Article abstract

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A multiple-case study was designed, involving eight machinery manufacturers in one European country, to collect data on their MCC and on the ICs of their OMs. Empirical case data were triangulated with analytical conceptual arguments grounded in the existing literature.

The study provides empirical evidence of, and logical explanations for, the fact that OMs working in high-MCC manufacturing organizations use the ICs of negotiation, information seeking, efficiency orientation, analytical thinking, and pattern recognition significantly more often than OMs employed by low-MCC organizations.

Future research could replicate this study in other industries and countries, as well as for other managerial roles.

The study provides indications for OM selection and training in companies that are pursuing a mass-customization strategy.

While the literature on technological and organization-level enablers of MCC has grown considerably, the understanding of its individual-level enablers is still limited and concerns mostly the workforce. This is the first study that relies not on practitioners' opinions, but on data regarding manufacturers' MCC and their managers' ICs to shed light on which managerial competencies are important to a manufacturer's MCC.

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Operations managers' individual competencies for mass customization

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Abstract

Purpose – The development of mass-customization capability (MCC) is crucial for a growing number of manufacturing firms nowadays and presents great challenges, especially in the area of operations management. This study aims to provide insights into which individual competencies (ICs) of an operations manager (OM) are important to the MCC of the manufacturing organization the OM works for.

Design/Methodology/Approach – A multiple-case study was designed, involving eight machinery manufacturers in one European country, to collect data on their MCC and on the ICs of their OMs. Empirical case data were triangulated with analytical conceptual arguments grounded in the existing literature.

Findings – The study provides empirical evidence of, and logical explanations for, the fact that OMs working in high-MCC manufacturing organizations use the ICs of negotiation, information seeking, efficiency orientation, analytical thinking, and pattern recognition significantly more often than OMs employed by low-MCC organizations.

Research limitations/implications – Future research could replicate this study in other industries and countries, as well as for other managerial roles.

Practical implications – The study provides indications for OM selection and training in companies that are pursuing a mass-customization strategy.

Originality/Value – While the literature on technological and organization-level enablers of MCC has grown considerably, the understanding of its individual-level enablers is still limited and concerns mostly the workforce. This is the first study that relies not on practitioners' opinions, but on data regarding manufacturers' MCC and their managers' ICs to shed light on which managerial competencies are important to a manufacturer's MCC.

Keywords: mass customization, individual competencies, behavioral operations, case study, human resource management

1. Introduction

Mass-customization capability (MCC) denotes the ability of an organization to provide customized products/services that fulfill each customer's idiosyncratic needs without substantial trade-offs in cost, delivery, and quality performance (e.g., Pine, 1993; Squire *et al.*, 2006). The development of MCC presents great challenges, especially in the area of operations management (Huang *et al.*, 2008), challenges which today face more and more firms due to the disparity between customers' growing expectations for customized products and their view of companies' ability to quickly deliver on them (Business Wire, 2018).

The literature on MCC enablers has increased exponentially (Fogliatto *et al.*, 2012) since the idea of mass customization was popularized by Pine (1993). Over time, the scope of this literature has widened from an initial focus on technological enablers to encompassing a variety of organization-level variables, such as the organizational capabilities of robust process design (Salvador *et al.*, 2009), continuous improvement (Kristal *et al.*, 2010), and information processing (Trentin *et al.*, 2012).

Individual-level enablers of MCC have received much less attention. A few insights, mostly concerning the workforce, are offered by studies that, however, are centered on organization-level enablers. The only previous work with a focus on individual competency (IC) requirements for mass customization, by Forza and Salvador (2006), has two major limitations: It relies only on practitioners' subjective opinions and reports only aggregate data for the whole set of professional roles considered in the research, without distinguishing among different functional areas and between managerial and non-managerial roles.

Narrowing this gap in the understanding of MCC enablers is important because individuals are one of the building blocks of organizational capabilities in general (Felin

et al., 2012) and, hence, of an organization's mass-customization capability in particular. This has long been acknowledged in the MCC literature. In one of the early works on the topic, for example, Lau (1995: 19) mentioned "the development of human resources" among the most important issues of mass customization and, one year later, Beaty (1996: 220) emphasized the importance of "the people challenge" in his account of IBM's early attempts to develop MCC. More recently, based on a sample of 645 manufacturing plants in 10 countries around the world, Zhang *et al*. (2017) found that an organization's MCC is improved by the organization's human capital, defined as the stock of knowledge and skills residing in the organization's employees. Unpacking this organization-level construct by identifying, for the different roles that exist within an organization, the individual characteristics that enhance the organization's MCC was, however, beyond the scope of Zhang *et al*.'s (2017) work.

The present study starts to narrow the above-mentioned gap by focusing on the role of the operations manager (OM), which prior research suggests is crucial to the enhancement of an organization's MCC (Åhlström and Westbrook, 1999; Forza and Salvador, 2006). Data on manufacturers' MCC and on the ICs of their OMs were gathered through a multiple-case study involving eight cases in the machinery industry of one European country.[1] The analysis of the collected data led to the identification of five ICs that the OMs working in high-MCC organizations had used significantly more often than the OMs employed by low-MCC manufacturers, that is, negotiation, information seeking, efficiency orientation, analytical thinking, and pattern recognition. The external validity of these empirical results was enhanced through the development of analytical conceptual arguments grounded in the existing literature that offer logical explanations for such findings. As a whole, the results of the present study improve the understanding of the managerial competencies that are important to a manufacturing organization's MCC. By

doing that, this piece of research also contributes to the literature in the emerging area of behavioral operations, defined as "the study of human behavior and cognition and their impacts on operating systems and processes" (Gino and Pisano, 2008: 679). Pragmatically, the findings of this study have implications for OM selection and training in companies that are pursuing a mass-customization strategy.

2. Literature review and research question

2.1. Individual competencies

Research in IC originated with the seminal work of McClelland (1973), who first proposed competencies as critical differentiators of individual performance in a job; and was then developed by Boyatzis (1982) and by Spencer and Spencer (1993). Boyatzis (1982) defined ICs as a person's underlying characteristics that lead to, or cause, superior or effective performance in a job. Individual competencies are abilities that manifest themselves in a variety of behaviors, depending on situations or times (Boyatzis, 2009). Prior research has often organized ICs into clusters or categories; for example, Boyatzis *et al.* (1995) classified ICs into three categories: The "goal and action management" cluster, containing ICs such as initiative, planning, and attention to details, which enable a person "to establish goals and plans of action" and "to make things happen toward a goal or consistent with a plan" (Boyatzis, 1982: 60); the "people management" cluster, encompassing "social intelligence" ICs, such as empathy, persuasiveness, and negotiation, which enable a person "to handle relationships" and "to induce desirable responses in others" (Boyatzis, 2009: 754); and the "analytic reasoning" cluster, including "cognitive intelligence" ICs, such as pattern recognition, theory building, and the use of concepts, which enable a person "to think or analyze information and situations" (Boyatzis, 2008: 8).

Prior research has paid specific attention to the ICs needed to operate in managerial roles. On one hand, this research stream has developed competency models that cover a wide range of managerial levels and functional areas. These models do not fit any specific position well, but highlight the similarities between the various managerial jobs and provide the background against which the special characteristics of different levels and functions stand out (Spencer and Spencer, 1993). On the other hand, this line of inquiry has identified a number of ICs required to operate in a specific managerial role, such as sales manager (Deeter-Schmelz *et al.*, 2008; Khandelwal Das *et al.*, 2014; Powers *et al.*, 2014), marketing manager (Kashani, 1995; Gray *et al.*, 2007), R&D manager (Friedman *et al.*, 1992; Rifkin *et al.*, 1999; Gritzo *et al.*, 2017), and manager responsible for corporate sustainable-management practices (Wesselink *et al.*, 2015; Siva *et al.*, 2018).

Prior research has also linked ICs to organizational capabilities, where the latter term denotes an organization's capacity to deploy resources, usually in combination, to effect a desired end (Amit and Schoemaker, 1993). Particularly, Felin *et al.*'s (2012) conceptualization of the micro-foundations of organizational routines and capabilities identifies individuals, with their characteristics and abilities, as one of the three building blocks of organizational capabilities, along with organizational structure and processes.

2.2. Mass-customization capability and its enablers

In line with the view of capabilities that is typical of the operations strategy literature (Peng *et al.*, 2008), MCC is conceptualized as a competitive performance (Huang *et al.*, 2010; Trentin *et al.*, 2015). The "means" to achieve this performance have been extensively investigated (Fogliatto *et al.*, 2012), but for many years the focus has been on its technological enablers (Fogliatto *et al.*, 2012; Sandrin *et al.*, 2014), such as product modularity (Duray *et al.*, 2000); postponement (Feitzinger and Lee, 1997), also known as

delayed product differentiation (Forza *et al.*, 2008); and product configuration systems (Forza and Salvador, 2002; Hvam *et al.*, 2008).

More recently, interest has grown in the organizational enablers of MCC. Salvador *et al.* (2009), for example, proposed three organizational capabilities underlying MCC: solution space development, choice navigation, and robust process design. While MCC represents a performance outcome, these three capabilities can be thought of as means to achieve this outcome, in line with the view of capabilities that is typical of the strategic-management literature (Trentin *et al.*, 2015). Other organization-level variables that prior research has examined for their MCC-enabling role include organizational structure (Huang *et al.*, 2010; Zhang *et al.*, 2014), cross-functional integration and coordination mechanisms (Ahmad *et al.*, 2010; Lai *et al.*, 2012; Trentin *et al.*, 2012; Zhang *et al.*, 2014), human-resource-management practices (Leffakis and Dwyer, 2014; Sandrin *et al.*, 2018), organizational-learning practices (Huang *et al.*, 2008; Wang *et al.*, 2014; Wang *et al.*, 2015), standardization and innovation capabilities (Wang *et al.*, 2016), intellectual capital (Zhang *et al.*, 2017), and absorptive capacity (Zhang *et al.*, 2015).

