A FRAMEWORK OF IDENTIFYING RELEVANT DIMENSIONS IN ASSESSING A DIGITALIZATION MODEL FOR COMPANIES OPERATING IN THE FASHION INDUSTRY

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Abstract: *The purpose of this paper is to identify relevant aspects regarding the digital transformation process of companies in the fashion industry production market, how the process is perceived by the managers of these companies, and the existence of a digitalization strategy. As a tool for qualitative research, a semi-structured interview was used to collect opinions on the digitalization process of companies in the fashion industry from experts with experience in digital transformation, based on the evolution of their own companies. The sample of interviewed individuals was consciously and explicitly selected to include pro-digitalization attitudes, individuals who already have their own experiences and informed opinions on the necessity, barriers, and steps to be taken in implementing a digitalization process. The digital textual analysis tool Atlas.ti was used for the collected data through semi-structured interviews. Finally, the dimensions of the specific digitalization model for the fashion industry were determined.*
Key words: *digital transformation, fashion industry, qualitative research, digital tools.*

1. INTRODUCTION

With the onset of the fourth industrial revolution, since 2011, manufacturing companies have shifted their focus towards incorporating the latest technologies into their products and integrating Industry 4.0 technologies into their production systems. The rapid evolution of digital technologies and solutions, and the capacity of companies to adopt and integrate them, make possible to reduce the time for the development of new products. The COVID-19 pandemic has been a turning point in accelerating the digitalization process across all industries, including manufacturing. Reports indicate that manufacturing industries have been hit harder and will experience slower growth compared to more advanced ones. While the impact of government support initiatives cannot be underestimated, it is the resilience of production that has made the difference and helped many companies thrive in these challenging times. It has also highlighted the ability of many companies to address adaptability and development flexibility [1]. Similar significant disruptions are expected soon (such as regulations on climate change, raw material shortages), and the response to addressing these challenges lies in increased resilience of manufacturing firms.

Industry 4.0 is related to three terms: digitization, digitalization, and digital transformation [2]: 1) digitization refers to the conversion of data or information from analog to digital format so that it can be processed using software [3]; 2) digitalization is the process of implementing digital technologies with the aim of transforming the business model, generating revenue, and creating opportunities for value-added growth [4]; 3) digital transformation (DT) represents the systemic restructuring resulting from the diffusion of digitization to improve business processes [4, 5]; 4) successful digital transformation occurs when organizations aim to transform their business to exploit the potential offered by new technologies [6].

Researchers have commented that the fourth industrial revolution brings about a fundamental paradigm shift in industrial production [7].

2. DIGITAL MATURITY MODELS

The fundamental concept behind maturity models is to guide decision-makers in achieving the desired level of digital maturity for the defined dimensions. Several maturity models have been published so far, describing the readiness of organizations for digitalization using different levels and dimensions. The levels can be described through maturity level descriptors, while the dimensions encompass various aspects of functions that indicate the overall state of digitalization within companies.

Table 1 summarizes the maturity models for digital transformation identified in the literature in terms of their levels and dimensions of maturity. According to existing research, the levels of maturity models (MM) are described by explicit descriptors. Some maturity models use level names that refer to the state of digitalization, such as initial, absent, or incomplete. Other authors use level names as positions within sequential stages of digitalization, such as digital awareness, computerization, and digital beginner. The presented maturity models involve four, five or six levels. Although it is incorporated into only two dimensions of the maturity model, the technology dimension needs to be presented more comprehensively. It can be said that dimensions encompassing information, data, IT, and intelligent technologies can be evaluated from a technological standpoint.

