Università degli Studi di Padova

Department of Management and Engineering

Ph.D. Course in Management Engineering and Real Estate Economics

XXXI CYCLE

ISCTE - Instituto Universitário de Lisboa

Department of Human Resources and Organizational Behavior

Ph.D. Course in Management

Curriculum: Human Resources and Organizational Behavior

OPERATIONS MANAGER'S INDIVIDUAL COMPETENCIES FOR MASS CUSTOMIZATION

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Thesis submitted in 2018

Ho sempre avuto l'idea che navigando ci siano soltanto due veri maestri,
uno è il mare, e l'altro è la barca,
E il cielo, state dimenticando il cielo,
Si, chiaro, il cielo, i venti, le nuvole, il cielo,
Si, il cielo.

José Saramago

A Vítor, mia stella polare

La gente non se lo sogna neanche che chi finisce una cosa
non è mai quello che l'ha cominciata,
anche se entrambi hanno un nome uguale,
che è solo questo a mantenersi costante, nient'altro.

José Saramago

ABSTRACT

To compete successfully in today's business environment, which is fraught with very heterogeneous and uncertain customer demands, manufacturing organizations are increasingly aiming to develop their mass customization capability (MCC), defined as the ability to fulfill each customer's idiosyncratic needs without considerable trade-offs in cost, delivery, and quality.

The literature has overlooked the role of individual competencies (ICs) in the development of MCC, even though companies are paying growing attention to the challenge of developing their employees' competencies.

The present study was aimed at narrowing this gap by using a well-established method for conducting IC assessments—namely, the behavioral event interview—to investigate the ICs of an operations manager (OM), which is among the professional roles most affected by product customization, that enhance the MCC of the manufacturing organization for which the OM works.

A multiple-case study was designed involving eight cases chosen according to literal and theoretical replication logic among the machinery manufacturers of one European country. From this sample, I collected multilevel data on the MCC of each organization and on the OMs' ICs.

Five OM ICs—*negotiation, information seeking, efficiency orientation, analytical/systems thinking*, and *pattern recognition*—emerged from this study, and this thesis provides empirical evidence and logical explanations for the positive effects of these ICs on a manufacturing organization's MCC.

This PhD thesis is the first research on MCC-enabling managerial competencies that relies on multilevel data, considering both an organization's MCC and its managers' ICs, rather than on practitioners' experiences and opinions. This study also has managerial implications, providing guidance for the

human resources management practices of companies pursuing a mass customization strategy.

This study could be replicated for other managerial roles as well as in other industries and countries.

ABSTRACT

Para competir com sucesso no atual contexto de mercado, caracterizado pela existência de clientes exigentes, heterogéneos e nem sempre de fácil compreensão, as organizações produtivas estão a desenvolver cada vez mais a sua capacidade de mass costumization (MCC), definida como a capacidade de satisfazer a exigência idiossincrática de cada cliente sem compromissos significativos em termos de custo, tempo de entrega e qualidade.

A literatura tem vindo a negligenciar o papel das competências individuais (IC) no desenvolvimento da MCC, mesmo se as empresas atualmente estão a ter maior atenção à oportunidade de desenvolver a competência dos próprios colaboradores.

O presente estudo teve como objetivo reduzir essa lacuna, utilizando um método de avaliação das IC bem consolidado—a behavioral event interview—e, desse modo, investigar como as IC de um operations manager (OM), sendo esse um dos papéis profissionais mais influenciados pela personalização de produto, melhora a MCC da empresa.

Para tanto, foi projetado um multiple-case study em oito empresas industriais, escolhidas com base na lógica da réplica literal e teórica entre fabricantes de máquinas de um país europeu. A partir dessa amostra recolhemos dados de vários níveis da MCC de cada organização e das IC do seu OM. Com o estudo emergiram cinco IC dos OMs—*negotiation, information seeking, efficiency orientation, analytical/systems thinking, e pattern recognition* —e o trabalho fornece evidências empíricas e explicações lógicas dos efeitos positivos dessas IC na MCC da empresa.

A presente tese é a primeira pesquisa sobre competências de gestão que facilitam a MCC e baseia-se em dados de vários níveis da MCC de uma organização e nas IC do seu OM e não sobre as suas experiências e opiniões. O

estudo apresenta também indicações para práticas de gestão ao nível dos recursos humanos em empresas que procuram uma estratégia de mass customization.

Este estudo apresenta a possibilidade de ser replicado noutros papéis profissionais, setores produtivos e até países.

ABSTRACT

Per competere con successo nell'attuale contesto di mercato, caratterizzato da esigenze dei clienti molto eterogenee e difficili da prevedere, le organizzazioni manifatturiere puntano sempre più a sviluppare la loro capacità di mass customization (MCC), definita come l'abilità di soddisfare le esigenze idiosincratiche di ogni cliente senza notevoli compromessi in termini di costo, tempi di consegna e qualità.

La letteratura ha trascurato il ruolo delle competenze individuali (IC) nello sviluppo della MCC, anche se le aziende stanno prestando crescente attenzione all'opportunità di sviluppare le competenze dei propri dipendenti.

Il presente studio è stato mirato a ridurre questo gap utilizzando un metodo di valutazione delle IC ben consolidato—ovvero, la behavioral event interview—per indagare le IC di un operations manager (OM), che è tra i ruoli professionali più influenzati dalla personalizzazione del prodotto, che migliorano la MCC dell'organizzazione produttiva per la quale l'OM lavora.

È stato progettato un multiple-case study che ha coinvolto otto organizzazioni manifatturiere, scelte in base alla logica di replicazione letterale e teorica tra i produttori di macchinari di un Paese europeo. Da questo campione ho raccolto dati multilivello sulla MCC di ciascuna organizzazione e sulle IC degli OM.

Da questo studio sono emerse cinque IC dell'OM—*negotiation, information seeking, efficiency orientation, analytical/systems thinking*, e *pattern recognition*— e questa tesi fornisce prove empiriche e spiegazioni logiche degli effetti positivi di queste IC sullla MCC di un'azienda manifatturiera.

Questa tesi di dottorato è la prima ricerca sulle competenze manageriali che facilitano la MCC che si basa su dati multilivello riguardanti la MCC di un'organizzazione e le IC del suo OM, piuttosto che sulle esperienze e opinioni

di professionisti. Questo studio ha anche delle implicazioni manageriali, fornendo indicazioni per le pratiche di gestione delle risorse umane delle aziende che perseguono una strategia di mass customization.

Questo studio potrebbe essere replicato per altri ruoli manageriali e in altri settori e paesi.

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1 INTRODUCTION

Today's business environment is becoming increasingly volatile, uncertain, complex, and ambiguous. The acronym VUCA (Volatility, Uncertainty, Complexity, Ambiguity) was introduced by the United States Army War College to describe the turbulence of the modern world of work (Stiehm & Townsend, 2002).

To compete successfully in a VUCA world, organizations must be agile and able to quickly respond to change, doing different things in different ways (Horney, Pasmore, & O'Shea, 2010). The key to staying ahead of competitors in today's business environment is to strike the right balance between product standardization and manufacturing flexibility (Lau, 1995).

In fact, manufacturing firms have recognized that mass customization can be the right answer to a highly competitive and uncertain environment (Liu, Shah, & Babakus, 2012), characterized by increasing heterogeneity in customers' demands (Lau, 1995). When properly implemented, mass customization not only leads to high levels of customization at low cost and customer satisfaction, partly through web-based customer interaction, but also improves quality and delivery speed. Mass customization strategy would, therefore, produce a winner in all competitive priorities—customization, price, service, quality, and delivery—simultaneously (Kumar, 2004).

Thus, to face the challenges of today's business environment, more and more organizations are aiming to develop their mass customization capability (MCC), which implies great challenges particularly in the area of operations management (Huang, Kristal, & Schroeder, 2008). MCC is the ability of an organization to provide customized products and services to meet the differentiated needs of customers without compromising on cost, delivery, and quality performance (e.g, Pine, 1993; Squire, Brown, Readman, & Bessant, 2006).

The literature on MCC enablers has increased considerably (Fogliatto, Da Silveira, & Borenstein, 2012), since Pine (1993) popularized the idea of mass customization. However, its initial focus was on technological variables; it now encompasses a variety of organization-level variables, but still neglects individual-level MCC enablers.

The only research on the individual characteristics that improve an organization's MCC is that of Forza and Salvador (2006), who relied on experts' opinions rather than on empirical evidence of the influence of such characteristics on MCC. The authors explored which individual competencies, classified according to Hoffman's definition (1999) into abilities, attitudes, and knowledge, are needed for mass customization. In this PhD research, I adopted the definition of individual competency (IC) put forward by Boyatzis (1982), the author of the first empirically based and thoroughly researched book on competency model development (Rothwell & Lindholm, 1999). It was through Boyatzis that the concept of work competencies became widely known (Yeung, 1996) and adopted to indicate an individual's underlying characteristics, including knowledge, skills, self-image, social roles, traits, and motives, "that are causally related to effective and/or superior performance in a job" (Boyatzis, 1982, p. 23).

The extant literature still lacks research into the relationship between ICs and MCC with a multilevel research design that allows for linking data on the ICs of employees to data on the MCC of the organization that employs those people. This research, which was aimed at understanding managers' behaviors that improve an organization's MCC, required the adoption of different disciplinary perspectives—namely, psychological/organizational, engineering, and managerial perspectives.

The adoption of an interdisciplinary approach offers insight that neither a traditional operational nor purely behavioral view can provide on its own (Gans &

Croson, 2008). Today, as real problems are more complex, interconnected, and contradictory than ever before, we require more interdisciplinary studies (Lyall & Meagher, 2012).

This research began with the design of a multiple-case study to collect multilevel data that would reveal the ICs of key managerial roles for mass customization that enhance the MCC of the manufacturing organization for which the managers work. However, the difficulty to get access to companies when asking to interview many managers, the importance of the role of operations manager (OM) in determining organizational capabilities (Slack, Chambers, & Johnston, 2010), especially in a mass-customization context (Åhlström & Westbrook, 1999), and the complete absence of studies on the ICs of OMs led me to focus the research on the following research question: Which ICs of an OM help improve a manufacturing organization's MCC and why is it so?

The results of this study contribute to the research in the emerging area of behavioral operations, which Gino and Pisano (2008) defined as "the study of human behavior and cognition and their impacts on operating systems and processes" (p. 679). This multilevel research, linking individual-level data on ICs to organizational-level data on MCC, satisfies the expectations of the behavioral operations field's evolution identified by Croson, Schultz, Siemsen and Yeo (2013): "we expect to see a more explicit discussion about the distinction between micro and macro, and the links between these levels" (p. 2).

The findings of this research, besides enriching the literature on MCC enablers, can pragmatically help organizations pursuing a mass customization strategy to select OMs with ICs, or to develop OMs' ICs through different training activities, that are coherent with this strategy.

The thesis is organized in six chapters, the first of which is the present introduction.

Chapter 2 is devoted to reviewing the literature on MCC and its enablers and on the ICs of key roles for mass customization: sales manager (SM), marketing manager (MM), R&D manager (R&DM), and OM. As mentioned above, several reasons led me to focus on research on which ICs of an OM help improve a manufacturing organization's MCC, and this enabled me to formulate the research question.

Chapter 3 describes in detail the methodology followed at each step of the research process, from broad constructions of the research to detailed methods of data collection, analysis, and interpretation.

Chapter 4 reports the results of the empirical investigation phase aimed at building a theory that links the "differentiating" ICs of OMs, which distinguish manufacturing organizations with higher MCC from those with lower MCC, to MCC. In this chapter, I identify the chains of evidence linking "differentiating" ICs to MCC that allowed for strengthening the internal validity of the results and deriving generalizations regarding the MCC-enabling role of these ICs.

Chapter 5 discusses the contributions of this research to literature in the fields of behavioral operations management, MCC, and IC. In addition, the managerial implications of this research are presented.

Finally, chapter 6 provides an overview of the results of this study and describes its limitations and future research opportunities.

2 LITERATURE REVIEW AND RESEARCH QUESTION

Adopting an interdisciplinary approach, this chapter links IC research, grounded in the fields of organizational behavior (OB) and human resource management (HRM), with MCC research, grounded in the field of operations management.

This study initially examined a broad range of managerial roles that are relevant to the development of a manufacturing organization's MCC: SM, MM, R&DM, and OM. Accordingly, the systematic review of literature on MCC and ICs considered all of these roles. The last part of the chapter focuses on the OM's role and extends the analysis beyond the academic literature, which is still silent as to OMs' ICs. The chapter ends with the formulation of the central research question.

2.1 THE INTERDISCIPLINARY NATURE OF THE STUDY

This research, which was aimed at understanding managers' behaviors, and their ICs beyond those behaviors that allow for improving the organization's MCC, required the adoption of different disciplinary perspectives—namely, psychological/organizational, engineering, and managerial perspectives.

Competency research started in the 1970s in the United States in the psychological field with McClelland (1973) and became an integral part of the study of OB—the science that studies human behavior in an organizational setting—owing to the works of Boyatzis (1982) and Spencer and Spencer (1993).

The competency approach and methodologies, shifting the focus from the job to the individual and his or her competencies (Nybø, 2004), have replaced traditional job-based human resources (HR) practices (Lawler III, 1994) and are used in the crucial processes of HRM. HRM, which deals with the management of HR in a structured way, therefore, is the discipline that offers concrete benefits for research on ICs.

This research entailed integrating the individual and organizational perspectives with the engineering perspective. In fact, MCC has been studied in the operations management research, which deals with the development and management of value-added processes and the tools, techniques, and methods that support them (Voss, 1995).

The disciplines cited—OB, HRM, and operations management—are different from an epistemological point of view and also belong to different knowledge subsystems (Choi & Pak, 2008). OB belongs to the subsystem of social sciences, HRM is part of management science, while operations management can be considered as an engineering science (Choi & Pak, 2008). As these disciplines belong to different knowledge subsystems, they are distant from each other, and it is precisely from the combination of these different disciplines, which are based on different epistemological assumptions, that new ideas and new knowledge are likely to emerge (Choi & Pak, 2008).

In this study, the adoption of an interdisciplinary approach allowed for harmonizing the links between disciplines into a coordinated and coherent whole (Choi & Pak, 2006). Interdisciplinary efforts sometimes can generate new disciplines (Choi & Pak, 2006). This is what happened in the early 2000s, when the integration of several disciplines, such as those mentioned, led to the creation of a sub-discipline of operations management called behavioral operations management (BOM) (Erjavec & Trkman, 2018).

BOM research explores the interaction of human behaviors and operational systems and processes and has "the goal to identify the ways in which human psychology and sociological phenomena impact operational performance" (Bendoly, van Wezel, & Bachrach, 2015).

Early studies in the BOM field focused on inventory, either on stochastic ordering policy (i.e., newsvendor) or on supply chain (i.e., beer game) (Croson et al., 2013). In the last decade, this field has attracted increased attention (Erjavec

& Trkman, 2018) and the research has encompassed several different fields, such as cognitive psychology, social psychology, group dynamics, and system dynamics (Bendoly, Croson, & Schu, 2009), but using a theoretical grounding that is generally limited to a few areas of behavioral research, such as bounded rationality and motivation theory (Croson et al., 2013). Therefore, the BOM research needs a behavioral theory underpinning to tie theories of behavior to operations settings (Croson et al., 2013), and applying a competency approach to the operations context can make a contribution in this direction.

A competency-based approach can be especially suitable for personnel assessment in a supply chain—an area of research that should become vital for the field of BOM, according to Croson et al. (2013).

In the future, the focus of research on behavioral aspects and personality traits (Witt & Baker, 2018) may be more important and would result in a new cluster of BOM (Erjavec & Trkman, 2018).

This thesis, by adopting a competency-based approach and methodologies, can be considered to fall within the field of BOM studies, and it is aimed at contributing to the development of a new stream of research focused on behavioral aspects.

2.2 MASS CUSTOMIZATION CAPABILITY AND ITS ENABLERS

As previously observed, MCC denotes the ability of an organization to provide customized products and 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). This capability, in accord with the view of capabilities that is typical of the operations strategy literature (Peng, Schroeder, & Shah, 2008), is generally conceptualized as competitive performance (Huang, Kristal, & Schroeder, 2010; Trentin, Forza, & Perin, 2015).

This performance dimension captures the mitigation of the trade-off between strategic flexibility and operational efficiency (Kortmann, Gelhard, Zimmermann, & Piller, 2014). MCC not only brings together two rival competitive priorities—*price* and *customization* (also called *flexibility* in the language of operations strategy)—but also simultaneously improves competitive performance in other key priorities (Kumar, 2004). When thoughtfully implemented through appropriate production systems, a mass customization strategy comprehensively addresses all the competitive priorities: customization, price, customer satisfaction and the remaining two key priorities—*quality* and *delivery* (Kumar, 2004). MCC, therefore, permits to improve a firm's performance on all five priorities—price, flexibility, service, quality, and delivery — simultaneously.

How to achieve MCC is a question that many studies have addressed (Fogliatto et al., 2012). Initially, the mass customization research focused on technological enablers (Sandrin, Trentin, & Forza, 2014), such as product modularity (Duray, Ward, Milligan, & Berry, 2000), parts commonality (Perera, Nagarur, & Tabucanon, 1999), delayed product differentiation (Feitzinger & Lee, 1997), and product configuration systems (Forza & Salvador, 2002).

Product modularity refers to the extent to which the components of a product can be separated and recombined to make different variants of the same product (Salvador, 2007; Schilling, 2000).