Individual-level enablers of MCC have received much less attention. Some insights have been offered, often only implicitly and with reference to production workers, in studies that, however, focus on organization-level enablers of MCC. For example, Liu *et al.*'s (2006) results on the impacts of work-design practices on MCC implicitly suggest that highly skilled workers committed to the organization and capable of performing a variety of tasks, including maintaining the equipment, enhance MCC. Likewise, the importance of having highly skilled, cross-trained workers to improve MCC can be inferred from the results of Huang *et al.* (2008), Huang *et al.* (2010), Trentin *et al.* (2012), Leffakis and Dwyer (2014), and Zhang *et al.* (2017). Furthermore, Salvador *et al.* (2009) explicitly mentioned the selection/development of employees who can deal with new and

ambiguous tasks as one of the approaches to building the organizational capability of robust process design and, thus, of enhancing MCC. Yet the only available study that focuses on individual-level enablers of MCC is the work by Forza and Salvador (2006). Their work explored which individual characteristics—classified into attitudes, knowledge, and abilities—are required by MCC, but reported only aggregated data for the whole set of professional roles considered in the research and relied on practitioners' subjective opinions only. This means that the existing literature still lacks any study that investigates which individual characteristics are important to an organization's MCC using data on employees' characteristics and on the MCC of the organizations such employees work for. The present study aims to narrow this gap by focusing on the role of OMs, which prior research suggests is crucial in the enhancement of an organization's MCC (Åhlström and Westbrook, 1999; Forza and Salvador, 2006). Accordingly, the present study addresses the following research question: Which ICs of an OM are important to a manufacturing organization's MCC?

3. Method

3.1. Research setting

As explained in the previous section, the topic of interest for this study has attracted little previous research and no formal theorizing. In such a case, that is, when theory is nascent, a qualitative research design is suggested (Edmondson and McManus, 2007). Because little is known, openness to input from the field, as well as rich, detailed, and evocative data are needed to help researchers identify and investigate key variables over the course of the study (Edmondson and McManus, 2007). Accordingly, the present study adopted a qualitative, case-based research design. Had we chosen a quantitative, survey-based design, in which data are limited to the constructs included in the survey, then the lack of

a previous theory on the topic would have entailed a greater risk that the collected data would miss relevant OM ICs. Another advantage of the adopted research design over a survey-based study was the ability of "getting closer to constructs" (Siggelkow, 2007: 22) by offering the reader concrete examples of the relevant OM ICs and of their working in the context of high-MCC manufacturing organizations.

Consistent with the choice of a qualitative research design, we decided to assess the ICs of OMs by means of behavioral event interviews (BEIs), which are considered one of the most effective methods for assessing ICs (e.g., Boyatzis, 1982; Spencer and Spencer, 1993). The BEI technique is based on a modification of Flanagan's (1954) critical incident interview, which is recognized as one of the most effective techniques for assessing managerial behavior (Campbell *et al.*, 1970). A BEI is a semi-structured interview in which an individual is asked to recall and relate specific events in which he/she felt effective in executing his/her job (e.g., Boyatzis, 1982; Spencer and Spencer, 1993). Once the respondent recalls an event, he/she is guided through telling the story of the event with a set of questions used to obtain, for each episode, more information on the situation, thoughts, feelings, dialogues, behaviors, and outcomes characterizing it (Boyatzis, 1982; Spencer and Spencer, 1993). This kind of interview permits ICs to be derived inductively through the analysis of individual behaviors (Boyatzis, 2009) and represents an efficient substitute for the direct observation of real behaviors (Boyatzis, 2009; Camuffo and Gerli, 2018). A BEI offers a high degree of validity, as the ICs identified by means of it are truly the ones required for effective performance and not the ones supposedly related to performance according to the respondent's subjective opinion (Marrelli, 1998). However, BEIs are extremely time and labor intensive (Spencer and Spencer, 1993; Marrelli, 1998), thus limiting the possibility of collecting data from a large sample.

The population from which our cases were chosen comprises mid- to large-sized manufacturing organizations (number of employees greater than 50 and turnover greater than 10 million euro) that produce machinery and equipment, such as electric motors and generators, professional food-processing equipment, machines for the pharmaceutical industry, and heat exchangers, in one European country. Manufacturers of these products represent a relevant context for our research because they typically offer at least some degree of product customization but vary in their ability to do that without substantial trade-offs in cost, delivery, and quality performance, as required by the definition of MCC. This is well illustrated by the two organizations with, respectively, the highest value and the lowest value of MCC in our sample. Both provide a high degree of product customization, but the former has constantly worked, since its foundation, on improving efficiency and delivery speed, whereas the latter has never invested in enhancing its productivity and responsiveness because it operates in a market that guarantees high margins and does not put pressure on delivery lead-times. As a matter of fact, product customization strategies include, but are certainly not limited to mass customization (Sousa and da Silveira, 2019). Small enterprises were excluded from the reference population due to the higher risk that such organizations do not have an OM.

From the reference population, eight cases were selected according to literal and theoretical replication logic (Yin, 2009). Specifically, we included both multiple cases with relatively high MCC and multiple cases with relatively low MCC.

3.2. Data collection

To assess OM ICs, we used the BEI technique, as explained in the previous section. For each case, the OM was asked to recall and relate four specific events in which he/she felt effective in executing his/her job. The chosen number of events was in line with prior

studies that used the same type of interview technique, such as Boyatzis *et al.* (2000)—three or four episodes—and Camuffo and Gerli (2018)—three events. Each BEI lasted about one and a half hours and was entirely recorded and subsequently transcribed.

As regards the outcome variable, that is, the MCC of a manufacturing organization, we adopted a perceptual measure of this organization-level construct, in line with the overwhelming majority of previous empirical studies using this variable (e.g., Huang *et al*., 2010; Zhang *et al*., 2019). For each case, at least two knowledgeable informants indicated the extent to which they agreed or disagreed with the following five statements that comprise Huang *et al*.'s (2010) validated, multi-item measurement scale of MCC: 1) we can easily add significant product variety without increasing cost; 2) we can customize products while maintaining high volume; 3) we can add product variety without sacrificing quality; 4) we are highly capable of large-scale product customization; and, 5) our capability for responding quickly to customization requirements is very high. Responses were provided on a five-point Likert scale anchored by "strongly disagree" (1) and "strongly agree" (5). The use of multiple informants prevented single-rater bias in the measurement of this organization-level construct: To determine the MCC of each case organization, we averaged the responses to the five measurement items across all the organization's informants. It is notable that the value of James *et al*.'s (1984) inter-rater agreement coefficient—always greater than 0.88, and on average equal to 0.95 in our sample—indicated, for each case, very good agreement among the different informants rating their organization's MCC (Boyer and Verma, 2000). For each case, the MCC value was triangulated with information on the degree of product customization provided by the organization to its customers (Sandrin, 2016) and on its operational performance.

3.3. Data analysis

The qualitative data collected through the BEIs were coded using thematic analysis, as suggested by Boyatzis (1998). Thematic analysis is a process for encoding qualitative information using a codebook articulating specific themes and how to identify them (Boyatzis, 1998; Boyatzis, 2009). The themes may be taken deductively from theory and prior research or generated inductively from the data (Boyatzis, 1998). We opted for an intermediate approach, using a combination of prior research and our own data to generate our codes. Our initial codebook included the 22 ICs defined by Boyatzis *et al.* (1995), who also provided behavioral indicators for these ICs. We also considered the ICs proposed by Spencer and Spencer (1993), for which behavioral indicators are available as well, and we included 8 of these ICs, which are not captured by Boyatzis *et al*.'s (1995) codebook. As a result, our initial, deductively generated codebook comprised 30 ICs.

However, we also drew upon our data to create a number of IC themes capturing specific behaviors that could not be encoded in any of the initial 30 ICs. When that was the case, we generated a new code, along with a tentative definition of the corresponding IC and possible behavioral indicators. Subsequently, both the conceptual definition and the behavioral indicators were refined based on relevant literature.

The final codebook included 35 ICs, which are listed, along with their definitions, in Appendix A. In accord with Boyatzis *et al.* (1995), we classified the ICs in our codebook into three categories: "goal and action management" ICs, "people management" ICs, and "analytic reasoning" ICs. The behavioral indicators adopted for some of these ICs are reported as an example in Table B1 of Appendix B.

To reduce the influence of subjectivity in the coding process, BEI data were encoded independently by two researchers using MAXQDA 2018 software (VERBI Software, 2017). Inter-rater reliability was assessed using Voss *et al*.'s (2002) inter-rater reliability

coefficient, computed as the number of agreements over the total number of agreements and disagreements. The value of this coefficient (0.83) was well beyond the threshold value of 0.7 that is suggested for this type of research (Boyatzis, 1998). In case of disagreement, the whole research team analyzed the interview transcription and, ultimately, made a decision based on IC definitions, IC behavioral indicators, and, sometimes, additional information collected from the OMs.

Once full agreement was reached, we computed the frequency of use of each IC for each interviewee. Since all interviewees were asked to recall and relate four episodes, we computed absolute, rather than relative, frequencies. Based on Camuffo *et al.* (2009), we defined such frequencies as the number of events in which each IC was detected in each BEI (ranging from 0 to 4).

To investigate which OM ICs differentiate organizations with higher MCC from organizations with lower MCC, we followed an approach inspired by the one that Camuffo and Gerli (2018: 416) had used to investigate which "management behaviors differentiate firms with higher levels of adoption of lean operation practices" from firms with lower levels of adoption of the same practices. First, we divided our sample into two equal-size groups ("high MCC" and "low MCC") using the sample median of Huang *et al.*'s (2010) MCC measure, equal to 3.73, as splitting criterion. This value is almost identical to the median of the same MCC measure for the 104 machinery manufacturing plants included in the High Performance Manufacturing Round 3 dataset used, for example, by Zhang *et al.*'s (2014; 2019) studies on MCC; this median is equal to 3.74 after transforming the original seven-point Likert response scale into the five-point Likert scale adopted in the present research.

Subsequently, we compared the frequency distributions of the ICs of the OMs in the two subsamples using the non-parametric Mann-Whitney U statistical test (Mann and

Whitney, 1947; Field, 2013). We opted for a non-parametric test because of the small size of our sample and violation of the normality assumption (Field, 2013). The test permitted to identify the ICs that had been used with a significantly higher frequency ($p < 0.05$) by the OMs of the high-MCC subsample compared with the OMs of the low-MCC subsample. In an attempt to rule out spurious associations, we revisited our qualitative data to find chains of evidence establishing a linkage between these "differentiating" OM ICs and their organizations' MCC (see Table B2 of Appendix B for some examples). In addition, we used existing literature to develop analytical conceptual arguments that enhanced the external validity of our findings. As pointed out by Yin (2009: 43), "case studies […] rely on *analytic* generalization. In analytic generalization, the investigator is striving to generalize a particular set of results to some broader theory."