Table 1

Digital Maturity Models

Maturity model	Maturity level	Dimensions	Authors
DREAMY model	(1) digitally oriented (2) integrated and interoperable (3) defined (4) managed (5) initial	(a) organization (b) technology (c) monitoring and control (d) process	*De Carolis, 2017*
Industry 4.0 Model	(1) optimized (2) predictable (3) stable (4) managed (5) performed (6) incomplete	(a) organizational alignment (b) process transformation (c) application management (d) data management (e) asset management	*Gökalp, 2018*
IMPULS Model	(1) interpreter (2) expert (3) experienced (4) intermediate (5) beginner (6) novice	(a) strategy and organization (b) smart products (c) intelligent operations (d) smart factory (e) employees (f) data-driven services	*Lichtbla, 2015*
Five phase model	(1) detailed (2) transformed (3) defined (4) managed (5) initial	(a) product (b) value chain (c) process (d) market	*Ganzarain and Errasti, 2016*
Maturity and readiness model	(1) maturity (2) survival (3) existence (4) absence	(a) strategy and organization (b) intelligent products and services (c) intelligent business processes	*Akdil, 2018*
Digitalization model	(1) awareness of digitalization (2) networked intelligent products (3) service-oriented enterprise (4) thinking in service systems (5) data-driven enterprise	(a) innovation culture (b) cooperation (c) strategy development (d) process organization (e) complementary IT system (f) intelligent product / company (g) customer orientation (h) competencies (i) structural organization	*Klötzer and Pflaum, 2017*

Information and data management ensure that data obtained from production and the value chain are meaningful. For this purpose, having an IT system that fulfils these needs is crucial. Intelligent technologies describe any technology that can connect users through the internet. Due to these characteristics, technologies are crucial throughout the digital transformation process.

3. RESEARCH METHOD

Different authors [8, 9] recommend the qualitative research methodology to investigate a new field of study or theorize important concepts through textual interpretation. Based on this premise, the authors consider that, as a management process, the issue of digital transformation in the fashion industry fulfils both conditions for the use of qualitative research methods (Figure 1).

Interviewing is the most common data collection format in qualitative research, and according to Oakley [10], it is a form of inquiry in which "practices and standards are not only recorded, but also touched upon, challenged, and consolidated". Most interviews used in qualitative research are either semi-structured or loosely structured or in-depth [11]. The semi-structured interview is a variant of an in-depth interview where respondents are required to answer pre-determined questions by the interviewer. These types of interviews can take from 30 minutes to over an hour. To make optimal use of this time, an interview guide is developed, serving the purpose of systematically and comprehensively exploring multiple respondents and keeping the interview focused on the desired line of development [12]. To enhance the efficiency of data collection, it is recommended to record the interview, with the interviewee's consent.
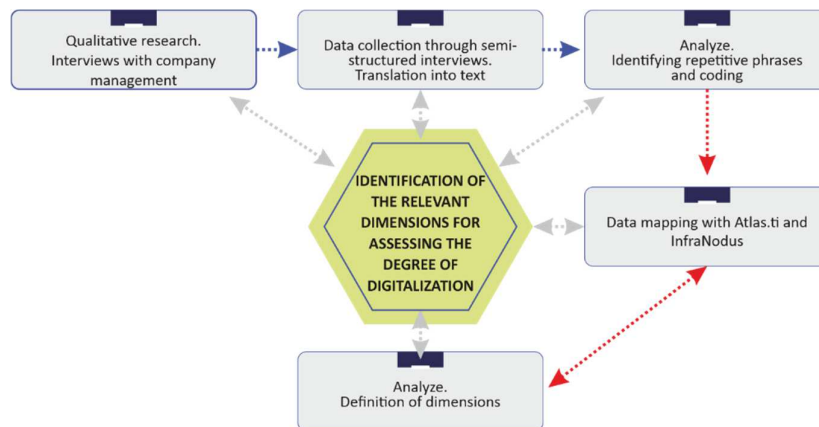

Fig. 1. Qualitative research framework

Table 2

List of interview participants

Company / Participant	Position in the company	Education level	Experience in the field
Company A/ Participant P1	Manager	Higher education/ Textile engineer	27 years
Company B/ Participant P2	Manager	Higher education / Economist	15 years
Company C/ Participant P3	Production manager	Higher education/ Textile engineer	32 years
Company D/ Participant P4	Production manager	Higher education/ Textile engineer	33 years
Company E/ Participant P5	Manager	Higher education/ Textile engineer	22 years
Company F/ Participant P6	Production manager	Higher education/ Textile engineer	20 years