On the other hand, parts commonality, also known as parts standardization, is the replacement of different components with one component that can perform the functions of all of them (Perera et al., 1999). Product modularity and parts commonality allow for mass-customized products to achieve the low cost and consistent quality associated with repetitive manufacturing (Duray et al., 2000).

Another highly renowned enabler of MCC is the capacity to delay product

differentiation along the manufacturing and distribution process. This capacity is also known as form postponement, or simply postponement, and means delaying, along a manufacturing and distribution process, one or more activities that specialize the work-in-progress inventory into specific end products (Forza, Salvador, & Trentin, 2008; Gang & Tang, 1997). By reducing the variety of components and activities at the earlier stages of the production process, postponement allows for delivering customized products quickly and at a low cost (Gang & Tang, 1997).

On the information technology (IT) front, finally, the capacity to implement and maintain a product configurator plays a crucial role in the development of MCC. Product configurators are IT-based systems that support both commercial and technical configuration processes. The commercial configuration process implies the translation of the customer's needs into a complete and correct description of all the sales characteristics used by the company to identify a specific product solution (Forza & Salvador, 2007).

The technical configuration process implies the generation of the technical product data necessary to build a product solution that is based on the solution's sales description (Forza & Salvador, 2007). Consequently, product configurators facilitate order acquisition and fulfillment by acquiring complete and correct customer specifications and by generating product- and manufacturing-related data (Peng, Liu, & Heim, 2011; Trentin, Perin, & Forza, 2012).

2.2.1 Organizational enablers of mass customization

There has recently been growing interest in the organizational enablers of MCC to understand, in particular, the organizational capabilities at the foundation of MCC. Organizational capabilities are often depicted in the literature as

combinations of routines, defined as repetitive patterns of interdependent organizational actions, characterized by a recognizable organization-level purpose (Felin, Foss, Heimeriks, & Madsen, 2012; Salvato & Rerup, 2011).

In this study, I adopted a definition of organizational capability in line with the conceptualization used in the strategic management literature. According to this view, organizational capabilities are the organizational knowledge of how to repeatedly manage inputs in order for the organization to obtain a desired output (Dosi, Faillo, & Marengo, 2008; Grant, 1996), and therefore can be thought of as "means" or pathways to achieve this outcome (Trentin et al., 2015).

MCC represents a performance outcome, and mass customization is about moving toward this goal by developing a set of organizational capabilities that can ensure a long-lasting competitive advantage (Salvador, Martin de Holan, & Piller, 2009).

Salvador et al. (2009) proposed three organizational capabilities that determine the fundamental ability of an organization to mass-customize its offering:

1. SOLUTION SPACE DEVELOPMENT: the capacity to identify the product attributes along which customers' needs diverge;
2. CHOICE NAVIGATION: the capacity to help customers determine their own solutions while minimizing complexity and the burden of choice;
3. ROBUST PROCESS DESIGN: the capacity to reuse or recombine existing resources to fulfill a stream of differentiated customer needs.

Other organization-level enablers that have been studied are as follows:

- HRM practices (Leffakis & Dwyer, 2014; Sandrin, Trentin, & Forza, 2018);
- Organizational-learning practices (Huang et al., 2008; Q. Wang, Wang, & Zhao, 2015; Z. Wang, Chen, Zhao, & Zhou, 2014);

- Intellectual capital (Zhang, Qi, & Guo, 2017);

- Organizational structure (Huang et al., 2010; Zhang, Zhao, & Qi, 2014);

- Cross-functional integration and coordination mechanisms (Ahmad, Schroeder, & Mallick, 2010; Lai, Zhang, Lee, & Zhao, 2012; Trentin et al., 2012; Zhang et al., 2014);

- Standardization and innovation capabilities (Z. Wang, Zhang, Sun, & Zhu, 2016);

- Absorptive capacity (Zhang, Zhao, Lyles, & Guo, 2015).

2.2.2 The role of individuals in the development of mass customization capability

Individuals and their ICs undoubtedly play a role in the development of MCC. An important enabler of mass customization is knowledge (Da Silveira, Borenstein, & Fogliatto, 2001), which also resides in the expertise, skills, and abilities of individuals. Employees' knowledge, skills, and capabilities, conceptualized as human capital, in fact constitute the foundation of a manufacturer's knowledge base and have direct and positive effects on both process innovation and MCC (Zhang et al., 2017). Employees' behavioral and technical competencies allow them to adjust current products and processes in accordance with changes in customer preferences and market environments (Zhang et al., 2017).

To identify which ICs contribute to the successful implementation of a mass customization strategy, I conducted a systematic literature review. The systematic literature review method was adopted to explain in a transparent and replicable manner how the relevant literature was selected (Müller-Seitz, 2012; Tranfield, Denyer, & Smart, 2003).

A preliminary search of scientific databases (SCOPUS and Web of Science) showed that studies focusing on the role of ICs in the pursuit of mass customization were limited to the work of Forza and Salvador (2006).

Consequently, I decided to include in the phrase search other terms related to the construct of ICs considering Boyatzis's (1982) definition of competency as "an underlying characteristic of a person, in that it may be a motive, trait, skill, aspect of one's self-image or social role, or a body of knowledge" (p. 21) and the construct of microfoundations. Microfoundations are the micro-level components underlying the routines and capabilities of an organization. Individuals with their characteristics, abilities, and psychological foundations are an important part of the microfoundations, even if the microfoundations do not focus solely on individuals and do not deny the role of structure (Barney & Felin, 2013; Felin et al., 2012).

The phrase search included (skill* OR competenc* OR capab* OR knowledge OR ability* OR attitud* OR behavior* OR microfoundation*) AND "mass custom*".

This search produced over 1,700 results using the following inclusion criteria:

- Electronic database search (SCOPUS, WoS);
- Search in 'Title, abstract, keywords';
- No restriction based on publication date.

. By excluding non-English language publications, conference papers, non-academic papers, books, book chapters, and fields different from "Business Management & Accounting" and "Social Sciences", I retrieved 671 papers. Abstract reading and the quick reading of these documents led me to exclude articles that are clearly out of the scope of my research. I obtained 22 potential relevant documents.

. The last cleaning step was a full text reading. I eliminated those articles in which either Mass Customization or ICs where marginally touched. At the end, I obtained only three relevant papers, which I read and analyzed carefully.

One paper was conceptual and the other two used the survey methodology to collect data at the plant level (Huang et al., 2010) or experts' subjective opinions (Forza & Salvador, 2006). In the first one, the research was conducted at the international level, focusing on three industries (machinery, electronics, and auto suppliers), while the second study was limited to European countries. None of the three papers specified the degree of product customization or the type of product.

TABLE 1: RELEVANT PAPERS ON ICS AND MCC CLASSIFICATION

REFERENCE	METHOD	PARTICIPANTS IN THE RESEARCH	COUNTRY	INDUSTRY	DEGREE OF PRODUCT CUSTOMI-ZATION
Kristal, Huang, Schroeder, 2010	Survey	Data at plant (organizational) level	8 countries (Japan, South Korea, Germany, Austria, Finland, Sweden, Italy, USA)	3 industries (machinery, electronics, auto suppliers)	(N)
Forza and Salvador, 2006	Survey	Managers experts on the topic of product customization	5 countries: Germany, Italy, Slovenia, Spain and United Kingdom	Manufacturing companies	(N)
Salvador, De Holan and Piller, 2009	Conceptual	(N.A.)	(N)	(N)	(N)

(N): Not mentioned
(N.A.): Not available

The IC mentioned in the conceptual work of Salvador et al. (2009) is *adaptivity*—the ability to deal with new and ambiguous tasks in order to offset any potential rigidness that is embedded in process, structures and technologies.

The IC suggested by Kristal et al. (2010), who investigated the role of quality management (QM) in the development of MCC, is *Top management leadership for quality*. This IC is defined as the ability of management to establish, practice, and lead a long-term vision for the organization, driven by changing customer requirements (Kristal et al., 2010).

Forza and Salvador's (2006) work explored which ICs, classified, according to Hoffman (1999), into abilities, attitudes, and knowledge, are needed for mass customization. These authors adopted the definition of skill proposed by Spencer and Spencer (1993)—the capability to perform a certain physical or mental task—to define the concept of ability. They considered attitude, as proposed by Fishbein and Ajzen (1975), as an individual's tendency to act in a consistent way vis-à-vis a particular object or situation (i.e., how a person acts, thinks, and feels), and they referred to knowledge as what an individual must know in order to perform a task.

The findings, limitations, and insights of Forza and Salvador's (2006) work on the ICs that are needed for mass customization are analyzed in the discussion section and compared with the findings of the present study.

2.2.3 Key managerial roles for mass customization capability

Forza and Salvador (2006) explored which roles are mostly affected by mass customization within companies. According to the experts interviewed by the authors, product personalization influences the various role sets differently depending on one's function and hierarchical level. The role sets influenced by product customization are those that belong to the following functions: technical, marketing/sales, and production/logistic functions.

Among the directive roles, marketing and sales directors, production directors, and technical directors are those most affected by product customization. At the operational level, R&D function plays a pivotal part in determining company-wide organizational mass customization competence (Forza & Salvador, 2006).

2.3 INDIVIDUAL COMPETENCIES

The birth of the competency movement is associated with David McClelland and his contributions in the field of psychology that have been applied to management.

At the beginning of the 1970s, McClelland (1973) was the first to identify in the concept of competence the element meant to overcome the poor ability of intelligence tests to predict individual performance in a work environment. However, it was because of Richard Boyatzis that job competency came to be widely understood (Yeung, 1996) to mean an underlying characteristic of a person, such as knowledge, skills, self-image, social roles, traits, and motives, "that are causally related to effective and/or superior performance in a job" (Boyatzis, 1982, p. 23). Thus, the competency concept considers behavioral competencies, which are cross-functional and not job-specific, as well as functional/technical competencies (Hofrichter & Spencer, 1996).

Using the competency studies of Boyatzis (1982) as the basis of their analysis, Spencer and Spencer (1993) deepened and developed the competency research on an empirical basis. The authors adhered to Boyatzis's definition of competency as "an *underlying characteristic* of an individual that is *causally related* to criterion-referenced effective and/or superior performance in a job or situation" (Spencer & Spencer, 1993, p. 9). They clarified the use of the word *characteristics* as a competency by stating that "a characteristic is not a competency unless it predicts something meaningful in the real world" (Spencer & Spencer, 1993, p. 13).

Competency is defined as an *underlying* characteristic of an individual, which is a deep and enduring part of that individual's personality. There are five types of characteristics (Spencer & Spencer, 1993):

1. *Motives*: what a person consistently thinks about or wants and that cause action;

2. *Traits*: physical characteristics and consistent responses to a situation or information;

3. *Self-Concept*: attitudes, values, or self-image of a person;

4. *Knowledge*: information a person has in specific content area;

5. *Skills*: ability to perform a certain physical or mental task.

Knowledge and skills normally are visible, surface characteristics of people. Furthermore, they are relatively easy to develop, while motives, traits, and self-concept are more hidden and therefore are more difficult to assess and develop.

A causal relationship exists between competency and its characteristics and performance. "*Motive, traits*, and *self-concept* competencies predict *skill* behavior actions, which in turn predict job performance outcomes" (Spencer and Spencer, 1993, p. 12). The competency causal flow is illustrated in the following figure.

DEFINITION OF A "COMPETENCY"
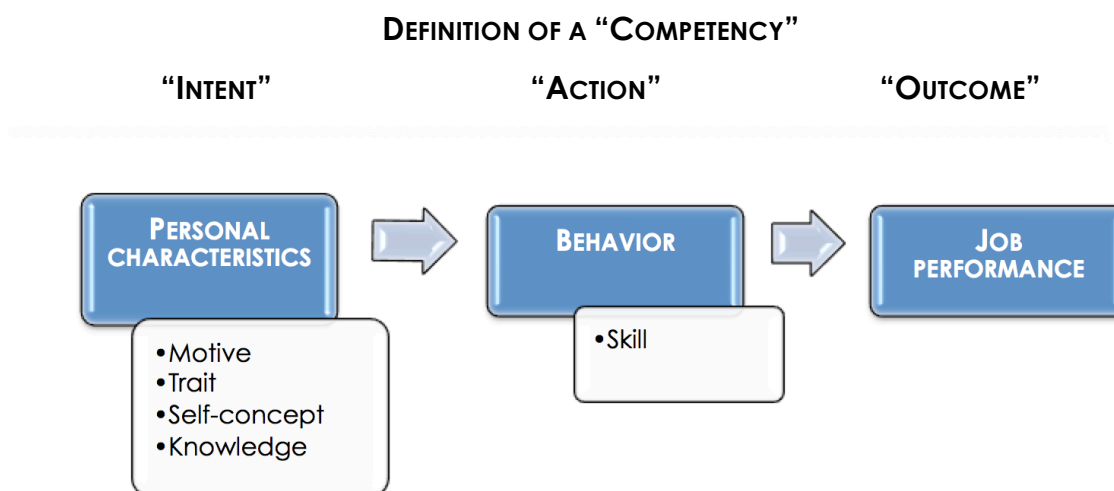
FIGURE 1: THE COMPETENCY CAUSAL FLOW (SPENCER AND SPENCER, 1993: P. 13)

Competencies always include *intent*, which is the motive or trait force that causes action toward an outcome. Behavior without *intent* does not define a competency (Spencer & Spencer, 1993). To define a competency, according a more recent definition proposed by Boyatzis (2009), behaviors must be organized around an underlying construct called intent. Thus, behaviors, which are related but different, are alternate manifestations of intent, as appropriate in various situations or times (Boyatzis, 2009).

For example, a person can ask questions or listen to someone for different reasons: to ingratiate him/her and gain standing in his/her view or because he/she is interested in understanding this person and his/her thoughts. The latter case is a demonstration of *empathy* because the underlying *intent* is to understand the person. The former underlying *intent* is, indeed, to influence the person by using effective tactics for *persuasion* (Boyatzis, 2009).

2.3.1 Measurement of competencies and competency models

Boyatzis described the importance of clearly defining competencies, specifying for each competency documented behavioral indicators that cause or influence an effective job performance (Rothwell & Lindholm, 1999) and developing a codebook of 22 ICs (Boyatzis, Cowen, & Kolb, 1995). Boyatzis grounded his competency interventions in his codebook, which articulates specific ICs and how to identify them, and he used the behavioral event interview (BEI) method to identify performers' competencies (Rothwell & Lindholm, 1999). McClelland (1998) designed BEI as a way to uncover differences between two types of incumbents: those outstanding and those typical in performing a job.

The BEIs are tape-recorded and transcribed, and the ICs are identified and coded using a thematic analysis process (Boyatzis, 2009).

The result of competency identification is a competency model describing the key characteristics that distinguish the best performers from the average performers (Rothwell & Lindholm, 1999). Over the past three decades, competency modeling has been developed not only within psychological disciplines (educational, behavioral, and differential psychology) but also within management science and industrial engineering (Marrelli, 1998; McLagan, 1997).

2.3.2 Competency-based human resource management

Competency-based HRM is about using the notion of competency and the competency analysis results to inform and improve the processes of recruitment and selection, development, reward, and performance management (Armstrong, 2006).

The competency approach to HRM makes competencies the foundation of the entire HRM function. All aspects of HRM are integrated through competencies rather than through the traditional notions of jobs or work activities, which drive recruitment, selection, placement, orientation, training, performance management, and workers' rewards (Dubois & Rothwell, 2004).

In the 35 years since David McClelland (1973) proposed competency as a critical differentiator of performance, competency-based HRM has become a common practice. Today in the United States, almost every organization with more than 300 employees uses some form of competency-based HRM (Boyatzis, 2008).

2.3.2.1 Applications of competency-based human resource management

Competencies and competency models can play an important part in all major HR activities (Armstrong, 2006; Campion & Odman, 2011). They can mainly be applied to the following areas:

- RECRUITMENT

Since the 1970s, when McClelland (1973) raised the issue of testing for competence rather than intelligence, competency has been used to guide decisions on recruitment (Nybø, 2004). The competencies defined for a role can be used as the framework during the recruitment phase (Armstrong, 2006). ICs can complete the job specifications of occupations and can enrich job announcements. To identify the key competencies of specific roles, competency researchers, in fact, often examine company job specifications or job announcements and conduct a content analysis (Gök & Hacioglu, 2010; S.-N. Liu, Lin, & Chen, 2011; Melaia, Abratt, & Bick, 2008).

- SELECTION

Competency frameworks can be used for hiring new employees by deploying assessments and other selection procedures that measure competencies (Bartram, 2005; Lawler III, 1994). The competency approach allows for identifying particular competency areas to investigate, through different selection techniques, to establish the extent to which candidates meet the job specifications expressed in competency terms.

Moreover, competency models can be used in assessment centers to choose the most suitable exercises or simulations to assess the competencies that distinguish high performance (Armstrong, 2006). Competency models are especially useful for selection procedures because they can distinguish the best performers from the average employees (Campion & Odman, 2011).

- TRAINING AND EDUCATION

Competency models can be used for assessing the levels of competency achieved by employees and thus for identifying their training needs. On the basis of the learning and development needs, courses or other training activities can be created with the aim of developing specific ICs (Lawler III, 1994; Shippmann et al., 2000).

Training and education, such as executive development and coaching programs, often have a competency model foundation (Campion & Odman, 2011). It is possible to use a multiplicity of competency-based tools at all stages of the educational process, from training needs analysis to didactics and outcome evaluation (Camuffo & Gerli, 2004).