4. Results

The results of the Mann-Whitney U statistical test (see Table I) led us to identify five differentiating ICs that had been used significantly more often ($p < 0.05$) by the OMs from the high-MCC subsample compared with the OMs from the low-MCC subsample.

<Table I>

The following subsections use our qualitative data to illustrate how each of these differentiating OM ICs worked in the context of the high-MCC organizations of our sample and, furthermore, draw on existing literature to develop analytical conceptual arguments that enhance the external validity of our empirical findings.

4.1. Analytical thinking and mass-customization capability

The IC of analytical thinking, defined as the ability to order multiple causal events (Spencer and Spencer, 1993; Boyatzis *et al.*, 1995)[2], is illustrated by the following BEI excerpt:

> This [more detailed master production schedule] is something we can do now because we have more time to devote to this type of [planning] activity, and this [increased availability of time, in turn,] is a consequence of the fact that I took the two most skillful people I had in the [production-planning] department and I relieved them of a number of lower-added-value tasks [by reallocating these tasks to other people]. (Case C's OM)

These words reveal the cognitive ability of Case C's OM to reconstruct a causal chain linking the division of labor among the personnel of the production-planning department to the level of detail of the master production schedule through the amount of time available for the creation of this schedule. With this causal chain in his mind, the Case C OM changed the division of labor among the personnel of the production-planning department so that the two most skillful employees could devote more of their time to the creation of the master production schedule for large and medium-sized electrical equipment, respectively. With more time available for this task, the two planners can generate a more detailed schedule, which uses daily time buckets instead of weekly ones for the five to six weeks ahead. This more detailed schedule, in turn, is a prerequisite to automatically identifying which materials to prioritize in production. With very complex and highly customized products, doing this automatically rather than manually is crucial to reducing the risk of missing parts in the final assembly phase and, consequently, the risk of delivery delays.

In Case A, the OM's ability to order multiple causal events made him realize the possibility of reducing set-up times by giving up the initial attempt to constrain salespeople to entering customer orders in such a way that the newly created assembly lines worked with a fixed takt time. Relaxing this constraint would enable the organization to win more customer orders, and the OM realized that the consequent increase of sales and production volumes would permit, over time, investment in additional machinery, thus enabling the dedication of different machines to different products. This is what happened: In 2017, the organization purchased a fourth lathe to produce rotor shafts and, since its products require shafts of four different diameters built from four different types of rods, each lathe can now be dedicated to one type of rod, thereby eliminating the need for changeovers.

In a similar vein, the Case D OM's analytical thinking made him realize the necessity of collecting reliable information from the sales department about the evolution of the ongoing negotiations with customers in order to improve the organization's MCC. This necessity arises from the fact that some of the purchase materials required by the organization's customized products have sourcing lead-times of six to seven months—much longer than the delivery lead-times expected by customers—and, at the same time, have relatively high inventory-holding costs because they are product-specific and, as such, have a relatively high risk of obsolescence. To meet the due dates promised to customers, it is therefore necessary to purchase such materials before customer order receipt and doing that without incurring excess inventory-carrying costs requires reliable information on which negotiations with customers are likely to conclude successfully.

Finally, the Case B OM's analytical thinking led her to identify the creation of an information tool giving all production supervisors access to the master production schedule and to the progress of its implementation as a critical action to improve the

organization's MCC. Production supervisors had traditionally seen their departments as islands, and "giving these people a virtual dashboard where they can see the work queue, in terms of man hours, at each department gives objectivity to the bottlenecks that are hindering the implementation of the plan at that moment" (Case B's OM). This "objectivity" makes supervisors more willing to exchange workers among departments to support the ones that are under pressure from time to time, depending on which specific products customers are demanding at a particular time. This exchange of workers is, in other words, a prerequisite for meeting the due dates promised to customers without costly expediting. Thus, the Case B OM's ability to reconstruct this causal chain helped the organization improve delivery and cost performance for its customized products.

The empirical evidence summarized above is consistent with the following conceptual argument, which revolves around the notion of continuous improvement, defined as a process of focused and sustained incremental innovation (Bessant and Francis, 1999). Continuous improvement is a prerequisite to the development of MCC (Liu *et al.*, 2006; Kristal *et al.*, 2010). This is because, when product customization is delivered, various dimensions of operational performance tend to be poorer than when no product variety is offered (MacDuffie *et al.*, 1996; Åhlström and Westbrook, 1999; Squire *et al.*, 2006), and mass customizers need to sustain a stream of incremental innovations that reduce these detrimental effects of product customization (Kristal *et al.*, 2010; Trentin *et al.*, 2015). A central role in continuous improvement is played by cause-and-effect thinking (Kim *et al.*, 2008). The OM's ability to reconstruct causal chains helps a manufacturing organization to identify problem areas in the operational processes (e.g., the division of labor within the production-planning department in Case C) and to develop solutions to improve such processes, as required by MCC (Huang *et al.*, 2008).

4.2. Information seeking and mass-customization capability

The IC of information seeking, defined as the ability to know more about things, people, or issues (Spencer and Spencer, 1993), is illustrated by the following BEI excerpts:

> When a customer wants a machine of this type, most of the [production] workload [associated with the order] is made up of an "indefinite machine" […]. We do not know many [product] features that will be specified by our technical office […]. I cannot determine workloads. So, what did I do? I interviewed the supervisors of our [production] departments to understand the main [capacity] constraints in their [respective] departments […]. These constraints were not easy to determine. (Case C's OM)
>
> The information provided by supervisors, I checked it using information from production planners and ERP data (Case C's OM).

These words reveal the ability of Case C's OM to make a systematic effort to obtain and check a large amount of information. The number of capacity constraints in the production of large, bespoke, electric motors and generators was in the order of hundreds, as these constraints depend on both the characteristics of the 200 production facilities available in the plant and the characteristics of what one wants to produce with such facilities. As will be explained in Section 4.3 below, the OM's ability to collect all these pieces of information was a prerequisite for creating a tool to support order-promising for these highly customized products and, thus, to improve delivery dependability.

In Case D, one indication of the OM's IC of information seeking was his keeping constantly in touch with the sales department to systematically collect reliable information about the evolution of the ongoing negotiations with customers (see Table B2 in Appendix B). As explained in Section 4.1 above, knowing which negotiations with customers are likely to conclude successfully is crucial for the organization to reduce

delivery lead-times for its customized products without incurring excess inventory obsolescence costs, thus improving MCC.

In both Case A and Case B, the IC of information seeking helped the OMs cope with information-processing needs related to the selection of production resources capable of enhancing the organization's MCC. In Case A, the OM personally deals with the selection of workers and systematically uses various sources of information to understand whether a candidate is suitable for a context in which 100% of the products are made on a to-order basis and, hence, where meeting customer-expected delivery lead-times often requires work-shift extensions until midnight or night shifts. The OM examines the CVs submitted to the company, especially those submitted directly to himself by other production employees, from whom he collects additional information on the candidate, and personally does the interview with the persons he deems suitable. As a result, the more recently hired workers at the plant are willing to work overtime, "even for requests made on very short notice", as observed by the OM.

In Case B, the OM's IC of information seeking played a role in the selection of production equipment. The Case B OM was concerned that the organization's machinery was flexible but not efficient enough, as compared with its competitors. To overcome this problem, the OM made a systematic effort to collect information on the process technologies adopted by the competition:

> Since I could not visit our competitors, I visited their suppliers [of machinery]. I saw what they were producing, I sought to understand which were the customers of the machines that were being built, I asked these suppliers to tell me the capabilities of those machines. (Case B's OM)

As will be explained in Section 4.5 below, these pieces of information provided essential input for a cost-benefit analysis that led to the adoption of process technologies that were more productive and, at the same time, had the right level of mix flexibility.

The following two conceptual arguments together capture the empirical evidence summarized above. First, the OM IC of information seeking contributes to the organization's capacity to process information, which includes the gathering, assessment, storage, distribution, modification, or use of organizationally relevant information (Tushman and Nadler, 1978; Huber, 1982; Egelhoff, 1991). Greater organizational information-processing capacity helps cope with the increased information-processing needs that the development of MCC brings about (Trentin *et al.*, 2012), such as the need for assessing machinery based on more performance criteria in Case B or the need for exchanging more information between sales and operations departments in Case D. Second, the OM IC of information seeking is often used in combination with other ICs, such as analytical thinking, pattern recognition, and efficiency orientation[3] (Spencer and Spencer, 1993), that are important to an organization's MCC (cf. Section 4.1 above and Sections 4.3 and 4.5 below).

4.3. Pattern recognition and mass-customization capability

The IC of pattern recognition, defined as the ability to identify a pattern in an assortment of unorganized information or seemingly random data (Boyatzis *et al.*, 1995), is illustrated by the following BEI excerpt:

> To synthesize these [capacity] constraints in a manner that could be understood and used by the person in charge of order promising, I assigned a weight to each type of machine and frame size [see Table B2 in Appendix B]. With these weights, all weekly constraints for the various types of machines

and for the various sizes of frames are translated into a single, weekly constraint in terms of equivalent machines. (Case C's OM)

These words reveal the Case C OM's ability to reduce a large amount of information, that is, the capacity constraints in the production of large, bespoke, electric motors and generators (cf. Section 4.2 above), through the identification of a common denominator—the equivalent machine—in the capacity requirements for these products. By translating all these capacity constraints into a single constraint expressed in terms of equivalent machines, the OM succeeded in creating a very simple tool to support the activity of order promising for these products, an activity that had always been a big challenge before. This tool "tells you if the delivery date you are promising is feasible, [and does this] even though the bill of materials, production cycle, and even a lot of technical characteristics of the machine are still to be specified" (Case C's OM). The introduction of this tool improved delivery dependability for these highly customized products.

In Case D, the OM's IC of pattern recognition made him see similarities between a new customer's request and product solutions previously developed for other customers. This helped the organization reuse several existing product parts, such as electric motors and fans, instead of sourcing new components for this new customer. This carryover, in turn, reduced the costs, sped up the delivery, and improved the reliability of the new custom solution.

