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THE IMPACT OF DIGITALIZATION ON BUSINESS FUNCTIONS IN MANUFACTURING SMALL AND MEDIUM-SIZED ENTERPRISES: AN EMPIRICAL STUDY FROM THE ENTREPRENEURIAL PERSPECTIVE

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Abstract

Purpose. *The paper aims to empirically examine the impact of digitalization on key business functions in small and medium-sized enterprises (SMEs) in Italy, from the entrepreneurial perspective.*
Design/methodology/approach. *An online survey of 205 Italian manufacturing SMEs was carried out and data were analyzed with hierarchical cluster analysis.*
Findings. *The analysis shows the existence of six clusters of SMEs that differ in the impact of digitalization on business functions and in the influence of digitalization on customer value.*
Practical and Social Implications. *The study suggests that companies should simultaneously digitalize all business functions to increase the effectiveness of the digital revolution, enhance customer value creation and invest both in digital managerial culture and skills.*
Originality of the study. *It focuses on the impact of digitalization on all business functions, which has not yet been empirically investigated as a whole.*

1. Introduction

The growth of the World Wide Web, the increasing number of technologies that accompany it (e.g., broadband internet, smartphones, Web 2.0, cloud computing, speech recognition, online payment systems, and cryptocurrencies), the development of e-commerce, the omnipresence of big data and the advent of the new digital technologies connected to the fourth Industrial Revolution (Industry 4.0) clearly point to the need for companies to go digital (Verhoef *et al*., 2021). Furthermore, social media are changing how companies interact with customers, create products, deliver services, and integrate their IT systems (Lamberton and Stephen, 2016).

The term "Fourth Industrial Revolution" has been commonly adopted to indicate the use of certain technologies (e.g., additive manufacturing, smart factories, Internet of Things [IoT] and cyber-physical systems) that allow achieving increased productivity, production flexibility, more efficient processes and higher product quality (Brondoni and Zaninotto, 2018). Digitalization changes business activities and business models, thus improving integration of machines, processes, employees, and individual products (Grabowska et al., 2020). It also enables new forms of cooperation among companies, leading to new products and services as well as new forms of relationships with customers (Rachinger *et al*., 2019).

According to some authors (Loebbecke and Picot, 2015; Rachinger *et al*., 2019), the digital revolution is not only about optimizing internal processes or incorporating new technologies but also – and fundamentally – about changing business models or the way companies capture and create value for customers and themselves.

The ability of SMEs to acquire knowledge is crucial for them to maintain their position in global business growth and job creation (OECD, 2021). However, most SMEs are struggling to benefit from this revolution as it requires changes in companies' practices through the adoption of specific technologies and the implementation of new capabilities to manage them (Dethine *et al*., 2020). SMEs lack the resources and managerial vision to understand the impact of digital transformation, and they adopt a gradual approach to digitalization compared to large companies (Bowman *et al*., 2019).

Most of the literature on the digitalization of SMEs is focused on the issue of obstacles – especially structural and cultural limits (Überbacher *et al*., 2020) – on the potential benefits in terms of performance (Pfister and Lehmnan, 2021) and on the determinants or antecedents of digitalization (Arora and Rathi, 2019; Lee *et al*., 2020; Raimo *et al*., 2022). The literature has paid less attention to company changes due to digital transformation from a broader perspective (Jones *et al*., 2014; Lee *et al*., 2020; Zamani, 2021)it contributes to the limited literature on micro-enterprise ICT adoption, with a particular focus on sole proprietors. It provides a basis for widening the

theoretical base of the literature pertaining to ICT adoption on two levels. First, a framework is developed which integrates the findings to illustrate the relationships between attitudes towards ICT adoption, endogenous and exogenous influencers of these attitudes and subsequent strategic response in ICT adoption. Second, building upon this framework the article reveals the unique challenges, opportunities and implications of ICT adoption for sole-proprietor micro-enterprises.",",container-title":"International Small Business Journal: Researching Entrepreneurship",",DOI":"10.1177/0266242612461802",",ISSN":"0266-2426, 1741-2870",",issue":"3",",journalAbbreviation":"International Small Business Journal",",language":"en",",page":"285-306",",source":"DOI.org (Crossref.

In this paper, we propose an empirical study to contribute to filling this gap by proposing a wide angle of analysis: how digitalization impacts the key functions of a business based on the transformations experienced in each function, and how this affects customer value from the entrepreneurial perspective. This perspective has been chosen to make the actual views and intentions of entrepreneurs emerge.

Therefore, the aim of this paper was to identify the impact of digitalization on the key business functions within SMEs and develop a conceptual framework, which was then verified by sending companies a questionnaire. By the impact of digitalization on the key business functions we refer to the adoption of IT and digital technologies by SMEs in order to introduce them in the main (key) business functions.

The first step of the empirical study was to classify SMEs in terms of the impact of digitalization on the key business functions and highlight the differences linked to company size, sector and type, as well as the level of digital innovation. The second step was to analyse how the impact of digitalization on these functions influences the entrepreneur's perception of customer value.

The paper is structured as follows. The first part explains the theoretical background of the changes that take place in companies as a consequence of digitalization; it also describes the transformation of companies' key functions. The next section describes the study's methodology. The analysis of the results is then presented. The last part discusses the findings and presents the conclusions, highlighting the study's theoretical contributions and practical implications, as well as future research directions.

2. Theoretical background

2.1 The digitalization of SMEs

While large companies are seizing the opportunities and challenges of digitalization, SMEs lack the managerial vision and resources to fully understand the impact of digitalization and start adopting it properly (Rüßmann *et al*., 2015). The literature on the digitalization of SMEs has stressed that Industry 4.0 represents a great opportunity to participate in global digital supply chains; however, these companies approach this revolution with caution, fearing that higher process transparency can be detrimental. This technology-led change can also affect the business model of manufacturing companies and their approaches to value creation, value offer and value capture (Mueller *et al*. 2018).

The current status of the research on the relationship between enterprise digitalization and performance can be assessed in industry reports. However, this grey literature lacks links to theoretical frameworks (Teng *et al*., 2022). For example, the *McKinsey Global Survey* (2022) has noted that, over the past two years, the strategic importance and adoption of new digital technologies in all business areas have accelerated dramatically. Top management, though, reported that companies (of all sizes and sectors) captured less than one-third of the value expected from recent digital transformations in terms of revenue increase and cost reduction. An OECD (2021) study found that the digitalization of SMEs impacted heavily the marketing, finance and administration functions. In Italy, SMEs are characterized by a slight delay in the adoption of emerging technologies, but they are in line with other European countries, like Germany and Denmark, regarding the adoption of additive manufacturing cloud computing and robotics (OECD, 2021).