- PERFORMANCE MANAGEMENT

In performance management systems, competencies are used to ensure that the behavioral aspects of how work activities are carried out are considered in performance reviews (Armstrong, 2006). Organizations are, in fact, increasingly extending their performance management systems to assess not only outcomes but also the qualitative aspects of jobs (Rankin, 2004). Employees' performance, therefore, can be assessed even more rigorously by developing competency-based appraisal systems.

- REWARD MANAGEMENT

Competency-based reward management links employees' compensation to competencies, structuring pay differences between jobs with different competencies or evaluating employees for pay increases (Campion & Odman, 2011). Although there have been calls recently to consider ICs in reward systems, the idea of competency-related pay has never taken off (Armstrong, 2006).

2.4 PRIOR RESEARCH ON THE INDIVIDUAL COMPETENCIES OF SALES, MARKETING, R&D, AND OPERATIONS MANAGERS

Prior research on which ICs SMs, MMs, R&DMs, and OMs should have for the successful implementation of a mass customization strategy is virtually non-existent. I conducted a systematic literature review to study the ICs of all key roles for mass customization by applying the cited inclusion and exclusion criteria (see Section 2.2.2.) and using the following phrase search for the different managerial roles:

- (skill* OR competenc* OR capab* OR knowledge OR abilit* OR attitud* OR behavior* OR microfoundation*)

AND

- "sales manager*"
- "marketing manager*"
- "R&D manager*"
- "operations manager*"

Prior competency research on the ICs of SMs, MMs, and R&DMs has implicitly adopted a universalistic, one-size-fits-all approach, while there are no studies on the ICs of OMs. Furthermore, very few empirical studies have been based on BEIs, which is the method that Boyatzis (1982) and Spencer and Spencer (1993) adopted in their competency studies, except for the study of R&DM's competencies.

2.4.1 Sales managers

The initial search produced nearly 100 results, and after applying exclusion criteria—excluding non-English-language publications, conference papers, non-academic papers, books, book chapters, and fields different from "Business Management & Accounting" and "Social Sciences"—I obtained 17 potentially

relevant papers. I excluded all the papers that did not respect the following criteria:

1) Detailed indication (not aggregated) of the behavioral competencies identified for the SM role;

2) Definition or description of the identified ICs.

This cleaning step led me to identify 11 relevant papers, which are presented in the following table.

TABLE 2: RELEVANT PAPERS ON ICS OF SALES MANAGERS

REFERENCE	METHOD	PARTICIPANTS IN THE RESEARCH	COUNTRY	INDUSTRY
Khandelwal Das, Kumar Upadhyay, Subrata Das, 2016	Conceptual	N.A.	(N)	(N)
Rosenbloom, Anderson, 1984	Conceptual	N.A.	(N)	(N)
Deeter-Schmelz, Goebel, Kennedy, 2008	Interviews	Sales professionals: sales managers (33) and sales representatives (25)	USA	(N)
Deeter-Schmelz, Kennedy, Goebel, 2002	Interviews	Sales professionals (51) (sales managers and sales representatives)	Midwest and the South USA	(N)
Weilbaker, 1990	Interviews + critical incident technique	Salespeople, sales managers, physicians (the customer)	USA	Pharmaceutical firms
Spencer and Spencer, 1993	Behavioral event interview	Professionals, Sales managers, Marketing managers, R&D Managers, Production Managers, Entrepreneurs	USA	(N)
Rosenbaum, 2001	Interviews + Self-evaluation + direct observation	Customers, managers, account team members	(N)	(N)
Piercy, Cravens, Lane, 2012	Self-evaluation compared with evaluations by managers at the same level in the company	Sales managers, Salespersons (301 usable questionnaires)	United Kingdom	B2B manufacturing organizations (101 companies)
Lysonsky, Johnson, 1983	Self-evaluation	Sales managers who attended sales management seminars (380)	(N)	Optical, furniture, mining, automobiles, hardware, chemicals, financial services, pharmaceuticals

Powers, jenning, DeCarlo, 2014	Experts panel + Self-evaluation	Director, Vice president, sales manager and account executive (20)	(N)	Business and financial services, telecommunications, manufacturing, health care, chemicals and electronics
Bush, 2013	Experts panel + Self-evaluation	Frontline sales managers (FLSMs) and Chief Sales Officers (CSOs)	North America	Education, forest and paper products, healthcare, information technology services

(N): not mentioned
N.A.: not available

The classification of the relevant articles on the basis of the method used in the study highlights that 46% of the studies employed interviews, but only one used the BEI method. More than 45% of the studies used self-evaluation, complemented by expert panels in half of the cases, and only 18% were conceptual works.

The "country" variable was not specified in 36% of the studies, but all studies that specified it focused on English-speaking countries.

Most of the studies did not specify the industry, and the remaining 45% examined quite a broad set of industries, with the exception of Weilbaker (1990), who focused on pharmaceutical firms.

Furthermore, these studies did not specify the type of products and the degree of product customization, and they did not consider volatile, uncertain, complex, and ambiguous contexts.

The SM competencies defined in the literature can be recoded, for two reasons, using the codebook proposed by Boyatzis et al. (1995). First, Boyatzis is considered to be a founding developer of competency modeling in the United States (Rothwell & Lindholm, 1999) and his work had a huge influence on HRM practice (Darafarin, Mousavi, & Javazi, 2016). Second, Boyatzis and his colleagues provided, for the ICs included in their codebook, a set of behavioral indicators that are helpful for coding qualitative data on ICs (Ryan, Emmerling, & Spencer, 2009). In addition, I decided to consider some ICs proposed by

Spencer and Spencer (1993) that Boyatzis et al. (1995) did not capture in their codebook.

The recoding of the SMs' ICs proposed in the literature allows for creating a generic competency model for SMs, derived from the competency literature, as shown in the following table.

TABLE 3: ICs of Sales Managers recoded according to Boyatzis et al. (1995) and Spencer and Spencer (1993)

ICS RECODED	TOPICS	CONSTRUCT'S DEFINITION	AUTHORS REFERENCES
PEOPLE MANAGEMENT COMPETENCIES			
Developing others	Coaching and Mentoring capabilities	Coaching: any tactical developmental conversations between the manager and the salesperson. Mentoring: a more strategic interaction that is aimed at assisting the individual salesperson in both their longer-term career progression and their personal development.	Khandelwal Das, Kumar Upadhyay, Subrata Das, 2016
	Cracking Skills	The sales manager mentors representatives, helping them to improve their selling skills	Deeter-Schmelz, Goebel, Kennedy, 2008
		The sales manager serves as a mentor to representatives, helping them improve selling skills. Manager as coach	Deeter-Schmelz, Kennedy, Goebel, 2002
	Willingness to Empower	The sales manager allows reps to take responsibility and action	Deeter-Schmelz, Goebel, Kennedy, 2008
		Sales manager allows reps to take responsibility and action; does not micro manage.	Deeter-Schmelz, Kennedy, Goebel, 2002
	Provides effective verbal feedback	N.d.	Powers, jenning, DeCarlo, 2014
	Coaches for Sales Results	Competencies required drawing out the best performance of the individual or group through ongoing observation, motivation, and developmental feedback.	Bush, 2013
	Developing others	A genuine intent to foster the learning or development of others with an appropriate level of need analysis. Its focus ins on the developmental intent and effect rather than on a formal role of training.	Spencer and Spencer, 1993
	Builds Talent	Competencies required to continuously assessing team capability and capacity, managing hiring, promotion, and termination to improve sales performance.	Bush, 2013

Leadership	Impact and Influence	Acting to have an impact on others (individuals or organizations), to influence or persuade others.	Spencer and Spencer, 1993
	Control competencies	How well the sales manager performs the control activities of monitoring, directing, evaluation and rewarding salespeople assigned to the manager's sales unit.	Piercy, Cravens, Lane, 2012
	Motivation Skills	The sales manager recognizes motivating factors and rewards good performance	Deeter-Schmelz, Goebel, Kennedy, 2008
		Sales manager understands what motivates salespeople and is oriented toward recognizing and rewarding good performance.	Deeter-Schmelz, Kennedy, Goebel, 2002
	Leadership Skills	The sales manager encourages and inspires reps	Deeter-Schmelz, Goebel, Kennedy, 2008
		Sales manager possesses the skills to encourage and inspire reps	Deeter-Schmelz, Kennedy, Goebel, 2002
	Motivation and Leadership Skills	N.d.	Rosenbloom, Anderson, 1984
	Role model for the sales force	N.d.	Powers, Jenning, DeCarlo, 2014
	Builds trust with the sales force	N.d.	Powers, jenning, DeCarlo, 2014
	Manages as a Leader	Competencies required to build credibility and trust, achieve aspirations, maintain an appropriate attitude, and lead teams and other individuals.	Bush, 2013
Networking	Establishing a Vision of a Committed Customer/ Supplier Relationship	Expanding customer's understanding of what a business relations can be. Build a flexible relationship that is responsive to market place changes. Communicate achievable objectives.	Rosenbaum, 2001
	Human Relations Skills	The sales manager works with people effectively and develops personal rapport with sales force member.	Deeter-Schmelz, Goebel, Kennedy, 2008
		Sales manager possesses the ability to work with people effectively and develop personal rapport with members of the sales force.	Deeter-Schmelz, Kennedy, Goebel, 2002
	Builds and Maintains Relationships	Competencies required to identify, build, and sustain key business relationships both internally and externally.	Bush, 2013
Oral communica-tion	Communication and Listening Skills	The sales manager has the skills to communicate and listen effectively.	Deeter-Schmelz, Goebel, Kennedy, 2008
		Sales manager possesses the skills and is willing to communicate and listen effectively.	Deeter-Schmelz, Kennedy, Goebel, 2002
	Communication skills	N.d.	Weilbaker, 1990
	Verbal communication	Required for Internal and external boundary scanning.	Lysonsky, Johnson, 1983
Group Management	Performance Management	Competencies required in managing individual and team outputs to proactively and continuously improve sales results.	Bush, 2013

	Teamwork and cooperation	The intention to work cooperatively with others, to be part of a team, to work together, as opposed to working separately or competitively.	Spencer and Spencer, 1993
	Designs and builds effective teams	N.d.	Powers, Jenning, DeCarlo, 2014
	Creates a supportive team environment	N.d.	Powers, Jenning, DeCarlo, 2014
	Managers team dynamics	N.d.	Powers, Jenning, DeCarlo, 2014
Empathy	Interpersonal understanding	Understanding, interpreting and responding to others' concerns, motives, feelings and behaviors; accurately recognizing strengths and limitations in others.	Spencer and Spencer, 1993
	Empathy	N.d.	Weilbaker, 1990
Customer-service orientation	Listening Beyond Product Needs	Seeing business process improvement potential and opportunities to add value for the customers' customers.	Rosenbaum, 2001
	Understanding of Buyer Behavior	N.d.	Rosenbloom, Anderson, 1984
	Customer-service orientation	A concern with helping or serving others; efforts to discover the customer or client's needs and to meet those needs. "Client" may include internal staff, such as a boss or downstream department, students, or actual external customers.	Spencer and Spencer, 1993
	Handle rejection	N.d.	Weilbaker, 1990
	Orchestrating Internal Resources	Ability to identify key contributors within their organization, build collaborative, customer-focused relationships.	Rosenbaum, 2001
Self-confidence	Confidence	N.d.	Weilbaker, 1990
Persua-siveness	Influences to Achieve Goals	Competencies required to effectively listen, speak, persuade, question, and write within appropriate business norms based on a solid understanding of needs, using whatever medium is most appropriate.	Bush, 2013
GOAL AND ACTION MANAGEMENT COMPETENCIES			
Flexibility	Adapatability	The sales manager is adaptable.	Deeter-Schmelz, Goebel, Kennedy, 2008
		N.d.	Weilbaker, 1990
Planning	Organization and Time Management Skills	The sales manager has the ability to organize and manage his or her own time and work activities.	Deeter-Schmelz, Goebel, Kennedy, 2008
		Sales manager possesses the ability to organize and manage his or her own work and time.	Deeter-Schmelz, Kennedy, Goebel, 2002
	Organizational skill	N.d.	Weilbaker, 1990

Achievement orientation	Develops Self to Achieve Goals	Competencies required to stay current, manage time and technology to expedite work, and identify and take advantage of development opportunities to achieve personal and professional goals.	Bush, 2013
	Perseverance	N.d.	Weilbaker, 1990
Efficiency orientation	Productivity Management	N.d.	Rosenbloom, Anderson, 1984
	Understanding the Financial Impact of Decision	Using the resources to contribute to customers' profitability.	Rosenbaum, 2001
Initiative	Creativity	N.d.	Weilbaker, 1990
ANALYTIC REASONING COMPETENCIES			
Written communica-tion	Written communication	Required for Internal and external boundary scanning.	Lysonsky, Johnson, 1983
Social objectivity	Sensitivity to cultural issues	N.d.	Powers, Jenning, DeCarlo, 2014

There are other behavioral competencies that could not be coded based on Boyatzis et al. (1995) and Spencer and Spencer (1993).

TABLE 4: OTHER BEHAVIORAL COMPETENCIES NOT CODED BY BOYATZIS ET AL. (1995) OR SPENCER AND SPENCER (1993)

OTHER BEHAVIORAL COMPETENCIES		
Aligning Customer/Supplier Strategic Objectives	Keeping abreast of new development and innovations in customers' market; Keeping abreast of emerging trends and initiatives involving customers' competitors; Seizing opportunities to tailor or customize product/service offering to ensure that they meet customers' long-tem needs.	Rosenbaum, 2001
Consultative Problem Solving	Modify proposals or plans, deal with concerns and incorporate the suggestions of others; acknowledge problems and try to discover what went wrong and how it could be corrected, rather than make excuses or minimize problems engage in problem solving around issues not directly related to the product or application.	Rosenbaum, 2001
Engaging in Self-Appraisal and continuous Learning	Seeking feedback.	Rosenbaum, 2001
	Ability to learn.	Weilbaker, 1990

The aforementioned papers also reported, in some cases, technical competencies not considered in this study.

The SM competency model, summarized in the following table, can represent a useful reference and a comparison point for competency models developed in specific contexts, such as mass customization.

TABLE 5: SALES MANAGER'S COMPETENCY MODEL FROM COMPETENCY LITERATURE REVIEW

SALES MANAGER'S COMPETENCY MODEL
PEOPLE MANAGEMENT COMPETENCIES
Developing others
Leadership
Networking
Oral communication
Group Management
Empathy
Customer-service orientation
Self-confidence
Persuasiveness
GOAL AND ACTION MANAGEMENT COMPETENCIES
Flexibility
Planning
Achievement orientation
Efficiency orientation
Initiative
ANALYTIC REASONING COMPETENCIES
Written communication
Social objectivity

2.4.2 Marketing managers

The search on scientific databases produced 583 initial results, 23 of which were potentially relevant papers. Following the same exclusion criteria presented in the previous paragraph for the SM, the last cleaning step led me to focus only on eight papers that were relevant to this study. They are classified in the following table.

TABLE 6: RELEVANT PAPERS ON ICs OF MARKETING MANAGERS

REFERENCE	METHOD	PARTICIPANTS IN THE RESEARCH	COUNTRY	INDUSTRY
Gok, Hacioglu, 2009	Content analysis	None	(N)	(N)
Liu, Lin, Chen, 2011	Content analysis + Interviews + self-evaluation	Industrial Marketing managers (34)	Taiwan	(N)
Melaia, Abratt, Bick, 2008	Content analysis + Interviews + Self evaluation	10 Marketing managers employed by the Sunday Times Top 100 Companies	(N)	(N)
Kashani, 1995	Interviews + Self evaluation	Marketing managers and General Managers	(N)	(N)
Spencer and Spencer, 1993	BEI	Professionals, Sales managers, Marketing managers, R&D Managers, Production Managers, Entrepreneurs	USA	(N)
Gray, Ottesan, Bell, Chapman, Whiten, 2007	Self evaluation + Experts panel	Marketing managers, Academics and Senior students	New Zealand	(N)
Gorchels, Jambulingam, Aurand, 1998	Superior evaluation	Japanese, German, and U.S. executive	Japan, German, USA	(N)
Thomas, 1986	Conceptual	N.A.	(N)	(N)

More than 37% of the studies used content analysis to analyze job/position announcements and almost 70% of these studies complemented this analysis with interviews and self-evaluations. A quarter of these studies employed interviews, but only one used the BEI method. One study used self-evaluation complemented by expert panels, another used superior evaluation, and the last one was a conceptual study.

Considering the "country" variable, 50% of the studies did not specify it, while the remaining studies focused on the United States, New Zealand, Japan, Germany, and Taiwan.

In addition, variables such as "product type" and "degree of product customization" were considered, but there were no studies that provided information on the values of these variables in the research context.

Among the relevant papers considered for the MM role, Kashani's (1995) study considered the growing complexity of the future market environment. A

turbulent environment requires a broader pallet of core capabilities that go beyond narrow, specialized skills (Kashani, 1995).

According to Kashani (1995), the most relevant competencies that an MM should have to achieve future performance in a turbulent environment are as follows: *negotiation, oral communication, customer-service orientation, initiative* (recoded according the codebook adopted), and other competencies such as *strategic thinking* and *problem solving.*

As in the SM case, competencies suggested in the relevant papers were recoded according to Boyatzis et al. (1995) and integrated with Spencer and Spencer's (1993) codebook. They are presented as follows.