In Case A, the OM's IC of pattern recognition led him to recognize that decisions in different areas share important implications for the organization's flexibility: "When I need to purchase a machine, when I need to hire a person… I know flexibility is an important aspect." The recognition of these common implications led to consistent set of decisions to improve the organization's flexibility. As explained in Section 4.1 above, for example, the choice of purchasing a fourth lathe in 2017 eliminated the need for

changeovers in the production of rotor shafts, thus increasing mix flexibility. Likewise, "when you hire a person, you make him/her do a certain job, but also another, so that he/she becomes multiskilled" (Case A's OM) and, again, mix flexibility is improved.

In Case B, finally, the OM's IC of pattern recognition made her realize that, contrary to what was generally assumed in the organization, "it wasn't true that our custom products are all different. […]. What really makes a difference is the frame of the product, that is, the connections with the outside environment." The recognition that many seemingly unique products share the same connections led to the definition of a number of product classes that differ from one another in the configuration of the product frame. In turn, this classification permitted the development of a product configurator that drastically reduced the time spent by the technical office to generate the technical drawings needed to realize the product, thus shortening delivery lead-times and improving the organization's MCC.

The empirical evidence summarized above is consistent with the following conceptual argument, which revolves around the notion of group technology. This is a "management philosophy" (Hyer and Wemmerlov, 1989: 1287) that "can be applied in all facets of a company" (Knight, 1998: 15) and helps manage diversity more efficiently and more effectively by identifying and exploiting similarities among things, such as parts, processes, people, customer needs, etc. (Shunk, 1985; Selim *et al.*, 1998). Group technology allows firms to alleviate the negative implications of product variety for operational performance (Suresh and Kay, 1998), thus enabling MCC (Suzić *et al.*, 2018). The OM's IC of pattern recognition helps an organization identify and exploit similarities (e.g., among capacity requirements in Case C or among customers' requests in Case D), according to the philosophy of group technology.

4.4. Negotiation and mass-customization capability

The IC of negotiation, defined as the ability to stimulate individuals or groups toward resolution of a conflict (Boyatzis *et al.*, 1995), is illustrated by the following BEI excerpt:

> Considering the request—which had been made through the labor union representative—that [work] shifts be planned in advance, I decided to make an effort to plan [work] shifts over an eight-week horizon so that people were informed in advance. The other method I use is to prepare a draft of this plan, to give this draft to [production] supervisors, so that they can check for workers' availability, and be willing to make changes. (Case A's OM)

These words reveal the OM's ability to resolve conflicts due to requests for work-shift extensions or night shifts, which are often necessary to meet customer-expected delivery dates, as explained in Section 4.2 above. Traditionally, workers at this plant had been accustomed to a rather stable organization of their work shifts. Thus, the requests for shift extensions and, mostly, night shifts were initially a source of conflicts with workers. The Case A OM managed to drastically reduce such conflicts by negotiating a new organization for shifts that reconciled workers' needs for an overview of their future work shifts with the organization's need for more workforce flexibility.

In a similar vein, the Case B OM's ability to stimulate individuals toward resolution of a conflict helped improve the organization's MCC by increasing workforce flexibility. When a worker that had been moved to another production department turned to the labor union to go back to his original department, the Case B OM "worked with the union to help the person understand that it was an opportunity for him, that the company had no particular expectations as to his productivity after just one week in the new department, that I [i.e., the OM] would have suspended judgment until he had had enough time to become more skillful." The Case B OM also told him that "he would work in either of

the two departments, depending on the necessity." In other words, the OM proposed an objective to which both parties—the worker and the company—could aspire and, in this manner, made it easier to exchange workers across departments to support the ones that are under pressure due to specific products customers are demanding at a particular time.

In Case C, the OM's IC of negotiation facilitated the redefinition of jobs within the production-planning department, a redefinition that, as explained in Section 4.1 above, was a prerequisite for using daily time buckets in the master production schedule and, consequently, improving delivery dependability. To reallocate the various tasks among the department's employees, it was necessary to determine the weekly workload for each task. The Case C OM decided to ask each employee how much time he/she typically devoted to each of his/her tasks per week, as "people would not have accepted those numbers and would even have doubted the calculation procedure," had the OM determined the workloads by himself. In addition, when a person extended the time declared for a certain task from 3 to 20 hours per week, the OM spent a lot of time in discussion with this person to understand his position and to come to a number that both parties—the employee and the company—deemed acceptable.

Finally, in Case D, the OM's IC of negotiation helped find "a good compromise" with the sales department regarding the product parts and the related suppliers that a custom solution for a new big customer would share with the organization's catalogue products (see Table B2 in Appendix B). While salespeople had initially pushed for developing new custom components, it was finally agreed that the adjustment and all the electronic boards for this custom solution would be the same as the organization's catalogue products. This choice substantially reduced inventory obsolescence costs when the same customer suddenly zeroed its orders.

The following three conceptual arguments together capture the empirical evidence summarized above. First, the OM's IC of negotiation facilitates collaboration between the operations department and other functional areas in order to arrive at mutually acceptable outcomes. Cross-functional collaboration improves the capacity of a discrete manufacturer to meet heterogeneous customer needs using common product parts. Common components can reduce manufacturing costs; however, they may also hinder the ability to extract price premiums through product differentiation (Desai *et al.*, 2001; Karlsson and Sköld, 2018). Consequently, collaboration among operations, sales/marketing, and design departments is necessary to strike the right balance between parts commonality and product differentiation (Desai *et al.*, 2001). The OM's IC of negotiation helps accomplish this result (e.g., in Case D), thus contributing to the organizational capability to fulfill a stream of differentiated customer needs by reusing or recombining existing resources—including product parts—which is a fundamental enabler of MCC (Salvador *et al.*, 2009). Second, the OM's IC of negotiation facilitates the introduction of work-shift extensions or night shifts, thus enhancing an organization's volume flexibility, and it also makes it easier to move workers across departments that build different products, thus improving an organization's mix flexibility. Both volume and mix flexibilities are a prerequisite to a build-to-order strategy (Salvador *et al.*, 2007), which allows for delivering a variety of customized products without incurring the costs associated with finished-goods inventory (Gunasekaran and Ngai, 2005). By facilitating a build-to-order strategy (e.g., in Case A), the OM's IC of negotiation contributes to the organizational capacity to plan, implement, and control an efficient flow of materials and products that fulfills a stream of differentiated customer demands—an organizational capability known in the literature as logistics for mass customization (Zipkin, 2001; Trentin *et al.*, 2015). A third mechanism linking the OM's IC of negotiation to an

organization's MCC revolves around the notion of continuous improvement. As explained in Section 4.1 above, continuous improvement, meant as a process of focused and sustained incremental innovation (Bessant and Francis, 1999), is a prerequisite to the development of MCC. The OM's IC of negotiation facilitates continuous improvement (e.g., in Case C) because negotiation is one of the strategies to overcome resistance to organizational change (Kotter and Schlesinger, 2008).

4.5. Efficiency orientation and mass-customization capability

The IC of efficiency orientation, defined as the ability to assess input/output relationships and to increase the efficiency of action (Boyatzis *et al.*, 1995), is illustrated by the following BEI excerpt:

> I compared the capabilities of the machines that were being produced for our competitors with the capabilities of our machines. I identified gaps and understood which benefits we would get from investing in a certain machine and whether there would be a return on the investment. (Case B's OM)

These words reveal the Case B OM's ability to assess costs and benefits relative to the adoption of process technologies that could replace the organization's existing machinery, deemed obsolete by the OM (cf. Section 4.2 above). This cost-benefit analysis permitted the identification of technologies that, without sacrificing the required flexibility, were more productive than the ones available at the plant, thus enhancing the organization's MCC.

In Case A, the OM's ability to increase the efficiency of action helped reduce the large stock of wound stator packs that existed between the department performing the winding activity and the final assembly lines. Traditionally, wound stator packs had always been produced in rather large batches, and making the winding department

produce only what was required by the downstream assembly lines—according to the logic of pull production—was a challenge, not because of long set-up times, but because the large variety of wound stator packs used in the organization's products made a kanban approach not viable. To overcome this problem, the Case A OM asked the information systems manager to make the final assembly schedule, with the quantities of the various motors to complete each day, visible to the winding department. In this manner, this department "will not start making the easiest thing for itself but knows that priority must be given to the materials required by the motors that will be assembled on, say, March 30th." (Case A's OM). As a result, not only did the stock of wound stator packs substantially decrease, but also delivery dependability improved.

In Case C, the OM's IC of efficiency orientation helped the organization drastically reduce the workload to check for materials availability for large, engineered-to-order motors and generators. The traditional, manual approach used for this task was cumbersome and, consequently, this check was not performed on a regular basis. As a consequence, costly expediting was often necessary to try to meet the delivery dates promised to customers. The Case C OM's concern for increasing the efficiency of action led to the introduction of a customization of the manufacturing execution system in use at the plant that permitted making this check almost effortless: "With this [information] tool, every day, for each of the [customer] orders we are fulfilling, we have the possibility to check if we are on-time, late or in advance" (Case C's OM).

Finally, the Case D OM's IC of efficiency orientation helped the organization reduce the costs of training workers as well as the costs of poor quality. The high degree of product customization provided by the organization makes "training a person […] really an investment", as observed by the OM, and increases the negative implications of workforce turnover for product quality. The OM's concern for reducing these costs led

him to insource a previously outsourced product to avoid firing two skillful workers when demand from a big foreign market suddenly decreased: "Had I [i.e., the OM] fired them [at the end of their temporary work contract], I would have lost them, and now [that demand from that market has started again] I would have to look for other two persons using some temporary employment agency, I'd have to interview these people, train them. And this would also impair product quality."

The empirical evidence summarized above is consistent with the following conceptual argument, which revolves around two facts. First, MCC can be seen as the ambidextrous capacity of an organization to reconcile the conflicting goals of efficiency and flexibility (Birkinshaw and Gupta, 2013; Kortmann *et al.*, 2014; Wiengarten *et al.*, 2017). Second, the route to higher MCC can start either from mass production or from custom manufacturing (Duray, 2002; Squire *et al.*, 2006; Trentin *et al.*, 2012; Akinc and Meredith, 2015). A custom manufacturer that aims to develop MCC needs to improve its efficiency while preserving its traditional flexibility. Clearly, the OM IC of efficiency orientation helps the organization achieve this objective (e.g., in Case B, by adopting process technologies that are more productive without sacrificing the required flexibility, or, in Case C, by automating the check for materials availability). Similarly, in a mass-production context, this OM IC helps the organization preserve its traditional efficiency while increasing its flexibility to enhance MCC.

