 1

Criteria's Pairwise Comparison Matrix							
	Cost	Scalability	Security	Validity	Reliability	**Weight**	Consistency index
Cost	1	4	2	3	1	**0.34**	1.82
Scalability	1/4	1	1/3	1/2	1/2	**0.08**	0.41
Security	1/2	3	1	2	3	**0.27**	1.45
Validity	1/3	2	1/2	1	2	**0.16**	0.87
Reliability	1	2	1/3	1/2	1	**0.16**	0.82

- **Step 8: Evaluate the consistency ratio (CR).**

  Equation (1) is utilized to generate the consistency index (CI) for validation purposes, whereas max represents the greatest eigenvalue. Equation (2) is used to determine CR, with RI standing for random index and the value as shown in Table 5. If the value of the consistency ratio is more than 0.1 (CR < 0.1), it is considered inconsistent, in the table the result of the CR is less than 0.1 therefore its acceptable (Hamidah Maidinsah & Raja Nurul Aisyah Raja Aziz, 2020)

Nmax	5.3706
CI	0.0927
RI	1.1880
CR	0.08

Table 5 CI , RI , CR , for expert 1

(1) $$CI = \frac{(\lambda_{max} - n)}{(n-1)}$$

(2) $$CR = \frac{CI}{RI}$$

Figure 14 equation 1&2 for criteria

Criteria	Weight	Priority
Cost	0.38	I
Scalability	0.15	IV
Security	0.16	III
Validity	0.24	II
Reliability	0.07	V

Table 6 Weight Priority Criteria for expert 1

It is noticeable from the preceding table that cost is the primary criterion, followed by validity and security in that order.

- **The next step will involve comparing the criteria for experts 2 & expert 3 to determine the most relevant factors for consideration.**

1. **Compare the Criteria**

Table 7 Criteria's Pairwise Comparison Matrix for expert 2

Criteria's Pairwise Comparison Matrix					
	Cost	Scalability	Security	Validity	Reliability
Cost	1	1/2	1	2	3
Scalability	2	1	1/2	3	2
Security	1	2	1	3	1/2
Validity	1/2	1/3	1/3	1	3
Reliability	1/3	1/2	2	1/3	1
sum	4.83	4.33	4.83	9.33	9.50

2. **Matrix of pairwise comparisons**

Criteria's Pairwise Comparison Matrix							
	Cost	Scalability	Security	Validity	Reliability	**Row Average**	Consistency index
Cost	1	4	2	3	1	**0.21**	1.30
Scalability	1/4	1	1/3	1/2	1/2	**0.26**	1.50
Security	1/2	3	1	2	3	**0.25**	1.45
Validity	1/3	2	1/2	1	2	**0.13**	0.85
Reliability	1	2	1/3	1/2	1	**0.15**	0.89

Table 8 Normalized Matrix for expert 2

3. **Using a pairwise comparison matrix to find Consistency index.**

Normalized Matrix						
	Cost	Scalability	Security	Validity	Reliability	**Row Average**
Cost	0.21	0.12	0.21	0.21	0.32	**0.21**
Scalability	0.41	0.23	0.10	0.32	0.21	**0.26**
Security	0.21	0.46	0.21	0.32	0.05	**0.25**
Validity	0.10	0.08	0.07	0.11	0.32	**0.13**
Reliability	0.07	0.12	0.41	0.04	0.11	**0.15**

Table 9 Criteria's Pairwise Comparison Matrix for expert 2

4. **Evaluate the consistency ratio (CR), as it shows in table 9 the CR is > 0.1 therefore it can't be acceptable, and 2 expert options will be eliminated**

Nmax	6.0002
CI	0.2501
RI	1.1880
CR	0.21

Table 10 Criteria's Pairwise Comparison Matrix for expert 2

1. **Compare the Criteria**

Criteria's Pairwise Comparison Matrix					
	Cost	Scalability	Security	Validity	Reliability
Cost	1	4	1	3	4
Scalability	1/4	1	2	1/2	2
Security	1	1/2	1	1/3	2
Validity	1/3	2	3	1	3
Reliability	1/4	1/2	1/2	1/3	1
sum	2.83	8.00	7.50	5.17	12.00

Table 11 Criteria's Pairwise Comparison Matrix for expert 3

2. **Matrix of pairwise comparisons**

Criteria's Pairwise Comparison Matrix							
	Cost	Scalability	Security	Validity	Reliability	**Row Average**	Consistency index
Cost	1	4	2	3	1	**0.38**	2.15
Scalability	1/4	1	1/3	1/2	1/2	**0.15**	0.82
Security	1/2	3	1	2	3	**0.16**	0.84
Validity	1/3	2	1/2	1	2	**0.24**	1.35
Reliability	1	2	1/3	1/2	1	**0.07**	0.40

Table 12 Normalized Matrix for expert 3

3. **Using a pairwise comparison matrix to find Consistency index.**

Table 13 Criteria's Pairwise Comparison Matrix for expert 3

Normalized Matrix						
	Cost	Scalability	Security	Validity	Reliability	**Row Average**
Cost	0.35	0.50	0.13	0.58	0.33	**0.38**
Scalability	0.09	0.13	0.27	0.10	0.17	**0.15**
Security	0.35	0.06	0.13	0.06	0.17	**0.16**
Validity	0.12	0.25	0.40	0.19	0.25	**0.24**
Reliability	0.09	0.06	0.07	0.06	0.08	**0.07**

4. **Evaluating the consistency ratio (CR), Table 13 shows that the CR for expert 3 is more than 0.1, therefore it won't be acceptable, and expert 3 option will be eliminated**

Nmax	5.56
CI	0.14
RI	1.19
CR	0.12

Table 14 Criteria's Pairwise Comparison Matrix for expert 3

- **Step 9: AHP structure for alternative in expert 1**
  The decision to eliminate experts 2 and 3 was made after the comparison of the criteria of experts 1, 2, and 3. The reasons for the removal of experts 2 and 3 were their CR exceeded 0. 1. Thus, only expert 1 is left and the AHP process would continue to compare the alternatives and find the best technology for the small business.

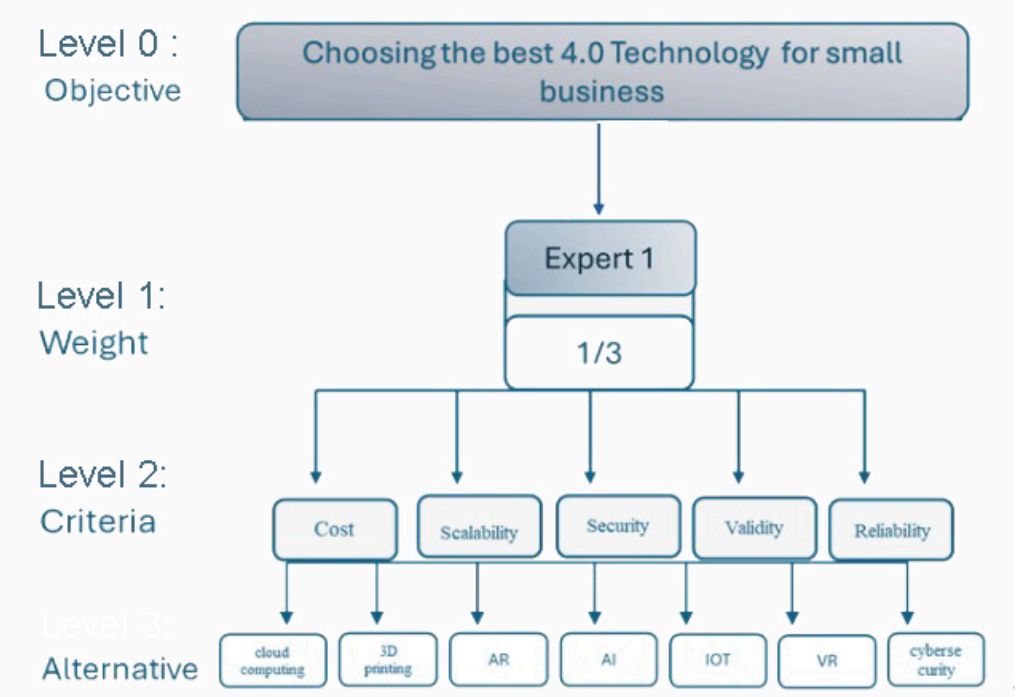


Figure 15 Choosing the best alternative from expert 1

- **Step 10: Compare the Alternative:**

Determine the relative worth of each alternative by comparing them using a scale of 1 to 5, where 1 denotes equal significance and 5 denotes much greater importance.
(Sahar Pouya, Handan Turkoglu,and Umit Arpacioglu, 2020).

Alternative's Pairwise Comparison Matrix							
	Cloud Computing	3D Printing	Augmented Reality	Virtual Reality	Artificial Intelligence	Cybersecurity	Internet of Things
Cloud Computing	1	2	1/2	2	2	1/2	2
3D Printing	1/2	1	1/2	1/2	1/2	1/2	2
Augmented Reality	2	2	1	2	2	1/2	2
Virtual Reality	1/2	2	1/2	1	1/2	1/2	2
Artificial Intelligence	1/2	2	1/2	2	1	1/2	2
Cybersecurity	2	2	2	2	2	1	2
Internet of Things	1/2	1/2	1/2	1/2	1/2	1/2	1
sum	7.0	11.5	5.5	10.0	8.5	4.0	13.0

Table 15 Alternative's Pairwise Comparison Matrix for expert 1

- **Step 11: matrix of pairwise comparisons**

When comparing alternatives pairwise, a rating scale table is used to determine their significance. As a result, the total value of each alternative is calculated across all comparisons. To normalize the matrix, the value of each element in each row is divided by the sum of all elements within that row, after the comparison matrix is established and element values have been summed. This normalization process involves dividing the total number of items by the value of each element (Ilka Zufria , M. Fakhriza , and , Nur Nofrizal Agustina Srg, 2021)., as illustrated in the table below:

Normalized Matrix								
	Cloud Computing	3D Printing	Augmented Reality	Virtual Reality	Artificial Intelligence	Cybersecurity	Internet of Things	Weight
Cloud Computing	0.14	0.17	0.09	0.20	0.24	0.13	0.15	0.16
3D Printing	0.07	0.09	0.09	0.05	0.06	0.13	0.15	0.09
Augmented Reality	0.29	0.17	0.18	0.20	0.24	0.13	0.15	0.19
Virtual Reality	0.07	0.17	0.09	0.10	0.06	0.13	0.15	0.11
Artificial Intelligence	0.07	0.17	0.09	0.20	0.12	0.13	0.15	0.13
Cybersecurity	0.29	0.17	0.36	0.20	0.24	0.25	0.15	0.24
Internet of Things	0.07	0.04	0.09	0.05	0.06	0.13	0.08	0.07

Table 16 Alternative Normalized Matrix for expert 1

- **Step 12: Comparing weight to Choose 4 to 5 technology.**

Based on a thorough assessment of each technology, it has been determined that prioritization is necessary. Consequently, 3D printing and IoT have been removed from consideration due to their lower importance levels.

