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PRODUCT CONFIGURATION IN SMES: GO DIGITAL?

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Abstract: *It is widely known that several manufacturing small and medium enterprises (SMEs) do customize the products they offer, being this a way to get their place in the market competition. There are examples of successful applications of product configurators in SMEs, even in quite small ones. However, we do not know the extent of the presence, in SMEs, of the various product configuration activities or the intensity of their digitalization. The present study provides further insights into product configuration activities in SMEs by studying a sample of Italian SMEs. It emerges that configuration activities are frequently present in manufacturing SMEs and that there is high potential for their digitalization.*

Key Words: ***Mass Customization, Digitalization, SME, Survey***

1. INTRODUCTION

In the last decades more and more customers require products that closely satisfy their specific needs, leading to an increase in product variety and customization by the companies (e.g., [1, 2, 3, 4]). Consequently, even manufacturing small and medium enterprises (SMEs) must offer product variety and customization to obtain and maintain their competitive position in the current market [5].

Offering product variety and customization implies a number of peculiar activities (e.g. those of the configuration process) and in general, augments the complexity the companies have to deal with. The management of product variety and customization is facilitated by the use of some supportive software applications (e.g., Product Data Management [PDM], Customer Relationship Management [CRM], and product configurators) [6]. Implementation of these kinds of software applications is often referred to as digitalization in recent literature (e.g., [7, 8]). For SMEs, it is often difficult to adopt and subsequently maintain such a kind of software applications due to the lack of financial resources and scarcity of both IT staff and other specialists (e.g., [9, 10]).

The literature provides a few examples of successful implementation of product configurators even in small SMEs (e.g., [11, 12]). However, besides sparse examples, we do not have information on the extent of the various product configuration activities in SMEs. Moreover, the intensity of digitalization of these configuration activities in SMEs remains unknown. Consequently, researchers do not know whether SMEs are a business context where configurators are diffusely adopted or have the potential to be diffusely adopted. For researchers this is important information to get because SMEs are a context with peculiar characteristics, for example, their improvement initiatives towards mass customization are constrained by limited human and financial resources [13]. If configuration activities are heavily diffused across SMEs then it becomes important to investigate the digitalization of the configuration process and in particular the application of configurators because configurators have shown a capability to support great improvements in the configuration process. If the application of configurators in these SMEs is limited then it is necessary to investigate why it is so. Eventually, this investigation will discover that it is needed to develop configurators that better fit SMEs' characteristics or that it is needed to push the advancements of other mass customization enablers that favor the application of configurators, such as part standardization and product modularity [13]. Altogether, these research efforts could support the development of mass customization implementation guidelines specific to SMEs and the technological development of configurators more suitable for SMEs.

The present study's objective is to gain more insights into product configuration activities, namely: the extent of their presence in the SMEs, and the intensity of their digitalization.

Preliminary results show that configuration activities are frequently present in manufacturing SMEs. Furthermore, although the current level of digitalization is not negligible, the companies have shown significant intention to further develop their digitalization, especially in some specific configuration activities.

The rest of the paper is organized into five sections. Section 2 presents a review of the relevant literature. Section 3 provides details of the method used for gathering information and describes the sample, while section 4 reports the results of the study. Finally, Section 5 discusses the results and provides suggestions for future research.

2. THEORETICAL BACKGROUND

The configuration process is frequently present in companies that offer high product variety. It includes

"the set of activities from the collection of information about customer needs to the release of the product documentation necessary to produce the requested product variant" [6: p. 143]. The configuration process generally includes several configurational activities that refer to three main groups: characteristics specification, component association, and configured product evaluation (e.g., [14, 15]). Please consider that these activities can be done with different sequences. In addition, there could be recycled so that both customers and company personnel can go through these (or some of these) activities several times before arriving at a customer order or even before arriving at a quotation.

The first group of the configuration activities regards the specification of product characteristics appropriate for a given customer. It includes the communication of options to the customers either in reply to their enquiries or as a proactive initiative of a salesperson or a sales application. The customers select the characteristics that satisfy their needs, and their choices are collected and stored. The selection of product characteristics can be performed with the help of sales personnel or independently by the customers [16]. In both cases, it is necessary not only to collect all the needed product specifications but also assuring they are compatible [11]. This compatibility assurance ideally should be performed while customers are choosing their product characteristics, however, if it is not possible it can be done in a second moment but in case of incompatibilities, the customers may be called to reconsider their choices. Sometimes this specification process leads to one or more product characteristics that are not already predefined by the company. In this case, the offered product space may be enlarged to satisfy the request for the new product variant that was not included in the existing product space.