5. Discussion and conclusion

5.1. Theoretical implications

The results of this study improve the understanding of which managerial competencies are important to a manufacturing organization's MCC. The MCC literature has traditionally focused on technological and organization-level enablers of MCC. The only

previous work on IC requirements for MCC, by Forza and Salvador (2006), has the limits of relying on practitioners' subjective opinions only and of reporting only aggregated data for the whole set of professional roles considered in the research. The present study starts to overcome these limitations by collecting data on OMs' ICs and on the MCC of the manufacturing organizations such OMs worked for. Interestingly, our data corroborate some of opinions expressed by the informants in Forza and Salvador's (2006) study, but they challenge others. On the one hand, negotiation and efficiency orientation—two of the OM ICs that make a difference between high-MCC and low-MCC organizations in our sample—also rank among the ICs most cited by the informants in Forza and Salvador's (2006) study. On the other hand, analytical thinking—another differentiating IC that emerged from our data—is one of the ICs least cited by the same informants, while pattern recognition and information seeking—the remaining two differentiating ICs in our study—were not even mentioned by those practitioners. Overall, our data suggest that prior research on IC requirements for MCC has underestimated the importance of the action management ability of information seeking and of the two cognitive abilities of analytical thinking and pattern recognition.

By improving the comprehension of which OM ICs are important to a manufacturing organization's MCC, the present paper also adds to the literature in the emerging field of behavioral operations (e.g., Bendoly *et al.*, 2006; Croson *et al.*, 2013; Greasley and Owen, 2018; Villena *et al.*, 2018). Personnel assessment to improve the understanding of the factors and traits that make for better OMs should become a vital research area for the field of behavioral operations (Croson *et al.*, 2013). Thus far, most of the studies in this area have been conceptual (Essex *et al.*, 2016) or have relied on the experiences and opinions of managers and students (Kotzab *et al.*, 2018). Future studies in this area could benefit from the adoption of a research design that helps identify the ICs truly required

for effective performance—for example, via BEIs (Marrelli, 1998)—and not the ICs supposedly related to performance according to respondents' subjective opinions. Recently, a few studies have adopted such a research design to investigate the topic of lean leadership, identifying managerial values and/or behaviors associated with the effective implementation of lean management (van Dun *et al.*, 2017; Camuffo and Gerli, 2018). The present study, however, is the first to use this kind of research design to shed light on which ICs make for a better OM in a mass-customization setting.

5.2. Managerial implications

Pragmatically, the results of this study provide guidance for OM selection and training in companies that are pursuing a mass-customization strategy. On the one hand, the set of differentiating ICs identified in this study and their behavioral indicators can be used for "behavioral event/situation-based questions" (Armstrong, 2014: 595) in the phase of OM candidate selection for such firms. For example, considering the importance of the OM IC of negotiation, candidates could be asked to describe a conflict situation in which they were involved and to describe what they did on that occasion. On the other hand, the same ICs and their behavioral indicators can be used to identify training needs of current or future OMs in such companies and to develop ad hoc training programs, which is also crucial for education institutions such as business schools. Another social contribution made by this study was to give the interviewed OMs feedback on the ICs that emerged from their BEIs. This feedback helped these OMs to better understand their strengths and weaknesses in their job and to reflect on possible strategies for personal development.

5.3. Limitations and suggestions for future research

While contributing both to the academic debate and to managerial practice, this study has limitations, which might be addressed by future research. First, our sample of eight machinery manufacturers in a single European country permitted an exploration of our research question but is insufficient to answer the general question of which OM ICs are important to an organization's MCC. Accomplishing this objective would require replicating our study in other industries and countries. Second, our study did not investigate whether the OM ICs that are important to an organization's MCC are contingent upon the degree of product customization the organization provides to its customers. Since this contextual variable has been shown to moderate the effect of a number of organization-level enablers of MCC (Huang *et al.*, 2010; Sandrin *et al.*, 2018), it would be interesting to understand if this moderating role extends to the individual level as well. Third, all our cases were retrospective and, as such, could be affected by retrospective bias (Eisenhardt and Graebner, 2007). This risk, however, was mitigated by our choice of assessing OM ICs through BEIs (Tognazzo *et al.*, 2017), which require the interviewee to provide a very detailed account of the situation, thoughts, feelings, dialogues, behaviors, and outcomes characterizing the event being reported. Finally, our study focused on the managerial role of OMs, as the development of MCC presents great challenges in the area of operations management (Huang *et al.*, 2008). However, other managerial roles that, according to Forza and Salvador (2006), are affected by mass customization include the ones of sales manager, marketing manager, and R&D manager. Future research could therefore replicate our study for these managerial roles.

Notes

[1] The country is not specified for confidentiality reasons.

[2] Boyatzis *et al.* (1995) referred to "analytical thinking" as "systems thinking."

[3] Spencer and Spencer (1993) referred to "efficiency orientation" as "achievement orientation."

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References

Åhlström, P. and Westbrook, R. (1999), "Implications of mass customization for operations management: an exploratory survey", *International Journal of Operations & Production Management*, Vol. 19, No. 3, pp. 262-275.

Ahmad, S., Schroeder, R. G. and Mallick, D. N. (2010), "The relationship among modularity, functional coordination, and mass customization: implications for competitiveness", *European Journal of Innovation Management*, Vol. 13, No. 1, pp. 46-61.

Akinc, U. and Meredith, J. R. (2015), "Make-to-forecast: customization with fast delivery", *International Journal of Operations & Production Management*, Vol. 35, No. 5, pp. 728-750.

Amit, R. and Schoemaker, P. J. H. (1993), "Strategic assets and organizational rent", *Strategic Management Journal*, Vol. 14, No. 1, pp. 33-46.

Armstrong, M. (2014), *Armstrong's Handbook of Human Resource Management Practice*, Kogan Page Publishers, London, UK.

Beaty, R. T. (1996), "Mass customisation", *Manufacturing Engineer*, Vol. 75, No. 5, pp. 217-220.

Bendoly, E., Donohue, K. and Schultz, K. L. (2006), "Behavior in operations management: assessing recent findings and revisiting old assumptions", *Journal of Operations Management*, Vol. 24, No. 6, pp. 737-752.

Bessant, J. and Francis, D. (1999), "Developing strategic continuous improvement capability", *International Journal of Operations & Production Management*, Vol. 19, No. 11, pp. 1106-1119.

Birkinshaw, J. and Gupta, K. (2013), "Clarifying the distinctive contribution of ambidexterity to the field of organization studies", *Academy of Management Perspectives*, Vol. 27, No. 4, pp. 287-298.

Boyatzis, R. E. (1982), *The Competent Manager: A Model for Effective Performance*, John Wiley & Sons, Inc., New York, NY.

Boyatzis, R. E. (1998), *Transforming Qualitative Information: Thematic Analysis and Code Development*, Sage Publication, Inc., Thousand Oaks, CA.

Boyatzis, R. E. (2008), "Competencies in the 21st century", *Journal of Management Development*, Vol. 27, No. 1, pp. 5-12.

Boyatzis, R. E. (2009), "Competencies as a behavioral approach to emotional intelligence", *Journal of Management Development*, Vol. 28, No. 9, pp. 749-770.

Boyatzis, R. E., Cowen, S. S. and Kolb, D. A. (1995), *Innovation in Professional Education: Steps on a Journey from Teaching to Learning*, Jossey-Bass, San Francisco, CA.

Boyatzis, R. E., Murphy, A. J. and Wheeler, J. V. (2000), "Philosophy as a missing link between values and behavior", *Psychological Reports*, Vol. 86, No. 1, pp. 47-64.

Boyer, K. K. and Verma, R. (2000), "Multiple raters in survey-based operations management research: a review and tutorial", *Production and Operations Management*, Vol. 9, No. 2, pp. 128-140.

Business Wire. (2018), "Consumers to U.S. product developers: make it just for me, ASAP", available at: https://www.businesswire.com/news/home/20180612005129/en/Consumers-U.S.-Product-Developers-ASAP, (accessed 02 May 2019).

Campbell, J. J., Dunnette, M. D., Lawler, E. E. and Weick, K. E. (1970), *Managerial Behavior, Performance, and Effectiveness*, McGraw-Hill, New York, NY.

Camuffo, A. and Gerli, F. (2018), "Modeling management behaviors in lean production environments", *International Journal of Operations & Production Management*, Vol. 38, No. 2, pp. 403-423.

Camuffo, A., Gerli, F., Borgo, S. and Somià, T. (2009), "The effects of management education on careers and compensation: a competency-based study of an Italian MBA programme", *Journal of Management Development*, Vol. 28, No. 9, pp. 839-858.

Croson, R., Schultz, K., Siemsen, E. and Yeo, M. L. (2013), "Behavioral operations: the state of the field", *Journal of Operations Management*, Vol. 31, No. 1, pp. 1-5.

Deeter-Schmelz, D., Goebel, D. J. and Kennedy, K. N. (2008), "What are the characteristics of an effective sales manager? An exploratory study comparing salesperson and sales manager perspectives", *The Journal of Personal Selling & Sales Management*, Vol. 28, No. 1, pp. 7-20.

Desai, P., Kekre, S., Radhakrishnan, S. and Srinivasan, K. (2001), "Product differentiation and commonality in design: balancing revenue and cost drivers", *Management Science*, Vol. 47, No. 1, pp. 37-51.

Duray, R. (2002), "Mass customization origins: mass or custom manufacturing?", *International Journal of Operations & Production Management*, Vol. 22, No. 3, pp. 314-328.

Duray, R., Ward, P. T., Milligan, G. W. and Berry, W. L. (2000), "Approaches to mass customization: configurations and empirical validation", *Journal of Operations Management*, Vol. 18, No. 6, pp. 605-625.

Edmondson, A. C. and McManus, S. E. (2007), "Methodological fit in management field research", *Academy of Management Review*, Vol. 32, No. 4, pp. 1246-1264.

Egelhoff, W. G. (1991), "Information-processing theory and the multinational enterprise", *Journal of International Business Studies*, Vol. 22, No. 3, pp. 341-368.

Eisenhardt, K. M. and Graebner, M. E. (2007), "Theory building from cases: opportunities and challenges", *Academy of Management Journal*, Vol. 50, No. 1, pp. 25-32.

Essex, A., Subramanian, N. and Gunasekaran, A. (2016), "The relationship between supply chain manager capabilities and performance: empirical evidence", *Production Planning & Control*, Vol. 27, No. 3, pp. 198-211.