Bettiol *et al.* (2017) looked at the level of digitalization through the adoption of Industry 4.0 technologies in a sample of small, medium and large Italian companies. They found that half of the sample, not just large businesses, adopted these technologies; they also noted the relevance of marketing in driving the decision to adopt such tools.

According to another study conducted on Italian SMEs (Cucculelli and Lena, 2017), what delays the digitalization of companies are cultural barriers. Entrepreneurs are not willing to innovate. They are used to the traditional manufacturing system and are somewhat concerned about the transformation of their businesses into "smart factories."

In a study on Italian small tourism hotels, it seems that the instinct and social skills of entrepreneurs, even though it does not know technology, play a key role for the adoption of social media and digital marketing tools (Pencarelli et al., 2015). A more recent study (Pencarelli et al., 2019) on

Italian SMEs in tourism sector stressed the gaps between full exploitation of the web potentialities and the best results obtained by the investigated firms, due to lack of adequate adoption of digital technologies (e.g. Internet and social media) and of culture, competencies and strategies to manage adequately such technologies.

Until now, this transformation has been mainly captured through case studies, and there is a lack of quantitative studies on the topic (Teng et al., 2022). In addition, given the existence of different indicators and evaluation methods to assess the level of adoption of technologies and the impact of digitalization on performance, results are inconsistent (Chavez *et al*., 2022). Even the more general literature on technology adoption in SMEs highlights that studies are still limited and the need to go beyond exploration and to take an extensive approach and that there is a need to have a broader understanding (Zamani, 2022).

2.2 The digitalization of business functions

In this study we define "digitalization" as "the application of IT or digital technologies that allow the optimization of existing business processes through more efficient coordination between functions and activities and/or the creation of additional customer value by improving user experiences" (Pagani and Pardo, 2017). Examples of digitalization include the use of social media for marketing communication and e-commerce for selling products or services. In Verhoef et al. (2021), digitalization is the second step of a three-step process that describes the digital transformation of companies, where the first step, "digitization," consists of the conversion of analogue information into digital information (e.g., the use of digital applications for internal financial statements) and the third step, "digital transformation," is the most pervasive phase and describes a company-wide change that leads to the development of new business models (Pagani and Pardo, 2017). Examples of digital transformation include Uber, which distributes the taxi business, and Airbnb, which distributes the hotel business.

The chosen definition of digitalization seems appropriate for SMEs as these companies become digital slowly and, given their legacy, face challenges and obstacles when trying to implement business model innovation aimed at digital transformation (Verhoef *et al*., 2021). Therefore, SMEs probably start to digitalize their operations with minor changes (i.e., digitization or digitalization) by impacting one or a few functions and/or user experiences before eventually transforming their traditional business into a digital one.

Furthermore, the chosen definition considers a wide range of possible digital technologies that SMEs can adopt. Drawing on the literature, we assume that Industry 4.0 revolution is being driven by nine technological

advances: autonomous robots, simulation, horizontal and vertical system integration, the industrial IoT, cybersecurity, the cloud, additive manufacturing, augmented reality and big data analytics.

With respect to Industry 4.0 technologies, we assume that their adoption is very challenging for SMEs because of limited budgets and IT knowledge (Wieland *et al*., 2017; Mittal *et al*., 2018). Existing solutions consist in centrally and complex organized systems, which are costly to adopt (Chavez *et al*., 2022). Consequently, they don't allow the flexible integration of IT systems as well as the self-organization of manufacturing processes in SMEs (Wieland *et al*., 2017). Machines, sensors, and IT systems are connected in the value chain and thanks to standard internet-based protocols can analyse data to configure themselves, predict failure and adapt to change (Chavez *et al*., 2022). Digitalization can strongly impact one, more or even all business functions, thereby optimizing business processes and/or improving customer experience (Verhoef *et al*., 2021).

To understand the extent to which the digital revolution is impacting business identity, it is important to identify the activities and functions that need to be considered as part of the value chain of a company. Starting with the five primary company activities introduced by Porter (1985), – inbound logistics, operations, outbound logistics, marketing/sales and service – further activities can be included to obtain a clearer picture of a company's structure, regardless of the distinction between primary and support activities made by Porter. It is possible to identify the following activities: R&D, purchasing, production, administration and finance, HR, marketing, sales and customer care, and inbound and outbound logistics.

The value chain concept has been largely adopted in the economics and management literature to identify the sources of competitive advantage (e.g., Robbins *et* al., 2020; Abecassis-Moedas and Moatti, 2022).

The following sections summarize some key transformations of business activities as a consequence of digital innovation. Even though such innovation impacts all activities, three groups were investigated jointly because of their strong integration with internal processes. The first group consists of production, logistics and purchasing as it includes the area of logistics and operations. The second group relates to HR and administration and finance. The third group contains R&D, marketing and sales, and it includes the relationship with customers. The inclusion of R&D in this group is based on the marketing concept-related perspective (Svensson, 2001), which holds that products/services should be designed by companies starting from the target market's needs. Given the extensive literature on the topic, the transformations described below should not be considered exhaustive.

2.3 The impact of digitalization on production, logistics and purchasing

Digitalization may help SMEs to reduce transaction costs by providing better and quicker access to information and improving communication between staff, suppliers and networks. It may also help SMEs to enter global markets through reductions in the costs associated with transport and border operations. Finally, digitalization may significantly enhance the scope to trade services (OECD, 2021).

Industry 4.0 technologies (e.g., cyber-physical systems and IoT) allow machines to communicate with each other and facilitate data collection and analysis, the evaluation of productivity, and the continuous improvement of processes (Blanchet *et al*., 2014). Manufacturing firms' robotic systems had to automate their production processes and develop fully automatic machines (Cagle *et al*., 2020). As repairs and defects decrease, the quality of production increases (Varghese and Tandur, 2014).