TABLE 7: ICS OF MARKETING MANAGERS RECODED ACCORDING TO BOYATZIS ET AL. (1995) AND SPENCER AND SPENCER (1993)

ICS RECODED	TOPICS	CONSTRUCT'S DEFINITION	AUTHORS REFERENCES
PEOPLE MANAGEMENT COMPETENCIES			
Oral communication	Communication	N.d.	Gorchels, Jambulingam, Aurand, 1998
	Communication & co-ordination	Professional efficiency	Liu, Lin, Chen, 2011
	Oral Communication Competencies	N.d.	Melaia, Abratt, Bick, 2008
	Communication capability	N.d.	Kashani, 1995
	Oral communication skills	N.d.	Gray, Ottesan, Bell, Chapman, Whiten, 2007
Networking	Internal network management, external network management	N.d.	Gok, Hacioglu, 2009
	Networking and relationship building	N.d.	Melaia, Abratt, Bick, 2008
Leadership	Leadership	N.d.	Gorchels, Jambulingam, Aurand, 1998
	Leadership	Professional efficiency	Liu, Lin, Chen, 2011
Customer-service orientation	Managing customer relationships	N.d.	Gok, Hacioglu, 2009
	Sensitivity to customers	N.d.	Kashani, 1995
Self-confidence	Self-confidence	N.d.	Gray, Ottesan, Bell, Chapman, Whiten, 2007
Negotiation	Negotiating	N.d.	Kashani, 1995
	Negotiation	N.d.	Gorchels, Jambulingam, Aurand, 1998

	Negotiation	N.d.	Melaia, Abratt, Bick, 2008
	Interdepartmental cooperation and conflict resolution skills	N.d.	Thomas, 1986
Empathy	Strong interpersonal skills	N.d.	Gray, Ottesan, Bell, Chapman, Whiten, 2007
Team work	Team work	N.d.	Gorchels, Jambulingam, Aurand, 1998
	Team work	N.d.	Gray, Ottesan, Bell, Chapman, Whiten, 2007
Group management	Partnering, coordinating, motivating, training, and managing cross-functional teams	N.d.	Gray, Ottesan, Bell, Chapman, Whiten, 2007
GOAL AND ACTION MANAGEMENT COMPETENCIES			
Initiative	Initiative	Professional attitude	Liu, Lin, Chen, 2011
	Innovation management skills	N.d.	Thomas, 1986
	Creativity	N.d.	Melaia, Abratt, Bick, 2008
	Innovativeness	N.d.	Kashani, 1995
	The ability to be creative	N.d.	Gray, Ottesan, Bell, Chapman, Whiten, 2007
	Change management	N.d.	Melaia, Abratt, Bick, 2008
	The skills to implement change	N.d.	Gray, Ottesan, Bell, Chapman, Whiten, 2007
Efficiency orientation	Professional efficiency	Professional efficiency	Liu, Lin, Chen, 2011
	Cost-benefit analysis & budget planning	Planning process	Liu, Lin, Chen, 2011
Planning	The skills to plan their own work	N.d.	Gray, Ottesan, Bell, Chapman, Whiten, 2007
	Focus on deadlines, meeting deadlines, sometimes making compromises to meet deadlines	N.d.	Spencer and Spencer, 1993
	Planning skills	N.d.	Thomas, 1986
	Organizational ability	N.d.	Thomas, 1986
Flexibility	Flexibility and adaptability	N.d.	Gray, Ottesan, Bell, Chapman, Whiten, 2007
Information seeking	Information seeking regarding the activities of competitors	N.d.	Spencer and Spencer, 1993
ANALYTIC REASONING COMPETENCIES			
Systems thinking	Analytical skills	N.d.	Gray, Ottesan, Bell, Chapman, Whiten, 2007
	Analytical	N.d.	Gorchels, Jambulingam, Aurand, 1998
	Logical thinking	Professional efficiency	Liu, Lin, Chen, 2011,
	A multi-disciplinary perspective	N.d.	Gray, Ottesan, Bell, Chapman, Whiten, 2007
	Systems thinking and skills	N.d.	Thomas, 1986, JMM

Written communication	Written communication skills	N.d.	Gray, Ottesan, Bell, Chapman, Whiten, 2007,
	Written communication	N.d.	Melaia, Abratt, Bick, 2008

TABLE 8: OTHER BEHAVIORAL COMPETENCIES NOT CODED BY BOYATZIS ET AL. (1995) OR SPENCER AND SPENCER (1993)

OTHER BEHAVIORAL COMPETENCIES		
Stress management (organizational commitment)	Stamina end tolerance for stress and long hours.	Spencer and Spencer, 1993
	Stress management	Liu, Lin, Chen, 2011
Problem solving	Problem solving	Liu, Lin, Chen, 2011
	Problem solving ability	Gray, Ottesan, Bell, Chapman, Whiten, 2007
	Analytical problem solving skills	Kashani, 1995
Strategic thinking	Strategic thinking skills	Thomas, 1986
	Strategic thinking	Kashani, 1995
Creative thinking	Professional efficiency	Liu, Lin, Chen, 2011,
Enthusiasm for the product and/or concern for the product's image	Enthusiasm for the product and/or concern for the product's image.	Spencer and Spencer, 1993

The MM competency model derived from the existing competency literature is composed of nine competencies that belong to the people management cluster, six goal and action competencies, and two analytic reasoning competencies.

TABLE 9: MARKETING MANAGER'S COMPETENCY MODEL FROM COMPETENCY LITERATURE REVIEW

MARKETING MANAGER'S COMPETENCY MODEL
PEOPLE MANAGEMENT COMPETENCIES
Oral communication
Networking
Leadership
Customer-service orientation
Self-confidence
Negotiation
Empathy
Team work
Group management

GOAL AND ACTION MANAGEMENT COMPETENCIES
Initiative
Efficiency orientation
Achievement orientation
Planning
Flexibility
Information seeking
ANALYTIC REASONING COMPETENCIES
Systems thinking
Written communication

2.4.3 R&D managers

For the role of R&DM, the systematic literature review of scientific databases yielded 273 initial results. After applying the same exclusion criteria already presented for the SM and MM roles, eight potentially relevant documents remained, only five of which were relevant to this study.

TABLE 10: RELEVANT PAPERS ON ICS OF R&D MANAGERS

REFERENCE	METHOD	PARTICIPANTS IN THE RESEARCH	COUNTRY	INDUSTRY	PRODUCT TYPE
Spencer and Spencer, 1993	BEI	Professionals, Sales managers, Marketing managers, R&D Managers, Production Managers, entrepreneurs	USA	(N)	(N)
Kenneth, Fineman and Ruhnke, 1999	BEI	R&D supervisors and R&D managers (17)	USA	5 companies: Biogen, Wyeth-Ayerst, Exxon, IBM, and Pratt&Whitney,	Healthcare, pharmaceutical products, fuels, hardware, software, aircraft engines and turbine
Dreyfus, 2008	BEI + Self evaluation + Psychological traits	Scientists and engineers working as 1° level R&D managers (35)	Mid-West USA	(N)	(N)
Gritzo, Fusfeld, and Carpenter, 2017	Large-scale survey data, two 360-degree feedback instruments	R&D leaders (all levels of management) who attended courses, direct reports, peers, supervisors, in the participants' organizations (36,000)	USA (Noth Carolina)	(N)	(N)

Friedman, Fleishman and Fletcher, 1992	Self evaluation	R&D managers (117)	USA and Canada	(N)	(N)

The majority of the studies were based on the BEI method, complemented by other methods, such as self-evaluation, in 33% of the cases. One work used the so-called 360° evaluation, while one adopted only self-evaluation.

All of the studied focused on English-speaking countries.

Regarding the variable "Product type," 80% of the studies did not specify it, while the remaining examined quite a broad set of products/services: healthcare, pharmaceutical products, fuels, hardware, software, aircraft engines, and turbines.

The studies did not provide information on the value of "degree of product customization" and did not consider VUCA contexts.

As for the other managerial roles examined, the ICs mentioned in the literature on R&DMs were recoded according to Boyatzis et al. (1995) and Spencer and Spencer (1993).

TABLE 11: ICS OF R&D MANAGERS RECODED ACCORDING TO BOYATZIS ET AL. (1995) AND SPENCER AND SPENCER (1993)

ICS RECODED	TOPICS	CONSTRUCT'S DEFINITION	AUTHORS REFERENCES
PEOPLE MANAGEMENT COMPETENCIES			
Developing others	Consulting and advising	N.d.	Kenneth, Fineman and Ruhnke, 1999
	Helping and delegating	N.d.	Dreyfus, 2008
	Developing others	A genuine intent to foster the learning or development of others with an appropriate level of need analysis. Its focus ins on the developmental intent and effect rather than on a formal role of training.	Spencer and Spencer, 1993

Leadership	Bridging organizational cultures between knowledge workers and business managers	Recognizing the general needs, concerns, values and characteristic work behaviors of technical/scientific professionals and distinguishing them from those of comparable employees in other business functions; operating effectively as a manager in the highly diverse technical/scientific culture while simultaneously relating to the expectations and requirements of the business management culture; establishing and maintaining credibility in both cultures; facilitating collaboration regardless of differences in order to accomplish strategic goals.	Kenneth, Fineman and Ruhnke, 1999
	Leadership	N.d.	Dreyfus, 2008
	Impact and Influence	Acting to have an impact on others (individuals or organizations), to influence or persuade others.	Spencer and Spencer, 1993
Networking	Building collaborative relationship	Establishing and sustaining collaborative working relationships with others, including internal clients, peers and higher levels of management, as well as external resources; determining needs, interest and capabilities of others relative to joint efforts and the potential value of the interaction; providing required information or service in a manner that fosters confidence and encourages future collaborative opportunities; soliciting and responding to feedback in a timely manner to ensure successful transactions.	Kenneth, Fineman and Ruhnke, 1999
Oral communication	Oral defense	The ability to orally explain and defend thinking, reasoning, and conclusions. This does not refer to the enthusiasm or eagerness to defend or explain.	Friedman, Fleishman and Fletcher, 1992
	Oral expression	The ability to use words and sentences in speaking so others will understand. It includes the ability to communicate information and the meaning of ideas to other people. The ability involves selecting the right words and putting them together to convey the intended message.	Friedman, Fleishman and Fletcher, 1992, JETM
	Communicating technical information	N.d.	Kenneth, Fineman and Ruhnke, 1999
Group Management	Teamwork and cooperation	The intention to work cooperatively with others, to be part of a team, to work together, as opposed to working separately or competitively.	Spencer and Spencer, 1993
	Managing group process	N.d.	Dreyfus, 2008
Empathy	Social sensitivity	The ability to act suitably in a social situation, regardless of the exact nature of the social contact. It involves adjusting your behavior to fit the social occasion. It depends on figuring out how people feel.	Friedman, Fleishman and Fletcher, 1992

	Interpersonal understanding	Understanding, interpreting and responding to others' concerns, motives, feelings and behaviors; accurately recognizing strengths and limitations in others.	Spencer and Spencer, 1993
	Bridging organizational cultures between knowledge workers and business managers	Recognizing the general needs, concerns, values and characteristic work behaviors of technical/scientific professionals and distinguishing them from those of comparable employees in other business functions; operating effectively as a manager in the highly diverse technical/scientific culture while simultaneously relating to the expectations and requirements of the business management culture; establishing and maintaining credibility in both cultures; facilitating collaboration regardless of differences to accomplish strategic goals.	Kenneth, Fineman and Ruhnke, 1999
Customer-service orientation	Customer-service orientation	A concern with helping or serving others; efforts to discover the customer or client's needs and to meet those needs. "Client" may include internal staff, such as a boss or downstream department, students, or actual external customers.	Spencer and Spencer, 1993
Self-confidence	Self-confidence	N.d.	Dreyfus, 2008
GOAL AND ACTION MANAGEMENT COMPETENCIES			
Flexibility	Quickly masters new technical knowledge necessary to do the job,	N.d.	Gritzo, Fusfeld, and Carpenter, 2017
	Adapting skills	N.d.	Dreyfus, 2008
Planning	Information ordering	The ability to correctly follow a rule or set of rules to arrange things or actions in the correct order. The things or actions to be put in order can include numbers, letters, words, pictures or procedures	Friedman, Fleishman and Fletcher, 1992
Achievement orientation	Resistance to premature judgment	The ability to withhold making final decisions until the important fact have been gathered and evaluated.	Friedman, Fleishman and Fletcher, 1992
	Achievement orientation	A concern for working well or for competing against a standard of excellence.	Spencer and Spencer, 1993
	Setting and managing goals	N.d.	Dreyfus, 2008
Initiative	Originality	The ability to produce unusual or clever ideas about a given topic or situation. It involves the ability to improvise solutions. The ability emphasizes the creativity and quality of the idea and not the number of ideas produced.	Friedman, Fleishman and Fletcher, 1992

	Is creative or innovative, tend to offer more novel idea and perspectives. Foster an innovative environment and culture	N.d.	Gritzo, Fusfeld, and Carpenter, 2017
	Initiative	N.d.	Dreyfus, 2008
Self-control	Is calm and patient when other people have to miss work due to sick days.	N.d.	Gritzo, Fusfeld, and Carpenter, 2017
Information seeking	Probe by asking relevant questions	N.d.	Gritzo, Fusfeld, and Carpenter, 2017
	Oral fact finding ability	The ability to uncover the important and relevant information about a problem through conversation, questioning or discussion of ideas produced.	Friedman, Fleishman and Fletcher, 1992
ANALYTIC REASONING COMPETENCIES			
Written communication	Written comprehension	The ability to write so others will understand. It includes the ability to communicate information and ideas in writing. The ability involves knowledge of word meanings, spelling, grammar, and the ability to organize sentences and paragraphs.	Friedman, Fleishman and Fletcher, 1992
Systems thinking	Logical reasoning	The ability to arrive at conclusions by either linking separate pieces of information or applying general rules. This includes coming up with a logical explanation for series of events or facts or applying a general rule to see if the fact fit.	Friedman, Fleishman and Fletcher, 1992
Pattern recognition	Sees underlying concepts and patterns in complex situations	N.d.	Gritzo, Fusfeld, and Carpenter, 2017

TABLE 12: OTHER BEHAVIORAL COMPETENCIES NOT CODED BY BOYATZIS ET AL. (1995) OR SPENCER AND SPENCER (1993)

OTHER BEHAVIORAL COMPETENCIES		
Problem sensitivity	The ability to recognize that a problem exists. It involves the ability to see if something is going wrong. It does not involve the ability to solve the problem, only the ability to recognize that there is a problem.	Friedman, Fleishman and Fletcher, 1992
Fluency of ideas	The ability to think of many different ideas about a given topic. This ability concerns the number of ideas generated rather than the quality or correctness of the idea.	Friedman, Fleishman and Fletcher, 1992

The R&D manager competency model is summarized in the following table.

TABLE 13: R&D MANAGER'S COMPETENCY MODEL FROM COMPETENCY LITERATURE REVIEW

R&D MANAGER'S COMPETENCY MODEL
PEOPLE MANAGEMENT COMPETENCIES
Developing others
Leadership
Networking
Oral communication
Group management
Empathy
Customer-service orientation
Self-confidence
GOAL AND ACTION MANAGEMENT COMPETENCIES
Flexibility
Planning
Achievement orientation
Initiative
Self-control
Information seeking
ANALYTIC REASONING COMPETENCIES
Written communication
Systems thinking
Pattern recognition

2.4.4 Operations managers

The OM's role is becoming increasingly important in today's business environment, in particular for companies that aim to develop MCC (Åhlström & Westbrook, 1999). The OM occupation, in fact, is expected to grow rapidly at the rate of 10% or more over the period 2016–2026, and during this period there will be 100,000 or more job openings ("O*NET online," 2018).

2.4.4.1 Academic sources

The systematic literature review regarding the role of OMs, which was performed with the same inclusion and exclusion criteria used for the other managerial occupations, did not produce relevant findings. The search yielded nearly 300 initial results, but when I applied the exclusion criteria, I obtained only

six potentially relevant papers, which, after a full text reading, turned out to be outside the scope of my research.

In the literature, therefore, competency models for the role of OM have not yet appeared, even though the operations function has a central role in determining organizational capabilities (Slack et al., 2010).

The presence of this gap led me to verify the existence of competency models for other roles within the operations function, such as the roles of production manager and supply chain manager. The research was conducted with the awareness that the roles are different and are treated separately in the scientific literature and the managerial practice. The role of OM, for example, is considered by the U.S. occupational data resource O*NET ("O*NET online," 2018) similar to that of general manager, considering a single profile for both "general and operations manager" (G&OM), which differs from the "supply chain manager" and "industrial production manager" profiles.

The research conducted highlighted the lack of specific studies on production managers' ICs, while there were studies on the ICs associated with the roles of logistics and supply chain managers. However, studies on the ICs needed for supply chain managers were conceptual (Essex, Subramanian, & Gunasekaran, 2016) or based on managers' and/or students' experiences (Kotzab, Teller, Bourlakis, & Wünsche, 2018). For this reason, there is a substantial gap in the literature concerning the testing of the relationships between varying supply chain manager competencies and individual and firm performance (Essex et al., 2016).

2.4.4.2 Non-academic sources

It was necessary to search outside the academic literature, which contains no research pertaining to OMs' ICs, to find a competency model for the role of OM. I decided to use the database O*NET, which contains job characteristics,

knowledge, abilities, and skills of U.S. occupations and was created, and is maintained, by the U.S. Department of Labor. The skills and abilities data, in particular, are completed and updated by occupational analysts based on employees' responses.

The easy and public availability of O*NET makes it a primary data resource for job analysis, design, and development. Indeed, the literature has acknowledged that the identification of skills and abilities needed for specific jobs and the development of competency models can build on the considerable existing resources and specifications that are found in this database (Scarlata, Stone, Jones, & Chen, 2011).