Alternative	Weight	Priority
Cloud Computing	0.16	III
3D Printing	0.09	VI
Augmented Reality	0.19	II
Virtual Reality	0.11	V
Artificial Intelligence	0.13	IV
Cybersecurity	0.24	I
Internet of Things	0.07	VII

Table 17 Weight Priority alternative for expert 1

- **Step 13: matrix of pairwise comparisons after removing 2 technologies**

Alternative's Pairwise Comparison Matrix					
	Cloud Computing	Augmented Reality	Virtual Reality	Artificial Intelligence	Cybersecurity
Cloud Computing	1	1/2	2	2	1/2
Augmented Reality	2	1	2	2	1/2
Virtual Reality	1/2	1/2	1	1/2	1/2
Artificial Intelligence	1/2	1/2	2	1	1/2
Cybersecurity	2	2	2	2	1
sum	6.0	4.5	9.0	7.5	3.0

- **Step 14: Using a pairwise comparison matrix to find Consistency index**

Each alternative is rated according to a paired comparison rating scale table. The total value of every element in every row is then calculated. The matrix is normalized by dividing each row's element value by the total number of rows. Following the matrix comparison and the summation of each element value, this step occurs. Finally, the total number of items is divided by the value of each element to derive meaningful insights, (Ilka Zufria , M. Fakhriza , and , Nur Nofrizal Agustina Srg, 2021). And this can be shown in Table 18, 19, & 20.

Table 19 Alternative Normalized Matrix with weight part 2

Alternative Normalized Matrix					
	Cloud Computing	Augmented Reality	Virtual Reality	Artificial Intelligence	Cybersecurity
Cloud Computing	0.17	0.11	0.22	0.27	0.17
Augmented Reality	0.33	0.22	0.22	0.27	0.17
Virtual Reality	0.08	0.11	0.11	0.07	0.17
Artificial Intelligence	0.08	0.11	0.22	0.13	0.17
Cybersecurity	0.33	0.44	0.22	0.27	0.33

Table 20 Alternative Normalized Matrix part 1

Alternative Normalized Matrix						
	Cloud Computing	Augmented Reality	Virtual Reality	Artificial Intelligence	Cybersecurity	Weight
Cloud Computing	0.17	0.11	0.22	0.27	0.17	0.19
Augmented Reality	0.33	0.22	0.22	0.27	0.17	0.24
Virtual Reality	0.08	0.11	0.11	0.07	0.17	0.11
Artificial Intelligence	0.08	0.11	0.22	0.13	0.17	0.14
Cybersecurity	0.33	0.44	0.22	0.27	0.33	0.32

Table 18 Alternative pairwise with consistency matrix

Alternative's Pairwise Comparison Matrix							
	Cloud Computing	Augmented Reality	Virtual Reality	Artificial Intelligence	Cybersecurity	Weight	Consistency index
Cloud Computing	1	1/2	2	2	1/2	1.20	0.97
Augmented Reality	2	1	2	2	1/2	1.50	1.28
Virtual Reality	1/2	1/2	1	1/2	1/2	0.60	0.55
Artificial Intelligence	1/2	1/2	2	1	1/2	0.90	0.73
Cybersecurity	2	2	2	2	1	1.80	1.68

- **Step 15: Evaluate the consistency ratio.**

Based on the maximum eigenvalue (max), equation (1) calculates the consistency index (CI). The consistency ratio (CR) is determined by equation (2), where "RI" represents the random index. A consistency ratio greater than 0.1 (CR < 0.1) indicates inconsistency. In the table provided, the CR value is below 0.1, thus meeting the criteria for acceptability. (Hamidah Maidinsah & Raja Nurul Aisyah Raja Aziz, 2020).

Nmax	5.22
CI	0.05
RI	1.19
CR	0.05

Table 21 Result of CR, RI, CI &Nmax

(1) $$CI = \frac{(\lambda_{max} - n)}{(n-1)}$$

(2) $$CR = \frac{CI}{RI}$$

Figure 16 Equation 1 &2 for alternative

1.17.1 AHP Result:

The Analytic Hierarchy Process (AHP) is performed to find the best technology for adoption and the criteria priorities and alternatives are made. Cost is the factor that we rank first (Priority I), then validity follows (Priority II), and after that, security is our third priority (Priority III), scalability is the fourth (Priority IV), and reliability is the fifth (Priority V). Out of the various possible alternatives, cybersecurity gets the status of Priority I, followed by augmented reality with the status of Priority II, artificial intelligence being Priority III, cloud computing as Priority IV and virtual reality as Priority V.

While the great challenges are cybersecurity and augmented reality technologies, those must be given up as a priority. However, it is advised that small business owners are not concerned about implanting IoT and 3D printing technologies because they are below the higher-ranking technologies. Indeed, this implies that if an SME is planning on implementing any innovation to their business, they must emphasize the issues of cybersecurity and augmented reality with reference to the AHP approach to guarantee satisfactory decision-making and the wanted results.

The preceding results were obtained from an exclusive survey conducted by professional employees at the company to find out which technology would be most suitable for the operations. An employee survey, contributed in the organization to sought insights from the respondents who were employees, and they brought out their preferences and priorities concerning advancement of 4. 0 technology adoption. The first Appendices 'Comparing criteria & alternative for 4.0 technology survey ' contain a questionnaire. In the second

appendix is Expert Opinion to Survey, this empowers the selection parameters and rule flows on which process management in the organization is structured and thus builds the foundation for decision-making processes.

1.18 Implementing SWOT analysis to help small businesses grow strategically

1.18.1 Overview of the SWOT framework

The SWOT (Strengths, Weaknesses, Opportunities, and Threats) studies a strategic planning tool that helps appraise internal and external determinants that affect an organization's performance. Through a systemic analysis of these four parameters, companies can determine their competitive profile, emerging opportunities and threats. This framework can offer organizations the best opportunity to choose the right option that will help in executing the intended goals in a proficient manner (Al -Refaie, A. ,W, 2016).

As for the following SWOT analysis along with its incorporation with the AHP matrix, all numerical values and ratings are hypothetical in the context of this study and meant to exemplify how small businesses might employ this kind of analysis for strategic planning and not an actual case study. The reason is to give the reader examples which show how these tools can be used in the management of a business for their growth and innovation. This ensures that small businesses, specifically those in the cosmetic industry, can benefit from what we present in this paper through SWOT-AHP in achieving sustainable productivity for growth and adaptation of new practices inspired by bigger firms.

1.18.2 Finding the key element

Cosmetic companies that are small and independently owned, and those who wish to begin implementing Industry 4.0 technologies should clearly consider the benefits and drawbacks involved. A SWOT analysis is beneficial for the small business because it demonstrates the strengths which the business can build on, the threats that the business should avoid, the opportunities that a business can exploit and any threats that the business may encounter. By doing this, small businesses will be able to decide on when and how to implement new systems such as automation of systems, the use of data-based systems in the market, helping the small business hence growth in innovation. The following key element will describe how small organizations can successfully negotiate these domains.

1. **Strengths**

- **Enhanced Production Efficiency:** Industry 4.0 has it that small businesses seeking to enhance manufacturing efficiency stand to benefit from the technology in the shortest time possible, considering that enhanced efficiency would mean less waste and more cost cuts.
- **Customization Capabilities:** Small businesses are in a position of leveraging sophisticated technologies, and meaningfully catering with more customized products to customers, and capture niche markets.
- **Data-Driven Insights:** New technologies involve the provision of collected customer data for the improvement of products and business decisions by small business.

2. **Weaknesses**

- **High Initial Investment:** Implementation of new Industry 4.0 solutions means that there is high initial capital intensity, a problem that many small businesses cannot fund.

- **Need for Staff Training:** People may have to be trained especially when adopting new technologies, hence lowering productivity for some period, before becoming efficient; and increasing operational costs.
- **Risk of Over-Reliance on Technology:** Some of the disadvantages of technology may include small business may rely mostly on the systems and thus in case the technology fails, it may greatly affect the business.

3. Opportunities

- **Expansion into New Markets:** On the other hand, when efficiency and product specialization are enhanced, small business enterprises make their appeal more general while expanding in international markets.
- **Eco-Friendly Practices:** Alternative sustainable technologies should be incorporated as a way of promoting environmentally friendly practices that smaller firms can use to attract environmentally conservationist consumers.
- **Potential Partnerships:** Small businesses would have to form partnerships with other larger firms, with a view to attracting extra resources, and broadening the scope of operations.

4. Threats

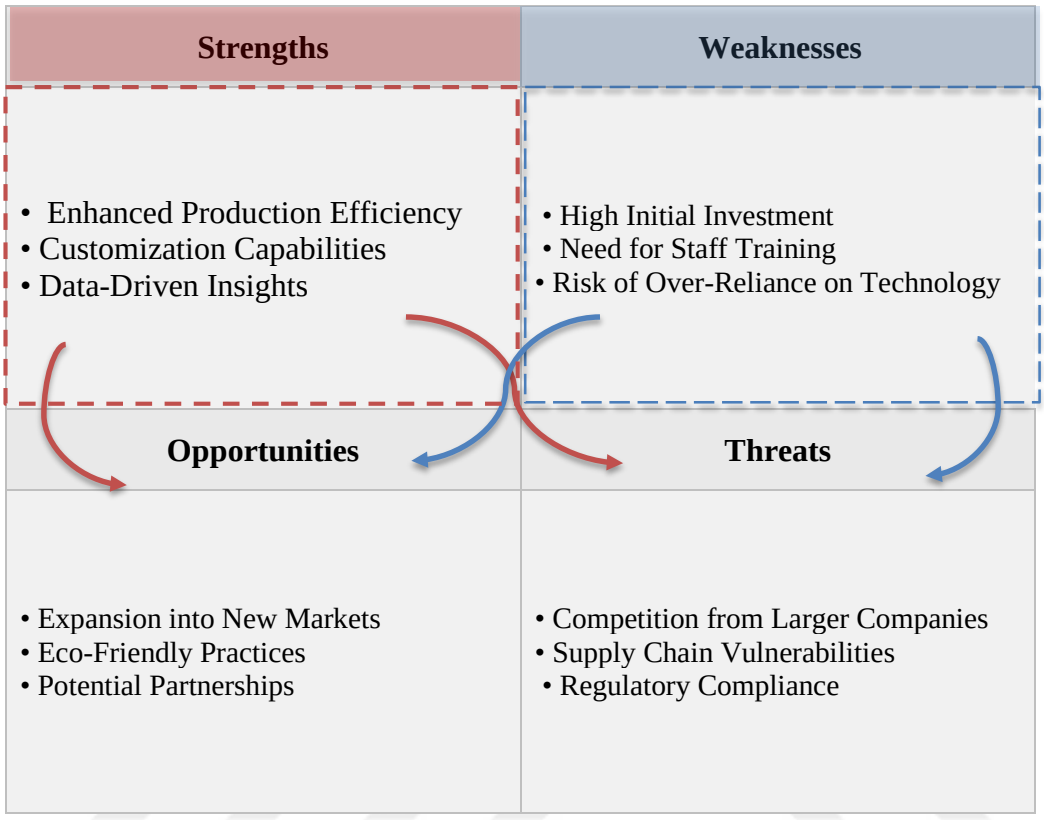
- **Competition from Larger Companies:** The novel technologies may also be adopted soon by big cosmetic companies, thereby posing a higher competitive threat to small businesses.
- **Supply Chain Vulnerabilities:** With the growth of operations through new technologies, many small businesses are realizing new forms of supply chain risks that hinder production or delivery schedules.
- **Regulatory Compliance:** New technologies might come with strings that dictate higher standards of industry regulation in the complexity and cost (Anastasia Gabriela Liem ,Neneng Nurlaela Arief, 2023).