The development of the Industry 4.0 concept allowed the emergence of new competitive business models based on tighter cooperation among companies situated in value chains (Rüßmann *et al*., 2015). Consequently, enterprises can be more competitive through the personalization of products and lower production costs (Grabowska *et al*., 2020). The following transformations in *production* can be identified: higher flexibility through the creation of small lots with large-scale costs, greater competitiveness thanks to the greater functionality deriving from IoT, and more efficient productivity obtained by reducing errors and set-up times (zero-defects production) (Brondoni and Zaninotto, 2018).

Supply chains equipped with the latest cyber-physical solutions ensure fast reorganization of *logistics* and a more flexible adaptation of trade activities. These new forms of supply chains allow businesses to respond to the most personalized customer expectations (Grabowska *et al*., 2020). In logistics, Industry 4.0 technologies allow a reduction of transportation processes and unnecessary material flows. Furthermore, thanks to the use of data in the supply chain, wrong deliveries, excessive waiting times and damaged products can all be reduced (Kagerman *et al*., 2013).

Advanced robotic systems allow businesses to improve logistical operations by realizing in-factory remote control transfers, perform store activities using robots and utilize unmanned transportation vehicles for materials transfers. This has increased in-house store communication, boosted the efficiency and productivity of logistics, and increased the monitorability of outputs (Cagle *et al*., 2020). By managing and controlling inventories online, firms are also able to create orders automatically when their inventories shorten and cut back on inventory costs. Traditional *purchasing* is changing to adapt to this new paradigm. Research on robotic process

automation (RPA) in buyers' practices is still in its infancy.

A recent study found that RPA impacts procurement in operational, organizational and relational terms (Zouari and Viale, 2020). Industry 4.0 technologies allow businesses to improve inventory management, achieve inventory optimization, develop remote control systems and achieve in-house communication (Cagle *et al*., 2020).

2.4 The impact of digitalization on HR, administration and finance

The managerial literature on the impact of digitalization on *HR* and *administration and finance* is scant. HR functions have been largely affected by the increasing use of employee-related software, IT-enabled HR functions, social networks and mobile solutions, which has had a positive impact on employee performance (Haque and Nishat, 2022). This impact has been most pronounced in recruitment − many companies now rely for this on Facebook, LinkedIn, Skype, videoconferencing, etc. – and in training processes, where new teaching techniques are employed, such as work-related videos, online courses and computerized learning methods. Moreover, the introduction of AI in HR management has facilitated problem-solving and automation of some processes (Lumi, 2020).

Administration and finance, together with marketing, represent the first two functions to be digitalized in SMEs (OECD, 2021). In addition, digitalization facilitates access to resources (including financial ones such as peer-to-peer lending), employee training, and recruitment channels (including government services), which are increasingly being made available online (OECD, 2021). Digitalization impacts many areas of finance, such as risk identification, measurement and management; fraud detection; wealth management; online transactions; customized bond schemes; customer retention and virtual assistants (Zaytsev *et al*., 2021). AI has a considerable impact on digital financial inclusion by solving the problem of information asymmetry; it also offers customer support and helpdesk service through chatbots, fraud detection and cyber security (Mhlanga, 2020).

2.5 The impact of digitalization on R&D, marketing and sales

With respect to *R&D*, the literature highlights that, in the digital era, innovation processes are gradually being compressed and the phases where customer feedback is collected are being anticipated and enhanced (Agostini *et al*., 2019).

Digital technologies support collaboration, coordination and communication in new product development teams (Nambisan, 2017) and expand the interaction with customers and employees (Bäckström and Lindberg, 2019) thanks to online platforms for collective idea generation and devel-

opment. Thanks to the use of the internet, social media and cloud technologies, open innovation facilitates knowledge sharing, collaboration between companies and consumers; it also encourages open discussions and builds relationships and communities linked by the same needs. For example, artificial reality and augmented reality can increase customer participation in the product design stage (Mourtzis and Doukas, 2012) and in the product development phase of 3D printing with digital design files (Holmstrom and Partanen, 2013).

Digitalization impacts all *marketing* activities (Shkurupska and Litovchenko, 2016; Sunday and Vera, 2018)a substantial number of theories have contributed extensively to information and communication technology (ICT, from informative ones (e.g., analysis of customers and competitors) to strategic ones (market segmentation and brand positioning), as well as marketing tools (Caliskan *et al*., 2021). Artificial intelligence (AI), machine learning, augmented reality, IoT and robotics strongly affect marketing. For example, they allow market-driven approaches that involve formalized techniques to obtain accurate and timely information on customers, markets, products, competitors and the general business environment (Rosário and Dias, 2022). Big data analysis with AI and machine learning (Ardito *et al*., 2019a) first, the authors identify the subset of enabling technologies pertaining to the fourth industrial revolution (Industry 4.0 allows one to discover patterns, classify textual data, give insightful inputs based on customer needs/expectations/trends, and manage segmentation and targeting activities more effectively (Kagermann, 2015). Thanks to these technologies, businesses can develop faster buyer-seller relationships in BtoB and B2B, understand customers' needs, predict their behaviours and respond to their desires (Ardito *et al*., 2019b) first, the authors identify the subset of enabling technologies pertaining to the fourth industrial revolution (Industry 4.0).

Internet-based communication allows consumers to connect instantly with businesses, share feedback and opinions on a product or brand and be directly involved in developing marketing strategies (Cham *et al*., 2022). Company websites, mobile apps and online communication techniques (e.g., search engine marketing, social media, online public relations, display advertising and email marketing (Cham *et al*., 2022; Rosario *et al*., 2022) allow businesses to easily access specific audiences, provide better services to existing customers, attract prospects, develop relationships with customers and improve brand image (Chaffey and Ellis-Chadwick, 2019).

In recent years, digitalization has completely changed *sales,* as the internet now allows businesses to sell and market products and services on e-commerce websites (Rosario et al., 2022). Omnichannel allows customers to receive whatever they want at a preferred time and place. Digitalization influences traditional CRM systems, which have evolved into e-CRM; as

a result, customer relationships are now managed through the internet, web browsers or other electronic touch points (Aluja and Medury, 2010). Due to the reduction in cost for web-based CRM systems, SMEs can access more complex functions, thereby enhancing their ability to communicate and collect information about their customers (Harrigan *et al*., 2011). Furthermore, internet applications have also contributed to strengthening the communication between a company's salespeople and its partners (Hollenbeck *et al*., 2009).