On O*NET, the general and operations manager (G&OM) profile describes, among other things, tasks, technology skills, tools used, work activities, skills, and abilities. Only behavioral competencies were considered, and skills and abilities were recoded according to Boyatzis et al. (1995) to allow for comparing with the other findings of the literature review.

TABLE 14: G&OM ICS RECODED ACCORDING TO BOYATZIS ET AL. (1995) AND SPENCER AND SPENCER (1993)

RECODED COMPETENCIES	G&OM SKILLS' AND ABILITIES' DEFINITION OF O*NET
EFFICIENCY ORIENTATION	Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.
	Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.
ATTENTION TO DETAIL	Selective Attention — The ability to concentrate on a task over a period of time without being distracted.
	Near Vision — The ability to see details at close range (within a few feet of the observer).
	Coordination — Adjusting actions in relation to others' actions.
FLEXIBILITY	Category Flexibility — The ability to generate or use different sets of rules for combining or grouping things in different ways.
	Fluency of Ideas — The ability to come up with a number of ideas about a topic.
INITIATIVE	Originality — The ability to come up with unusual or clever ideas about a given topic or situation, or to develop creative ways to solve a problem.
	Management of Financial Resources — Determining how money will be spent to get the work done, and accounting for these expenditures.

PLANNING	Management of Material Resources — Obtaining and seeing to the appropriate use of equipment, facilities, and materials needed to do certain work.
	Time Management — Managing one's own time and the time of others.
PERSUASIVENESS	Persuasion — Persuading others to change their minds or behavior.
EMPATHY	Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
	Social Perceptiveness — Being aware of others' reactions and understanding why they react as they do.
	Oral Comprehension — The ability to listen to and understand information and ideas presented through spoken words and sentences.
ORAL COMMUNICATION	Oral Expression — The ability to communicate information and ideas in speaking so others will understand.
	Speech Clarity — The ability to speak clearly so others can understand you.
	Speech Recognition — The ability to identify and understand the speech of another person.
	Speaking — Talking to others to convey information effectively.
WRITTEN COMMUNICATION	Reading Comprehension — Understanding written sentences and paragraphs in work related documents.
	Writing — Communicating effectively in writing as appropriate for the needs of the audience.
	Written Comprehension — The ability to read and understand information and ideas presented in writing.
	Written Expression — The ability to communicate information and ideas in writing so others will understand.
NEGOTIATION	Negotiation — Bringing others together and trying to reconcile differences.
CUSTOMER-SERVICE ORIENTATION	Service Orientation — Actively looking for ways to help people.
DEVELOPING OTHERS	Instructing — Teaching others how to do something.
	Management of Personnel Resources — Motivating, developing, and directing people as they work, identifying the best people for the job.
SYSTEMS THINKING	Systems Analysis — Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.
	Information Ordering — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).
USE OF CONCEPT	Deductive Reasoning — The ability to apply general rules to specific problems to produce answers that make sense.
	Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
PATTERN RECOGNITION	Inductive Reasoning — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).
PROBLEM AWARENESS	Problem Sensitivity — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.

There are other skills and abilities in the G&OM profile identified by O*NET that could not be recoded according to Boyatzis et al. (1995) and Spencer and Spencer (1993) because of their technical nature, such as "systems evaluation"

or their reference to a broad concept that is difficult to split into specific ICs, like "complex problem solving."

2.5 GENERIC MODELS FOR MANAGERS

The lack of competency profiles for the managerial role of OM led me to look for generic competency models for managers to refer to. A generic competency model identifies the ICs shared by any manager, regardless of his/her organizational level, function, and environment. For this reason, such a model does not fit any specific position well but is intended to form a basis of comparison with a new model (Spencer & Spencer, 1993). A renowned generic competency model for managers is the one proposed by Spencer and Spencer (1993), which included new data to the sample used by Boyatzis (1982). This competency model contains "differentiating" ICs, which distinguish superior from average performers, and some base requirements.

TABLE 15: SPENCER AND SPENCER'S GENERIC COMPETENCY MODEL FOR MANAGERS

TYPES OF ICS	GENERIC COMPETENCY MODEL FOR MANAGERS
DIFFERENTIATING COMPETENCIES	Persuasiveness
	Achievement orientation
	Teamwork
	Systems thinking
	Initiative
	Developing others
	Self-confidence
	Directiveness
	Information seeking
	Leadership
	Use of concept
BASE REQUIREMENTS	Expertise/Specialized knowledge
	Organizational awareness
	Building relationship

Source: Spencer and Spencer (1993)

2.6 RESEARCH QUESTION

In my research, I began collecting cases in the machinery industry and conducting BEIs for all the managerial roles cited, but the difficulty of gaining access to companies when asking to interview many managers led me to focus the research on a single role. Considering this difficulty, the importance of the OM role in determining organizational capabilities (Slack et al., 2010), especially in a mass-customization context (Åhlström & Westbrook, 1999), and the complete absence of studies on the ICs of OMs, I decided to focus on the following research question:

> *Which ICs of an OM help improve a manufacturing organization's MCC and why is it so?*

This focus facilitated accessing other manufacturing organizations in the machinery industry, thus leading to a final sample of eight cases.

3 METHODOLOGY

The choice of methodology was consequent to the identification of the research purpose (Voss, Tsikriktsis, & Frohlich, 2002). The *research purpose* of this thesis was to examine the relationship between key variables—ICs and MCC—that have been widely studied and analyzed, but almost always separately. Miles and Huberman (1994) and Creswell (2013) suggested creating a conceptual framework that explains, either graphically or in narrative form, the perspective of the research, presenting information from broad assumptions to narrow methods.
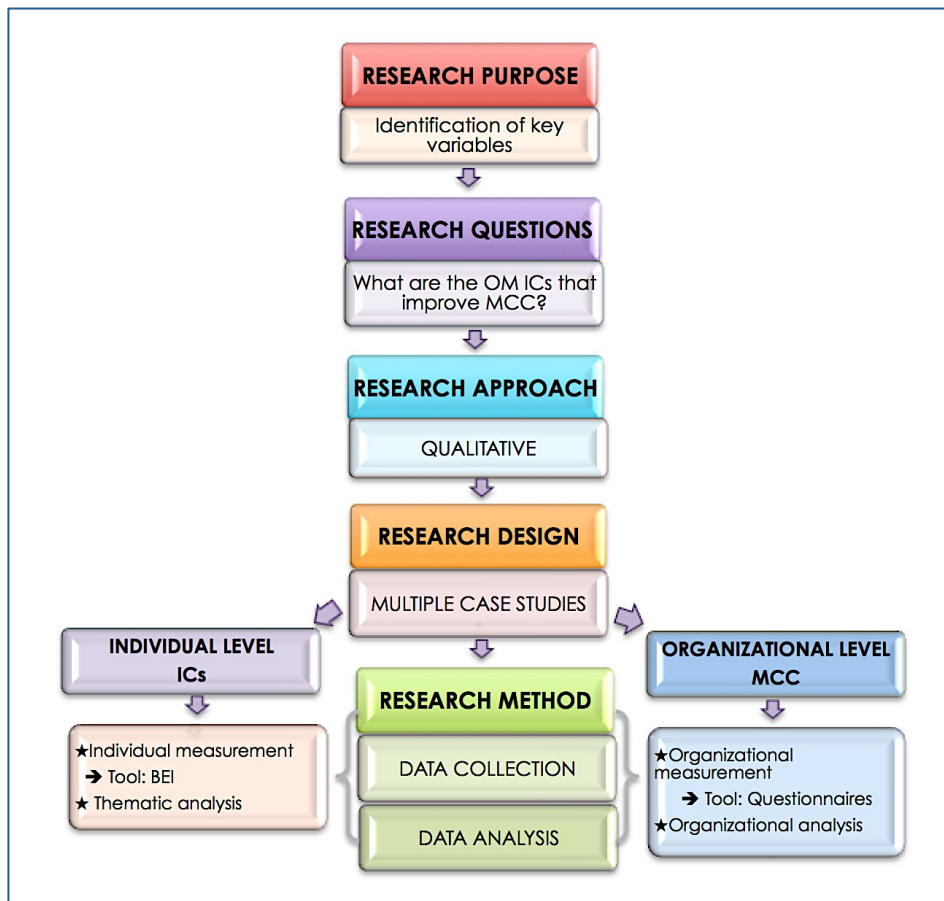
FIGURE 2: THE RESEARCH FRAMEWORK

Research approaches, designs, and methods are three key terms that describe the steps from broad constructions of research to detailed methods of data collection, analysis, and interpretation (Creswell, 2013). The study's conceptual framework must be clearly linked to the research questions (Miles & Huberman, 1994), as shown in the above figure.

3.1 RESEARCH APPROACH

The overall decision involves which approach should be used and is based on the nature of the research problem (Voss et al., 2002). The research problem in my case can be considered as a "blue sky" topic, which refers to a new research domain (Murphy, Klotz, & Kreiner, 2017), owing to the few prior works on the linkage across the individual and organizational levels (Rousseau, 2012) and in particular between ICs and MCC. Organizational scholars are used to focusing on the micro (psychological perspective) or macro (sociological perspective), but not on both the micro and macro or "thinking multilevel" by adopting a holistic view, which can allow for understanding the whole while keeping an eye on the parts (Klein & Kozlowski, 2000).

When research on a topic is at an initial stage, as is the case of the research on the role of ICs in the development of MCC, the appropriate methodological approach, according to the archetypes of methodological fit proposed by Edmondson and McManus (2007), is qualitative. When theory is nascent, researchers do not know which key variables will emerge from the data and how they are related. Thus, researchers need rich, detailed and evocative data to shed light on the phenomenon (Edmondson & McManus, 2007). The interviews with organizational informants adopted in this thesis are a qualitative method that allows for learning with an open mind. In addition, qualitative data are very useful for understanding why the emergent relationships hold

(Eisenhardt, 1989), as required by theory building (Whetten, 1989). Qualitative data are typically collected in the participants' setting and are analyzed inductively, building from particulars to general themes, with the researcher making interpretations of the meaning of the data (Creswell, 2013).

Furthermore, a qualitative research approach is consistent with the decision to assess the ICs of OMs using BEIs, a type of interview that will be described in detail in Section 3.3.1.2 and that is recognized as one of the most effective techniques for assessing managerial behavior (Spencer & Spencer, 1993).

The research approach involves philosophical assumptions about the world and the nature of research that the researcher brings to the study. Since there is no bi-univocal correspondence between the research approach used and the epistemological position, a post-positivist paradigm, which represents the traditional form of research and is sometimes called the scientific method, is suitable for such empirical research. As the name suggests, post-positivism represents the thinking after positivism; it challenges the claim of "absolute truth" of knowledge (Phillips & Burbules, 2000) and recognizes that this was never going to be obtained when studying the behavior and actions of human beings (Popper, 1969).

Post-positivists hold a deterministic philosophy in which causes determine effects or outcomes and these relationships, which are observed in a given context, can be generalized developing theories that can explain and predict phenomena. Post-positivists need to identify and assess the causes that influence outcomes and develop numeric measures of observations of individuals' behaviors (Creswell, 2013). At most, the data can corroborate the generalizations, but cannot represent a justification (Popper, 1969).

3.2 RESEARCH DESIGN

Research designs are types of inquiry, also called *strategies of inquiry* (Denzin & Lincoln, 2011), within qualitative, quantitative, and mixed-methods approaches that provide specific direction for procedures in the research (Creswell, 2013).

The choice to use the case study as strategy of inquiry for this research was supported by its extensive adoption in psychology, sociology to study individuals and organizations and related problems (Yin, 2009). There were two fundamental justifications for this decision:

1. This approach would allow for adopting replication logic, therefore promising to augment the external validity (Yin, 2009) and provide a stronger base for theory building (Kortmann et al., 2014);

2. It would provide a logical justification for reasons why some relations should be valid (Whetten, 1989) and would be particularly useful for answering "why" questions (Eisenhardt, 1989; Yin, 2009).

Furthermore, the decision to use multiple case studies, rather than a single case study, lies in the fact that focusing on a single case would have meant analyzing a single OM. Therefore, a single case study, especially when studying ICs, would have limited the generalizability of the research results (Meredith, 1998).

In conducting this case research, I decided to use retrospective, rather than longitudinal, cases essentially for two reasons. First, the method adopted to assess ICs—that is, BEI—is based on the collections of events that happened to respondents in the past. Furthermore, retrospective cases allow for more controlled case selection because it is possible to identify more accurately cases of high or low MCC in retrospect. Clearly, the choice of adopting retrospective case studies is not without limitations: interviewees may not recall important events and, even if they do, the data may be biased with impression management and retrospective sense making (Eisenhardt & Graebner, 2007; Voss et al., 2002).

3.2.1 Levels of analysis and units of analysis

The accurate specification of the research question allows for selecting the appropriate unit of analysis (Yin, 2009). The research question—"*Which ICs of an OM help improve a manufacturing organization's MCC, and why is it so?*"—made it possible to identify two units of analysis at two different levels: the OM at the individual level and the manufacturing organization, where he/she performs his/her role, at the organizational level.

Therefore, this study was multilevel, as ICs are characteristics of an individual, while MCC is a property of an organization.

3.2.2 Reference population

The reference population consists of mid- to large-sized manufacturing organizations in one European country, which employ more than 50 persons and have a turnover or a balance sheet total greater than 10 million euro, according to the European Commission Recommendation of May 6, 2003.

Small enterprises were not considered in this study owing to the risk of not identifying the OM role inside the organization.

The population comprises manufacturing organizations that produce machinery and equipment, which are kind of products that typically are customized, such as professional food processing equipment or machines for the pharmaceutical industry.

The adoption of the abovementioned selection criteria allowed for focusing on a relevant context for this study.

3.2.3 Sampling

The cases were selected from the reference population following literal and theoretical replication logic. Each case, in fact, was selected so that "it either

predicts similar results (a literal replication) or produces contrary results but for predictable reasons (a theoretical replication)" (Voss et al., 2002, p. 203). Accordingly, among the eight cases selected, both multiple cases with relatively high MCC and multiple cases with relatively low MCC were included. The number of cases was limited because of the onerousness of the tool used to assess competencies: BEIs are extremely time- and labor-intensive (Marrelli, 1998; Spencer & Spencer, 1993).

3.3 RESEARCH METHOD

The third major element in the research framework (see Fig. 2) is the specific research methods proposed for the data collection, analysis, and interpretation in the study (Creswell, 2013).

3.3.1 Data collection

According to Gioia (2013), in the early stages of data gathering and analysis, it is important to give extraordinary voice to informants, who are treated as "knowledgeable agents," and to create rich opportunities for discovering new concepts.

For each case, the OM was interviewed using the BEI to assess his/her ICs, while at least two knowledgeable informants filled a questionnaire containing a multi-item measurement scale of MCC to measure the outcome organizational variable (Huang et al., 2010).

Furthermore, for each manufacturing organization, I collected information on the following:

1. Organization size, sales, and production volume;
2. Degree of product customization;

3. Operational performance;

4. Diffusion of renowned organizational practices for mass customization.

3.3.1.1 Number of investigators

The choice to collect data using multiple investigators was due to different reasons, which promised two key advantages.

First, the interdisciplinary nature of the study suggested the presence of investigators with different disciplinary perspectives, who can offer complementary insights that can enhance the creative potential of the study (Eisenhardt, 1989; Voss et al., 2002).

Second, the convergence of observations from multiple investigators increases confidence in the findings (Eisenhardt, 1989) and, consequently, the reliability, which can be checked through a inter-rater agreement coefficient (Voss et al., 2002).

The strategy for collecting data in a team of investigators was to assume different roles, based on their expertise. In this research, I conducted the BEIs, because of my previous experience of conducting this kind of interview in firms, in the presence of another researcher with expertise in operations management, who recorded notes and observations with a particular focus on mass customization aspects (e.g., Eisenhardt & Bourgeois, 1988).

3.3.1.2 Approach for measuring individual competencies

To identify which ICs help improve a manufacturing organization's MCC, operations managers were interviewed using the BEI method.

BEI is based on a modification of the critical incident interview technique (Flanagan, 1954), which, according to Campbell, Dunnette, Lawler and Weick

(1970), is considered to be one of the most effective techniques for assessing managerial behavior.

A BEI is a semi-structured interview in which the interviewer asks the interviewee to recall and relate specific events in which he/she felt effective in executing his/her job (e.g., Boyatzis, 1982; Spencer & Spencer, 1993). It is also an intensive face-to-face interview that involves soliciting critical incidents and documenting what the respondent was thinking, feeling and doing during the event (Rothwell & Lindholm, 1999).

Once the interviewee has recalled an event, "he or she is guided through telling the story of the event with a basic set of four questions:

1) What led up to the situation?
2) Who said or did what to whom?
3) What did you say or do next? What were you thinking and feeling?
4) What was the outcome or result of the event?" (Boyatzis, 2009, p. 752)

The BEI permits deriving ICs inductively from performance, through the analysis of individual behaviors activated in episodes of efficacy, and thus they reflect effective job performance (Boyatzis, 2009). Therefore, it offers a high degree of validity by being grounded in events experienced by the interviewee and not on the interviewee's opinions and general evaluations (Marrelli, 1998).

Since this kind of interview detects how persons behave in real-life situations, it represents an efficient substitute for the direct observation of real behaviors (Boyatzis, 2009). In addition, BEI provides information on aspects of managerial behavior that would not be directly observable (Boyatzis, 1982).

This interview technique, which enables the researcher to collect detailed information on the behaviors, strategies, and context, has been widely used for qualitative data analysis (Campion & Odman, 2011). However, the BEI method has certain limitations, and the most important ones should be noted.