1.18.3 Construction of Swot Matrix

Strengths	Weaknesses
• Enhanced Production Efficiency • Customization Capabilities • Data-Driven Insights	• High Initial Investment • Need for Staff Training • Risk of Over-Reliance on Technology
Opportunities	**Threats**
• Expansion into New Markets • Eco-Friendly Practices • Potential Partnerships	• Competition from Larger Companies • Supply Chain Vulnerabilities • Regulatory Compliance

For more depth analysis of the SWOT elements, a strategic combination of the elements can be made. This concerns internal strengths and weaknesses with the external opportunities and threats for the development of some course of action. (Anastasia Gabriela Liem ,Neneng Nurlaela Arief, 2023)

1.18.3.1 SWOT Analysis Treatment: Matching Strategy



By pairing the elements of the SWOT matrix, four types of strategies were derived:

- **Strengths–Opportunities (SO) Strategies:** Exploit the strengths to the maximum that is available in the organization.
- **Weaknesses–Opportunities (WO) Strategies:** Exploiting opportunity involves learning from weaknesses in an organization.
- **Strengths–Threats (ST) Strategies:** Levers should be applied to reduce threats.
- **Weaknesses–Threats (WT) Strategies:** Alleviate threats, to lessen the effect of risks on the organization. (Wang, 2007)

SO, Strategies (Maxi-Maxi)

i. Increase production efficiency for entry into new markets with acceptable price and delivery strategies.

ii. Optimize the use of analytical information to create environmentally responsible procedures that reflect tendencies towards sustainability.
iii. select the opportunity to employ customization capacity to establish potential partnership by presenting on-line solutions to the collaborators.

WO Strategies (Mini-Maxi)

i. Reduce on the need to train its staff by partnering with other firms on development of some composite methods of training.
ii. To manage with high initial investment, consider proposing the company apply for grants or funding for the project with an environmental touch.
iii. Minimize the risk of technological dependency by demonstrating flexibility in operational models, when seeking market growth.

ST Strategies (Maxi-Mini)

i. To prevent and prepare supply chain risk, apply analytical tools to identify major risks and develop sound risk mitigation measures.
ii. Build a competitive advantage over larger organizations through better delivery and cost structures resulting from improved production efficiency.
iii. Utilize customization features to address the strict regulatory standards need that exists with individual solutions.

WT Strategies (Mini-Mini)

i. Create a strategy to minimize high first costs together with planning for compliance that must be followed by gradual introduction of technologies.
ii. Limit the impact which excessive reliance on technologies can have by developing partnerships with the links of supply chain to manage the weaknesses.
iii. Provide staff training opportunities to respond to competencies miscarriage and improve the workforce ability to deter threats in a competition.

The strategic pairing approach helps implement systematic matching of existing internal resources with environmental conditions and comes up with operational strategies. The

above strategies are a guide in the preparation and management of small business in today's unpredictable and competitive environment. (Rahmawati, Dwi Rahadi &, Raden Aswin, 2019)

1.18.4 Using AHP for weighting and prioritization Finding the key element

1.18.4.1 Strengths Analysis: Organizational Internal Strengths to Focus On

1. **Step 1: Prepare the SWOT Factors List:** SWOT analysis should first be done to establish all the strengths, weaknesses, opportunities and threats which affect the business.

Strengths	Weaknesses
• Enhanced Production Efficiency • Customization Capabilities • Data-Driven Insights	• High Initial Investment • Need for Staff Training • Risk of Over-Reliance on Technology
Opportunities	**Threats**
• Expansion into New Markets • Eco-Friendly Practices • Potential Partnerships	• Competition from Larger Companies • Supply Chain Vulnerabilities • Regulatory Compliance

2. **Step 2: Construct the Comparison Matrix & Assign Scores:** enter a pairwise comparison matrix in which the factors ought to be compared based on the scale of their importance. In each of the pairwise comparisons, provide a score. A 9, for

example, represents the condition where one factor is more important than another factor; on the other hand, a 1 means that both factors are equally important.

Strengths	Enhanced Production Efficiency	Customization Capabilities	Data-Driven Insights
Enhanced Production Efficiency	**1**	5	3
Customization Capabilities	1/5	**1**	1/3
Data-Driven Insights	1/3	3	**1**

3. **Step 3: Calculate Factor Weights:**

a. Sum Each Column: Sum all the numbers in all entries lying in the first row and second row of the matrix.

b. Normalize the Matrix: Each element of the matrix should be divided by the column total to scale the matrix.

c. Averaging: To get the priority vector thus, the average of each row should be computed.

Strengths	Enhanced Production Efficiency	Customization Capabilities	Data-Driven Insights
Enhanced Production Efficiency	**1**	5	3
Customization Capabilities	1/5	**1**	1/3
Data-Driven Insights	1/3	3	**1**
Total	**1.53**	**9**	**4.3**

- **Priorities (Row Averages)**

The displayed row averages are the average of each row of the normalized matrix.

- **Row 1 Average**:

Average=0.65 + 0.56 + 0.693 / 3 = 0.633

- **Row 2 Average**:

Average=0.13 + 0.11 + 0.083 / 3 = 0.11

- **Row 3 Average**:

Average=0.22 + 0.33 + 0.233 / 3 = 0.260

Strengths	Enhanced Production Efficiency	Customization Capabilities	Data-Driven Insights	Row Average
Enhanced Production Efficiency	0.65	0.56	0.69	**0.63**
Customization Capabilities	0.13	0.11	0.08	**0.11**
Data-Driven Insights	0.22	0.33	0.23	**0.26**

4. **Step 4 Check for Consistency:** To make the comparisons reliable use the Consistency Ratio (CR)

- **First Row**:

(1*0.633) + (5*0.107) + (3*0.260 = 1.948

- **Second Row**:

(0.2*0.633) + (1*0.107) + (0.333*0.260) = 0.321

- **Third Row**:

(0.333*0.633) + (3*0.107) + (1*0.260) = 0.792

5. **Step 5: Calculate λ_max**

The corresponding priority weight is divided by each member in the weighted sum vector:

- **First Element**:

  $\lambda 1 = 1.948 / 0.633 = 3.078$

- **Second Element**:

  $\lambda 2 = 0.321 / 0.107 = 3.000$

- **Third Element**:

  $\lambda 3 = 0.792 / 0.260 = 3.046$

- **λ_max**:

$\lambda max = 3.078 + 3.000 + 3.0463 = 3.041$

6. **Step 6: Calculate CI and CR**

- **Consistence Index (CI)**:

$CI = (\lambda max - n) / (n - 1) =$
$(3.041 - 3) / (3 - 1) = 0.020$

- **Consistency Ratio (CR)**:
  For n = 3, RI = 0.58 CR = RI / CI = 0.58 / 0.020 = 0.034

CR = 0.034, the matrix is appropriate and consistent.

Criteria	Weights	Priorty
Enhanced Production Efficiency	0.63	I
Data-Driven Insights	0.26	II
Customization Capabilities	0.11	III

Based on the wights, **Enhanced Production Efficiency** is the most important followed by **Data-Driven Insights,** and then **Customization Capabilities**

1.18.4.2 Weaknesses Analysis: The following focuses on how to identify, understand and prioritize internal challenges.

- **Construct the Comparison Matrix & Assign Score**

Weaknesses	High Initial Investment	Need for Staff Training	Risk of Over-Reliance on Technology
High Initial Investment	**1**	3	5
Need for Staff Training	1/3	**1**	2
Risk of Over-Reliance on Technology	1/5	1/2	**1**

- **Computing Factor Weights with The Use of Column Summation, Normalized Factor Weights and Average of Row Weights**

Weaknesses	High Initial Investment	Need for Staff Training	Risk of Over-Reliance on Technology
High Initial Investment	**1**	3	5
Need for Staff Training	1/3	**1**	2
Risk of Over-Reliance on Technology	1/5	1/2	**1**
Total	**1.533**	**4.5**	**8**

- **Check for Consistency: Calculating the Consistency Ratio (CR)**

To make the comparisons consistent, it is necessary to normalize each element of the weighted sum vector by dividing it through the specific priority weight, and considering the result thus obtained, to calculate the Consistency Ratio.

Weaknesses	High Initial Investment	Need for Staff Training	Risk of Over-Reliance on Technology	Row Average
High Initial Investment	0.6523	0.6667	0.625	**0.648**
Need for Staff Training	0.2174	0.2222	0.25	**0.230**
Risk of Over-Reliance on Technology	0.1304	0.111	0.125	**0.122**

Result:

- CR= RI / CI =0.58 / 0.0025 = 0.0043
- **Consistency Ratio (CR) = 0.0043**
- Since CR < 0.1, the matrix is **consistent**.

Criteria	Weights	Priorty
High Initial Investment	**0.648**	I
Need for Staff Training	**0.230**	II
Risk of Over-Reliance on Technology	**0.122**	III

Based on the wights, **High Initial Investment is** the most important followed by **Need for Staff Training**, and then **Risk of Over-Reliance on Technology**

1.18.4.3 Opportunities Analysis: Assessing and Ranking Outside Possibilities

• Build the Comparison Matrix & Score them

Opportunities	Expansion into New Markets	Eco-Friendly Practices	Potential Partnerships
Expansion into New Markets	**1**	3	2
Eco-Friendly Practices	1/3	**1**	2
Potential Partnerships	1/2	1/3	**1**

- **Computing Factor Weights with The Use of Column Summation, Normalized Factor Weights and Average of Row Weights**

Opportunities	Expansion into New Markets	Eco-Friendly Practices	Potential Partnerships
Expansion into New Markets	**1**	3	2
Eco-Friendly Practices	1/3	**1**	2
Potential Partnerships	1/2	1/3	**1**
Total	**1.8333**	**4.3333**	**5**

• Check for Consistency: To define the CR amount it is required to use the following semi-quantitative formula:

Opportunities	Expansion into New Markets	Eco-Friendly Practices	Potential Partnerships	Row Average
Expansion into New Markets	**0.5455**	**0.6923**	**0.4**	**0.5459**
Eco-Friendly Practices	**0.1820**	**0.2308**	**0.4**	**0.2709**
Potential Partnerships	**0.2727**	**0.0769**	**0.2**	**0.1832**

- **Final Result:**

The new coefficient of Consistency Ratio (CR) is 0.0431, which is less than 0.1 as it suggests that the pairwise comparison matrix is consistent

Criteria	Weights	Priorty
Expansion into New Markets	**0.5459**	I
Eco-Friendly Practices	**0.2709**	II
Potential Partnerships	**0.1832**	III

Based on the weights, **Expansion into New Markets** is the highest priority, followed by **Eco-Friendly Practices**, with **Potential Partnerships** being the least important.