2.6 Research questions

The literature shows that investing in digital technologies improves the efficiency of production processes, maximizes product customization (Bettiol *et al*., 2017), allows for more efficient performances (Agostini et al., 2019), enhances customer-company relationships (Ardito *et al*., 2019; Caliskan *et al*., 2020) and improve brand awareness, generation of leads, loyalty and revenues (Lamberton and Stephen, 2016). In other words, digitalization can influence positively all business functions and thus value creation for both customers and businesses. Our empirical study aims to contribute to analysing the impact of digitalization on the key business functions discussed above and on customer value among SMEs. It asks the following research questions:

RQ1. How do SMEs differ in terms of the impact of digitalization on business functions?

RQ2. How does the impact of digitalization on business functions change according to SMEs' position in the supply chain, as well as their size, sector and revenues?

RQ3. How much does the impact of digitalization on business functions relate to customer value creation according to the entrepreneurs?

3. Methodology

3.1 Tools and data collection

In order to answers the research questions, a survey on a sample of Italian manufacturing companies was conducted. The questionnaire, based on the literature on the digital transformation of business functions, consisted of three parts. The first concern the company's profile: company position in the supply chain (B2C, B2B, mixed B2C and B2B), company size (small and

medium), sector (furniture, textile, mechanics, etc.) and revenues.

The second part aimed to identify the impact of digital technologies on eight business functions (Porter, 1985; Robbins *et* al., 2020; Abecassis-Moedas and Moatti, 2022): R&D, purchasing, production, HR, administration and finance, marketing, sales and customer care, and logistics. Here, the question was "How positive is the impact of digitalization on business functions?"

By positive impact, we mean positive (or successful) effects (or transformations) of the adoption of IT and digital technologies on business functions.

A 7-point Likert scale was used where 1 represented "Not at all positive" and 7 represented "Very positive." The following definition of digitalization (Rüßmann et al., 2015; Pagani and Pardo, 2017; Verhoef *et al*., 2021) was included in the questionnaire before the list of items:

Digitalization is the application of IT or digital technologies (e.g., broadband internet, smartphones, Web 2.0, SEO, cloud computing, speech recognition, online payment systems and cryptocurrencies) that allow the optimization of business processes through more efficient coordination between functions and activities and/or the creation of additional customer value by improving user experiences.

Digital technologies include Industry 4.0 technologies such as (1) autonomous robots, (2) simulation, (3) horizontal and vertical system integration, (4) industrial IoT, (5) cybersecurity, (6) cloud computing, (7) additive manufacturing, (8) augmented reality and (9) big data analytics.

The items used were the business functions with a brief description of some key transformations that may occur through digitalization taken from the literature (Table 1).

Table 1 - Business functions and key transformations due to digitalization

Business functions	**Key transformations due to digitalization**	**References**
R&D	Innovation processes that are better connected to the collection of customer feedback. Use of web-based platforms for collective idea generation and development. Knowledge sharing and collaboration with consumers and customers for open innovation thanks to the use of the internet, social media and cloud technologies. Use of AI and augmented reality for involving customers in the product design stage. Use of 3D printing in the product development phase.	Mourtzis and Doukas, 2012; Holmstrom and Partanen, 2013; Agostini *et al*., 2019.
Purchasing	Use of RPA for procurement in operational, organizational and relational activities. Adoption of Industry 4.0 technologies to improve inventory management, develop remote control systems and achieve in-house communication. Online management and control of inventories, as well as the creation of automatic ordering systems when inventories shorten. Use of virtual reality training to improve inventory management.	Cagle *et al*., 2020; Zouari, 2020.
Production	Adoption of cyber-physical systems and IoT to make machines communicate with each other, collect and analyse data, and evaluate productivity. Use of robotic systems for production processes. Higher flexibility achieved through the creation of small lots at large-scale costs. Greater competitiveness achieved by adopting IoT for more efficient productivity and the reduction of errors and set-up times.	Blanchet *et al*., 2014; Varghese and Tandur, 2014; Brondoni and Zaninotto, 2018; Cagle *et al*., 2020.
Logistics	Reorganization of logistics through the use of the latest cyber-physical solutions. Adoption of Industry 4.0 technologies for reducing transportation costs and unnecessary material flows. Advanced use of data for the reduction of wrong deliveries, excessive waiting times and damaged products. Use of robotic systems to improve logistical operations by remote control in-factory transfers. Storage activities conducted via robotics. Introduction of unmanned transportation vehicles in material transfers.	Kagerman *et al*., 2015; Cagle *et al*., 2020; Grabowska *et al*., 2020.
HR	Increased use of employee-related software and IT-enabled HR functions. Use of social networking sites, such as Facebook, LinkedIn, and use of Skype, for recruitment activities. Use of videoconferencing and related new teaching techniques, such as work-related videos, online courses and computerized learning methods, for employee training. Introduction of AI in HR management processes.	Lumi, 2020; Haque and Nishat, 2022.
Administration and finance	Digitalized access to resources, including financial ones (e.g., peer-to-peer lending). Digitalization adopted for risk identification, fraud detection, cyber security, wealth management, online transactions and customized bond schemes. Introduction of AI for managing information asymmetries. Customer support and helpdesk service provided through chatbots.	Mhlanga, 2020; Zaytstev *et al*., 2020; OECD, 2021.

Marketing	Innovation regarding analytics and predicting consumer behaviour; augmented reality; technologies for faster channel relationships both in B2C and B2B; and online communication techniques, such as SEM, online PR, display advertising and email marketing. Adoption of innovative solutions to easily access specific audiences, provide the best service to existing customers, attract prospects and develop a strong customer relationship and brand image.	Ardito *et al.*, 2019b; Chaffey and Ellis-Chadwick, 2019; Faruk *et al.*, 2021; Rosário and Dias, 2022.
Sales	E-commerce. CRM. Omnichannel strategy. AI for predictive technical assistance.	Cham *et al.*, 2022; Rosario *et al.*, 2022.

Source: authors' elaboration.

The third part of the questionnaire aimed to understand the positive influence of digitalization on customer value from the entrepreneurs' perspective. Respondents were again asked to answer using a 7-point Likert scale.

3.2 Sample and data collection

The surveyed manufacturing companies were selected based on their size (SMEs) and type (both B2C and B2B). Regarding size, we applied the EC upper threshold of 250 employees (EC, 2019b), thus excluding micro-enterprises with fewer than 10 employees, as very small companies lack the resources and skills necessary for digitalization.