First, the interview method relies on the recall of the respondent, who chooses what to tell on the basis of what he/she remembers, and can be affected by retrospective bias (Boyatzis, 1982). This risk, however, is mitigated by the request to the interviewee to provide very detailed information of the situation, thoughts, feelings, dialogues, behaviors, and outcomes characterizing the event being told (Tognazzo, Gubitta, & Gerli, 2017).

Second, the interview method is not aimed to collect specific information or specialized knowledge that is at the basis of the decisions, thoughts, and actions recalled by the interviewee (Boyatzis, 1982). Therefore, BEI data are not considered adequate sources for determining functional/technical competencies, while they are suitable for identifying behavioral competencies, such as those studied in this research.

Third, the BEI is extremely time- and labor-intensive (Marrelli, 1998; Spencer & Spencer, 1993), thus limiting the possibility to collect data from a large sample. The small number of people interviewed can, consequently, make a broad acceptance of the research results more difficult (Marrelli, 1998).

Finally, this interview method requires a high degree of analytical ability and experience in competency analysis work to infer the competencies (Marrelli, 1998; Spencer & Spencer, 1993). This potential disadvantage, in this research, was offset by my experience of over ten years in conducting BEI in firms.

Each BEI lasted about one-and-a-half hours. All interviewees were informed of the purpose of the research and each one gave written consent to use the data. The interviews were audio-recorded and transcribed verbatim for subsequent coding using thematic analysis (Boyatzis, 1998).

3.3.1.3 Approach for measuring mass customization capability

To measure the MCC variable, I adopted the validated, multi-item measurement scale proposed by Huang et al. (2010).

I collected information from at least two knowledgeable informants for each case, asking them their degree of agreement or disagreement with the following five statements:

- MCC1: we are highly capable of large-scale product customization;
- MCC2: we can easily add significant product variety without increasing costs;
- MCC3: we can customize products while maintaining high volume;
- MCC4: we can add product variety without sacrificing quality;
- MCC5: our capability to respond quickly to customization requirements is very high.

I adopted a five-point Likert scale anchored by "strongly disagree" (1) and "strongly agree" (5).

The data were collected from multiple informants to avoid single-rater bias and were triangulated with information on the degree of product customization of each organization (Sandrin, 2016) and its operational performance.

3.3.2 Data analysis

The qualitative data collected through BEIs were coded using a codebook articulating specific themes and how to identify them (see Section 3.3.2.2.). It is important to note that, at the time of the interview, all of the OMs of the sample had been working with their company for at least 3 years. Thus, the data I gathered on the behaviors of these OMs all refer to events happened in the past

in the same company they were working for at the time of the interview ICs. Conversely, the data on the company's MCC refer to the time of the interview.

Subsequently, the results derived from the coding process were analyzed by performing a Mann-Whitney U statistical test to identify the "differentiating" ICs of OMs. Finally, chains of evidence linking "differentiating" ICs to MCC were identified to make generalizations regarding the MCC-enabling role of these ICs.

3.3.2.1 Codebook approach and thematic analysis

Individual competencies and related behavioral indicators may be taken deductively from theory and prior research or generated inductively from the data (Boyatzis, 1998). I chose an intermediate approach—that is, I used a combination of prior research and data to generate the codes.

The qualitative data collected from the BEIs were coded using thematic analysis, as suggested by Boyatzis (1998). Thematic analysis is the process of coding qualitative information using a codebook that articulates specific themes and how to identify them. Using such a codebook enables the researcher to convert open-ended responses into a set of quantified variables for analysis (Boyatzis, 1998, 2009). Thematic analysis has the advantage of allowing for the translation of qualitative information into quantitative data. Furthermore, this method, which has been used in many studies, showed the predictive validity of the ICs activated by the respondent during the events collected as coded from the interviews (Boyatzis, 2009).

3.3.2.2 Codebook adopted in this research

In this research, I decided to start with the codebook developed by Boyatzis et al.'s (1995) because Boyatzis is considered a founding developer of competency modeling in the United States (Rothwell & Lindholm, 1999) and his work had a

huge influence on HRM practice (Darafarin et al., 2016). In addition, Boyatzis and his colleagues provided, for the ICs included in their codebook, a set of behavioral indicators that are helpful in coding qualitative data on ICs (Ryan et al., 2009). Finally, Boyatzis et al.'s (1995) codebook was adopted in other recent studies on behavioral competencies (cf. Tognazzo et al., 2017).

Boyatzis et al.'s (1995) codebook includes 22 themes of ICs and provides behavioral indicators for each competency. The competency *initiative*, for example, could be identified when the interviewee showed one or more of the following behaviors:

> "a) Takes action first, not reacting to or being forced by events (e.g., he/she seizes opportunities);
>
> b) Takes action by seeking information in a non-traditional or unusual way (e.g., utilizes a wide variety of sources of information not typically used);
>
> c) Takes action different than anyone else or the expectations of others" (Boyatzis, 1998, p. 105).

I also considered the ICs proposed by Spencer and Spencer (1993) and included eight of them with their behavioral indicators, which were not captured by Boyatzis et al. (1995). In addition, I included two ICs from the codebook revisited by Boyatzis (2009) and I did the same for the other three ICs taken from the relevant literature in order to capture specific behaviors that, during the coding process, could not be coded in any of the initial ICs. In this case, I created a new code and defined the corresponding IC and its behavioral indicators in consideration of the relevant competency literature.

The final codebook included the following 35 ICs that I grouped, following Boyatzis et al.'s (1995) classification, into three clusters: "goal and action management" ICs, "people management" ICs, and "analytic reasoning" ICs.

Goal and action management ICs

1. *Efficiency orientation*: The ability to assess input/output relationships and to increase the efficiency of action (Boyatzis et al., 1995).

2. *Planning*: The ability to identify and organize future or intended actions with a result or direction (Boyatzis et al., 1995).

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 (Boyatzis et al., 1995).

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 (Boyatzis et al., 1995).

5. *Self-control*: The ability to inhibit personal needs or desires for the benefit of organizational, family, or group needs (Boyatzis et al., 1995).

6. *Flexibility*: The ability to adapt to changing circumstances, or alter one's behavior to better fit the situation (Boyatzis et al., 1995).

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 (Spencer & Spencer, 1993).

8. *Information seeking*: The ability to know more about things, people or issues (Spencer & Spencer, 1993).

9. *Organizational commitment*: The ability to align one's behavior with the needs, priorities, and goals of the organization (Spencer & Spencer, 1993).

People management ICs

10. *Empathy*: The ability to understand others (Boyatzis et al., 1995).

11. *Persuasiveness*: The ability to convince another person or persons of the merits of, or to adopt, an attitude, opinion, or position (Boyatzis et al., 1995).

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 (Boyatzis et al., 1995).

13. *Negotiation*: The ability to stimulate individuals or groups toward resolution of a conflict (Boyatzis et al., 1995).

14. *Self-confidence*: The ability to consistently display decisiveness or presence (Boyatzis et al., 1995).

15. *Group management*: The ability to stimulate members of a group to work together effectively (Boyatzis et al., 1995).

16. *Developing others*: The ability to stimulate someone to develop his/her abilities or improve their performance toward an objective (Boyatzis et al., 1995).

17. *Oral communications*: The ability to explain, describe or tell something to others through a personal presentation (Boyatzis et al., 1995).

18. *Customer-service orientation*: The ability to discover and meet the needs of an internal or external customer (Spencer & Spencer, 1993).

19. *Team work*: The ability to work cooperatively with others, to be part of a team, to work together, as opposed to working separately or competitively (Spencer & Spencer, 1993).

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 (Spencer & Spencer, 1993).

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 (Spencer & Spencer, 1993).

22. *Leadership*: The ability to take a role as a leader of a team or other group (Spencer & Spencer, 1993).

23. *Emotional self-awareness*: The ability to recognize one's emotions and their effects (Boyatzis, 2009).

24. *Positive outlook*: The ability to see the positive aspects of things and the future (Boyatzis, 2009).

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 (Boyatzis et al., 1995).

26. *Analytical/Systems thinking*: The ability to order multiple causal events (Boyatzis et al., 1995; Spencer & Spencer, 1993).

27. *Pattern recognition*: The ability to identify a pattern in an assortment of unorganized information or seemingly random data (Boyatzis et al., 1995).

28. *Theory building*: The ability to develop, or invent, new theories, models, or frameworks that explain available information and predict future events (Boyatzis et al., 1995).

29. *Using technology*: The ability to use advanced technology to perform tasks or functions on the job (Boyatzis et al., 1995).

30. *Quantitative analysis*: The ability to derive meaning from the use of arithmetic and mathematical symbols, methods, and theories (Boyatzis et al., 1995).

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 (Boyatzis et al., 1995).

32. Written communication: The ability to explain, describe, or tell something to others through a memo, letter, report, or written document (Boyatzis et al., 1995).

33. Visionary thinking: The ability to articulate a vivid image of what you desire to create (Puccio, Mance, & Murdock, 2007).

34. *Problem awareness*: The ability to perceive situations that may require action to promote organizational success (Tett, Guterman, Bleier, & Murphy, 2000).

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 (Morris, Webb, Fu, & Singhal, 2013).

3.3.2.3 Behavioral event interview analysis

The analysis was conducted independently by me and by another researcher, who independently coded the interviews using MAXQDA 12 software to mitigate the influence of subjectivity in the coding process.

The degree of agreement was checked through an inter-rater agreement coefficient (Voss et al., 2002), computed as the number of agreements over the total number of agreements and disagreements. The inter-rater reliability showed a level of agreement (0.83) above the threshold value of 0.7, which Boyatzis (1998) suggested for this kind of competency analysis.

When disagreement occurred, the research team accurately analyzed the interview transcriptions, IC definitions, and IC behavioral indicators, and finally made a decision, sometimes based on additional information requested of the OMs.

An example of how disagreements were solved is as follows. An OM BEI excerpt considered:

Since I could not visit our competitors, I visited their suppliers [of process technologies]. I saw what they [i.e., these suppliers] 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.

My colleague coded these excerpts into the IC *information seeking*, identifying the following behavioral indicator:

Makes a systematic effort over a limited period of time to obtain needed data or feedback (Spencer &Spencer, 1993, p. 35).

I coded these excerpts into the IC *initiative* considering the behavioral indicator:

Takes action by seeking information in a non-traditional or unusual way (e.g. utilizes a wide variety of sources of information not typically used) (Boyatzis, 1998, p 105).

I focused on the fact that the OM sought information in a non-traditional way, by visiting the supplier of process technology to obtain information about the organization's competitors.

Both interpretations identified the OM's search for information; however, as Boyatzis (2009) specified, a person can ask for information for multiple reasons or to various intended ends. To correctly identify the IC activated by the OM, is important to understand the underlying intent.

The intent of the IC *initiative* is "to take action to accomplish something, and to take this action prior to being asked or forced or provoked into it" (Boyatzis, 1998, p. 105).

The intent of the IC *information seeking* is "to know more about things, people or issues" (Spencer & Spencer, 1993, p. 35).

After a discussion with the research team and the careful analysis of the entire event transcription, I decided to attribute the IC *information seeking*, and not the IC *initiative*, because the OM was "forced" to seek information by the

market competition and the need to improve performance, as explained by the OM: "My goal was to improve efficiency while preserving flexibility."

Once full agreement was reached, each IC was measured by analyzing its frequency shown during the behavioral event interview (Ryan et al., 2009).

I defined the frequency, based on Camuffo et al. (2009), as the recurrence of a competency expressed by the interviewee, normalized by the number of events described during the interview, which were four in this research.

3.3.2.4 Statistical analysis

To identify the "differentiating" competencies of OMs that distinguish manufacturing organizations with higher MCC from those with lower MCC, I decided to use the approach adopted by Camuffo and Gerli (2018).

The sample was divided into two equal-size subsamples ("high MCC" vs. "low MCC") using, as splitting criterion, the sample median of the MCC measurement scale, responded by at least two knowledgeable informants for each case.

To assess the reliability of the answers, the inter-rater agreement coefficient was assessed as proposed by James, Demaree and Wolf (1984). The value was always greater than 0.88 and, on average, equal to 0.951. According to Boyer and Verma (2000), these values represent a very good agreement among the respondents assessing the MCC of their organization.

For each case organization, I calculated a single MCC value by averaging the evaluation of the five MCC measurement items among the informants from that organization.

I then compared the frequency distributions of ICs of the two sub-samples using the non-parametric Mann-Whitney U statistical test. I decided to use non-

parametric statistical analysis given the violation of the normality assumption and given the small sample size (Field, 2013).

As a result, I identified a number of ICs differentiating the OMs of the "high MCC" subsample from the OMs of the "low MCC subsample", which were used with a significantly higher frequency.

The "differentiating" ICs of OMs identified by performing the Mann-Whitney U statistical test were considered as potential enablers of MCC. To find evidence of the linkage between the differentiating ICs and the organization's MCC, the data were thoroughly reassessed.

3.3.2.5 Analytical generalizations

The identification of chains of evidence linking differentiating ICs to MCC allowed for strengthening the internal validity of the results and deriving generalizations regarding the MCC-enabling role of these ICs.

Generalizations derived by the present research are consistent with case study research methodology (cf. Yin, 2009), relying on analytical/conceptual arguments aimed at explaining the reasons why the propositions of this research might be extended outside the original sample to other organizations.

4 RESULTS

This chapter, after describing the case organizations profiles and giving general information on the OMs interviewed, reports the results of the empirical investigation.

After identifying the "differentiating" competencies, which distinguish the manufacturing organizations with higher MCC from those with lower MCC in the sample, I will describe the chains of evidence linking each "differentiating" IC to MCC and I will derive generalizations regarding their MCC-enabling role. Subsequently, I will present and describe the competencies that are common to all, or almost all, the interviewed OMs and that, consequently, seem to be required to operate effectively in product customization contexts, regardless of whether the organization is able to deliver product customization efficiently and quickly, according to the definition of mass customization. Finally, I will compare the OM's ICs emerged from this study with the sales manager's, marketing manager's and R&D manager's ICs derived from the literature review.

For confidentiality reasons, much of the information on individual cases, such as the OMs' competency profiles, data on organizational performance, and the European country where the case organizations are located, is omitted.

4.1 CASE PROFILES

Eight cases were chosen from the reference population (see Section 3.2.2.), following the literal and theoretical replication logic. Accordingly, both multiple cases with relatively high MCC and multiple cases with relatively low MCC were included.

The sample was divided into two equal groups of four cases—"high MCC" and "low MCC" groups—adopting the sample median of the MCC value as splitting criterion.

The classification resulting from this sample partition is presented in the following table.

TABLE 16: SAMPLE PROFILE

CASE CODE	SUBSAMPLE	ORGANIZATION SIZE	MAIN PRODUCT FAMILY/IES
A	High MCC	Medium	Electric motors
B	High MCC	Medium	Heat exchangers
C	High MCC	Large	Electric motors and generators
D	High MCC	Medium	Static converters for the control of electric motors
E	Low MCC	Medium	Equipment for professional cooking
F	Low MCC	Medium	Electrical cabinets and modules for industrial automation
G	Low MCC	Medium	Machinery and equipment for agriculture and other purposes
H	Low MCC	Medium	Machines for the pharmaceutical industry

In keeping with the definition of the reference population, all the case organizations are mid- to large-sized manufacturers of machinery and equipment for different sectors, such as machines for the pharmaceutical industry or for agriculture, equipment for professional cooking, electric motor and generation, and heat exchangers.

In addition to the data on the case organizations, I collected general information on their OMs regarding age, years of experience in the OM role, years spent at the company, and education. The data showed the following:

- Half of the OMs were more than 60 year old, with an average age of 53 years;
- Seven out of 8 OMs in the sample had more than 10 years of experience in the OM role, and the one exceptional case had 8 years of experience;
- Seven out of the 8 OMs had been working with their company for more than 10 years;

- 75% of the OMs in the sample had an engineering degree, while the remaining 25% had a technical high school diploma.

4.2 DIFFERENTIATING COMPETENCIES

The "differentiating" ICs, identified by performing the non-parametric Mann-Whitney U statistical test, are those that were used with a significantly higher frequency by the OMs of the "high MCC" subsample as compared with the OMs of the "low MCC" subsample ($p<0.05$). These competencies can be considered as possible individual enablers of MCC of their organizations.

Five "differentiating" OM competencies were identified, listed in the following table:

TABLE 17: AVERAGE FREQUENCY OF DIFFERENTIATING COMPETENCIES BETWEEN THE LOW AND HIGH MCC SUBSAMPLES

TYPES OF ICS	OM'S ICS	LOW MCC AVERAGE FREQUENCY	HIGH MCC AVERAGE FREQUENCY
DIFFERENTIATING ICS	ANALYTICAL/SYSTEMS THINKING	*	***
	PATTERN RECOGNITION	*	***
	NEGOTIATION	*	***
	INFORMATION SEEKING	*	***
	EFFICIENCY ORIENTATION	**	****

LEGENDA:
*= [0, 25%[
**= [25%, 50%[
***= [50%, 75%[
****= [75%, 100%]

Recalling the definition of frequency provided in Section 3.3.2.3, this table shows that, on average, the OMs of the High MCC subsample had activated all the "differentiating" competencies in one or two events more as compared with the OMs of the Low MCC subsample.

The differentiating ICs fall within the three clusters identified by Boyatzis et al.'s (1995) classification. *Analytical/systems thinking* and *pattern recognition*

belong to the "analytic reasoning" cluster, *negotiation* to the "people management" cluster, and *efficiency orientation* and *information seeking* to the "goal and action management" cluster.