In this case, the interview was conducted with 6 participants, managers from relevant production companies in the fashion industry from Romania (Table 2). The interview contains questions grouped into three categories: personal/company positioning regarding the digitalization process; digitized processes/potential for digitalization; effects of the digitalization process. The questions were designed to target specific aspects of the digitalization process, allowing the interviewees to provide the most relevant data and information for the research.

The interviews were conducted online on the Google Meet platform between May 2022 and September 2022. The interviewees agreed to have the interviews recorded while maintaining confidentiality. The decision to conduct the interviews online was made in agreement with the interviewees because the companies are in different cities of Romania.

Out of the 6 interviews, 5 were conducted in Romanian and one in English. The average duration of the interviews was one hour and 20 minutes. The interviewees provided insightful perspectives, due to their extensive knowledge of the industry and significant experience in managing their companies.

Since the data analysis was carried out using qualitative data analysis software applications that operate with text, a primary processing stage of the interview recordings was required, which involved converting them from audio/video format to text format. The Sonix AI application was used for this purpose, and the resulting texts had a certain level of error (3-5%), requiring manual correction. The correction process did not affect the content of the text or the meaning of the ideas conveyed by the interviewees. Another challenge was the relatively long duration of the conversion process.

4. QUALITATIVE DATA ANALYSIS USING ATLAS.ti SOFTWARE APPLICATION

The interviews were processed using the qualitative data analysis software ATLAS.ti. The ATLAS.ti 7 software package was utilized to analyze and interpret the collected research evidence and information. An advantage of using ATLAS.ti was that it facilitated access to keywords, relationship diagrams, and other analysis features [13]. The application was able to identify and mark areas of interest for the study during the primary stage of analysis [14]. These quotations were grouped for evaluation in a separate register, and the quotes were regularly analyzed in relation to the research method. All documents were read repeatedly and clarified, guided by the research topic, to identify recurring trends and ideas [15].

The initial stage of qualitative data analysis involves the use of the open coding function of the ATLAS.ti software package to identify relevant words, sentences, and phrases related to the field of interest (Figure 2). These identified elements are labelled as "quotations" with open coding and are used to generate memos from the same passage [16]. As new ideas emerge, multiple code pages can be developed, and to find correlations and common properties, these codes can be explored and classified into categories [17]. Categories can be named to communicate their amplitude, and if necessary, subcategories of codes can be created and applied to these categories [18]. Open coding is typically the first step in data analysis [14, 19].

The qualitative analysis focused on the antecedents and consequences of digitization in the fashion industry showed that entrepreneurs can be motivated by both intrinsic and extrinsic factors in adopting digitization, and that digitization can have both positive and negative impacts on the fashion industry, including society, sustainability, the economy, and the environment [20]. The frequency count represents the respondents' formulations that can fit into the specified code in the first column of the table (Figure 3).