A list of 2,705 SMEs in the Marche region of Italy was obtained from the database of the local Chamber of Commerce. The list was stratified by province and included businesses with between 11 and 250 employees, and a turnover of up to 50 million euros. It is representative of the population of companies in the region. The questionnaire was sent to these companies via email from July to October 2020 and a useful sample of 205 questionnaires was used.

3.3 Cluster variables

The sampled companies were classified and described according to fourteen criteria. The first eight variables of the clustering indicate the key business functions according to the adopted conceptual framework: R&D, purchasing, production, administration and finance, HR, marketing, sales and customer care, and (inbound and outbound) logistics and warehouse. The last four variables describe the characteristics of the company's profile, as well as its level of innovation and investment in digitalization:

Company type: B2B, B2C, and mixed B2B and B2C.

Company size: small (10–50 employees) and medium (51–250 employees); medium-sized companies were divided into three sub-categories (51–

100, 101–200 and 201–250 employees).

Sector: metal products, leather and similar articles, textiles and clothing, wood and cork, rubber and plastic articles, mineral products, food industry, furniture, computers and electrotechnics, and electronics.

Revenues: five discrete categories calculated in millions of euros (< 1, 1–4, 5–9.9, 10–49.9, > 50).

3.4 Tandem approach for clustering: a pure data-driven view of opinion data

The tandem approach to cluster analysis was the classic and well-known strategy adopted for the clustering of respondents' opinions (Aluja *et al*., 1999). In the sequential (tandem) approach, the analyst can apply a dimension reduction technique and then subject the low-dimensional orthogonal solution to a clustering algorithm (Lebart *et al*., 1984).

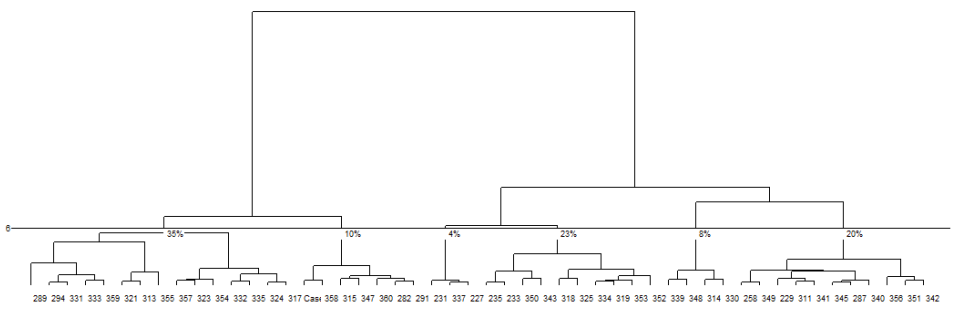
In our paper, the tandem strategy was applied to the answers given to the eight items, which represent as many business activities, on which digital technologies could have had an impact. Diagonalizing the data matrix by using principal component analysis and studying the structure of correlations generated by the respondents relating to the eight items were performed.

A new scale (between -1 and +1) was adopted to reduce bias generate by the subjective use of the scale adopted in the survey.

The importance of the size effect was very strong and emerged from the first principal component, which was correlated to the individual average value for a correlation coefficient that reached 0.9998.

After the size effect was removed and the tandem approach to the new opinion variables was adopted, the dendrogram in Figure I was obtained. Using the finest of the three possible tree-cut levels, six clusters of companies were generated. Multivariate analysis indicated that statistically significant differences existed between the six clusters.

Figure 1. Dendrogram of the hierarchical cluster analysis using the Ward linkage



Source: authors' elaboration.

A statistical description of each of the clusters, using both the variables that algorithmically determined the clustering (active variables) and the descriptors listed above (illustrative variables) was presented. The statistical technique of description is based on the calculation of an adequate test value to measure the probability that the difference between the single cluster and the entire sample is random. We used the t-test for the quantitative variables while for the characterization provided by the single categories of a qualitative variable, a hypergeometric distribution penalized with the dimensions of the single cluster was used (Lebart *et al*., 1984).

4. Findings

4.1. Sample characteristics and descriptive statistics

The sample consists of 205 manufacturing companies from the Marche region and is stratified by company size and province. Table 2 shows the distribution of companies by type (B2B, B2C, and mixed B2C and B2B), size and sector.

Table 2. Sample charactetistics

Company Type		
	N	%
B2B	127	62
B2C	19	9
Mixed B2C and B2B	59	29
Company Size		
Small (11–50 employees)	126	61
Medium (51–100 employees)	55	27
Medium (101–200 employees)	20	10
Medium (201–250 employees)	4	2
Sector		
Metal	33	16
Leather	22	11
Textiles and clothing	19	9
Wood and cork	17	8
Rubber and plastic	15	7
Minerals	15	7
Food	15	7
Furniture	13	6

Computers and electronics	qui	5
Electrical appliances	11	5
Other	25	3
Revenue (million euros)		
< 1	25	12
1–4.9	77	38
5–9.9	34	17
10–49.9	61	30
> 50	8	4
		N = 205

Source: authors' elaboration.

Table 3 shows that the impact of digitalization is about 4 (mean value) on a 1-7 Likert scale and that the gaps between the business functions are slight in the perspective of entrepreneurs. However, marketing, administration and finance, sales perform the highest impact of digitalization on business functions while HR, production and logistics show the lowest impact.

Table 3 – Impact of digitalization on business functions (descriptive statistics)

Business function	Mean (scale 1-7)	Standard Deviation
Purchasing	4.317	1.832
R&D	4.185	1.927
Administration and Finance	4.532	1.760
HR	3.756	1.813
Production	3.980	1.853
Marketing	4.805	1.931
Sales	4.395	2.011
Logistics	4.020	1.970

4.2. Classification of the manufacturing companies through hierarchical cluster analysis

Six different groups of manufacturing companies (Appendix 1) were identified. The table 4 shows the values of the t-test adjusted by the adoption as a hypothesis the simultaneous random extraction of the respondents in a cluster. To put it in other words, equality between the judgment expressed on the single item by the specific cluster and that expressed on average by the entire sample. For test values greater than about 2, the probability that a difference has been observed between the cluster and the sample tends to zero. Hence, that item significantly characterizes (positively or negatively) the cluster (Lebart *et al*., 1984).