The configuration activities of the second group, component association, aim to identify the necessary product components that fulfil the product characteristics chosen by the customer and to establish relationships among these identified components. These configurational activities eventually (e.g. in the case of a new product characteristic) need to identify components that are not already predefined by the company: this is at the borderline of the scope of the configuration notion. Consequently, ad-hoc engineering of new components is required [11].

Finally, the third group, configured product evaluation, concerns the evaluation of compatibility of all selected components and goal satisfaction (i.e. whether the configured product satisfies customers' needs including also their time and economic constraints) [14]. Notably, configured product evaluation can result in a need to change the original selection of characteristics and/or ad-hoc engineering. Once the necessary components and the relationships between them have been determined, operative instructions for product variant manufacturing are generated. Actually, the company may find alternative ways in terms of components and production sequences that satisfy a given customer request with different impacts on costs and delivery lead times. The price determination is usually included in the configuration process and it is a crucial product evaluation information for the customer. Sometimes, also the delivery lead-time is considered or partially considered. Therefore, the configuration process can include the determination of terms of delivery, a description of the product or service (e.g., technical drawings, charts, images, user manual), and other aspects some of which are useful for the product evaluation.

Notably, the configurational activities used can differ across companies [11], and, as a consequence, the outputs generated by these activities can vary among companies. Specifically, the configuration process may result in all or some of the following outputs: quotation letter with price [11]; product cost [17]; product code (e.g., [18, 12]); bill of materials (e.g., [18, 17]); production cycle (e.g., [19, 20]); technical drawings (e.g., [21, 22]); product image [23]; or usage manuals [21].

3. METHOD AND SAMPLE DESCRIPTION

3.1. Method

To gather the information from SMEs, we developed a questionnaire with several sections each one dedicated to a specific set of issues. This questionnaire starts with the overall company characteristics such as number of employees. Then it considers the main company commercial and operative characteristics such as kind of customers and modality to answer to the market. Subsequently, it asks information on the company ability to fulfill personalized orders, considering both the performances that define this ability and the enablers that underpin this ability. Arrived at this point, the context of interest is clear, so the questionnaire passes to the issue of digitalization. First, it asks some brief information on the overall digitalization of the company such as presence of Enterprise Resource Planning (ERP), commercial presence on the web, Customer Relationship Management (CRM) and use of Product Data Management (PDM)/Product Lifecycle Management (PLM). Finally, it goes into detail on the configuration activities and on their digitalization. Notably, the present paper focuses on these configuration activities and their digitalization; however, it uses also some information on the overall digitalization of the company and, in order to describe the sample and specify the context, some information on the overall company characteristics and its commercial and operative context.

The questionnaire was designed to be completed by one respondent with overall knowledge of the company during one-on-one meetings with the company's representative. If he/she had not all the information needed other informants were contacted by the respondent to collect the needed information.

The questions used to collect the needed information are provided in Tables 2-8 which report the results of the study. This decision was made to facilitate the reading of this paper.

The answers provided during the interview underwent a first check during the same interview. However, this control has been a light one since the presence of the interviewer was thought mainly to get answers as complete as possible. Challenging too much

the respondent would have been counterproductive. We performed a more accurate control in a second moment. This check highlighted issues of missing data and some possible issues of coherence between answers. We excluded from the present article questions that had observations with possible coherence issues. Instead, we included questions with some missing observations. We planned a second interaction with respondents to control the potential coherence issues and issues related to missing information. In most cases, we had the possibility to go back to companies to complete for missing data and to check for incoherent data. This control activity improved the data quality. However, the overall figure emerging from the data analysis was not significantly modified by this cleaning activity. Unfortunately, for the companies with several missing data the questionnaire resulted to be not enough informative for our analysis and consequently it has been left out. The remaining 85 questionnaires have been analysed. The questionnaires with enough information on the digitalization of configuration activities were 73.

3.2. Sample description

3.2.1 Company size

According to the European commission classification, all companies in our sample are SMEs (i.e., they have fewer than 250 employees, see Table 1). More precisely, the data reported in Table 1 show that 71% of the companies are defined as small companies (fewer than 50 employees), and 29% are medium companies.