The responses were read and coded by identifying specific constructs, resulting in a list of codes presented in Table 3. The detailed responses from the participants focusing on the code "Digitalization cost" will be presented, as the code has the highest frequency. Digitalization cost (17 occurrences) encompass aspects related to the costs required to implement the digitalization process. It can be concluded that costs and identifying sources of funding represent a natural concern for entrepreneurs.
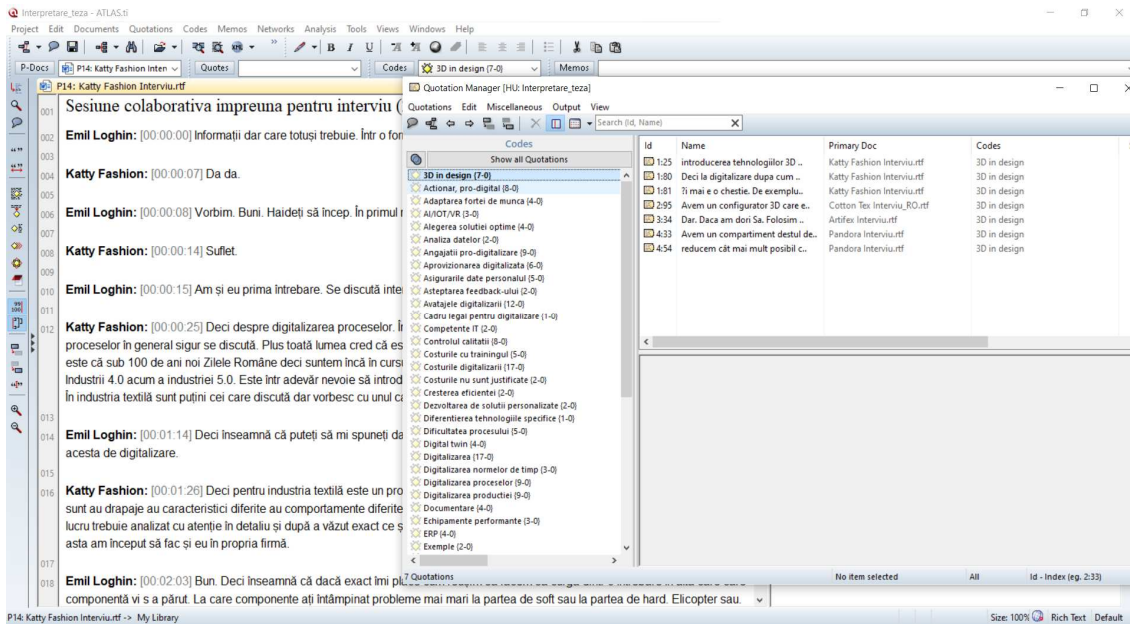
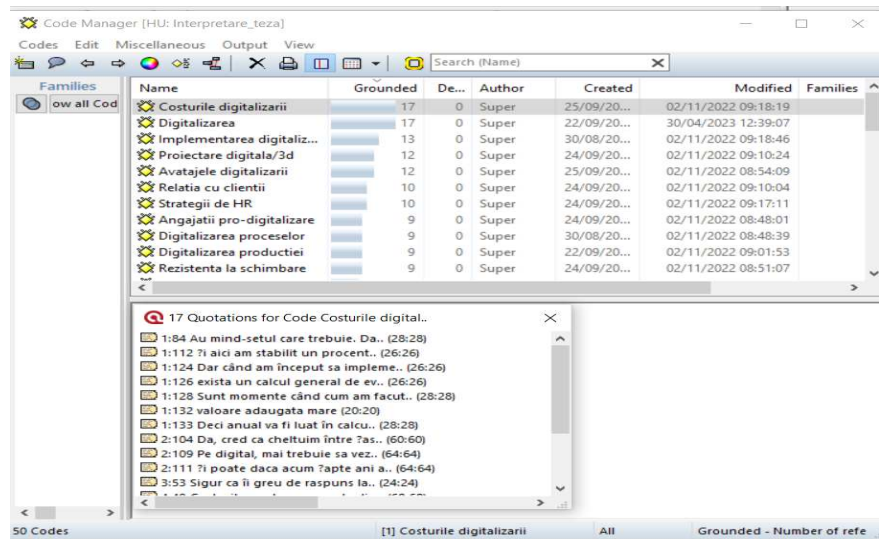**Fig. 2.** Text segment coding (Authors own processing in Atlas.ti)

Fig. 3. Number of occurrences "Digitalization cost" (Authors own processing in Atlas.ti)

Table 3

Atlas.ti Codes (processing results pertaining to the author)

Atlas.ti Code	Number of occurrences
Digitalization cost	17
Digitalization	16
Implementing digitalization	13
Digitalization advantages	12
Digital / 3D design	12
Customer relationship	10
HR strategies	10