Table 4. A synthesis of the cluster analysis results

Variable	**Cluster 1** Smart production, HR and administration factories	**Cluster 2** The smartest factories	**Cluster 3** The most digitalized companies	**Cluster 4** Digitalized sellers and marketers	**Cluster 5** Digitalized marketers and administrators	**Cluster 6** The most digitalized marketers, R&D and sellers
Purchasing	2.76	-4.55	3.05	3.70	-0.20	-5.09
R&D	-5.10	1.54	3.08	1.61	-5.24	5.31
Production	3.96	4.40	-0.37	-1.10	-4.19	-3.71
Administration and finance	3.10	-3.82	3.03	-0.86	2.75	-3.29
HR	3.43	-1.85	4.74	-6.30	1.75	0.41
Logistics	2.86	1.25	0.31	3.55	-4.60	-4.99
Marketing	-8.64	-4.70	2.43	4.56	2.67	5.91
Sales	-6.37	-4.09	3.16	4.90	-1.66	5.04

Source: authors' elaboration.

Six clusters created with the eight active variables are presented in detail in Appendix 1. The following Table 5 identifies the categorical descriptive variables of each cluster according to a probabilistic ranking criterion.

Table 5. Synthesis of the cluster analysis results (categorical descriptive variables with a significance level greater than 90%)

Cluster	Variable	Characteristic category	Test-value
Cluster 1	Sector	Transport means	1.65
	Revenue (million euros)	1,000,000–4,999,999	1.63
	Company type	B2B	1.37
	Sector	Other products deriving from the processing of non-metallic minerals	1.29
Cluster 2	Sector	Textiles	2.02
	Company size	Small (11–50)	1.58
	Revenue	500,000–999,999	1.41
Cluster 3	Sector	Computers and electronics	1.54
	Revenue	5,000,000–9,999,999	1.36
	Sector	Food industry	1.31
Cluster 4	Company type	B2C and B2B	1.80
Cluster 5	Company type	B2B	1.57
Cluster 6	Company type	B2C and B2B	1.66

Source: authors' elaboration.

Further, an analysis of variance (regression with zero-sum parameters) was performed to validate the hypothesis that entrepreneurs' opinions concerning the importance of digital tools in creating value for customers depend on which of the six clusters the company belongs to. The regression performs a goodness-of-fit index of 16% and the F-test of simultaneous nullity of the parameters has a p-value of less than 0.01 (Table 6). The estimation method adopted the zero-sum parameter approach. Each parameter is either the positive or negative difference from the baseline, which is the average judgment detected in the whole sample on a scale of 1 to 7 compared to the increase in value for the customer.

Table 6 - The impact of digitalization on customer value

Parameter label	Coefficient	Standard deviation	P-value	Test-value
Cluster 3	1.0915	0.515	0.035	2.11
Cluster 6	0.2522	0.264	0.340	0.95
Cluster 4	-0.0229	0.254	0.928	-0.09
Cluster 5	-0.0629	0.370	0.865	-0.17
Cluster 2	-0.5835	0.347	0.094	-1.68
Cluster 1	-0.6744	0.225	0.003	-2.96
Constant	5.5335	0.154	0.000	20.02

Source: authors' elaboration.

The individual clusters based on the active variables or the business functions will be described below. These descriptions are enriched with the information obtained from the four descriptive variables relating to the company's characteristics (size, type, sector and revenues). The impact of digitalization on customer value was also reported for each cluster.

Cluster 1 – Smart production, HR and administration factories

The first and largest cluster represents 35% of the sample ($n = 71$). It was named "Smart production, HR and administration factories" as the impact of digital technologies in this cluster is significant above average on production (3.96), HR (3.43), administration and finance (3.10), logistics (2.86) and purchasing (2.76). The impact on the remaining functions is significant below average: marketing (-8.64), sales (-6.37) and R&D (-5.10). Companies with the following characteristics prevail in the cluster: B2B, transport vehicles and metallurgical products, and revenues between 1 and 5 million euros. The impact of digitalization on value creation for customers from the entrepreneur's perspective is the lowest in the sample (-2.96).

Cluster 2 – The smartest factories

The second cluster is much smaller and represents 10% of the sample (n = 20). It is the cluster in which digitalization has the biggest above-average significant impact on production (4.40). The impact on R&D is also above average but not significant. Four functions have a significant below-average impact on marketing (-4.70), purchasing (-4.55), sales (-4.09), and administration and finance (-3.82). The following company characteristics prevail in this cluster: textile sector, small companies, and revenues between 500,000 and 1 million euros. The impact of digitalization on customer value according to the respondents is the lowest (-1.68) in the sample after Cluster 1.

Cluster 3 – The most digitalized companies

Cluster 3 is the smallest as it accounts for 4% of the sample (n = 8). It is the cluster with the highest positive impact of digitalization on business functions – above average for all the functions except production. In particular, the impact is significant and above average for HR (4.74), sales (3.16), R&D (3.08), purchasing (3.05), administration and finance (3.03), and marketing (2.43), while it is below average for production. Hence, we labelled this cluster "The most digitalized companies". With respect to the entire sample, the prevalent company characteristics are the following: food industry, computers and revenues between 5 and 10 million euros. For the respondents in this cluster, digitalization has the biggest above-average impact (2.11) on value creation for customers.

Cluster 4 – Digitalized sellers and marketers

The fourth cluster represents 23% of the sample (n = 47) and was labelled "Digitalized sellers and marketers" as the positive impact of digitalization is significant and above average for sales (4.90), marketing (4.56), purchasing (3.70) and logistics (3.55); it is above average for R&D. The remaining functions have negative values, especially a significant below-average impact on HR (-6.30) and a below-average impact on production and administration and finance. In this cluster, the mixed B2C and B2B company types and companies investing up to 30% in digital communication prevail. Sector and company size are not statistically significant. Digitalization impacts value creation slightly above the average (-0.09).

Cluster 5 – Digitalized administrators and marketers

Cluster 5 represents 8% of the entire sample (n = 17). Digitalization has a significant above-average impact on administration and finance (2.75)

and marketing (2.67) and an above-average impact on HR. This is why we called this cluster "Digital administrators and marketers." The impact of digitalization is significant and below average on R&D (-5.24), logistics (-4.60) and production (-4.19) and below average for sales and purchasing. Mixed B2C and B2B companies prevail, while sector and company size are not statistically significant. Finally, the impact of digitalization on customer value is above average (-0.17).