Table 1. *Company size*

Number of employees	Number. of companies	Percentage of companies
<10	9	11%
10–50	51	60%
51–250	25	29%
TOTAL	85	100%

3.2.2 Kind of customers and distribution channels

The companies in our sample include both companies that sell products for final consumers' use (Business to Customers – B2C) and companies that offer products for industrial applications (Business to Business – B2B). However, in the sample there is a big prevalence of B2B business: Table 2 shows that roughly two-thirds of the business of the considered companies if business B2B.

Table 2. *Turnover split*

How is your turnover split?	Sample mean (%)
% Products for final customers	**31.2**
% sold directly to final consumers	15.4
% sold through commercial intermediaries	15.8
% Products for business customers	**68.7**
% sold directly to final business clients	52.3
% sold through commercial intermediaries	16.4

In our sample sales are done both directly to customers and through intermediaries. The data reported in Table 2 indicate that the turnover derives mostly from direct selling, and that only one-third of it is realized through intermediaries. However, while in the B2C it is equally split between direct selling and intermediaries in the B2B there it is mainly obtained through direct selling.

3.2.3 Degree of customization

When determining the customization degree (Table 3), the respondents were asked to indicate the percentage of the product orders for which:

- the customer asked for new functionalities that required ad-hoc design,
- the customer chose by combining predefined options present in the catalog without asking for new functionalities,
- the customer found the final product already completely defined in the catalog.

Table 3. *Customization degree*

Which percentages of customer orders belong to the following categories?	% of companies that stay in the following range:					Sample mean (%)
	0%	1%–24%	25%–49%	50%–74%	75%–100%	
Product orders for which the customer asked for new functionalities that required ad–hoc design	18.3	32.4	9.9	9.9	29.6	38.3
Product orders for which the customer chose by combining predefined options present in the catalogue without asking for new functionalities	26.5	32.4	19.1	10.3	11.8	26.5
Product orders for which the customer found the final product already completely defined in the catalogue	29.2	27.7	6.1	12.3	24.6	35.1

The results reported in Table 3 indicate that:

- 82% of the companies receive orders with some functionality to be designed ad hoc. In particular, 40% of the companies receive more than half of the orders with functionality to be designed ad hoc;

• 74% of the companies receive orders with a choice of options. However, only 22% of the companies have more than or equal to 50% of orders with products chosen as a combination of options in the catalog;

• 29% of the companies have no orders with final products already defined in the catalog.

The fact that 82% of sampled SMEs have engineer to order (ETO), whereas only 74% have some configure to order (CTO) (and only 22% have CTO in more than or equal to 50% of their orders and only 12% is CTO for more than or equal to 75% of their orders) does not threaten the validity of our sample for studying the product configuration practice. This is for two reasons. The first one is that an ETO company could redesign its product space to increase the use of CTO: sometimes even the introduction of configurators helps to reduce the percentage of ETO orders. Second, the application of a configurator can improve also the configuration activities in an ETO process. The notion of partial configurability introduced by Forza and Salvador [11] supports this point. Let us take for example the request of a machine with one feature to be engineered to order and all other features that are chosen from a predefined list. In this case, a configurator could produce automatically an incomplete bill of material and calculate the cost related to the part of the bill of material automatically generated. Obviously, the configuration process cannot be completed automatically; however, the gains in cost, time, and quality can be huge. An example of such a configurator is provided by [24].

3.2.4. Modality of response to customer demand

When determining the modality of response to customer demand (Table 4), the respondents were asked to indicate the percentage of the customer orders:

• that pass through the technical/R&D department for a technical control or for design activities,

• fulfilled with products made based on the sales forecast (and not "to order").

The results reported in Table 4 indicate that on average:

• 65% of orders go through the technical office. Therefore, compared with Table 3 it emerges that almost all of them are orders with new functions or orders with combinations of predefined options.

• 31.8% of orders are fulfilled from stocks and, therefore, do not involve production. By comparing with Table 3 it emerges that out of 35% of orders of final products already defined in the catalog, 32% are made on forecast, and 3% are made on order.