The general proposition that I developed in this study is that the OM's use of the abovementioned "differentiating" competencies positively influences the MCC of his/her manufacturing organization. In the following, I report the empirical evidence of the linkage between each of these ICs and MCC in the sample organizations, and I provide a logical explanation for why this linkage might hold outside of the research sample.

4.2.1 Analytical/Systems thinking and mass customization capability

Analytical/systems thinking is defined both by Boyatzis et al. (1995) and by Spencer and Spencer (1993) as the ability to order multiple causal events, breaking a situation or a problem into smaller pieces and organizing them in a systematic way. In this research, I adopted the following behavioral indicators that Boyatzis et al. (1995) proposed for this IC:

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).

Analytical/Systems thinking competency was used with a significantly higher frequency ($p < 0.05$) by the OMs of the "high MCC" subsample than by the OMs of the "low MCC" subsample.

Some examples are reported in Table 1 in the Appendix, along with contextual information, BEI excerpts coded into *analytical/system thinking* competency, and the linkage with MCC.

The first example refers to an event recalled by an OM about an organization that produces heat exchangers and that belongs to the "high MCC" subsample. The OM described that her company traditionally was not so efficient because there was no control over the progress of the customer order fulfillment process, and each production supervisor saw his/her department as an island and did optimizations locally.

The OM stated the following:

> *"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."*

This BEI excerpt was coded using the behavioral indicator (b) of the *analytical/systems thinking* IC:

> 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).

In this case, the OM understood that giving all production supervisors visibility of the master production schedule and the progress of its implementation (A) was a prerequisite for improving collaboration among production departments (B) and ultimately enhancing delivery performance (C).

In general, the OM's ability to reconstruct causal chains allowed for detecting problem areas in the operational processes of the organization and for

devising solutions to improve such processes, which is essential for MCC (Huang et al., 2008). Continuous improvement, which Bessant and Francis (1999) defined as a process of focused and sustained incremental innovation, is a prerequisite to the development of MCC (Kristal et al., 2010; G. Liu, Shah, & Schroeder, 2006). Mass customizers need to continuously generate incremental innovations to counteract the deterioration of different dimensions of operational performance due to product customization (Kristal et al., 2010; Trentin et al., 2015) and, as highlighted, cause-and-effect thinking plays a central role in continuous improvement (Kim, Mabin, & Davies, 2008). Therefore, I developed the following proposition:

> *P1: The MCC of a manufacturing organization is positively influenced by the OM's use of the IC of analytical/systems thinking.*

4.2.2 Pattern recognition and mass customization capability

Patten recognition is defined as the ability to identify a pattern in an assortment of unorganized information or seemingly random data (Boyatzis et al., 1995), and it is identified by the following behavioral indicators:

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).

Pattern recognition competency was deployed by the OMs in the "high MCC" subsample with a significantly higher frequency (p < 0.05) as compared to the OMs of the "low MCC" subsample.

The empirical results of *pattern recognition* competency identified in the sample are reported in Table 2 in the Appendix.

The following example is taken from an event recounted by the OM of a company belonging to the "high MCC" subsample that produces static converters for the control of electric motors. A few years ago, the company entered the world of renewable energy with a variety of solutions and manages to exploit synergies among its product solutions, striving to keep as many common parts as possible and changing the "clothes".

During a meeting with a new potential customer, OM said:

> *"Okay, now you need 1,000-volt batteries. With 1,000 volts, we [already] have similar solutions for the world of ski lifts, chair lifts, cable cars."*

This BEI excerpt was coded using the behavioral indicator (c) of the *pattern recognition* competency:

> c) Sees similarities of a new situation to aspects of past situations
> of a different type.

In this case, the OM's ability to recognize similarities between the request of a new customer and the product solutions already available permitted the reuse of existing product components, thus avoiding the need to develop new solutions.

In general, the *pattern recognition* competency that the OMs deployed, helped their organizations identify and exploit similarities according to the philosophy of group technology. Group technology is a "management philosophy" (Hyer & Wemmerlov, 1989) that makes managing diversity more efficient and effective by identifying and exploiting similarities among things

(Selim, Askin, & Vakharia, 1998; Shunk, 1985). Group technology "can be applied in all facets of a company" (Knight, 1998) and allows firms to alleviate the negative implications of product variety for operational performance and, accordingly, enables MCC (Suzić, Forza, Trentin, & Anišić, 2018). Thus, I developed the following proposition:

> *P2: The MCC of a manufacturing organization is positively influenced by the OM's use of the IC of pattern recognition.*

4.2.3 Negotiation and mass customization capability

Boyatzis et al. (1995) defined *negotiation* as the ability to stimulate individuals or groups toward conflict resolution, which can be identified through the following behavioral indicators:

> 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.

Negotiation is a competency used by the OMs in the "high MCC" subsample with a significantly higher frequency ($p < 0.05$) as compared to the OMs in the "low MCC" subsample.

    Negotiation enhances the MCC of an organization through two mechanisms:

1. Cross-functional collaboration;
2. Workforce flexibility.

First, *negotiation* facilitates cross-functional collaboration between the operations function and the other functions of an organization and allows for achieving shared results. Collaboration among the operations, design, and marketing functions improves a manufacturer's capacity to satisfy customers' idiosyncratic needs using common product parts. According to Desai, Kekre, Radhakrishnan and Srinivasan (2001), it is important to find the balance between the commonality of parts and product differentiation because common parts allow for reducing manufacturing costs while simultaneously preventing the extraction of prime premiums derived from product differentiation (Desai et al., 2001). Moreover, *negotiation* can facilitate determining the right compromise between the need to satisfy a stream of differentiated customer needs and the need for reusing or recombining existing resources, such as product parts, which is fundamental for MCC (Salvador et al., 2009).

An OM in the "high MCC" subsample, who had been working for an organization that produces static converters for the control of electric motors, provided an example of the working of this mechanism through which negotiation enhances the MCC of an organization, reported in Table 3 in the Appendix. The OM explained that his company, five or six years ago, had entered the Chinese market. The sales department had pushed for a high degree of customization although this market is characterized by high variability in demand volume. Having tailor-made product components, the organization had a large stock of obsolete materials. To satisfy the Chinese customer and simultaneously reduce inventory obsolescence costs, the OM pushed for the reuse of existing product parts.

The OM, recalling the event, said:

"I battled with the sales department, [which wanted to deliver a product with a very high degree of customization…] … and we found a good compromise."

The cited BEI excerpt was coded with the behavioral indicator (b) of the competency *negotiation:*

> b) Identifies areas of mutual interest or benefit, often an objective to which all parties can aspire.

The ability of the OM to negotiate, finding a compromise with the sales department on the degree of product customization, helped the organization reduce inventory obsolescence costs owing to the possibility of increasing parts commonality among its products.

Negotiation improves the MCC of an organization through a second mechanism that pertains to workforce flexibility. An OM's ability to resolve conflicts with workers, such as negotiating with them over work shift extensions, night shifts, or movement across departments that make different products, can enhance both the volume flexibility and mix flexibility of the organization. Volume flexibility and mix flexibility are prerequisites for a build-to-order strategy (Salvador et al., 2007), which allows for delivering, without incurring the costs associated with finished-goods inventory, a variety of customized products (Gunasekaran & Ngai, 2005).

The OM's *negotiation* ability, therefore, helps an organization implement a flow of materials that satisfies idiosyncratic customer needs in an efficient way. This organizational capability is defined as logistic for mass customization in the literature (Trentin et al., 2015). Based on the above arguments, I formulated the following proposition:

> **P3: The MCC of a manufacturing organization is positively influenced by the OM's use of the IC of negotiation.**

4.2.4 Efficiency orientation and mass customization capability

Efficiency orientation is defined as the intent to assess input/output relationships and to increase the efficiency of action (Boyatzis et al., 1995). The behavioral indicators adopted in this study to identify *efficiency orientation* are as follows:

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 toward goals more efficiently.

Efficiency orientation is a competency used with a significantly higher frequency ($p < 0.05$) by OMs in the "high MCC" subsample, as compared with OMs in the "low MCC" subsample. The empirical results regarding the use of this IC are reported in Table 4 in the Appendix.

Efficiency orientation was identified, for example, in an episode recalled by an OM of a company that produces heat exchangers, who was in the "high MCC" subsample. The OM stated that the organizations' machines were flexible, but not that efficient as compared with competitors, and thus her goal was to improve efficiency while preserving flexibility. To achieve this outcome she behaved as follows:

"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."

The cited BEI excerpt describes behaviors that were coded as a demonstration of *efficiency orientation* using indicator (a):

a) Assesses inputs and outputs, or costs and benefits, with the expressed intent of increasing efficiency.

In this case, the OM's intent to increase efficiency led the organization to adopt process technologies that were more productive, and it did so with the right level of mix flexibility.

In general, the reason why *efficiency orientation* improves an organization's MCC is quite straightforward: Efficiency is one of the conflicting goals, together with flexibility, that a manufacturing organization aims to reconcile in a mass customization context. MCC, in fact, has been defined as the ambidextrous capacity of a manufacturing organization to combine the two divergent objectives cited above (Birkinshaw & Gupta, 2013; Kortmann et al., 2014). Clearly, an OM oriented to efficiency is of help to an organization that is pursuing this objective. If this organization was traditionally a custom manufacturer, characterized by a low level of efficiency, this OM IC would help improve this performance dimension while maintaining flexibility. Conversely, if the organization wanting to develop MCC was a traditional mass producer, characterized by high efficiency, this OM IC would help preserve efficiency while striving to improve flexibility. Therefore, I developed the following proposition:

> *P4: The MCC of a manufacturing organization is positively influenced by the OM's use of the IC of efficiency orientation.*

4.2.5 Information seeking and mass customization capability

Information seeking is defined as the ability to know more about things, people, or issues (Spencer & Spencer, 1993), and it can be identified through the following behavioral indicators:

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, and 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, and 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.

Information seeking is the fifth "differentiating" competency, which was deployed, as the others, with a significantly higher frequency ($p < 0.05$) by OMs in the "high MCC" subsample, as compared with OMs in the "low MCC" subsample.

The positive effect of *information seeking* on the MCC of an organization can have two general explanations:

1. Contribution to the organizational information-processing capacity;
2. Prerequisite for a number of competencies (Spencer & Spencer, 1993) that are beneficial to an organization's MCC.

First, the *information seeking* competency of an OM enhances the capacity of an organization to process (i.e., collect, store, assess, distribute, modify, or use) information. A greater capacity for processing organizational information helps

in addressing the growing information-processing needs that the development of MCC entails (Trentin et al., 2012).

Second, *information seeking*, as a prerequisite for several other ICs (Spencer & Spencer, 1993), is often used in combination with other ICs that are beneficial, as demonstrated, to an organization's MCC—such as *analytical/systems thinking* and *pattern recognition.*

Empirical results concerning the *information seeking* competency are reported in Table 5 in the Appendix.

The OM of an organization that produces static converters for the control of electric motors, who was in the "high MCC" subsample, recalled an example of the use of this IC. The OM explained that the organization must purchase the most critical materials, with long sourcing lead-time, without having a real order from the customer, and this necessity increases the inventory-holding costs. To solve this problem, the OM would usually adopt the following strategy:

> *"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."*

The cited BEI excerpt was coded as a demonstration of *information seeking* competency using the following behavioral indicator:

> f) Has personally established ongoing systems or habits for various kinds of information gathering.

The OM's ability to collect reliable information about likely imminent customer orders, developed through the habit of keeping constantly in touch with the salespeople, improves the capacity of the organization to deliver its customized product with relatively short lead-times, without creating excess inventory. Based on the above arguments, I formulated the following proposition:

P5: The MCC of a manufacturing organization is positively influenced by the OM's use of the IC of information seeking.

4.3 COMMON COMPETENCIES IN PRODUCT CUSTOMIZATION CONTEXTS

In analyzing the frequencies of OMs' ICs, I noticed that almost every OM possessed these ICs (i.e., 8 or 7 OMs), even if sometimes they were activated with different frequencies. The fact that almost every OM in the sample possessed specific ICs suggested that those are the competencies required to operate effectively in product customization contexts, regardless of whether the organization is able to deliver product customization efficiently and quickly, according to the definition of mass customization.

Of course, this conjecture, based on a limited sample, should be examined through large-scale empirical studies to strengthen its external validity.

The ICs that are common in the product customization context, according to the sample analysis, are shown in the following table.

TABLE 18: ICS COMMON IN PRODUCT CUSTOMIZATION CONTEXTS

ICs	IC DEFINITION	SOURCE
ACHIEVEMENT ORIENTATION	The ability to work well or to compete against a standard of excellence that may be; the individual's own past performance, an objective measure, challenging goals set by the individual, or even what anyone has aver done.	Spencer & Spencer, 1993
EFFICIENCY ORIENTATION	The ability to assess inputs and outputs, or costs and benefits, and includes the concern for increasing the efficiency of action.	Boyatzis et al., 1995
PLANNING	The ability to identify and organize future, or intended actions with a result or direction.	Boyatzis et al., 1995
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.	Boyatzis et al., 1995
PERSUASIVENESS	The ability to convince another person or persons of the merits of, or to adopt, an attitude, opinion, or position.	Boyatzis et al., 1995

LEADERSHIP	The ability to take a role as a leader of the team or other group. It implies a desire to lead others.	Spencer & Spencer, 1993
CUSTOMER-SERVICE ORIENTATION	The ability to help or serve others, to meet their needs. It means focusing on discovering and meeting the customer or client's needs.	Spencer & Spencer, 1993
PROBLEM AWARENESS	The ability to perceive situations that may require action to promote organizational success.	Tett et al., 2000

The OMs' ICs that are common in the product customization context fall within the three clusters identified by Boyatzis et al. (1995).

Achievement orientation, efficiency orientation, planning, and *attention to detail* belong to the "goal and management" cluster; *persuasiveness, leadership*, and *customer-service orientation* belong to the "people management" cluster; and *problem awareness* belongs to the "analytic reasoning" cluster. This competency portfolio is composed of 50% goal and action ICs, 37.5% relational ICs, and 12.5% cognitive competencies.

Achievement orientation, efficiency orientation, planning, and *persuasiveness* are competencies that every OM in the sample possessed, while *problem awareness, attention to detail, leadership*, and *customer-service orientation* were observable in seven of the eight BEIs conducted with the sample of OMs.

Efficiency orientation differs from the other competencies in that it is both possessed by all OMs and is activated with a significantly higher frequency by the OMs in the high-MCC subsample, and is, therefore, also a "differentiating" competency.

The following table shows that all the common competencies in product customization contexts have almost the same average frequency in the two different subsamples. This points out that, not only these competencies are possessed my all or almost all the OMs of the sample, but also that they had been activated with almost the same frequency during the events recalled by the interviewees.

TYPES OF ICs	OM's ICs	LOW MCC AVERAGE FREQUENCY	HIGH MCC AVERAGE FREQUENCY
COMMON COMPETENCIES IN PRODUCT CUSTOMIZATION CONTEXTS	PLANNING	****	****
	PERSUASIVENESS	***	***
	ACHIEVEMENT ORIENTATION	**	***
	PROBLEM AWARENESS	**	**
	CUSTOMER-SERVICE ORIENTATION	**	**
	LEADERSHIP	**	**
	ATTENTION TO DETAIL	**	**

LEGENDA:

*= [0, 25%[
**= [25%, 50%[
***= [50%, 75%[
****= [75%, 100%]

4.4 COMPARISON OF THE OM'S ICs IDENTIFIED BY THIS RESEARCH WITH THE SALES MANAGER'S, MARKETING MANAGER'S AND R&D MANAGER'S COMPETENCY MODELS IDENTIFIED BY THE LITERATURE

Table 19 shows which of the OM's ICs emerged from this research, both the "differentiating" competencies and the common competencies in product customization contexts, are shared by the competency models of sales manager, marketing manager and R&D manager derived from the literature review.

Most of the competencies that are owned by OMs operating in product customization contexts are shared, according to the literature, by all the other roles. More specifically, *leadership, customer-service orientation, planning,* and *achievement orientation* are competencies identified by the literature for all the other managerial roles studied. Instead, *attention to detail* and *problem awareness* are not shared by the other key managerial role and seem to be specific to OMs operating in product customization contexts.

As regards the "differentiating" competencies of an OM's that contributed to an organization's ability to deliver product customization efficiently and quickly, according to the definition of mass customization, they are shared only by some of the other roles studied. In particular, *negotiation* and *pattern recognition* are competencies shared, respectively, only by the MM and the R&D manager. *Negotiation* seems to be relevant for roles that require managing relationships and networks, while *pattern recognition* seems to make the difference for more technical roles. The others "differentiating competencies", that is, *information seeking, analytical/systems thinking,* and *efficiency orientation*, are instead shared by two of the other three managerial roles studied.

TABLE 20: COMPARISON OF THE OM'S ICS IDENTIFIED BY THIS RESEARCH WITH SALES MANAGER'S, MARKETING MANAGER'S AND R&D MANAGER'S COMPETENCY MODELS IDENTIFIED BY THE LITERATURE

TYPE OF IC	OM's ICs IDENTIFIED BY THIS RESEARCH	SALES MANAGER'S COMPETENCY MODEL DERIVED FROM THE LITERATURE	MARKETING MANAGER'S COMPETENCY MODEL DERIVED FROM THE LITERATURE	R&D MANAGER'S COMPETENCY MODEL DERIVED FROM THE LITERATURE
COMMON COMPETENCIES IN PRODUCT CUSTOMIZATION CONTEXTS	Leadership	X	X	X
	Customer-service orientation	X	X	X
	Planning	X	X	X
	Achievement orientation	X	X	X
	Persuasiveness	X		
	Attention to detail			
	Problem Awareness			
DIFFERENTIATING COMPETENCIES	Information seeking		X	X
	Systems thinking		X	X
	Efficiency orientation	X	X	
	Negotiation		X	
	Pattern recognition			X

5 DISCUSSION

This chapter shows the contributions that this research makes to the literature in the emerging field of behavioral operations, to the literature on MCC enablers and to the literature on ICs. Moreover, the chapter discusses the managerial contribution of the present study.