Cluster 6 – The most digitized marketers, R&D and sellers

Finally, Cluster 6 represents 20% of the sample ($n = 42$) and was named "The most digitalized marketers, R&D and sellers" because the impact of digitalization in the cluster is significant and above average for marketing (5.91), R&D (5.31) and sales (5.04). HR shows an above-average positive impact. The four remaining functions show a significant and below-average impact of digitalization: purchasing (-5.09), logistics (-4.99), production (-3.71) and administration and finance (-3.29). In this cluster, sector and company size are not statistically significant variables, while mixed B2C and B2B enterprises and enterprises investing more than 50% of their communications budget in digital communication are prevalent. Finally, after those of Cluster 3, these companies declare the strongest confidence (0.95) regarding the impact of digitalization on customer value.

5. Discussion

By adopting a broad perspective, this study has offered an initial empirical contribution to the research on the impact of digitalization on all the business functions of SMEs. This is an understudied topic in the management literature. Quantitative empirical studies are more focused on large companies (Arnold *et al*., 2016; Chavez *et al*, 2020; Radziwon *et al*., 2020), and broad perspectives are still rare in innovation studies (e.g., Caliskan *et al*., 2021; Teng et al., 2022; Zimani, 2022). Furthermore, this study explores another interesting and poorly investigated topic in the literature: how business functions relate to digitalization and customer value from the entrepreneurial perspective. Descriptive statistics show that the average value of the impact of digitalization on business functions is around 4 (in a 1-7 Likert scale) and that the gaps between busienss functions are slight, in the perspective of entrepreneurs. From the analysis, six clusters of companies were identified, highlighting the heterogeneous impact of digitalization on the business functions of SMEs.

Even though every cluster is different, three groups share some similarities. One group can be defined as "Smart factories" (Clusters 1 and 2) to

indicate that digitalization, in the perception of the respondents, has a significant, above-average impact on production and a significant, below-average impact on marketing. In both clusters, which include about half of the sample, the impact on logistics is above average. Regarding purchasing, in Cluster 1 the impact is above average, while in Cluster 2 it is below average.

The second group, labelled "Digital marketers" (Clusters 4, 5 and 6), consists of companies that, in the perception of the respondents, are characterized by above average and significant impact of the internet and digital technologies on marketing and significantly below average impact on production. In Clusters 4 and 6, digitalization has a significant impact on both marketing and sales, though in Cluster 6 the impact is higher and more significant. In Clusters 4 and 6, the impact on administration and finance is below average, but Cluster 4 shows a below-average and significant impact on HR, while in Cluster 6 this is the case for logistics and purchasing. Cluster 5 is a hybrid cluster because marketing and administration/finance are the most digitalized functions but sales have a below-average impact.

The third group contains only Cluster 3. This is characterized by eight companies that are highly above average digitalized in all functions; therefore, it has been termed "The highly digitalized companies."

The results of this study paint a heterogeneous picture. Only a niche of SMEs is above average digitalized, and digitalization impacts mostly (half of the sample) production and logistics; purchasing is impacted only occasionally. In the other half of the sample, digitalization impacts marketing and sales.

The "smart factories" have mainly digitalized the upstream activities of the value chain, while maintaining a traditional approach to communicating and distributing products. On the contrary, the "digital marketers" have mainly digitalized the downstream functions, while production has not improved in terms of the recent advances in digital technology.

This result is in line with the literature on Italian SMEs, according to which the digital transformation of SMEs is ongoing and incomplete (Bettiol *et al*., 2017; Cucculelli *et al*., 2019; Osservatori.net, 2022; OECD, 2021).

Although digitalization is a great opportunity, this study shows that most companies approach digitalization with caution (Mueller *et al*., 2018) most probably because of a lack of managerial vision and resources (Moeuf *et al*., 2017; Uberbacher *et al*. 2020) or an unclear understanding of its potential benefits (Pfister and Lehman, 2021). Other possible interpretations of a low level of digitalization of the companies examined may be a lack of culture or strategies in the use of digital technologies (Pencarelli et al., 2019). Further, it seems that the entrepreneur may play a key role in the adoption of digital technologies, since he recognizes their importance even if he/she does not know the technology (Pencarelli et al., 2015).

Another significant result of this study concerns the relationship between digitalization, business functions and customer value. According to the entrepreneurs of the "Smart factories" group (Clusters 1 and 2), the impact of digitalization on customer value is low, which reveals a clear focus on efficiency. This cannot necessarily be related to competitiveness, if it is aimed at increasing profits. In the second group, "Digital marketers" (Clusters 4, 5 and 6), the impact on customer value is considered high, especially in Cluster 6, whose companies have invested in digital marketing and sales; however, these businesses remain somewhat traditional with regard to production activities.

The fact that the companies which are more oriented towards digital innovation in downstream activities report increased customer value as a result of digitalization is consistent with the attention paid to demand needs and how they can be accommodated. This reveals a marketing orientation that the "Smart factories" group has not yet acquired, with a consequent approach to technology and more broadly to innovation that is guided more by the technology itself than by real attention to the market. This result also confirms the opinion of most scholars, who underline the positive relationship between digitalization of marketing activities and performance (e.g., Bettiol *et al*., 2017; Rosario *et al*., 2022) and consequently the positive influence on value for customers and companies.

6. Conclusions

The results of descriptive statistics show that the average value of the impact of digitalization on business functions is around 4 (in a 1-7 Likert scale) and that the gap between business functions is slight, in the perspective of entrepreneurs.

The results of the hierarchical cluster analysis show an uneven picture. On one hand, there are companies that are very focused on the digitalization of manufacturing processes and all related activities (logistics, purchasing, etc.), with an apparent orientation towards efficiency and profit rather than competitiveness and market development. On the other hand, there are companies that are more focused on digital innovation in marketing and sales, which pay attention above all to the ability to interact effectively with customers and strengthen their position in the market. Only a small number of businesses showed a balanced digitalization of all functions.

Our empirical investigation has also highlighted that a series of differentiation variables must be considered when trying to understand the impact of digitalization, such as size, sector and type of market (B2C or B2B). These variables allow for better segmentation of the complex world of SMEs and invite us to reject homogenizing analyses.