The comparison of figures reported in Table 4 with figures reported in Table 3 shows that both configured and catalogue products do pass through the technical office. This seems a suspect discrepancy but it is not. While it is justifiable for configured products in absence of a configurator, it seems not justifiable for products completely defined on the catalogue. However, as reported by Forza and Salvador [7], it could be that all orders pass through the technical office because a note on an order for a standard product could lead to a change in the product and more specifically could lead even to an ad hoc engineered product. This is an organizational solution taken to address the limited individual technical competencies of sales personnel and the willingness to deliver quality to the customer.

Table 4. *Activities included in order fulfillment*

Which percentages of customer orders belong to the following categories?	**% of companies that stay in the following range:**					**Sample mean %**
	0%	**1%–24%**	**25%–49%**	**50%–74%**	**75%–100%**	
Customer orders that pass through the technical/R&D department for a technical control or for design activities	6.6	24.6	1.6	8.2	59	65.0
Customer orders fulfilled with products made on sales forecast (and not "to order")	42.6	19.7	4.9	4.9	27.9	31.8

Furthermore, the fact that 65% of orders go through the technical office while only 38% of orders have new functions indicates that on average 27% of the orders are processed by the technical office while with the use of a configurator with appropriate functionalities they could skip this office gaining in cost and answering time. This is a conservative figure of the potential applicability of configurators in the considered sample because if we consider the possibility to manage partial configurability for sure the potential of applications are much greater.

4. RESULTS

4.1. Presence of activities

In the questionnaire 11 configuration activities have been proposed, namely: selecting product characteristics [11, 24], determining price [11], generating the bill of material [11, 17, 18 24], generating the production cycle [11, 19, 20], determining the cost [11, 17], generating technical drawings [11, 21, 22], providing a product image (rendering, photo, sketch) [11, 23], generating a product code [11, 12, 18, 24], providing usage instructions [11, 21], specifying characteristics that are not predefined [11, 24], and identifying components that need ad hoc engineering [11, 24]. The answers provided for each one of these 11 configuration activities are summarized in Figure 1. It emerges that each one of them is present, on average, in 67% of the companies that gave a response.

Figure 1 shows that all participating companies specified that they perform the "Selecting the product/service characteristics/functionalities appropriate for the customer" task and determine the price during the configuration activity. Furthermore, more than 70% of companies answered that they determine cost and price and generate a bill of materials during the configuration activity.

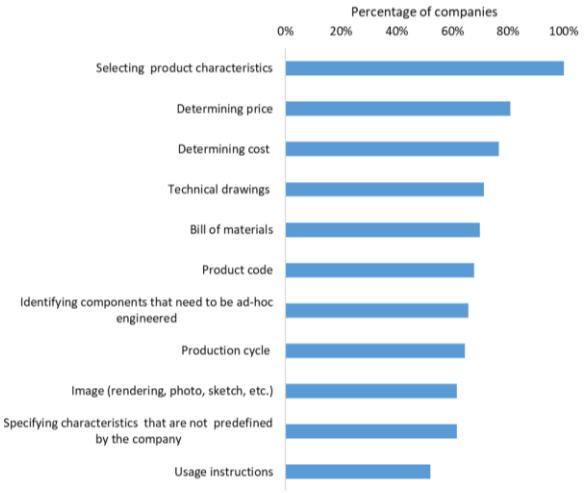

Fig. 1. *Presence of each configuration activity*

We analyzed also the number of configuration activities performed in each SME. All companies, except 5, indicated that they conduct at least five configuration activities, while the median number of activities present for a company is nine (Figure 2). The information reported in Figure 2 is important because it is an indicator of the complexity of the configuration process. More configuration activities imply the request for more functionalities in a configurator and greater implementation efforts. One could argue that this is not so relevant because the incidence of CTO orders is not so high. Again, we should consider the possibility of automation of partial configurability. Therefore, this information significantly contributes to characterizing the specificity the configuration context of SMEs.

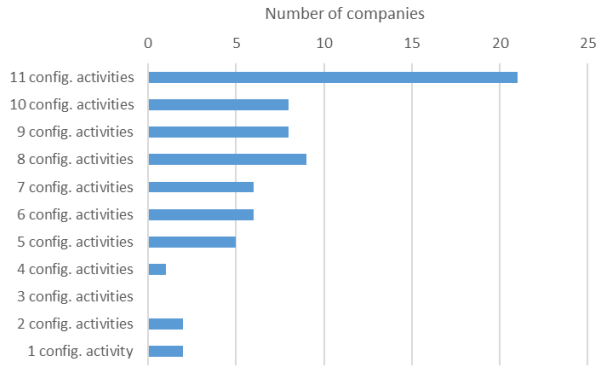

Fig. 2. *Number of configuration activities per company*

One further word is needed for the activity of selecting the appropriate product/service characteristics/functionalities for the customer.