1.18.4.4 Threats Analysis: Analyzing and Ranking External Threats

• Build the Comparison Matrix and Score it

Threats	Competition from Larger Companies	Supply Chain Vulnerabilities	Regulatory Compliance
Competition from Larger Companies	**1**	3	1/3
Supply Chain Vulnerabilities	1/3	**1**	3
Regulatory Compliance	3	1/3	**1**

- **Computing Factor Weights with the help of Column Summation, Weighted Factor Weights, normalized and average of row weights.**

Threats	Competition from Larger Companies	Supply Chain Vulnerabilities	Regulatory Compliance
Competition from Larger Companies	**1**	3	1/3
Supply Chain Vulnerabilities	1/3	**1**	3
Regulatory Compliance	3	1/3	**1**
Total	**4.333**	**4.333**	**4.333**

- **Check for Consistency: Once the pairwise comparisons have been done it is**

Threats	Competition from Larger Companies	Supply Chain Vulnerabilities	Regulatory Compliance	Row Average
Competition from Larger Companies	0.231	0.692	0.077	**0.333**
Supply Chain Vulnerabilities	0.077	0.231	0.692	**0.333**
Regulatory Compliance	0.692	0.077	0.231	**0.333**

Final Result:

CI= n − 1 / λ max − n CI= 3 − 1 /3 − 3 = 0
CR= 0.58 / 0 = 0

The matrix of a pairwise comparison is consistent since the CR is equal to 0, therefore there are no contradictions. According to the analysis mentioned, the CR value which stands below 0.1 depicts the insists reliability of the matrix. There is no superior or inferior matrix

Criteria	Weights	Priorty
Competition from Larger Companies	**0.333**	I
Supply Chain Vulnerabilities	**0.333**	I
Regulatory Compliance	**0.333**	I

1.18.5 Strategic Suggestions

The following strategic recommendations are put out for small enterprises to improve their growth, reduce risks, and take advantage of opportunities based on the results of the SWOT analysis: (Mohamad Rakhmansyah , Tri Wahyuningsih , Abdullah Dwi Srenggini ,&I Ketut Gunawan, 2022)

Strategic Scope	Suggestion	Strategies for Implementation
Strengths		
Enhanced Production Efficiency	Optimization of processes to desirable goal, which is to cut expenditure and at the same time increase satisfaction levels.	1) Increase attempts at making production processes more organized. 2) Improve work turnover with the help of automation and decrease the number of errors.
Customization Capabilities	One specific segmentation strategy is to offer product differentiation in the marketplace by customizing products.	1)Give the customer the opportunity to enter any special request. 2) Emphasize customization in marketing communication.
Data-Driven Insights	The management should incorporate data into their planning and running of the organization.	1)Analyze customers' behavior and the sales. 2)Use the data as marketing and products enhancements.

Strategic Scope	Suggestion	Strategies for Implementation
Weaknesses		
High Initial Investment	Discover how to minimize the cost of the initial capital.	1)Learn from investors or seek grant for such opportunities, Family, friends or associate. 2) Combine your resources with other companies to cut expenses.
Need for Staff Training	Staff development should be done to improve skills.	1) Sponsor training programs for those employees. 2) Promote staff to go for courses and get certification.
Risk of Over-Reliance on Technology	Do not overuse the technology.	1)Always have backup strategies for technology just in case it lets you down. 2)Train the employees to perform their tasks occasionally without using technology to some extent.

Strategic Scope	Suggestion	Strategies for Implementation
Opportunities		
Expansion into New Markets	Venture into new markets to improve the size of the business.	1) Identify research areas that consumers are willing to pay for. 2) Adapt the marketing practices to new markets.
Eco-Friendly Practices	Reduce the impact on the environment to attract environmentally aware clients.	1)Adopt use of sustainable materials and methods. 2)Participate in the campaign that encourages environmental conservation in marketing.
Potential Partnerships	Collaboration is a good way to share resources and to increase visibility.	1)Start seeking for firms that can partner with in terms of complementary business. 2)Either using existing resources or jointly coming up with something new in the market.

Strategic Scope	Suggestion	Strategies for Implementation
Threats		
Competition from Larger Companies	Compete by delivering personal solutions and strong customer relations.	1)Pay attention to specific markets. 2)Create and sustain good working relations with the customers.
Supply Chain Vulnerabilities	Strengthen the suppliers by getting more than one supplier.	1)One of the strategies is to purchase and rely on more than one supplier for the goods that are most essential to a given firm.
Regulatory Compliance	Maintain legal requirements to try to prevent the firm from encountering legal problems.	1)Be aware of the current laws. 2) Consult the lawyers to ensure that all managers are complying.

1.18.6 Conclusion and Implications for Future Plans

Small businesses can find a clear direction on how to develop, enhance, and leverage their strengths, minimize their weaknesses, and overcome threats that might be present on their operating environment.

- **Key Findings:**

1) **Strengths:** Local businesses can easily create competitive advantage since there are areas a big business really does poorly such as efficient production and developing personal products or services.

2) **Weaknesses:** The main threats include high initial costs for starting the business and the requirement for training the staff, having learned that these are major areas of strength that can be worked on by sourcing competent personnel and giving our staff adequate training.

3) **Opportunities:** Looking for new markets and sustainable orientations for the organization's activities prospectives and optimizing processes are promising, but clear schemes must be developed to use them successfully.

4) **Threats:** This means that small businesses must address risks that may include competition with other large business enterprises, supply chain challenges, and alterations in the business regulations among others.

- **Implications for Future Plans:**

a) Growth Strategy: Management should encourage the development of new markets and partnership arrangements to drive the growth of small businesses since this would not require huge investment.
b) Efficiency: The investment will go to technology, training, and operations enhancements as it makes businesses work smarter, enhance quality and satisfy customers as they expand.
c) Managing Risk: This indicates that businesses need to put serious effort into contingency strategies for disrupted and/or altered supply chain management, particularly changing legislation.

Smaller businesses for the future need to remain adaptable specifically for changes in the market, technological trends, and sustainability expectations. Thus, it is possible to state that such constant reconsideration of the strategies is useful for the companies' orientations at long-term perspective. (GÜREL, 2017)

CONCLUSION AND RECOMMENDATIONS

This journey describes the cosmetic industry's massive historical importance, from prehistoric times to today. This evolution, based on adaptability, symbolizes industry’s willingness to go with social change. But the sector faces critical challenges in its current environment. The study explored the difficulties facing small cosmetic enterprises. It explained how they may be ready to accept lean manufacturing, strategic analysis, and competitiveness even as their larger counterparts seemingly overlook such matters from a higher vantage point. This presents a major obstacle. Furthermore, the Research noted that decision-making methods such as AHP and SWOT are particularly important for the manufacturing industry. Since integration is enriching, it elevates and adds sophistication to SWOT. It enhances decision-making; it deepens strategic planning considerations as well: not only including aspects of environmental sustainability into consideration but also society's impacts on environment too.

As part of the findings, the analysis demonstrated how the small businesses could leverage strengths like production efficiency and the nature of delivering unique goods or services. Industry 4.0 technologies have also completely overturned operations, and in Big Companies East Africa they were applied effectively to improve operating efficiency and quality of products as well. With the increasingly pressing concern of sustainability, people have compared companies such as Beiersdorf and Big Companies to find their strengths in sustainability agendas, where they can improve. In the North American market, Big Companies underwent strategic analysis including strengths weaknesses opportunities and threats using methods such as SWOT AHP. This analysis highlighted that market positioning and competitiveness are vital for global cosmetic titans.

On the other hand, such threats as high initial costs and necessary further staff training should be underlined and invested more for can effectively be managed. There were also big companies' sustainable development actions, which proved how serious it is to take steps to reduce its ecological footprint and at the same time improve social inclusiveness. Although these innovations are effective, they illustrate. The need is for universal integration in business operations daily.

At the same time, threats like increased competition from large businesses, an imbalance in supply chain and threats from unfavorable changes in regulations must be planned and managed for ahead of time. In effect, the study illustrates how even minute cosmetic firms must pursue creative strategies; why planning methods matter in terms of decisions being made; what opportunities there are for industry 4.0 to emerge from this situation but enhance chances or improve corporate probabilities and public well-being; perhaps most importantly, why sustainability and inclusiveness is not only good for company life expect.

Still, the competition from larger businesses, supply chain potential challenges, and regulatory issues become another set of real threats requiring more careful planning and action planning on risk management. Thus, if the entire industry is to move forward in a sustainable manner.

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APPENDIX

1.19 Appendix: Comparing Criteria & Alternative for 4.0 Technology Survey

- Compare the importance of the following criteria relating to each other:

Process of Analytic Hierarchy, or AHP

1. make a comparison between each of the criteria.

2. For each comparison, determine which is more significant and choose the appropriate weight.

Increasing column importance over row Equal Increasing row importance over

1/5 - 1/4 - 1/3 - 1/2 - 1 - 2 - 3 - 4 - 5

- Cost to Scalability:

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Cost to Security:**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2

7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Cost to Validity:**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Cost to Reliability:**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Scalability to Security:**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1

6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Scalability to Validity:**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Scalability to Reliability:**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Security to Validity:**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4

3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Security to Reliability:**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Validity of Reliability**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Compare the importance of the following Alternative relative to each other:**

Process of Analytic Hierarchy, or AHP

1. make a comparison between each of the criteria.

2. For each comparison, determine which is more significant and choose the appropriate weight.

- **Cloud Computing to 3D Printing**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Cloud Computing to Augmented Reality (AR):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Cloud Computing to Virtual Reality (VR):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Cloud Computing to Artificial Intelligence (AI):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Cloud Computing to Cybersecurity:**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1

6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Cloud Computing to Internet of Things (IoT):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **3D Printing to Augmented Reality (AR):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **3D Printing to Virtual Reality (VR):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **3D Printing to Artificial Intelligence (AI):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **3D Printing to Cybersecurity:**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3

8. Very strongly more important = 4
9. Extremely more important = 5

- **3D Printing to Internet of Things (IoT):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Augmented Reality (AR) to Virtual Reality (VR):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Augmented Reality (AR) to Artificial Intelligence (AI):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Augmented Reality (AR) to Cybersecurity:**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Augmented Reality (AR) to Internet of Things (IoT):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2

7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Virtual Reality (VR) to Artificial Intelligence (AI):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Virtual Reality (VR) to Cybersecurity:**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
- Extremely more important = 5

- **Virtual Reality (VR) to Internet of Things (IoT):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Artificial Intelligence (AI) to Cybersecurity:**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Artificial Intelligence (AI) to Internet of Things (IoT):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2

7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

- **Cybersecurity to Internet Things (IoT):**

1. Extremely less important = 1/5
2. Very strongly less important = 1/4
3. Strongly less important= 1/3
4. Moderately less important = 1/2
5. Equally important = 1
6. Moderately more important = 2
7. Strongly more important = 3
8. Very strongly more important = 4
9. Extremely more important = 5

1.20 Appendix: Expert Respond to survey

Compare the importance of the following criteria relating to each other:

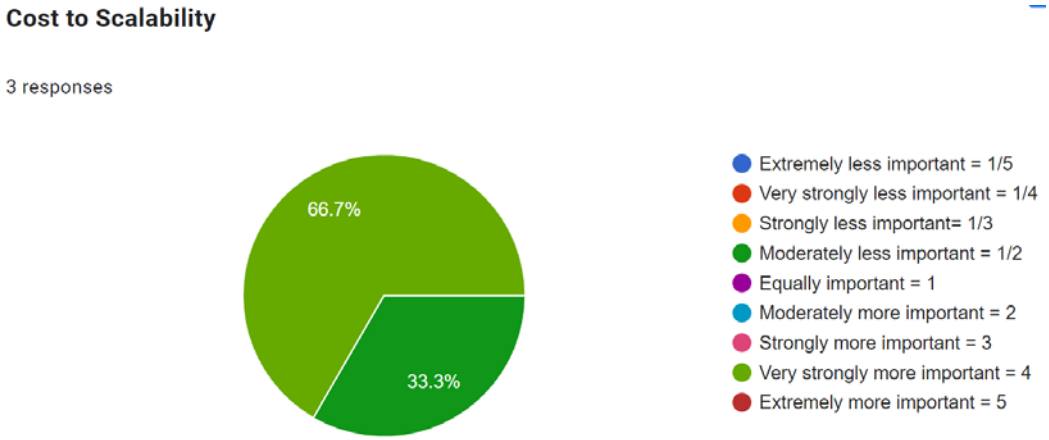

Figure 17 cost to scalability.