Feitzinger, E. and Lee, H. L. (1997), "Mass customization at Hewlett-Packard: the power of postponement", *Harvard Business Review*, Vol. 75, No. 1, pp. 116-121.

Felin, T., Foss, N. J., Heimeriks, K. H. and Madsen, T. L. (2012), "Microfoundations of routines and capabilities: individuals, processes, and structure", *Journal of Management Studies*, Vol. 49, No. 8, pp. 1351-1374.

Field, A. (2013), *Discovering statistics using IBM SPSS statistics*, Sage, London, UK.

Flanagan, J. C. (1954), "The critical incident technique", *Psychological Bulletin*, Vol. 51, No. 4, pp. 327-358.

Fogliatto, F. S., da Silveira, G. J. and Borenstein, D. (2012), "The mass customization decade: an updated review of the literature", *International Journal of Production Economics*, Vol. 138, No. 1, pp. 14-25.

Forza, C. and Salvador, F. (2002), "Managing for variety in the order acquisition and fulfilment process: the contribution of product configuration systems", *International Journal of Production Economics*, Vol. 76, No. 1, pp. 87-98.

Forza, C. and Salvador, F. (2006), "HRM policies for mass customization: understanding individual competence requirements and training needs for the mass customizing industrial company", in Blecker, T. and G. Friedrich, (Eds.), *Mass Customization: Challenges and Solutions*, Springer, New York, NY, pp. 251-269.

Forza, C., Salvador, F. and Trentin, A. (2008), "Form postponement effects on operational performance: a typological theory", *International Journal of Operations & Production Management*, Vol. 28, No. 11, pp. 1067-1094.

Friedman, L., Fleishman, E. A. and Fletcher, J. M. (1992), "Cognitive and interpersonal abilities related to the primary activities of R&D managers", *Journal of Engineering and Technology Management*, Vol. 9, No. 3–4, pp. 211-242.

Gino, F. and Pisano, G. (2008), "Toward a theory of behavioral operations", *Manufacturing & Service Operations Management*, Vol. 10, No. 4, pp. 676-691.

Gray, B. J., Grundvåg Ottesen, G., Bell, J., Chapman, C. and Whiten, J. (2007), "What are the essential capabilities of marketers? A comparative study of managers', academics' and students' perceptions", *Marketing Intelligence & Planning*, Vol. 25, No. 3, pp. 271-295.

Greasley, A. and Owen, C. (2018), "Modelling people's behaviour using discrete-event simulation: a review", *International Journal of Operations & Production Management*, Vol. 38, No. 5, pp. 1228-1244.

Gritzo, L., Fusfeld, A. and Carpenter, D. (2017), "Success factors in R&D leadership", *Research-Technology Management*, Vol. 60, No. 4, pp. 43-52.

Gunasekaran, A. and Ngai, E. W. T. (2005), "Build-to-order supply chain management: a literature review and framework for development", *Journal of Operations Management*, Vol. 23, No. 5, pp. 423-451.

Huang, X., Kristal, M. M. and Schroeder, R. G. (2008), "Linking learning and effective process implementation to mass customization capability", *Journal of Operations Management*, Vol. 26, No. 6, pp. 714-729.

Huang, X., Kristal, M. M. and Schroeder, R. G. (2010), "The impact of organizational structure on mass customization capability: a contingency view", *Production and Operations Management*, Vol. 19, No. 5, pp. 515-530.

Huber, G. (1982), "Organizational information systems: determinants of their performance and behavior", *Management Science*, Vol. 28, No. 2, pp. 138-155.

Hvam, L., Mortensen, N. H. and Riis, J. (2008), *Product Customization*, Springer, Berlin, Germany.

Hyer, N. L. and Wemmerlov, U. (1989), "Group technology in the US manufacturing industry: a survey of current practices", *International Journal of Production Research*, Vol. 27, No. 8, pp. 1287-1304.

James, L. R., Demaree, R. G. and Wolf, G. (1984), "Estimating within-group interrater reliability with and without response bias", *Journal of Applied Psychology*, Vol. 69, No. 1, pp. 85-98.

Karlsson, C. and Sköld, M. (2018), "Specialization and commonalization in multi-branded manufacturing corporations: learnings from automotive industries", *International Journal of Operations & Production Management*, Vol. 38, No. 1, pp. 67-89.

Kashani, K. (1995), "Marketing futures: priorities for a turbulent environment", *Long Range Planning*, Vol. 28, No. 4, pp. 87-98.

Khandelwal Das, K., Kumar Upadhyay, A. and Das, S. (2014), "Getting stellar sales performance: why sales managers' mentoring, coaching and technology capabilities make the difference", *Development and Learning in Organizations: An International Journal*, Vol. 28, No. 5, pp. 13-16.

Kim, S., Mabin, V. J. and Davies, J. (2008), "The theory of constraints thinking processes: retrospect and prospect", *International Journal of Operations & Production Management*, Vol. 28, No. 2, pp. 155-184.

Knight, W. A. (1998), "Group technology, concurrent engineering and design for manufacture and assembly", in Suresh, N. C. and J. M. Kay, (Eds.), *Group Technology and Cellular Manufacturing: A State-of-the-Art Synthesis of Research and Practice*, Springer US, Boston, MA, pp. 15-36.

Kortmann, S., Gelhard, C., Zimmermann, C. and Piller, F. T. (2014), "Linking strategic flexibility and operational efficiency: the mediating role of ambidextrous operational capabilities", *Journal of Operations Management*, Vol. 32, No. 7, pp. 475-490.

Kotter, J. P. and Schlesinger, L. A. (2008), "Choosing strategies for change", *Harvard Business Review*, Vol. 86, No. 7-8, pp. 130-139.

Kotzab, H., Teller, C., Bourlakis, M. and Wünsche, S. (2018), "Key competences of logistics and SCM professionals—The lifelong learning perspective", *Supply Chain Management: An International Journal*, Vol. 23, No. 1, pp. 50-64.

Kristal, M. M., Huang, X. and Schroeder, R. G. (2010), "The effect of quality management on mass customization capability", *International Journal of Operations & Production Management*, Vol. 30, No. 9, pp. 900-922.

Lai, F., Zhang, M., Lee, D. M. S. and Zhao, X. (2012), "The impact of supply chain integration on mass customization capability: an extended resource-based view", *IEEE Transactions on Engineering Management*, Vol. 59, No. 3, pp. 443-456.

Lau, R. S. M. (1995), "Mass customization: the next industrial revolution", *Industrial Management*, Vol. 37, No. 5, pp. 18-19.

Leffakis, Z. M. and Dwyer, D. J. (2014), "The effects of human resource systems on operational performance in mass customisation manufacturing environments", *Production Planning & Control*, Vol. 25, No. 15, pp. 1213-1230.

Liu, G., Shah, R. and Schroeder, R. G. (2006), "Linking work design to mass customization: a sociotechnical systems perspective", *Decision Sciences*, Vol. 37, No. 4, pp. 519-545.

MacDuffie, J. P., Sethuraman, K. and Fisher, M. L. (1996), "Product variety and manufacturing performance: evidence from the International Automotive Assembly Plant Study", *Management Science*, Vol. 42, No. 3, pp. 350-369.

Mann, H. B. and Whitney, D. R. (1947), "On a test of whether one of two random variables is stochastically larger than the other", *The Annals of Mathematical Statistics*, Vol. 18, No. 1, pp. 50-60.

Marrelli, A. F. (1998), "An introduction to competency analysis and modeling", *Performance Improvement*, Vol. 37, No. 5, pp. 8-17.

McClelland, D. C. (1973), "Testing for competence rather than for "intelligence"", *American Psychologist*, Vol. 28, No. 1, pp. 1-14.

Morris, M. H., Webb, J. W., Fu, J. and Singhal, S. (2013), "A competency-based perspective on entrepreneurship education: conceptual and empirical insights", *Journal of Small Business Management*, Vol. 51, No. 3, pp. 352-369.

Peng, D. X., Schroeder, R. G. and Shah, R. (2008), "Linking routines to operations capabilities: a new perspective", *Journal of Operations Management*, Vol. 26, No. 6, pp. 730-748.

Pine, B. J. (1993), *Mass Customization: The New Frontier in Business Competition*, Harvard Business School Press, Cambridge, MA.

Powers, T. L., Jennings, J. A. and DeCarlo, T. E. (2014), "An assessment of needed sales management skills", *Journal of Personal Selling & Sales Management*, Vol. 34, No. 3, pp. 206-222.

Puccio, G. J., Mance, M. and Murdock, M. C. (2007), *Creative Leadership: Skills That Drive Change*, Sage Publications, Inc., Thousand Oaks, CA.

Rifkin, K. I., Fineman, M. and Ruhnke, C. H. (1999), "The human side: developing technical managers—First you need a competency model", *Research-Technology Management*, Vol. 42, No. 2, pp. 53-57.

Salvador, F., de Holan, P. M. and Piller, F. (2009), "Cracking the code of mass customization", *MIT Sloan Management Review*, Vol. 50, No. 3, pp. 71-78.

Salvador, F., Rungtusanatham, M., Forza, C. and Trentin, A. (2007), "Mix flexibility and volume flexibility in a build-to-order environment: synergies and trade-offs", *International Journal of Operations & Production Management*, Vol. 27, No. 11, pp. 1173-1191.

Sandrin, E. (2016), "An empirical study of the external environmental factors influencing the degree of product customization", *International Journal of Industrial Engineering and Management*, Vol. 7, No. 4, pp. 135-142.

Sandrin, E., Trentin, A. and Forza, C. (2014), "Organizing for mass customization: literature review and research agenda", *International Journal of Industrial Engineering and Management*, Vol. 5, No. 4, pp. 159-167.

Sandrin, E., Trentin, A. and Forza, C. (2018), "Leveraging high-involvement practices to develop mass customization capability: a contingent configurational perspective", *International Journal of Production Economics*, Vol. 196, No. 1, pp. 335–345.

Selim, H. M., Askin, R. G. and Vakharia, A. J. (1998), "Cell formation in group technology: review, evaluation and directions for future research", *Computers & Industrial Engineering*, Vol. 34, No. 1, pp. 3-20.

Shunk, D. L. (1985), "Group technology provides organized approach to realizing benefits of CIMS", *Industrial Engineering*, Vol. 17, No. 4, pp. 74-76, 78.