Table 5. *Activity division by the role of the person who carried it out*

Selecting the product/service characteristics/ functionalities appropriate for the customer:	**% of companies**
activity carried out by the client alone	36.3
activity carried out by salespeople	79.7

This activity is usually carried out by sales personnel (79.7%), while 36.3% of companies indicated that this activity is carried out by the client alone (Table 5). Noticeably, 16% of companies have both possibilities.

4.2. Digitalization level of SMEs

The presence of ERP, MRP, PDM/PLM, and CRM software applications is used to comprehend the overall digitalization status of manufacturing companies that offer customized and/or a high variety of products (Table 6).

Table 6. *Usage of software in companies*

Which of the following software and hardware technologies does your company use?	**% of companies**
Commercial presence on the web (use of own website or someone else's platform, e.g., Facebook, for commercial activities)	80.8
ERP (Enterprise Resource Planning)	74
MRP (Materials Requirements Planning)	68.5
CRM (Customer Relationship Management)	41.1
PDM (Product Data Management) or PLM (Product Lifecycle Management)	38.4

It was noted that:

- The considered companies have a high presence of ERP (74%), where ERP is defined as business processes integration (i.e., sales, purchases, warehouse management, accounting, etc.). This means that 7 of 10 companies have the core of the management software. Obviously, these ERPs in most cases are not renowned applications such as SAP. Notwithstanding this, the presence of such applications is a signal of a presence of business processes integration supported by software applications: a first step of digital integration has been performed.
- The considered companies also tend to have a high commercial presence on the web (80.8%). A majority of companies use their commercial presence on the web to present their products (84.8%), to collect contacts (64.4%), to receive requests for offers (37.3%), to produce offers (17%), and to receive orders (17%). The row data show that the commercial activity on the web differs from one company to another.
- The core of software production management support (MRP) is present in 68.5% of the sample. Keeping in mind that a number of companies do not need an MRP because they have an extremely limited number of purchasing materials, these findings can be considered a good level of digitalization.
- The adoption of CRM is not negligible (41.1%). This percentage is even more interesting, knowing that some of these companies work for third parties or with a limited number of customers.
- Finally, adoption of the PDM/PLM is 38.3%, which is not low considering the complexity of these systems. This percentage shows the willingness of these companies to offer excellent support for the product technical data management.

The presented data indicate, in general, considerable levels of digitalization. Of course, this does not mean that this digitalization is effective, but it does indicate

that the considered companies have a significant openness to digitalization.

4.3. Digitalization of configuration activities

The configuration activities are also significantly digitalized. Figure 3 reports for each activity how many companies declared that for them this activity is digitalized and how many declared that for them it is not digitalized. On average, each configuration activity is digitalized in 58% of SMEs (Table 7 column 3 last row).

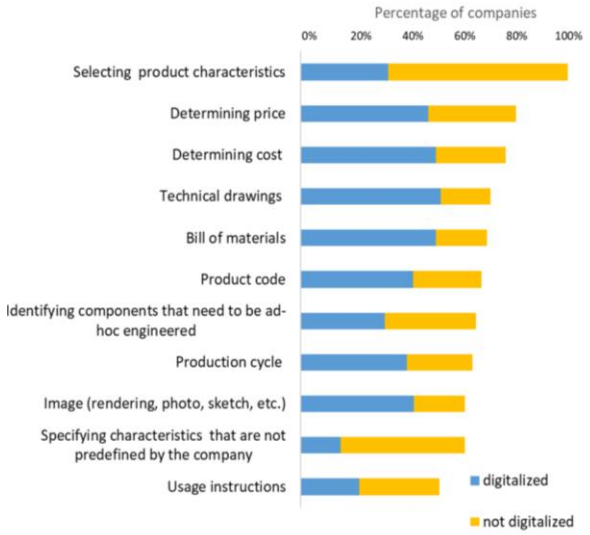

Fig. 3. *Level of digitalization of the configuration activities*

For each configuration activity, we asked each SME whether it feels the need to improve the digitalization of this activity. Table 7 reports, in column four, the results of this enquiry. Despite the fact that the various activities are digitalized, on average, in 58% of the SMEs, the need to improve existing digitalization is perceived, on average, by 42% of SMEs (see Table 7, column 4, last row). It is interesting to note that a number of SMEs felt the need to improve the digitalization of some activities they have already digitalized. This result suggests that in the future, besides greater digitalization, we can also expect to see in the SMEs better digitalization of configuration activities.