Cost to Security:

3 responses

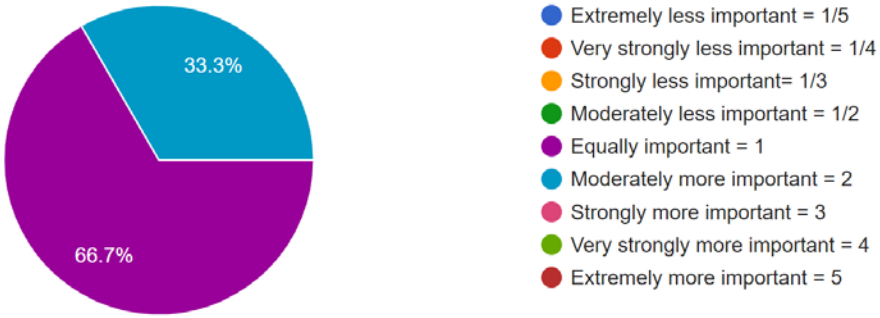

Figure 18 cost to security.

Cost to Validity:

3 responses

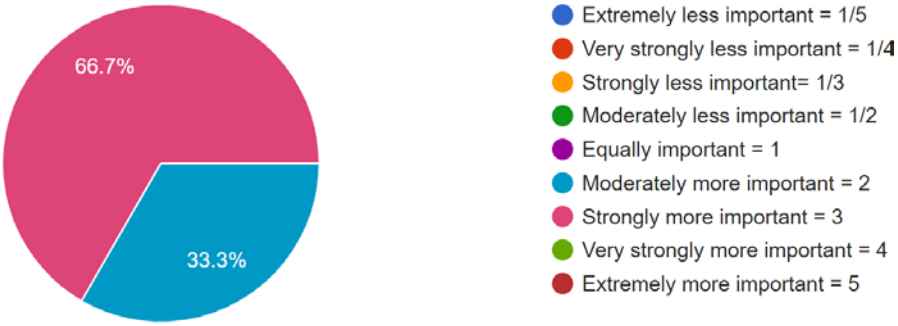

Figure 19 cost to validity

Cost to Reliability :

3 responses

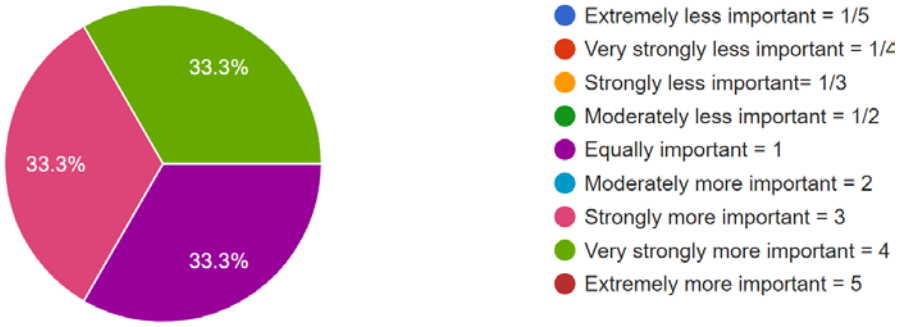

Figure 20 cost to reliability.

Scalability to Security:

3 responses

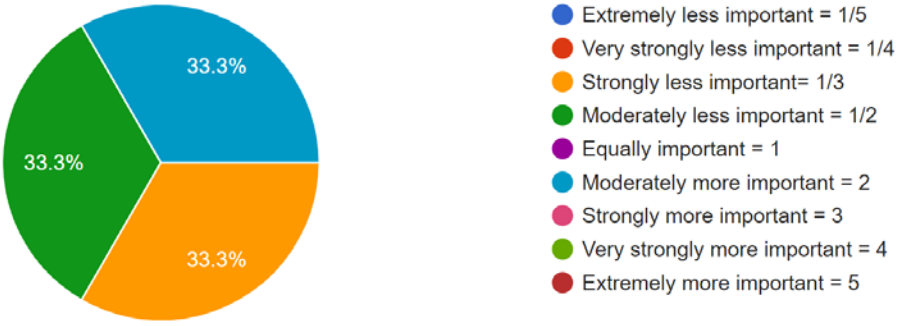

Figure 21 scalability to security.

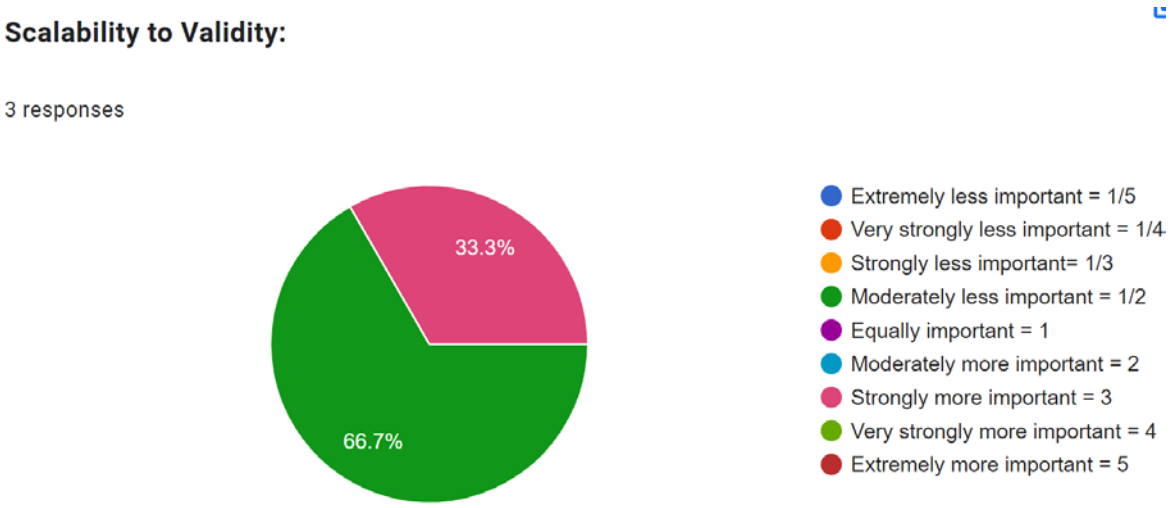

Figure 22 scalability to validity.

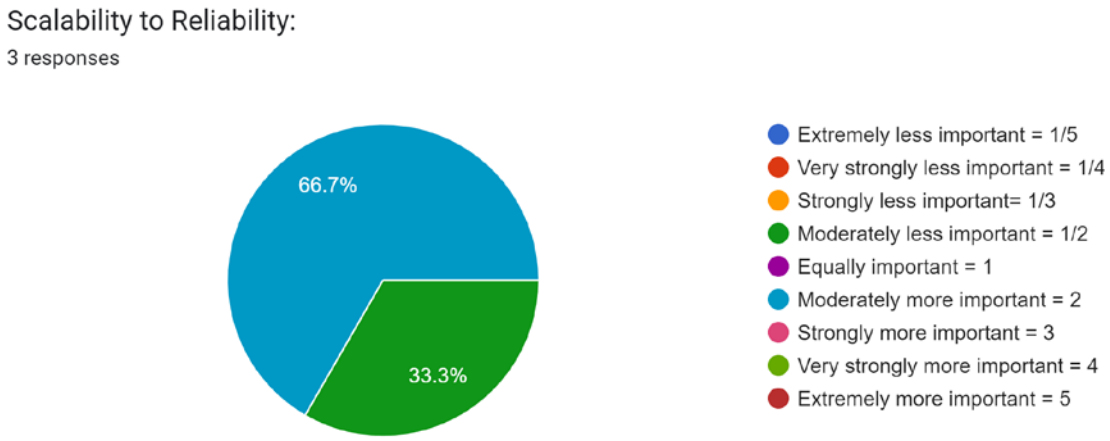

Figure 23 scalability to validity

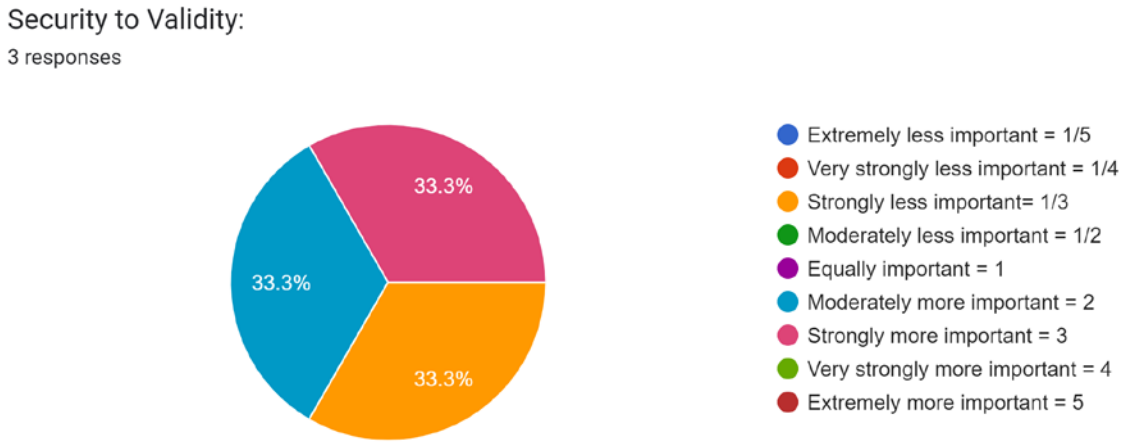

Figure 24 scalability to validity

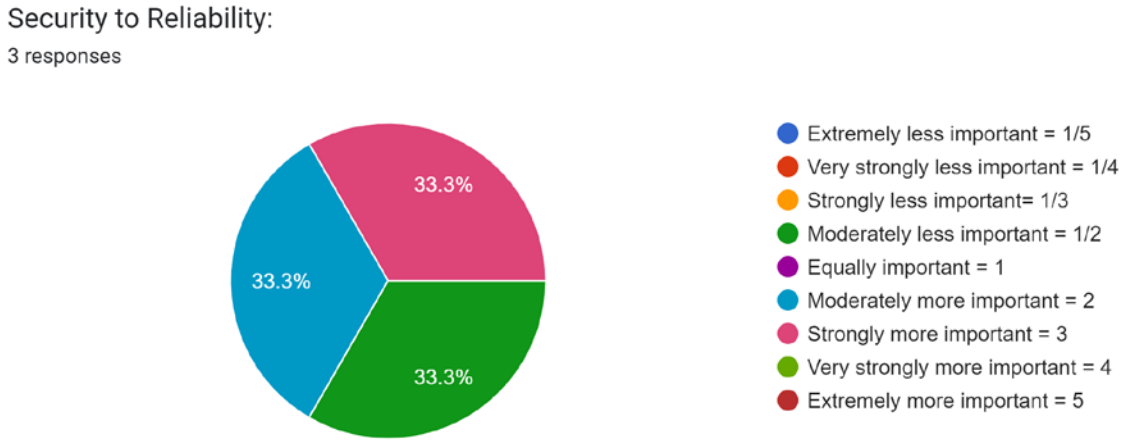

Figure 25 security to reliability.