Siggelkow, N. (2007), "Persuasion with case studies", *Academy of Management Journal*, Vol. 50, No. 1, pp. 20-24.

Siva, V., Gremyr, I. and Halldórsson, Á. (2018), "Organising sustainability competencies through quality management: integration or specialisation", *Sustainability*, Vol. 10, No. 5, 1326, pp. 1-14.

Sousa, R. and da Silveira, G. J. C. (2019), "The relationship between servitization and product customization strategies", *International Journal of Operations & Production Management*, Vol. 39, No. 3, pp. 454-474.

Spencer, L. M. and Spencer, S. M. (1993), *Competence at Work: Models for Superior Performance*, John Wiey & Sons, Inc., New York, NY.

Squire, B., Brown, S., Readman, J. and Bessant, J. (2006), "The impact of mass customisation on manufacturing trade-offs", *Production and Operations Management*, Vol. 15, No. 1, pp. 10-21.

Suresh, N. C. and Kay, J. M. (1998), "Group technology & cellular manufacturing: updated perspectives", in Suresh, N. C. and J. M. Kay, (Eds.), *Group Technology and Cellular Manufacturing: A State-of-the-Art Synthesis of Research and Practice*, Springer US, Boston, MA, pp. 1-14.

Suzić, N., Forza, C., Trentin, A. and Anišić, Z. (2018), "Implementation guidelines for mass customization: current characteristics and suggestions for improvement", *Production Planning & Control*, Vol. 29, No. 10, pp. 856-871.

Tett, R. P., Guterman, H. A., Bleier, A. and Murphy, P. J. (2000), "Development and content validation of a" hyperdimensional" taxonomy of managerial competence", *Human Performance*, Vol. 13, No. 3, pp. 205-251.

Tognazzo, A., Gubitta, P. and Gerli, F. (2017), "Fostering performance through leaders' behavioral competencies: an Italian multi-level mixed-method study", *International Journal of Organizational Analysis*, Vol. 25, No. 2, pp. 295-311.

Trentin, A., Forza, C. and Perin, E. (2012), "Organisation design strategies for mass customisation: an information-processing-view perspective", *International Journal of Production Research*, Vol. 50, No. 14, pp. 3860-3877.

Trentin, A., Forza, C. and Perin, E. (2015), "Embeddedness and path dependence of organizational capabilities for mass customization and green management: a longitudinal case study in the machinery industry", *International Journal of Production Economics*, Vol. 169, No. 1, pp. 253-276.

Tushman, M. L. and Nadler, D. A. (1978), "Information processing as an integrating concept in organizational design", *Academy of Management Review*, Vol. 3, No. 3, pp. 613-624.

van Dun, D. H., Hicks, J. N. and Wilderom, C. P. M. (2017), "Values and behaviors of effective lean managers: mixed-methods exploratory research", *European Management Journal*, Vol. 35, No. 2, pp. 174-186.

VERBI Software. (2017), *MAXQDA 2018 Analytics Pro, computer program*, VERBI Software, Berlin, Germany.

Villena, V. H., Lu, G., Gomez-Mejia, L. R. and Revilla, E. (2018), "Is top management team-supply chain manager interaction the missing link? An analysis of risk-bearing antecedents for supply chain managers", *International Journal of Operations & Production Management*, Vol. 38, No. 8, pp. 1640-1663.

Voss, C., Tsikriktsis, N. and Frohlich, M. (2002), "Case research in operations management", *International Journal of Operations & Production Management*, Vol. 22, No. 2, pp. 195-219.

Wang, Q., Wang, Z. and Zhao, X. (2015), "Strategic orientations and mass customisation capability: the moderating effect of product life cycle", *International Journal of Production Research*, Vol. 53, No. 17, pp. 5278-5295.

Wang, Z., Chen, L., Zhao, X. and Zhou, W. (2014), "Modularity in building mass customization capability: the mediating effects of customization knowledge utilization and business process improvement", *Technovation*, Vol. 34, No. 11, pp. 678-687.

Wang, Z., Zhang, M., Sun, H. and Zhu, G. (2016), "Effects of standardization and innovation on mass customization: an empirical investigation", *Technovation*, Vol. 48–49, No., pp. 79-86.

Wesselink, R., Blok, V., van Leur, S., Lans, T. and Dentoni, D. (2015), "Individual competencies for managers engaged in corporate sustainable management

practices", *Journal of Cleaner Production*, Vol. 106, No. 1 November, pp. 497-506.

Wiengarten, F., Singh, P. J., Fynes, B. and Nazarpour, A. (2017), "Impact of mass customization on cost and flexibility performances: the role of social capital", *Operations Management Research*, Vol. 10, No. 3-4, pp. 137-147.

Yin, R. K. (2009), *Case Study Research: Design and Methods*, Sage Publications, Inc., Thousand Oaks, CA.

Zhang, M., Guo, H., Huo, B., Zhao, X. and Huang, J. (2019), "Linking supply chain quality integration with mass customization and product modularity", *International Journal of Production Economics*, Vol. 207, No. January, pp. 227-235.

Zhang, M., Qi, Y. and Guo, H. (2017), "Impacts of intellectual capital on process innovation and mass customisation capability: direct and mediating effects", *International Journal of Production Research*, Vol. 55, No. 23, pp. 6971-6983.

Zhang, M., Zhao, X. and Qi, Y. (2014), "The effects of organizational flatness, coordination, and product modularity on mass customization capability", *International Journal of Production Economics*, Vol. 158, No. 1, pp. 145-155.

Zhang, M., Zhao, X. D., Lyles, M. A. and Guo, H. F. (2015), "Absorptive capacity and mass customization capability", *International Journal of Operations & Production Management*, Vol. 35, No. 9, pp. 1275-1294.

Zipkin, P. (2001), "The limits of mass customization", *MIT Sloan Management Review*, Vol. 42, No. 3, pp. 81-87.

Appendix A: Final IC codebook

Goal and action management ICs

1. *Efficiency orientation*:	The ability to assess input/output relationships and to increase the efficiency of action.[1]
2. *Planning*:	The ability to identify and organize future or intended actions with a result or direction. [1]
3. *Initiative*:	The ability to take action to accomplish something, and to take this action prior to being asked or forced or provoked into it. A person displaying initiative is clearly identified as the initiator of actions in a situation. [1]
4. *Attention to detail*:	The ability to seek order and predictability by reducing uncertainty. This is often enacted by a person giving careful consideration prior to and taking actions. [1]
5. *Self-control*:	The ability to inhibit personal needs or desires for the benefit of organizational, family, or group needs. [1]
6. *Flexibility*:	The ability to adapt to changing circumstances, or alter one's behavior to better fit the situation. [1]
7. *Achievement orientation*:	The ability to compete against a standard of excellence. The standard may be the individual's own past performance, an objective measure, the performance of others, challenging goals set by the individual, or even what *anyone* has ever done. [2]
8. *Information seeking*:	The ability to know more about things, people or issues. [2]
9. *Organizational commitment*:	The ability to align one's behavior with the needs, priorities, and goals of the organization. [2]

People management ICs

10. *Empathy*:	The ability to understand others. [1]
11. *Persuasiveness*:	The ability to convince another person or persons of the merits of, or to adopt, an attitude, opinion, or position. [1]
12. *Networking*:	The ability to build relationships, whether they are one-to-one relations, a coalition, an alliance, or a complex set of relationships among a group of people. [1]
13. *Negotiation*:	The ability to stimulate individuals or groups toward resolution of a conflict. [1]
14. *Self-confidence*:	The ability to consistently display decisiveness or presence. [1]
15. *Group management*:	The ability to stimulate members of a group to work together effectively. [1]
16. *Developing others*:	The ability to stimulate someone to develop his/her abilities or improve their performance toward an objective.[1]
17. *Oral communications*:	The ability to explain, describe or tell something to others through a personal presentation. [1]
18. *Customer-service orientation*:	The ability to discover and meet the needs of an internal or external customer. [2]
19. *Teamwork*:	The ability to work cooperatively with others, to be part of a team, to work together, as opposed to working separately or competitively. [2]

20.	*Organizational awareness*:	The ability to understand the power relationships in one's own or other organizations and, at the higher levels, the position of the organization in the larger world. [2]
21.	*Directiveness*:	The ability to make others comply with one's wishes, where personal power or the power of one's position is used appropriately and effectively, with the long-term good of the organization in mind. [2]
22.	*Leadership*:	The ability to take a role as a leader of a team or other group. [2]
23.	*Emotional self-awareness*:	The ability to recognize one's emotions and their effects.[3]
24.	*Positive outlook*:	The ability to see the positive aspects of things and the future. [3]

Analytic reasoning ICs

25.	*Use of concepts*:	The ability to apply concepts to interpret or explain situations. The concept should have been in mind prior to the event or situation being interpreted. [1]
26.	*Analytical thinking*:	The ability to order multiple causal events. [1, 2]
27.	*Pattern recognition*:	The ability to identify a pattern in an assortment of unorganized information or seemingly random data. [1]
28.	*Theory building*:	The ability to develop, or invent, new theories, models, or frameworks that explain available information and predict future events. [1]
29.	*Using technology*:	The ability to use advanced technology to perform tasks or functions on the job. [1]
30.	*Quantitative analysis*:	The ability to derive meaning from the use of arithmetic and mathematical symbols, methods, and theories. [1]
31.	*Social objectivity*:	The ability to perceive another person's beliefs, emotions, and perspectives, particularly when they are different from the observer's own beliefs, emotions, and perspectives. [1]
32.	*Written communication*:	The ability to explain, describe, or tell something to others through a memo, letter, report or written document. [1]
33.	*Visionary thinking*:	The ability to articulate a vivid image of what you desire to create. [4]
34.	*Problem awareness*:	The ability to perceive situations that may require action to promote organizational success. [5]
35.	*Opportunity recognition*:	The ability to perceive changed conditions or overlooked possibilities in the environment that represent potential sources of profit or return to a venture. [6]

[1] Boyatzis *et al.* (1995)

[2] Spencer and Spencer (1993)

[3] Boyatzis (2009)

[4] Puccio *et al.* (2007)

[5] Tett *et al.* (2000)

[6] Morris *et al.* (2013)

Appendix B: Examples of behavioral indicators and of chains of evidence

Table B1. Behavioral indicators of the ICs found to differentiate OMs working in high- vs. low-MCC organizations