To try to get a clue about the future level of digitalization for each configuration activity we calculated a desired level of digitalization (see Table 7, column 5) by using the answers to the presence of each configuration activity, its actual digitalization and the declared need to improve its digitalization. A company is counted in the numerator of this percentage when it digitalized the row activity or it expressed the need to digitalize this activity. Each company is counted only once in this numerator. The percentage is calculated on the total number of companies that do have the row activity. This percentage represents the desired level of digitalization: part of the desire is already satisfied while part is reasonably expected to be satisfied in the future. Therefore, this percentage provides also an indication of the level of digitalization we could expect in the future. Likely, it refers to a near or at least not too far future since the part not yet digitalized is estimated based on an actually perceived need and not on a generic possibility to digitalize it. The results of this analysis are that, the average level of digitalization of the configuration activities is expected to grow from 58% to 77% if all companies digitalize activities for which they said they feel the need to do so.

Table 7. *Presence of activity, level of digitalization, and need for further digitalization*

Configuration activity	**Presence of activity (%)**	**Actual digitaliz. (%)**	**Need to improve digitaliz. (%)**	**Desired digitaliz. (%)**
Selecting the product / service characteristics / functionalities appropriate for the customer	100.0	32.9	45.8	50.3
Specifying characteristics / functionalities requested by the customer that are not included in those predefined by the company	61.6	24.4	54.5	55.0
Identifying which product components / groups of the bill of materials, if any, need to be ad-hoc engineered	65.7	47.9	52.2	69.9
Generating/determining for a new product/service configuration requested by the customer				
its product code	68	62.3	33.3	83.7
its bill of materials	70	72.6	43.2	87.1
its production cycle	64	61.7	48.3	77.5
its price	81	59.3	42.9	84.4
its cost	77	66.1	43.2	88.8
its technical drawings	71	73.8	26.3	88.0
its image (rendering, photo, sketch, etc.)	62	68.9	41.9	68.9
its usage instructions	52	42.1	25	72.2
Mean	*70*	*58*	*42*	*77.1*

Table 8. Presence of activity, level of digitalization, and need for further digitalization

Selecting the product/service characteristics/ functionalities appropriate for the customer:	**Presence of activity (%)**	**Actual digitaliz. (%)**	**Need to improve digitaliz (%).**	**Desired digitaliz. (%)**
activity carried out by the client alone	36.3	20.0	40.0	48.0
activity carried out by salespeople	79.7	34.6	47.4	56.3

Noticeably, selecting the product/service characteristics/ functionalities appropriate for the

customer has a low percentage of digitalization (Table 7). Interestingly, this low percentage is comparable when the selection activity is carried out by sales personnel (34.6%), and when it is done by clients on their own (20%; Table 8).

5. DISCUSSION AND CONCLUSIONS

We considered a sample of Italian SMEs (see Section 3.2). On average, the turnover of the SMEs in our sample is composed of 69% of products for industrial applications, while 31% of products for final consumers (see Section 3.3.2). Far most companies (82%) accept orders for products with new functions that require ad hoc design, half accept orders of products obtained by combining only predefined options, and more than half roughly one-third (29%) of the sample does not offer product variants completely defined in the company's catalogs (see Section 3.2.3). In line with this customization strategy, on average only one-third of their turnover is realized through intermediaries, while more than 68% is realized through direct selling (see Section 3.2.2). Interestingly, more than 80% of orders pass through the technical office, however, 57% of the companies have at least some orders fulfilled with products made to stock (see Section 3.2.4). Given these characteristics, our sample is one of manufacturing SMEs characterized by mixed customization strategies with a high presence of deep customization.