(Interviewee P1): *"...they have the mindset that is needed. Yes, all these things help to actually reduce that cost because it is a balancing the act of investments between the*

end-user and us"...and here, we have established a percentage of the added value that we manage to obtain in our current activities"...But when we started to implement, we had to rely on our own budget; ...there is a general evaluation calculation;...There have been moments when in 2019 we made an investment of almost one hundred and something thousand euros. Yes, it was possible. We got a part of it through a competition voucher, and we won the competition...it was possible because we managed to optimize the process and found some clients who were willing to pay for our services. Yes, that's how it is, adapting to the situation.

(Interviewee P2): *"...Yes, I believe we spend between six and seven hundred thousand euros per year on the minimum barrier of digitization."*

(Interviewee P3): *"...Surely it is difficult to answer this question. There was a certain amount invested before 2020. After that, not much. Things have changed. Currently, it is hard to say, around 100,000 euros. Maybe much more. It depends."*

(Interviewee P4): *"...The costs for digitized processes are obviously lower than for non-digitized ones.... The annual investment varies from year to year. There have been periods when we have had massive investments, such as when we first purchased a certain technical solution. On average, it is somewhere around 1-2 million euros per year, with the clarification that there were peak values at the time of acquisition. For example, for automated machines, where the costs are much higher."*

(Interviewee P6): *"...So, before the pandemic, the annual investments exceeded, let's say, I don't know, five or six million euros...Sure, each software provider has its own policy, with its complexity, as well as prices. Of course, the most expensive is the software."*

Note: The translations provided above are based on the text provided and may not capture the full context or nuances of the original language.

From the analysis of isolated text paragraphs conducted using ATLAS.ti, the following conclusions can be formulated regarding the qualitative analysis that synthesizes the perception of managers from representative production companies in the fashion industry, regarding the digitization process:

1. It is a necessary process for integrating and maintaining businesses in the global economy.
2. It is a process that involves significant investments. Most companies have already invested in addressing immediate needs related to increasing production capacity, improving working conditions for employees and the efficiency of the manufacturing processes.
3. The primary focus is on digitizing the design process, including 3D design, which is seen as a solution for attracting new clients by reducing the time required for developing a new product and improving communication.
4. Digitizing manufacturing and production processes is currently only a desire because it requires the substantial restructuring of processes and significant investments. Collecting production data is vital for decision-making and optimization, and sensor-based tracking systems are considered feasible, but not yet a priority.
5. It has been observed that there is no digital transformation strategy. In the author's opinion, the efforts made by different companies for digitization target specific processes to achieve immediate effects. From the author's perspective, there is a lack of interconnectivity among the different digital solutions adopted in the same company. Moreover, the organizational effort seems to be too challenging for entrepreneurs to accept it.

To firstly test the content and structure of the evaluation tool for assessing a company's readiness for digitization, the results provided by text processing using ATLAS.ti were correlated with the proposed dimensions. This association is made in Table 4, aiming to obtain an overview of code distribution across dimensions.

The result is somewhat surprising, indicating a somewhat ordered and periodic distribution of points resembling a sinusoidal curve. This distribution profile suggests that the chosen dimensions are relevant for the digitization process. Additionally, it is observed that the most frequent references, albeit not the most

numerous ones, pertain to Human Resources and Production System.

5. HE DIGITALIZATION MODEL

The qualitative analysis aimed to gather opinions on the digitization process of companies in the fashion industry from specialists who have demonstrated openness to digital transformation through the evolution of their own companies. Additionally, the goal was to identify the positioning of the analyzed companies in relation to the terms "doing digital" and "being digital".