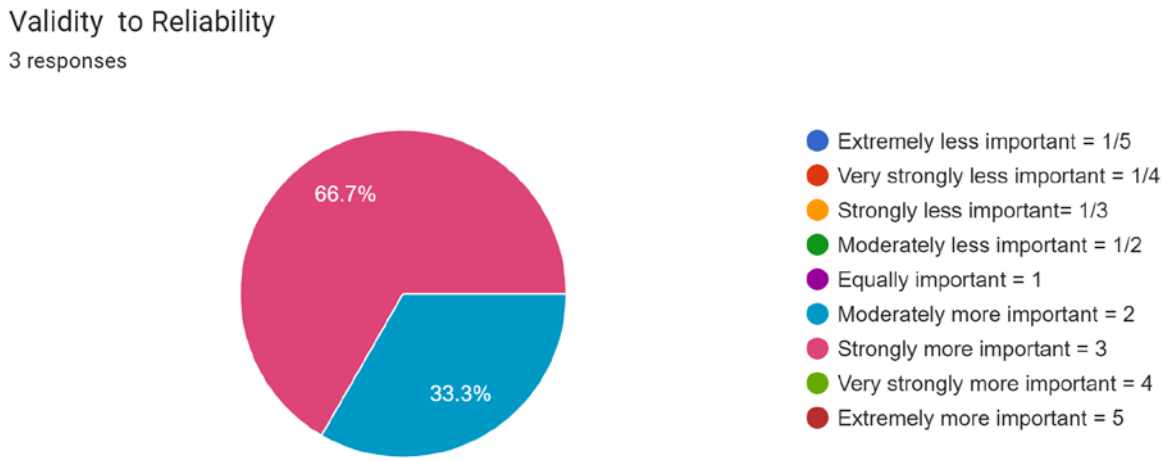

Figure 26 validity to reliability

- **compare the importance of the following Alternative relative to each other:**

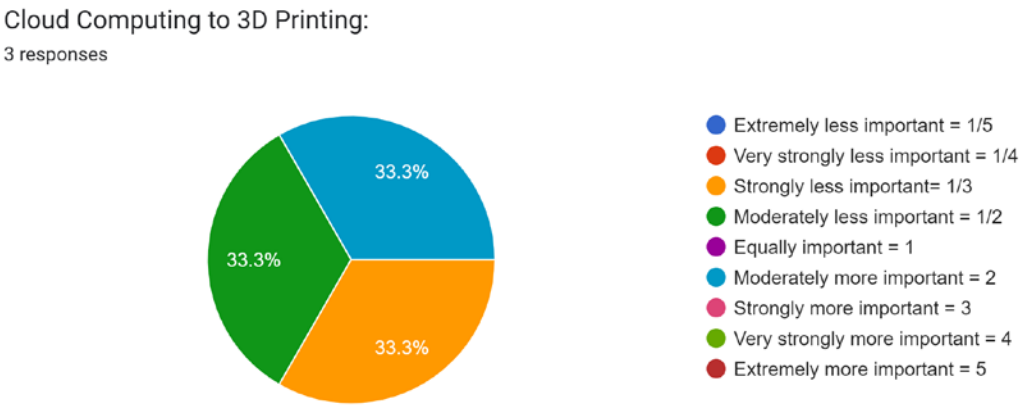

Figure 27 cloud computing to 3D printing.

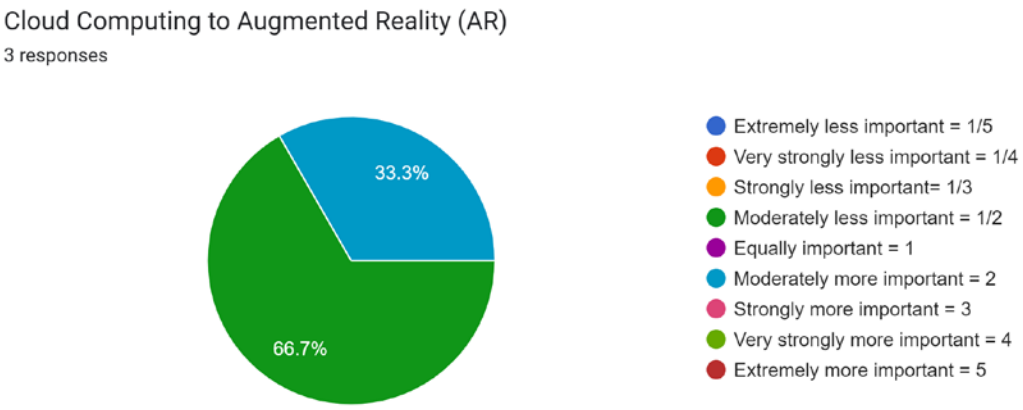

Figure 28 cloud computing to augment reality

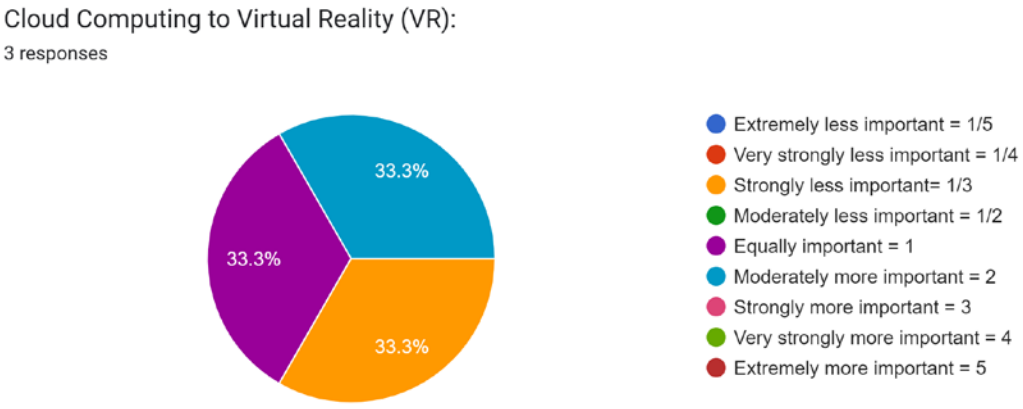

Figure 29 cloud computing to virtual reality

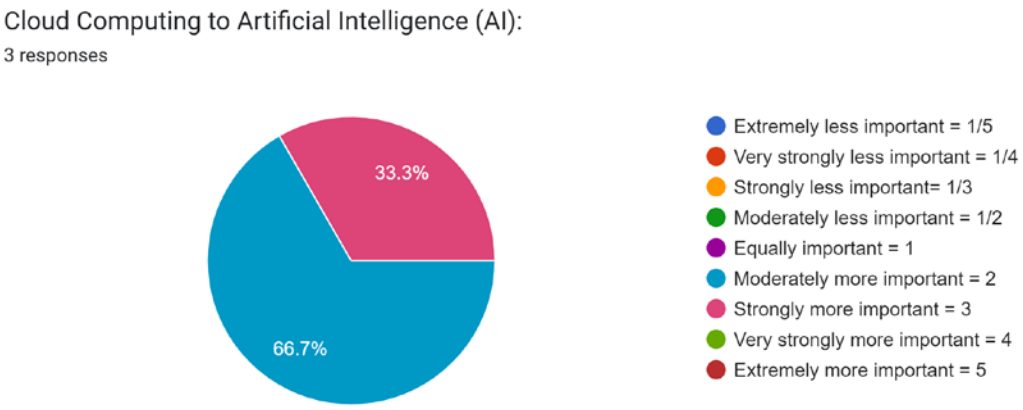

Figure 30 cloud computing to artificial intelligence

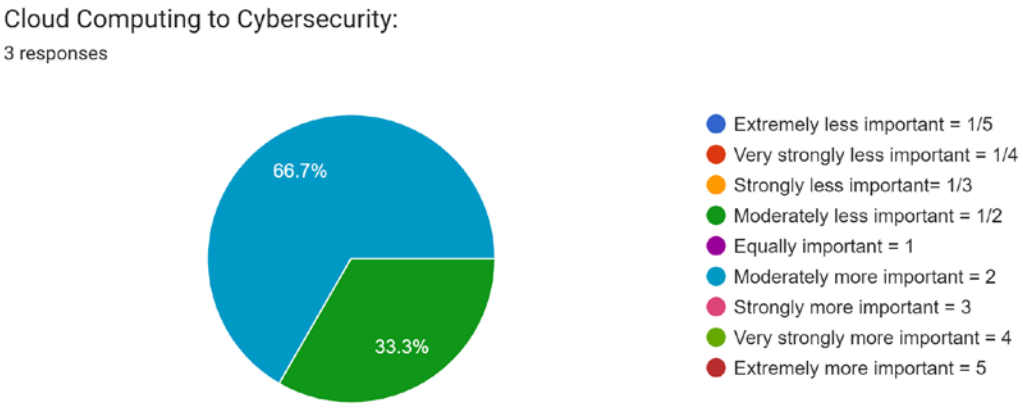

Figure 31 cloud computing to cybersecurity.