In terms of managerial implications, this study suggests the need for a balanced introduction of digitalization into all company functions; this is the only way to fully exploit the advantages of the digital revolution. Data management and digitalized processes must be equally developed in all the business functions to ensure integration of all the activities of the value chain, both internal and external ones (upstream and downstream). The strategy to be used to bring about this change in companies must primarily leverage elements of managerial culture. Therefore, training aimed at improving the specialist skills present in a company is required, since the lack of these skills often prevents having an integrated vision of the processes. Furthermore, when hiring staff, businesses must look at profiles characterized by the most varied and transversal skills and experiences to more easily allow for cross-fertilization of the different company areas. It is also important for firms to cooperate with external experts in digital technologies (e.g. web agencies) who may contribute to create a favourable environment for employees and facilitate the adoption of adequate digital technologies. Further, to favour digitalization of business functions, adequate software and hardware should be included to upgrade the existing software and hardware systems.

This study is exploratory in nature and the main limitation consists in the small size of the sample and the geographic origin of the companies which do not allow generalizability. Future research in this area should look at different countries. Another limitation is that the business functions may not have been clearly identified in SMEs, and several interviewees may lack adequate awareness of the frontiers of digital innovation. Although a definition of digitalization and examples of the impact of digitalization on business functions were provided, entrepreneurs' answers were highly subjective, and the items in the questionnaire could have been understood and interpreted differently by entrepreneurs based on their managerial and digital cultures. Therefore, future studies should improve the research protocol to guide entrepreneurs' responses more effectively and try to minimize the subjectivity resulting from different perceptions of the company's level of digitalization.

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Appendix 1 – Characterization by continuous variables of the tree's cut "a" clusters into six clusters (90% significance level).

CLUSTER 1 (Weight = 71.00 Count = 71)						
Characteristic variables	**Cluster mean**	**Overall mean**	**Cluster Std. deviation**	**Overall Std. deviation**	**Test-value**	**Probability**
Production	0.150	-0.149	0.675	0.785	3.96	0.000
HR	0.008	-0.241	0.694	0.754	3.43	0.000
Administration and Finance	0.408	0.174	0.633	0.785	3.10	0.001
Logistics	0.134	-0.087	0.699	0.804	2.86	0.002
Purchasing	0.254	0.060	0.574	0.730	2.76	0.003
R&D	-0.339	0.030	0.529	0.751	-5.10	0.000
Sales	-0.343	0.138	0.588	0.786	-6.37	0.000
Marketing	-0.238	0.376	0.592	0.740	-8.64	0.000

CLUSTER 2 (Weight = 20.00 Count = 20)						
Characteristic variables	**Cluster mean**	**Overall mean**	**Cluster Std. deviation**	**Overall Std. deviation**	**Test-value**	**Probability**
Production	0.587	-0.149	0.662	0.785	4.40	0.000
R&D	0.276	0.030	0.790	0.751	1.54	0.062
Logistics	0.126	-0.087	0.785	0.804	1.25	0.106
HR	-0.537	-0.241	0.735	0.754	-1.85	0.032
Administration and Finance	-0.464	0.174	0.596	0.785	-3.82	0.000
Sales	-0.547	0.138	0.690	0.786	-4.09	0.000
Purchasing	-0.647	0.060	0.419	0.730	-4.55	0.000
Marketing	-0.364	0.376	0.691	0.740	-4.70	0.000

CLUSTER 3 (Weight =8.00 Count =8)						
Characteristic variables	**Cluster mean**	**Overall mean**	**Cluster Std. deviation**	**Overall Std. deviation**	**Test-value**	**Probability**
HR	1.000	-0.241	0.000	0.754	4.74	0.000
Sales	1.000	0.138	0.000	0.786	3.16	0.001
R&D	0.833	0.030	0.441	0.751	3.08	0.001

Purchasing	0.833	0.060	0.441	0.730	3.05	0.001
Administration and Finance	1.000	0.174	0.000	0.785	3.03	0.001
Marketing	1.000	0.376	0.000	0.740	2.43	0.008
Logistics	0.000	-0.087	1.000	0.804	0.31	0.378
Production	-0.250	-0.149	0.968	0.785	-0.37	0.355

CLUSTER 4 (Weight = 47.00 Count = 47)						
Characteristic variables	**Cluster mean**	**Overall mean**	**Cluster Std. deviation**	**Overall Std. deviation**	**Test-value**	**Probability**
Sales	0.632	0.138	0.553	0.786	4.90	0.000
Marketing	0.809	0.376	0.394	0.740	4.56	0.000
Purchasing	0.407	0.060	0.660	0.730	3.70	0.000
Logistics	0.279	-0.087	0.689	0.804	3.55	0.000
R&D	0.185	0.030	0.686	0.751	1.61	0.054
Administration and Finance	0.087	0.174	0.771	0.785	-0.86	0.196
Production	-0.260	-0.149	0.707	0.785	-1.10	0.136
HR	-0.850	-0.241	0.284	0.754	-6.30	0.000

CLUSTER 5 (Weight = 17.00 Count = 17)						
Characteristic variables	**Cluster mean**	**Overall mean**	**Cluster Std. deviation**	**Overall Std. deviation**	**Test-value**	**Probability**
Administration and Finance	0.676	0.174	0.579	0.785	2.75	0.003
Marketing	0.835	0.376	0.301	0.740	2.67	0.004
HR	0.067	-0.241	0.782	0.754	1.75	0.040
Purchasing	0.026	0.060	0.709	0.730	-0.20	0.420
Sales	-0.166	0.138	0.712	0.786	-1.66	0.048
Production	-0.915	-0.149	0.251	0.785	-4.19	0.000
Logistics	-0.948	-0.087	0.209	0.804	-4.60	0.000
R&D	-0.886	0.030	0.253	0.751	-5.24	0.000

CLUSTER 6 (Weight = 42.00 Count = 42)						
Characteristic variables	**Cluster mean**	**Overall mean**	**Cluster Std. deviation**	**Overall Std. deviation**	**Test-value**	**Probability**
Marketing	0.979	0.376	0.097	0.740	5.91	0.000
R&D	0.581	0.030	0.587	0.751	5.31	0.000
Sales	0.684	0.138	0.539	0.786	5.04	0.000
HR	-0.198	-0.241	0.685	0.754	0.41	0.342
Administration and Finance	-0.182	0.174	0.840	0.785	-3.29	0.001
Production	-0.551	-0.149	0.667	0.785	-3.71	0.000
Logistics	-0.640	-0.087	0.657	0.804	-4.99	0.000
Purchasing	-0.453	0.060	0.648	0.730	-5.09	0.000