Based on the declared coded words, a series of common opinions were identified among all the interviewees, including:
1) The advantages of digitization are undeniable and lead to business transformation and growth.
2) The costs of digitization are too high, even for successful companies. Addressing issues related to the implementation of digital solutions can be achieved through in-house development if the company has an IT department or by accessing dedicated

sources of financing, although only one out of six firms accessed such an instrument yet.
3) The essential issue and main barrier in developing a coherent digital transformation process is the workforce lacking the necessary skills, as discussed by all six interviewees. They have average job stability and may experience difficulties in learning due to their age. Observations were made regarding the relevance and adequacy of the curriculum for fashion industry specializations in terms of the weight given to digital-specific disciplines or the use of digital tools.
4) Some reservations were expressed regarding the feasibility of digital solutions in relation to the specific processes of the fashion industry, which must respond to product and material diversity, unpredictable behavior of textiles, and significant human interventions in the manufacturing processes.
5) However, the author did not identify the existence of a digitalization strategy among the interviewed companies, nor did the entrepreneurs have a vision for transforming the current business model.

Table 4

Association of ATLAS.ti codes with the dimensions of the digitalization model

ATLAS.ti codes	Freq.	Organization/ Company	Inovation culture	Techno-logy	Process	External relations	HR	Production systems
Digitalization cost	17	X						
Digitalization	16	X						
Implementing Digitalization	13				X			
Digitalization advantages	12		X					
Digital/3D design	12							X
Customer relationship	10					X		
HR strategies	10						X	
Pro-digitalization employees	9						X	
Process digitalization	9				X			
Production digitalization	9							X
Resistance to change	9						X	
Pro-digital owner	8	X						

This may be explained by the fact that most companies in the industry in Romania operate based on client orders and do not promote their own brand.

From the analysis of the maturity models presented in the second part of the study, it is evident that there are dimensions that are generally applicable (Organization – Company - Strategy), as well as dimensions specific to the studied domain. Furthermore, based on the qualitative research conducted for companies in the fashion industry, a series of descriptive elements associated with defined text codes were grouped, allowing the authors to propose a set of dimensions that will form the basis for developing an evaluation tool for a company's readiness for digitization (Table 5). Innovation is directly associated with the development of ICT applications, and it is considered that a company that values a culture of innovation has a superior capacity to transform its management processes and is prepared for genuine digital transformation.

Table 5

The dimensions of the digital transformation process

Dimension	Descriptive elements
Organization/ Company	*Digitization cost, Digitalization (of the company), Pro-digital shareholder, Business transformation, Digitization legislation*
Description: Is there a digitalization strategy? Is the vision communicated to external partners? Does digitalization produce change in the relationship with suppliers? Are there disruptive effects capable of causing business model change? Does digitalization allow the identification of new opportunities for the company?	
Innovation culture	*The advantages of digitalization, Choosing the optimal solution, Documentation, Possibility of customization, Digitization project management, Optimizing solutions*
Description: Does digitalization generate innovation? Are resources allocated for innovation in the use of digital systems? Is the process of continuous improvement stimulated in relation to digitalization? Is the performance generated by digitalization evaluated? Are the risks associated with digitalization identified and managed?	
Technology	*Interconnection of automations, Digital tools, Software, Digital twin, Customized digital tools, AI/IoT/VR, Technology differentiation, Data security*
Description: Is the evolution of digital technologies relevant to the fashion industry known? Are old technologies maintained? Is external support sought for the implementation of digitalization projects? Is AR/VR technology useful for the fashion industry? Is virtual prototyping technology useful? Is data compatibility with customers monitored? Is digital printing technology useful? Is Digital Twin technology usable in the fashion industry? Is the use of robotic systems useful in the fashion industry? Is tracking products with RFID sensors useful?	
Process	*Implementation of digitalization, Digitization of processes, 3D in design, Complexity of the process, Process robotization, Process automation, Feedback*
Description: Is sharing process data within the company important? Are data security systems necessary? Is the GDPR system used? Is the use of data evaluated for companies in the fashion industry? Are production time data used to improve processes? Are databases used for the development of new products? Can digitalization reduce the manufacturing cycle time of products?	
External relationships	*Customer relationship, Stakeholder relationship*
Description: Is collaboration with external partners beneficial for integrating digital systems in the fashion industry companies? Is digital integration with other organizations necessary? Are resources identified for digital integration with other organizations? Are risks evaluated?	
Human Resources	*HR strategies, Pro-digitalization employees, Resistance to change, Staff data security, Training costs, Fear of replacement, Explaining digitalization, Fear of change, Workforce adaptation.*
Description: Are digital skills necessary for personnel in the fashion industry companies? Are staff responsibilities defined? Are there sufficient training programs to acquire digital skills for personnel? Are new positions being created? Is there a policy for replacing personnel with irrelevant skills in relation to digitalization? Does the use of digital technologies determine the increase in staff efficiency/productivity? Is digital communication important for business development?	
Production systems	*Digital design/3D, Production digitalization, Quality control, Digitalized procurement, ERP (Enterprise Resource Planning), Digitalization of time standards, High-performance equipment*
Description: Do digital processes allow real-time production reconfiguration? Can labor productivity be improved through digitalization? Can new technologies be integrated with existing digital technologies? Is a digitalized company more responsive to market demands? Is a preventive maintenance system for IT infrastructure used? In the fashion industry, on-demand production is common. Is digitalization a facilitating factor? Is the process of digital co-creation encouraged? Is digitalization a prerequisite for increasing production flexibility? Is procurement a process adaptable to digitalization?	