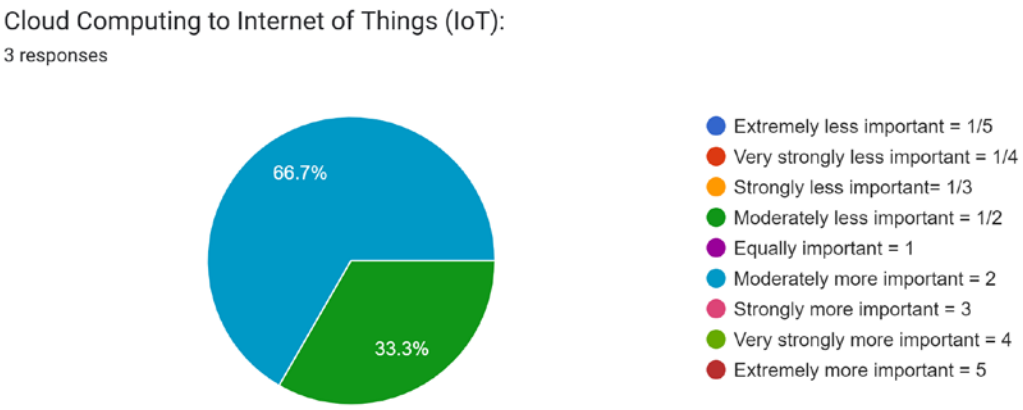

Figure 32 cloud computing to internet of things

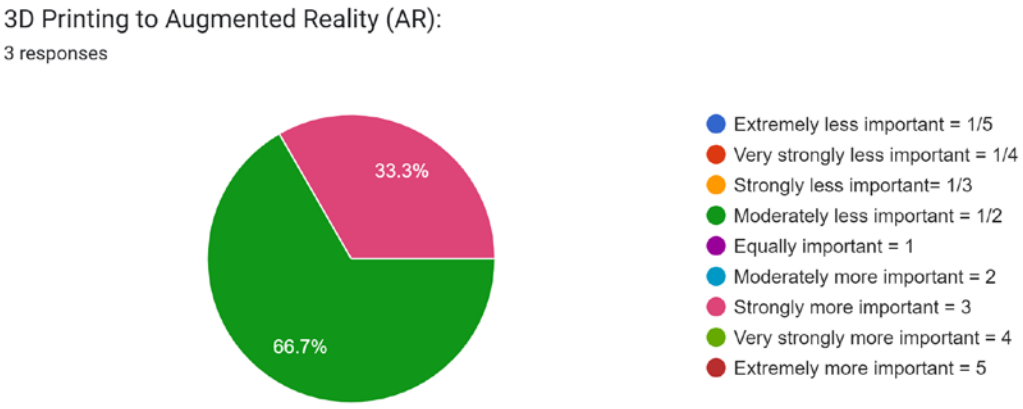

Figure 33 3d printing to Augmented reality

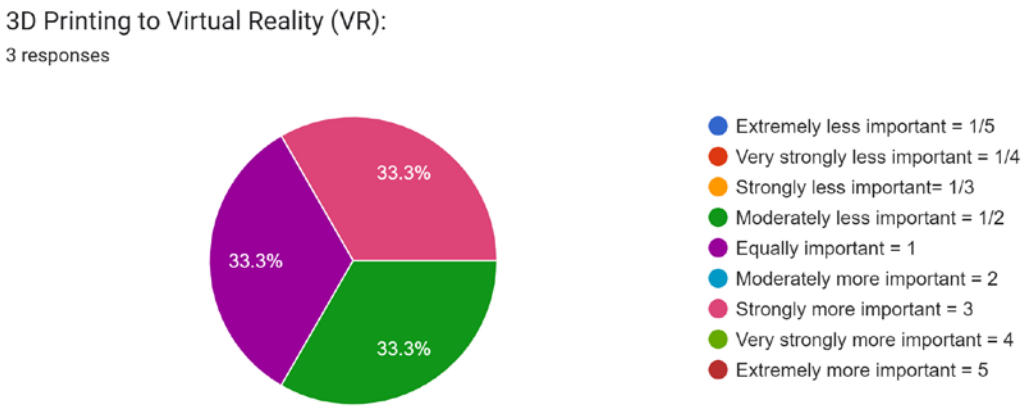

Figure 34 3D printing to virtual reality

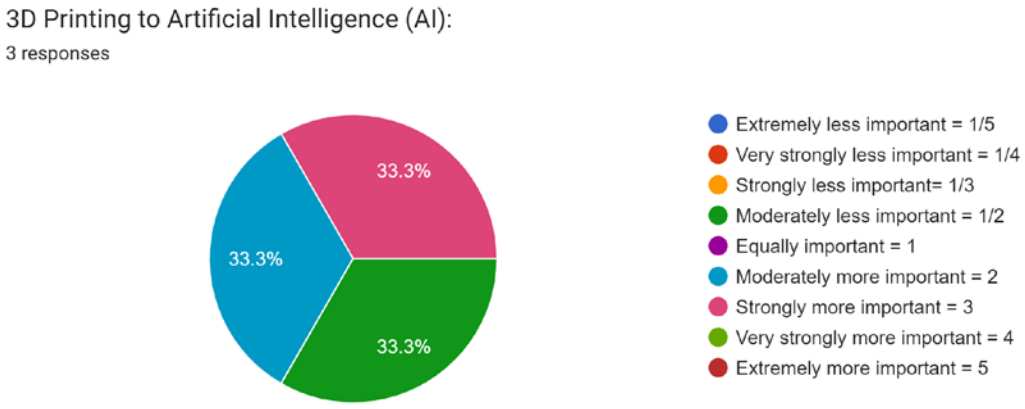

Figure 35 3D printing to Artificial intelligence

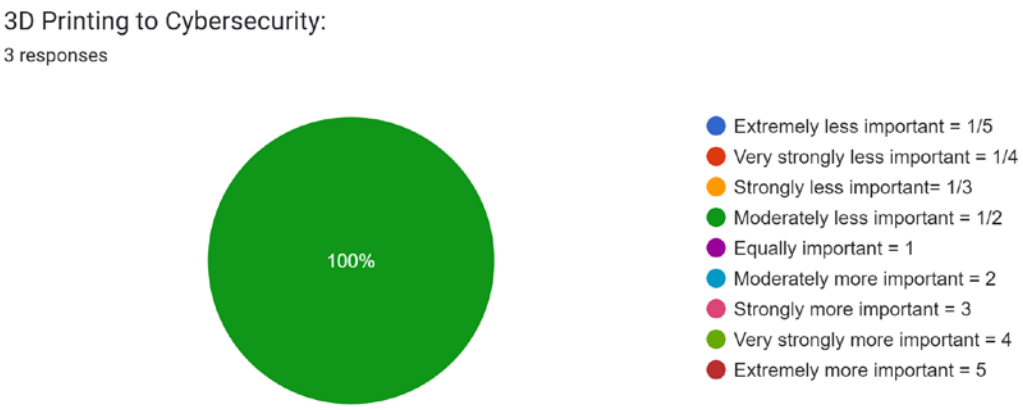

Figure 36 3D printing to Cybersecurity.

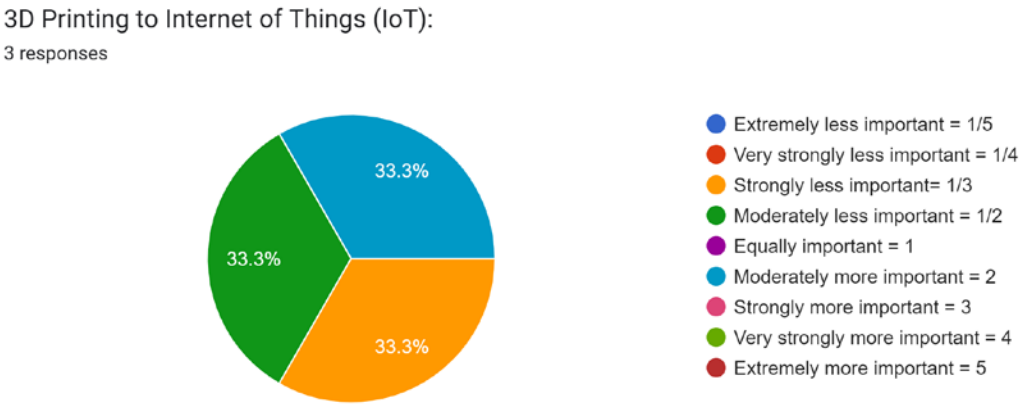

Figure 37 3D printing to internet of things.

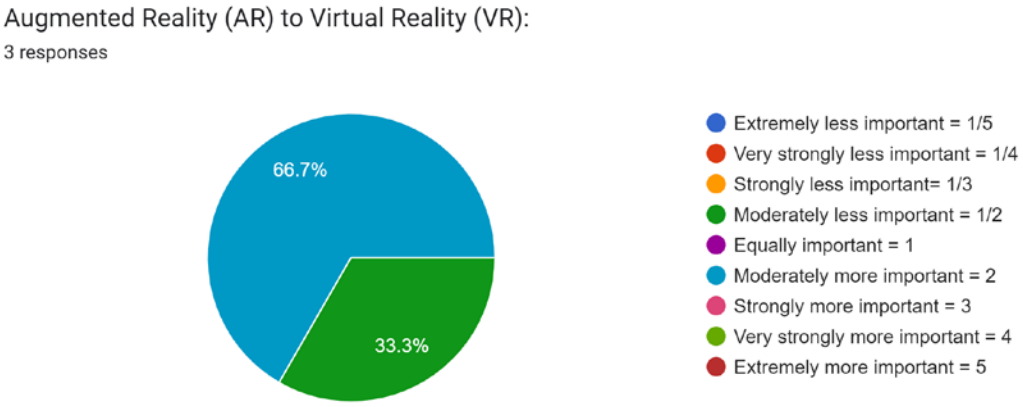

Figure 38 Augmented reality to virtual reality

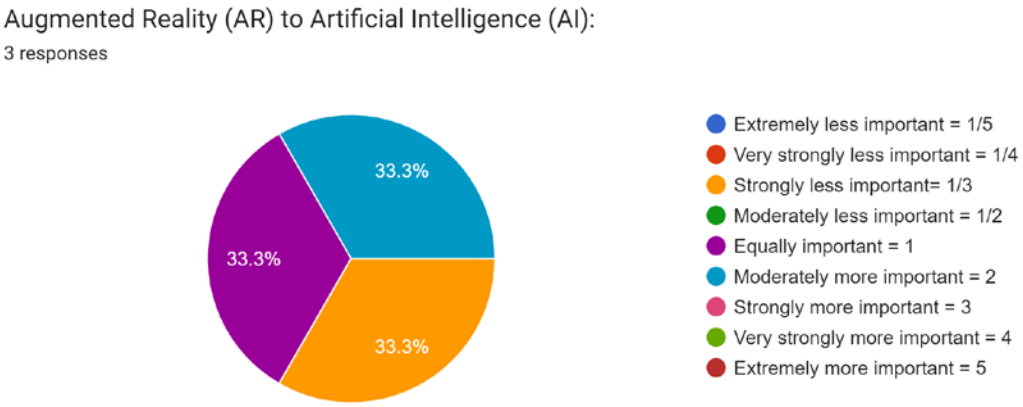

Figure 39 Augmented reality to artificial intelligence

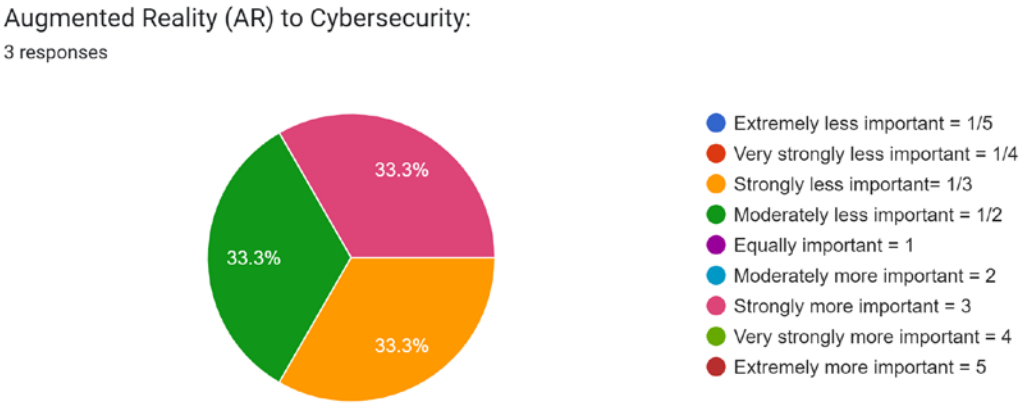

Figure 40 Augmented reality to cybersecurity.