Given the above-reported characteristics of the sample, it is not surprising to see that almost all the provided configuration activities were found in the considered sample (see Section 4.1). Some Two activities, in particular, are present in 80–100% of the considered SMEs, namely, selecting product characteristics and determining price, while determining cost, producing a bill of materials, and producing technical drawings, are present in more than 70% of considered SMEs. In the considered SMEs, the product configuration process is complex, with many outputs. Thus, these manufacturing companies, though small, have to deal with great complexity due to the product customization strategy they adopted. The digitalization of the configuration process in these companies could free up considerable technical resources from the product configuration process during the order definition and/or order fulfillment processes.

Corresponding to the complexity induced by the product customization, these SMEs present a digitalization status that is advanced as regards ERP and MRP, commercial presence on the web, CRM, and PDM/PLM (see Section 4.2). Of course, this does not mean that this digitalization is effective, but it does indicate that the considered SMEs are significantly open to digitalization.

Even the configuration activities are significantly digitalized, but the level of digitalization differs vastly across activities (see Section 4.3). While determining the product code and producing the bill of materials are highly digitalized, other configuration activities, such as selecting product characteristics or producing usage instructions, are much less so. In this respect, there is a considerable gap between the current digitalization of the selection of product characteristics and what the digitally oriented customers are increasingly asking for. Why this is so? This is a research question suggested by this result.

The gap we have highlighted is likely not unknown to these SMEs since the data show that they feel the need to further digitalize configuration activities (see Section 4.3). In fact, even though configuration activities are also significantly digitalized (on average, each configuration activity is digitalized in 58% of the considered SMEs), this level of digitalization is expected to grow to 77% if all companies modify the activities for which they believe there is a need. In particular, the activity of selecting the product/service characteristics/ functionalities appropriate for the customer is declared to be further digitalized in almost half of the companies where this activity is carried out directly by clients. To signal the strength of this trend, there are some cases that evidence the willingness of some companies to digitalize this activity and move it to customers, even in cases where it currently is not performed by customers. The fact that 81% of them do have a commercial presence on the web, 41% do have a CRM, and 68.5% do have an MRP let's think that they have the bases to do it. However, many other things should be considered to say whether they are mature enough for this step. This is another question for research that this result indicates as timely.

One important issue that emerged is the fact the considered manufacturing SMEs follow mixed customization strategies with a high presence of deep customization. Almost all companies (82%) accept orders for products with new functions that require ad hoc design, 74% accept orders of products obtained by combining only predefined options, and 29% of the sample does not offer product variants completely defined in the company's catalogs (see Section 3.2.3). In this context, the notion of partial configurability [11] is a crucial notion. Through this notion is possible to bring the benefits deriving from the use of configurators also to these SMEs. Without this notion in many cases, the use of configurators would not be justified, due to the relatively small part of CTO orders. The implication for configurators is that functionalities such as those that allow performing a partial commercial and technical configuration became highly important. It would be a mistake to consider all these companies limitedly interested by the configurational approach. Probably it is exactly the contrary. Through the configurational approach [11] they could reconsider their product space and their way to answer to the market. Using configurators that support some fundamental activities, they could increase their awareness about their product space and manage it in a better way.

A second important issue is associated exactly with the SMEs' insight into their product space. Interestingly the questions that got the highest difficulty in collecting were those related to the size of their product space. Number of families, number of end product variants, numbers of new end product codes introduced per year are all questions the respondents found extremely difficult to answer. This is not the first time that we got this experience with such a kind of companies. This issue is problematic for research since this information is important to characterize the context. However, we also

experienced that this knowledge is available and shared in a company when the configurational approach is implemented. From this consideration, we argue that the lack of this information may be used as an indicator of the status of evolution in managing product variety in a company and probably, as researchers, we could use it in our explanatory models.

The picture that emerges from this sample is interesting and encouraging for product configuration researchers. If the same results emerge from a wider and more representative sample, this will indicate that product configuration activities are present in SMEs and are not simpler than those in bigger companies. On the contrary, due to the need to address the partial configurability and mixed customization strategy, they could be even more difficult. Likewise, resources are more constrained in SMEs and the volume of activities is lower. It is more difficult to have the required resources to introduce product configurators, and when they are introduced, the gain likely is lower because the smaller size likely leads to a lower number of configurations per year. In order to identify ways to overcome these issues, we think the research should consider the identification of less expensive product configurators appropriate for SMEs; the identification of appropriate implementation processes; the identification of contexts that are more appropriate for the digitalization of the configuration activities; and the possible splitting the introduction of configurators in packages that are affordable for SMEs. Researchers of product configuration are called to investigate in these directions.

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