Individual competency	**Behavioral indicators** **The use of the IC is indicated by one or more of the following behaviors:**	**Source of the behavioral indicators**
Analytical thinking	a) Describes multiple causal events (i.e., multiple cause-and-effect relationships) in terms of a series, plan of action and events, or flow diagram. b) Establishes priorities among a list of at least three alternative actions reflecting a concept of multiple causality (i.e., A should be done first because it leads to B, which leads to C and we want C to occur).	Boyatzis *et al.* (1995)
Information seeking	a) Asks direct questions of immediately available people (or people who are directly involved in the situation even if not physically present), consults available resources. b) Gets out personally to see the factory or other work-related situation. Questions those closest to the problem when others might ignore these people. c) Asks a series of questions to get at the root of a situation or a problem, below the surface presentation. d) Calls on others, who are not personally involved, to get their perspective, background information, experience. e) Makes a systematic effort over a limited period of time to obtain needed data or feedback; or does formal research through newspapers, magazines, or other resources. f) Has personally established ongoing systems or habits for various kinds of information gathering. g) Involves others who would not normally be involved and gets them to seek out information.	Spencer and Spencer (1993)
Pattern recognition	a) Identifies a pattern in events or information not used by others and uses the pattern to explain or interpret the events or information. b) Reduces large amounts of information through the use of a concept not previously applied to this situation or information. c) Sees similarities of a new situation to aspects of past situations of a different type. d) Uses metaphors or analogies to explain events or information (this should be more than a figure of speech or single phrase).	Boyatzis *et al.* (1995)
Negotiation	a) Involves all parties in openly discussing the conflict with the intent of resolving the conflict. b) Identifies areas of mutual interest or benefit, often an objective to which all parties can aspire. c) Determines the concerns or positions of each of the parties and communicates them to all involved as an initial step toward open discussion of the conflict.	Boyatzis *et al.* (1995)
Efficiency orientation	a) Assesses inputs and outputs, or costs and benefits, with the expressed intent of increasing efficiency. b) Expresses a concern with doing something more efficiently. c) Uses resources to progress towards goals more efficiently.	Adapted from Boyatzis *et al.* (1995)

Table B2. Examples of chains of evidence

Individual competency	Case (main product line(s)) – MCC level	Contextual information	Behavioral-event-interview excerpt coded into the IC (behavioral indicator, as per Table B1 in Appendix B)	Linkage between the IC and MCC
Analytical thinking	B (heat exchangers) – High MCC	"Our company has always had a focus on customer service, but this goal had traditionally been accomplished in a way that was not so efficient: no control over the progress of customer order fulfillment process and a last-gasp effort to meet the due date."	"Each production supervisor [traditionally] saw his/her department as an island, did optimizations locally […] So, the two most downstream departments were constantly under pressure, as they had to deliver to customers, but also cope with all the problems created upstream." "[To overcome this problem,] I got some information tools created to enable all production supervisors to see themselves as a part of the overall process […] I gave them visibility over the [master] production schedule and over the progress of its implementation." (b)	"Today, we have many people that are moved across [production] departments; there is an exchange of workers to support the areas that, from time to time [i.e., depending on which products customers are demanding at that moment], are under pressure."
Information seeking	D (static converters for the control of electric motors) – High MCC	"Very often, for the most critical objects [i.e., purchase materials with long sourcing lead-times], we purchase them even though we do not have a real [customer] order yet." These purchase materials are characterized by relatively high unit costs and by a strong risk of obsolescence, owing to their high degree of customization and their increasingly shorter life cycles. As a result, inventory-holding costs for these items are relatively high.	"I need to know 'what is cooking': if the negotiation [with the customer] is going in one direction or another; if a certain [customer] order is likely to materialize in the short run […] I am constantly in touch with the sales department." (f)	"I go to the purchasing department and say, 'The negotiation with the customer is at this point. We do not have a complete bill of materials yet [… Nonetheless,] start releasing orders for long-lead-time materials' […] Clearly, all this must be carefully thought over, as I am also responsible for inventory [levels], and I could end up having a big stock of materials […] The [customer] order was entered in late May and the delivery date [promised to the customer] was September 1st. If you consider that August is a month that [virtually] does not exist […] For sure, we would have failed to meet the delivery date, had I not acted this way."
Pattern recognition	C (electric motors and	"So, the left-most part of this table [i.e., spreadsheet] reports all [capacity]	"To synthesize these [capacity] constraints in a manner that could be understood and used by the person in charge of order promising, I assigned a weight to each type of machine [i.e., motor or generator] and frame size [i.e., X, Y, Z, W (actual	"The right-most part of the table has a row for each type of machine with a certain frame size and has a column for each of the next 20 weeks. So, each cell reports the number of, say, generators with frame size X to complete in a certain week. Below each column, we have the total—that is, the

	generators) – High MCC	constraints, both for individual frame sizes and for combinations of sizes."	figures are not reported for confidentiality reasons)… Specifically,] the generator with frame size X has a weight of one [equivalent machine]; the generator with frame size W has a weight of two [equivalent machines], etc. And we know we cannot build more than 60 equivalent machines per week. With these weights, all weekly constraints for the various types of machines and for the various sizes of frames are translated into a single, weekly constraint in terms of equivalent machines." (b)	number of equivalent machines to complete in that week. The system gives you a warning each time you violate one of the constraints reported on the left [of the table] and/or the constraint on the total [on the right of the table]. So, the system tells you if the delivery date you are promising is feasible, [and does this] even though the bill of materials, production cycle, and even a lot of technical characteristics of the machine are still to be specified." "[By doing this,] I succeeded in simplifying a thing that seemed very complicated; I created a tool that is very simple to use." "This system helps you avoid [production] overloads or, better, helps you avoid incurring overloads unknowingly."
Negotiation	D (static converters for the control of electric motors) – High MCC	"Five–six years ago, we entered the Chinese market [, which is characterized by high variability in demand volume…] In three months, we passed from producing 400 electric drives per month to producing 1,000 per month [...] The problem is that, in March 2017, this [Chinese] customer said, 'Gentlemen, slow down, from 1,000 drives down to zero'."	"I battled with the sales department, [which pushed for a very high degree of customization of the product targeted to the Chinese customer…] I also brought some numbers… the fact that we had high stocks of obsolete materials also came from there [i.e., from having custom components…] We found a good compromise." (b)	"The 'Chinese' product has the adjustment and all the electronic boards in common with our standard products […] if I had had to throw away all the electronic boards [when the Chinese customer zeroed its orders], the damage would have been much higher."
Efficiency orientation	A (electric motors) – High MCC	"Till a few years ago, this department [where six production lines carry out the winding of stator packs] was used to produce wound stator packs in rather large batches, and so there was quite a big inventory of such materials."	"The challenge was to lower this inventory—that is, to produce only what was required downstream by our 12 assembly lines. This is not that simple, if you consider the large variety of wound stator packs we produce. How did I manage to do that? I asked the information systems manager to make the final assembly schedule, with the quantities of the various motors to complete each day, visible to this department [which produces wound stator packs]." (c)	"In this manner, the department [that produces wound stator packs] will not start making the easiest thing for itself, but knows that priority must be given to the materials required by the motors that will be assembled on, say, March 30. This has enabled us to automatically reduce our inventory." "On one occasion, we had a lot of absences from work in this department; we had scarce personnel and we could not afford to waste our resources. On that occasion, I showed to the head of the department that these [assembly] dates gave me the priorities: based on the types of motors that would be assembled on those dates, I chose to assign the [available] workers to one production line rather than to another."

List of captions

Table I: Results of the Mann-Whitney U statistical test

Table I. Results of the Mann-Whitney U statistical test

Boyatzis *et al.*'s (1995) IC cluster	IC number (as per Appendix A)	Individual competency	Mean frequency for: high-MCC subsample	Mean frequency for: low-MCC subsample	Mann-Whitney Z value	Exact sig. (2-tailed)	$p<0.05$
Goal and action management	1	Efficiency orientation	3.25	1.50	-2.397	0.029	✓
	2	Planning	3.00	2.50	-0.599	0.771	
	3	Initiative	0.75	0.50	-0.316	1.000	
	4	Attention to detail	1.50	1.00	-0.661	0.714	
	5	Self-control	0.50	0.25	-0.683	1.000	
	6	Flexibility	1.75	0.50	-1.214	0.400	
	7	Achievement orientation	2.00	1.50	-1.265	0.143	
	8	Information seeking	2.50	0.00	-2.460	0.029	✓
	9	Organizational commitment	0.75	0.25	-0.833	0.714	
People management	10	Empathy	1.75	0.75	-1.049	0.400	
	11	Persuasiveness	2.50	2.25	-0.619	0.657	
	12	Networking	0.75	0.50	-0.189	1.000	
	13	Negotiation	2.25	0.00	-2.477	0.029	✓
	14	Self-confidence	0.75	1.50	-0.899	0.571	
	15	Group management	0.75	0.50	-0.683	1.000	
	16	Developing others	1.25	0.75	-0.661	0.714	
	17	Oral communication	0.25	0.25	0.000	1.000	
	18	Customer-service orientation	1.75	1.00	-1.084	0.486	
	19	Teamwork	0.25	0.25	0.000	1.000	
	20	Organizational awareness	1.00	0.25	-2.049	0.143	
	21	Directiveness	1.25	0.75	-0.607	0.657	
	22	Leadership	1.25	1.50	-0.331	1.000	
	23	Emotional self-awareness	0.00	0.25	-1.000	1.000	
	24	Positive outlook	0.00	0.25	-1.000	1.000	
Analytic reasoning	25	Use of concepts	0.75	0.50	-0.683	1.000	
	26	Analytical thinking	2.00	0.00	-2.477	0.029	✓
	27	Pattern recognition	2.75	0.25	-2.381	0.029	✓
	28	Theory building	0.25	0.00	-1.000	1.000	
	29	Using technology	0.50	0.00	-1.000	1.000	
	30	Quantitative analysis	0.00	0.00	0.000	1.000	
	31	Social objectivity	0.75	0.25	-1.323	0.486	
	32	Written communication	0.25	0.75	-0.833	0.714	
	33	Visionary thinking	1.00	1.00	0.000	1.000	
	34	Problem awareness	1.75	1.25	-0.607	0.714	
	35	Opportunity recognition	0.00	0.25	-1.000	1.000	