The Technology dimension will encompass information regarding the company's vision to utilize various adapted/personalized technological solutions specific to the fashion industry domain. The Process dimension includes information concerning the integration and interconnection process of the data flow generated by the company.

6. CONCLUSIONS

The digital transformation of processes in the fashion industry requires special attention, as the impact of technology in the industry will be significant in the future. The fashion industry in Romania, although it has taken a few steps towards digitization according to the previous study, these steps are small and largely influenced by the lack of financial resources required for such programs. Qualitative research allows for direct contact with owners or managers of companies in the industry and identifies their perception, problems, and decision-making situations they face in adapting technologies to managerial principles of efficiency and effectiveness.

Opinions from pro-digitalization specialists in the fashion industry were collected for a qualitative analysis, providing their perspective on strategies and the positioning of companies in the context of digital transformation. Additionally, the study was able to identify a set of relevant dimensions necessary for assessing the level of preparedness for digitalization in a company, such as Innovation Culture, Technology, Processes, External Networks, Human Resources, and Production System. All these aspects depend on the organizations' ability to innovate and utilize adapted technological solutions that will enable the digital transformation of companies in the fashion industry. The digitalization process involves the interconnection of both internal and external processes, including relationships with external business partners, as knowledge transfer and quick response to their requirements will add value to companies.

However, digitalization depends on the quality of human resources and their ability to assimilate technological knowledge to use industry-specific software and hardware products.

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Identificarea dimensiunilor relevante pentru evaluarea unui model de digitalizare a companiilor din industria modei

Scopul acestei lucrări este de a identifica aspecte relevante privind procesul de transformare digitală a companiilor de pe piața de producție din industria modei, modul în care procesul este perceput de managerii acestor companii și existența unei strategii de digitalizare. Ca instrument de cercetare calitativă a fost folosit un interviu semistructurat pentru a colecta opinii cu privire la procesul de digitalizare al companiilor din industria modei de la experți cu experiență în transformarea digitală, pe baza analizei propriilor companii. Eșantionul de persoane intervievate a fost selectat în mod conștient și explicit pentru a include atitudini pro-digitalizare, persoane care au deja propriile experiențe și opinii formate cu privire la necesitatea, barierele și pașii care trebuie întreprinși în implementarea unui proces de digitalizare. Instrumentul digital de analiză textuală Atlas.ti a fost utilizat pentru analiza datelor colectate prin interviuri semi-structurate. În final, au fost determinate dimensiunile unui model de digitalizare care se consider[specific pentru companiile din industria modei..

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