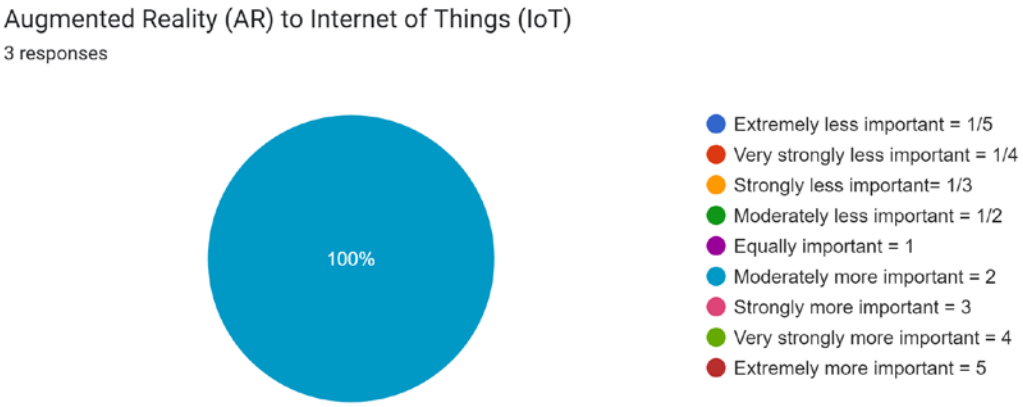

Figure 41 Augmented reality to internet of things

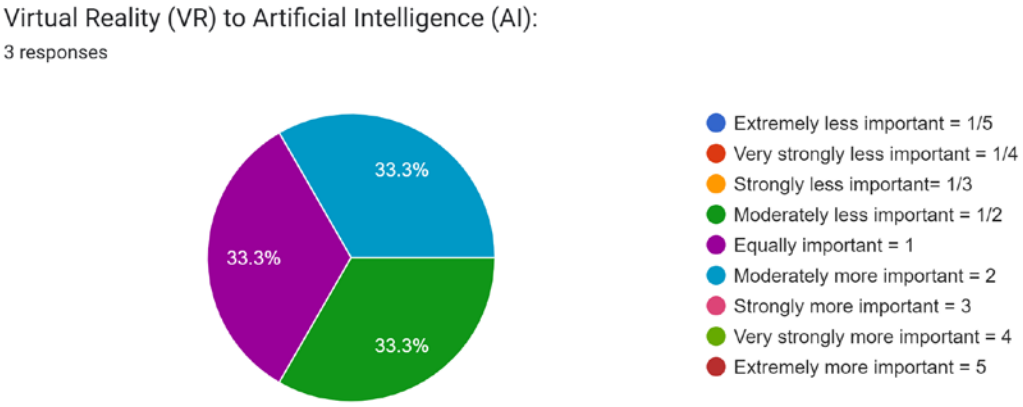

Figure 42 virtual reality to artificial intelligence

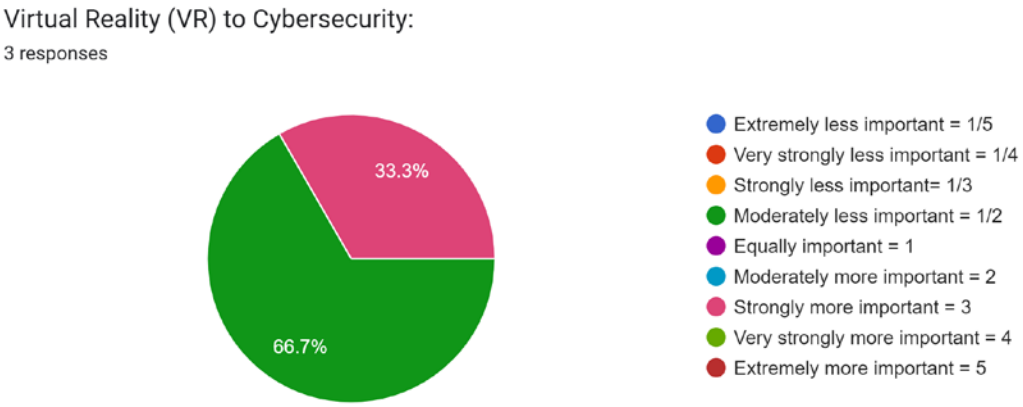

Figure 43 virtual reality to cybersecurity.

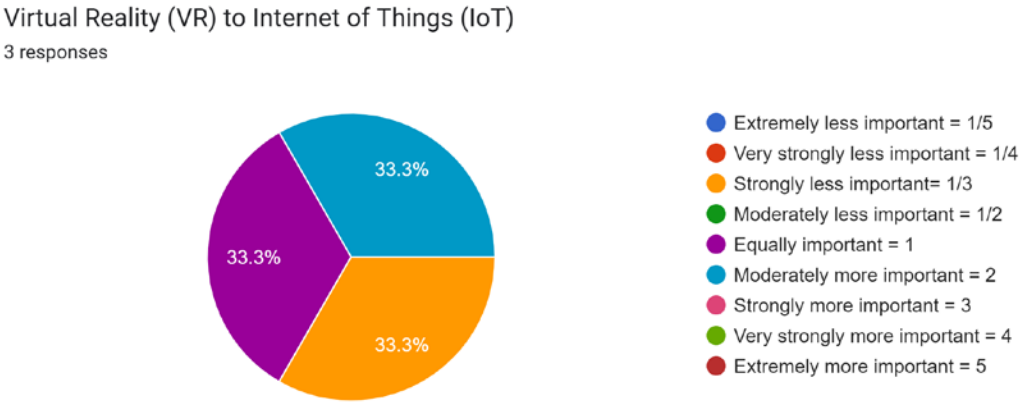

Figure 44 virtual reality to internet of things.

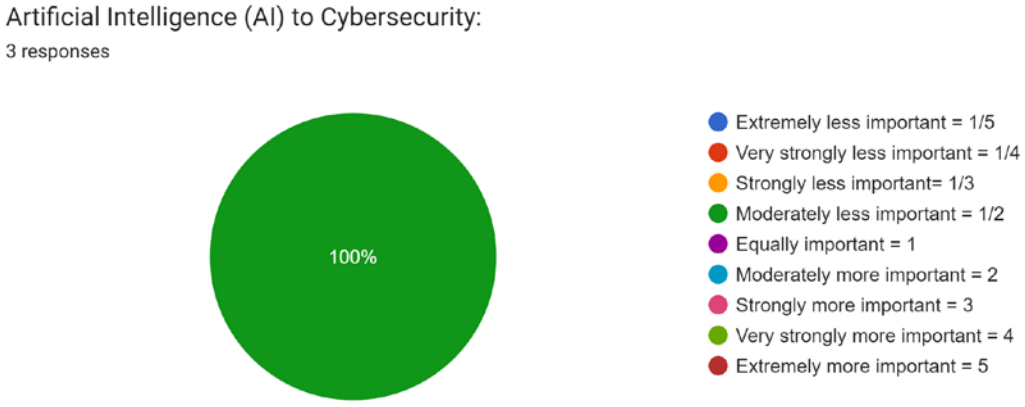

Figure 45 Artificial intelligence to cybersecurity.

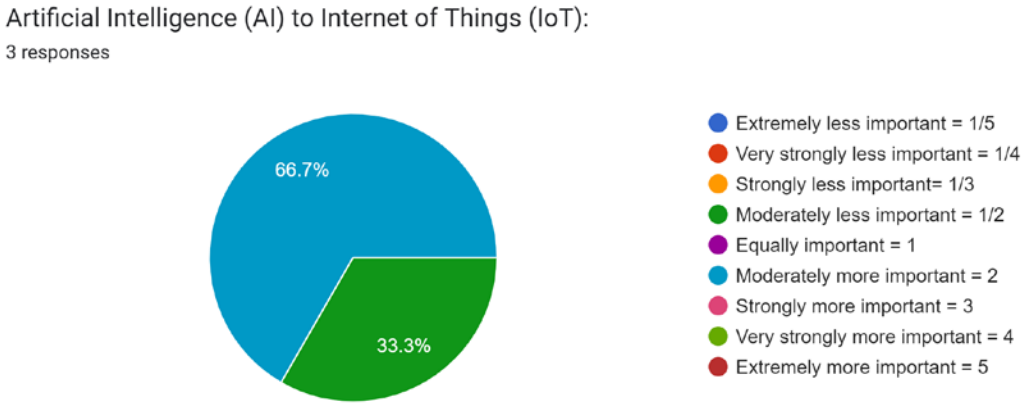

Figure 46 Artificial intelligence to internet of things

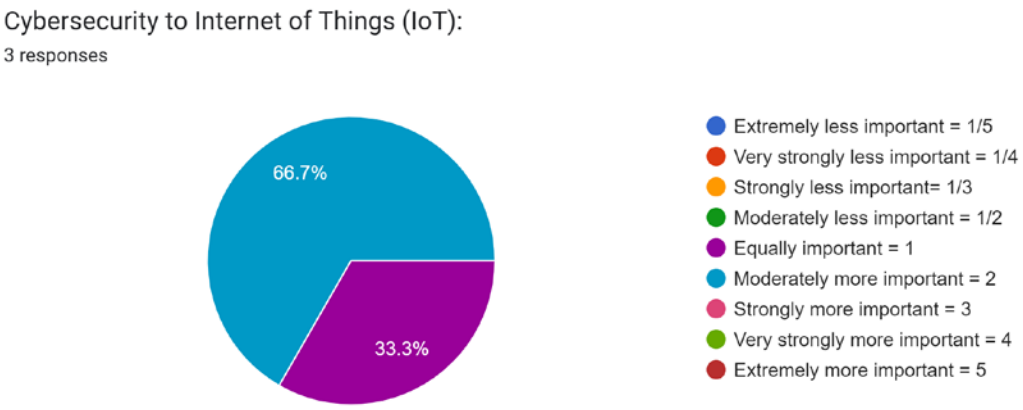

Figure 47 cybersecurity to internet of things

1.21 Appendix: AHP structure to choose 4.0 Technology