5.1 CONTRIBUTIONS TO THE BEHAVIORAL OPERATIONS MANAGEMENT LITERATURE

The contribution of the present study to the BOM literature is twofold:

1. The adoption of the competency approach to identify managerial behaviors that support the successful implementation of a mass-customization strategy;

2. The introduction of the BEI method to measure managerial behavior in mass customization contexts.

The competency approach has been adopted rarely in studies explicitly defined as BOM studies, even though the existing literature (Croson et al., 2013; Erjavec & Trkman, 2018) predicts that the focus on individuals' characteristics, such as personality traits or other behavioral aspects, and personnel assessment should become vital for the future development of the BOM field.

The competency construct could assume even more importance within BOM research because it not only encompasses different types of characteristics of a person—traits, motive, self-concept, knowledge, and skills (Spencer & Spencer, 1993)—but introduces a causal relationship between behavior and performance.

In recent years, BOM research on ICs has focused on lean production systems and the role of the supply chain manager. To date, in the lean management field, with the exception of recent studies by Camuffo and Gerli

(2018) and van Dun, Hicks and Wilderom (2017), there has been neither specific theorizing about nor a quantitative, empirical investigation into the management behaviors and related ICs associated with the successful implementation of lean operations practices.

Likewise, research on the competencies of supply chain managers only recently has become more empirical, quantitative, and focused on identifying competencies that influence individual and organizational performance (Essex et al., 2016).

The direction of the present research was similar to the recent cited studies in that it entailed an empirical investigation using the BEI, which allowed for deriving competencies inductively through the analysis of individual behaviors.

A second contribution to BOM studies concerns the introduction of the BEI methodology to measure management behaviors for the purpose of theory building. The application of this qualitative methodology, recently adopted by Camuffo and Gerli (2018) for the purpose of theory testing, to develop new theoretical propositions represents a novelty in the BOM field. Most of the BOM studies have involved experimental research, although a few studies have been qualitative/conceptual in nature. The methods used include primarily laboratory experiments, simulation games, and scenario-based role-playing experiments (Erjavec & Trkman, 2018). The introduction of new methods in the BOM field, such as the BEI used in this study, is considered particularly important because it enables the triangulation of the results obtained with other methods, overcoming the limitations associated with each method (Croson et al., 2013).

In addition to these general contributions to the BOM literature, the results of this thesis make specific contributions to the IC research and the MCC research, besides contributing to the specific practice of HRM.

5.2 CONTRIBUTION TO THE MASS CUSTOMIZATION CAPABILITY LITERATURE

The mass customization literature is rich in studies on the enablers of MCC that are technological and organizational in nature, but this literature has almost completely neglected individual-level enablers.

Even though some of the studies that focus on organization-level enablers implicitly offer some insights on individual-level enablers, these messages refer almost exclusively to workforce (e.g., Liu et al., 2006; Huang et al., 2008, 2010; Leffakis & Dwyer, 2014). The only study that has focused on the individual-level enablers of MCC is that of Forza and Salvador (2006).

After this work, the present research is the first empirical study on ICs for mass customization. Forza and Salvador's (2000) exploratory study has a serious limitation that I attempted to overcome in this research: Their findings were derived from experts'/practitioners' knowledge and opinions rather than from facts and incidents involving the individuals performing their jobs. In other words, they did not collect individual-level data on employees' competencies, whereas this research did so using BEIs. Therefore, this study is the first to adopt an empirical multi-level research design that allows for linking ICs to an organization's MCC.

Despite the limitation highlighted and the fact that Forza and Salvador's (2006) results were not distinguished according to the role affected by mass customization within the company, the comparison with the findings of the present study offers interesting insights. To enable the comparison of the findings of these two studies, some attitudes and abilities were recoded according to the codebook adopted in this study.

The comparison between the OM's ICs identified in this study and Forza and Salvador's (2006) results is shown in the following table.

TYPE OF IC	OM'S ICS	FORZA & SALVADOR (2006)
DIFFERENTIATING COMPETENCIES	Negotiation	X
	Information seeking	
	Systems thinking	X
	Pattern recognition	
	Efficiency orientation	X
COMMON COMPETENCIES IN PRODUCT CUSTOMIZATION CONTEXTS	Achievement orientation	
	Persuasiveness	X
	Leadership	
	Planning	X
	Attention to detail	
	Customer-service orientation	X
	Problem Awareness	

Almost half of the ICs common to OMs operating in a context of product customization identified in this study echo those in Forza and Salvador's (2006) study

Customer-service orientation, *persuasiveness*, and *planning*, considered by Forza and Salvador (2006) as abilities, are the ICs of the class of abilities cited most frequently by the experts in their study.

Customer-service orientation, defined by the authors as the ability to think and act in a customer-oriented way, is the IC most cited by the experts, who considered this as the most necessary ability for mass customization.

Persuasiveness, defined by Forza and Salvador (2006) as the ability to ensure collaboration, and *planning*, defined as the ability to plan, coordinate, and organize, both received 6% of the total citations of the abilities' class, composed of 27 ICs, positioning both in the fourth position of the ranking. The experts' opinions, therefore, confirm some important results of the present study.

According to the findings of the present study, *planning* and *persuasiveness* are the ICs activated with the highest frequency by the OMs in the sample: Every OM used the ability to plan in 75% of cases and the ability to persuade in almost 60% of cases.

Some of the "differentiating" ICs identified in this study, which are those present at a significantly higher level in OMs of companies with higher MCC, were cited by the experts interviewed by Forza and Salvador (2006).

In particular, *negotiation*, defined by Forza and Salvador (2006) as the attitude to solve conflicts and mediate by identifying advantages and disadvantages, is the second most cited IC of the cluster composed of 10 attitudes. *Negotiation*, therefore, is one of the most important attitudes for product customization and is between those ICs related to the need to face complex, uncertain, and ever-changing environments (Forza & Salvador, 2006).

The *efficiency orientation* competency, which in this study was both possessed by all OMs and was activated with a significantly higher frequency by the OMs in the high-MCC subsample, was considered by the experts interviewed by Forza and Salvador (2006) as one of the most important abilities for mass customization. This IC, defined by Forza and Salvador (2006) as the ability to evaluate costs and the financial implications of each decision, is the third ability cited by the experts inside the cluster of 27 ICs.

The ICs identified in this study that echo those cited in Forza and Salvador's (2006) work are mainly relational in nature (*negotiation, customer-service orientation*, and *persuasiveness*) or belong to the goal and management cluster (*efficiency orientation* and *planning*). On cognitive ICs, there is no agreement with the prior study because, on the one hand, systematic and analytical thinking, which are considered to be part of the same competency, was classified by the authors as attitude and, on the other hand, it was cited minimally by the experts, ranking at the end of the 10 attitudes considered in this class of competencies.

A further contribution emerges if the findings on distinctive ICs are interpreted in light of the existing, and relatively more developed, literature on the organizational enablers of MCC. This can represent the first step toward an

understanding of the micro-foundations, or building blocks, of a number of organizational capabilities for MCC. This was not an objective of the study and, accordingly, the research protocol did not include the collection of data on organizational capabilities for MCC. All the differentiating competencies identified in this study are important individual enablers for mass customization organizational capabilities, such as a robust process design and logistic for mass customization. The same IC, such as *negotiation*, acts on MCC through different causal chains that pass through different organizational capabilities. This is not surprising because ICs can predict behavior in a wide variety of situations and job tasks (Spencer & Spencer, 1993) and can, therefore, be activated in different organizational processes.

5.3   CONTRIBUTIONS TO THE INDIVIDUAL COMPETENCIES LITERATURE

As regards the IC literature, this study offers insights into the ICs required in so-called VUCA (volatile, uncertain, complex, and ambiguous) environments, which include mass customization contexts, and starts to fill the gap represented by the lack of IC models specific to the role of OM.

5.3.1 Individual competencies for VUCA environments

In dynamic environments, technical competencies for a successful manager are less critical than behaviors, which focus on agility and competencies that underpin those behaviors (Hall & Rowland, 2016).

Leader and manager behaviors are determinant for managing complexity and can also aggravate or reduce it, as they are powerful influencers of complexity in an organization (Ashkenas, Siegal, & Spiegel, 2013).

At least four of the "differentiating" ICs identified in this study can be discussed in relation to prior research findings relevant to VUCA contexts. Some specific examples are as follows.

- *Information seeking*

In a complex environment, efficient problem solving requires a broad search for information from different disciplinary expertise (Iansiti, 1995), and therefore the *information seeking* competency, to probe for potential new linkages between previously unrelated knowledge bases. In a world of growing dynamic complexity it is essential to use multiple sources of information, both available internally, within the boundaries of the organization, and externally (Badilescu-Buga, 2013; Sun, 2012). In high-variety environments, information gathering on customer needs is fundamental and requires many different organizational functions to interact with the customer in some informal or formal way (Bramham, MacCarthy, & Guinery, 2005). *Information seeking* is a prerequisite for a number of competencies (Spencer & Spencer, 1993), such as *analytical/systems thinking* and *pattern recognition*.

- *Analytical/Systems thinking* and *pattern recognition*

In a complex and dynamic environment, organizational complexity is almost inevitably aggravated by cognitive complexity, which derives from a mismatch between how the world is and how people envision it, which is based on past experience (Ashkenas et al., 2013). According to Sloman (1996), people can answer the same reasoning problem using two different reasoning systems because the mind has dual aspects—one that conforms to the analytic, sequential view, and the other that conforms to the associative view. When there is cognitive complexity, the possibility of using both of these reasoning systems can offer a competitive advantage.

OMs or high-MCC companies can choose between the two ways of reasoning because they possess both *analytical/systems thinking* and *pattern recognition* ability.

Analytical/systems thinking is associated with the analytic, sequential way, which is slow and deliberative. *Pattern recognition* is related to the associative way, which involves a broader and holistic view, but is quicker because it allows for capitalizing on the ability of memory using judgments regarding pattern similarity (Senge, 1990). These two ways of reasoning complement each other (Sloman, 1996). Having both *analytical/systems thinking* and *pattern recognition* ICs offers an advantage in highly complex environments, especially when rapid decisions are requested, because it allows for choosing between quick but potentially sub-optimal actions or slower but optimal solutions (Lloyd-kelly, Gobet, & Lane, 2005).

• *Negotiation*

In the era of globalization and rapid technological changes, a strong *negotiation* ability is a prerequisite for professional success (Watkins, 1999). For managerial roles, such as MM, *negotiation* is one of the most relevant competencies for managing a turbulent environment (Kashani, 1995).

The *pattern recognition* competency can be essential for managing complex and confusing negotiating situations effectively. The *pattern recognition* competency, which expert managers generally possess, allows for recognizing configurations or familiar patterns that represent threats and opportunities (e.g., coalitional alignments) and, consequently, for anticipating reactions and other contingencies to rapidly come up with promising negotiating actions (Watkins, 1999).

Furthermore, the *negotiation* competency is recognized by the Association of MBAs (AMBA), in its criteria for accreditation, as one of the

important "soft" management skills that must be developed throughout the MBA programs (Hall & Rowland, 2016). Today, to obtain accreditation from international bodies, such as AMBA, business schools include in their programs *negotiation* and other ICs (e.g., ability to manage change, dealing with ambiguity) that are important for future managers and leaders to possess to manage complexity.

5.3.2 Competency model for operations managers

This study constitutes an attempt to start filling the gap represented by the lack of IC models specific to the role of OM.

5.3.2.1 Comparison with generic competency model for managers

The generic competency model that Spencer and Spencer (1993) developed provides a basis for comparison with the results of this research. To enable the comparison, it was necessary to recode Spencer and Spencer's (1993) differentiating ICs according to the IC codebook adopted in this research.

TABLE 22: SPENCER AND SPENCER'S (1993) GENERIC COMPETENCY MODEL FOR MANAGERS RECODED

GENERIC COMPETENCY MODEL FOR MANAGERS	RECODED COMPETENCIES ON THE BASE OF THE CODEBOOK ADOPTED
Impact and influence	Persuasiveness
Achievement orientation	Achievement orientation
Teamwork and cooperation	Teamwork
Analytic thinking	Systems thinking
Initiative	Initiative
Developing others	Developing others
Self-confidence	Self-confidence
Directiveness	Directiveness
Information seeking	Information seeking
Team leadership	Leadership
Conceptual thinking	Use of concept

Spencer and Spencer's generic competency model for managers cites the following:

- Two of the differentiating ICs of OMs of companies with a high MCC: *analytical/systems thinking* and *information seeking*;
- Three of the ICs common to the OMs operating in the context of personalization: *achievement orientation, persuasiveness*, and *leadership*.

This generic competency "provides the background against which the special characteristics of different levels, functions and environment stands out" (Spencer & Spencer, 1993). Accordingly, *negotiation, pattern recognition*, and *efficiency orientation* can be seen as the special competencies needed to operate in a mass customization context.

TABLE 23: COMPARISON BETWEEN THE ICS IDENTIFIED IN THIS STUDY AND SPENCER&SPENCER'S (1993) GENERIC ICS MODEL

TYPE OF IC	OM'S ICS	SPENCER AND SPENCER'S (1993) GENERIC ICS MODEL
DIFFERENTIATING ICS	Systems thinking	X
	Information seeking	X
	Negotiation	
	Pattern recognition	
	Efficiency orientation	
ICS COMMON IN CONTEXTS OF PERSONALIZATION	Achievement orientation	X
	Persuasiveness	X
	Leadership	X
	Planning	
	Attention to detail	
	Customer-service orientation	
	Problem Awareness	

5.3.2.2 Comparison with U.S. occupational database O*NET

A comparison between the OMs' ICs identified in this research and the G&OM competency profile proposed by O*NET revealed the following:

- All "differentiating" competencies are mentioned by O*NET with the only exception being *information seeking*;

- Almost all ICs common to OMs operating in the context of personalization are included in the G&OM competency model of O*NET with the exception of *achievement orientation* and *leadership.*

Although it is complete and highly detailed, the G&OM competency profile is generic and does not consider different contexts and environments. The adoption of a universalistic perspective entails some limitations because it does not consider some OMs' ICs that are important for being effective in specific business environments.

TABLE 24: ICS IDENTIFIED IN THIS STUDY ACCORDING TO O*NET COMPETENCY DEFINITION

TYPE OF IC	OM'S ICS	O*NET COMPETENCIES G&OM DEFINITION
DIFFERENTIATING ICS	NEGOTIATION	Negotiation — Bringing others together and trying to reconcile differences.
	INFORMATION SEEKING	(N)
	SYSTEMS THINKING	Systems Analysis — Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes. Information Ordering — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).
	PATTERN RECOGNITION	Inductive Reasoning — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).
	EFFICIENCY ORIENTATION	Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action. Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.
ICS COMMON IN CONTEXTS OF PERSONALIZATION	ACHIEVEMENT ORIENTATION	(N)
	PERSUASIVENESS	Persuasion — Persuading others to change their minds or behavior.
	LEADERSHIP	(N)

		Management of Financial Resources — Determining how money will be spent to get the work done, and accounting for these expenditures.
	PLANNING	Management of Material Resources — Obtaining and seeing to the appropriate use of equipment, facilities, and materials needed to do certain work.
		Time Management — Managing one's own time and the time of others.
	ATTENTION TO detail	Selective Attention — The ability to concentrate on a task over a period of time without being distracted.
		Near Vision — The ability to see details at close range (within a few feet of the observer).
	CUSTOMER-SERVICE ORIENTATION	Service Orientation — Actively looking for ways to help people.
	PROBLEM AWARENESS	Problem Sensitivity — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.

5.4 CONTRIBUTIONS TO MANAGERIAL PRACTICE

Pragmatically, the results of this study offer contributions and insights both to the HR function, especially for selection and development processes, and to the managers involved in this research.

5.4.1 Human resource management practices

HRM and operations management are disciplines that have always been distant from each other although HR and operations are closely tied to one another in all business environments (Boudreau, Hopp, McClain, & Thomas, 2003).

Incorporating the operations context in HRM theories makes them more contextually precise and helps in identifying new ways for HR practices to add value (Boudreau et al., 2003). In the present study, the possibility of incorporating the mass customization context in competency-based studies yielded more realistic insights.

The results of this study contribute to the HR function of companies pursuing an MCC by assisting in improving the majority of the HR processes. Furthermore, the results especially provide helpful insights regarding the selection of OMs with the "right" ICs and the development of the "right" abilities.

Effectively, selection and learning and development are, according to Armstrong (2006), the most important areas where competencies are applied:

1) Selection – 85%

2) Learning and development – 82%

3) Performance management – 76%

4) Recruitment – 55%

5.4.1.1 Selection

The contribution of this study to the selection process is the identification of a competency model for the OM role that can be used as a framework for selection. This study allows for identifying the particular "differentiating" competencies that permit to establish the extent to which candidates meet the job specifications as set out in competency terms (Armstrong, 2006).

By focusing on assessing specific "differentiating" competencies and using behavioral interviews, questionnaire or other selection tools, it is possible to identify the candidates who should be top-performing OMs in the context of mass customization. For example, it is possible to use the selection tool proposed by Rudloff (2007). He suggested a list of sample behavioral interview questions for identifying and assessing various ICs, such as *negotiation* (cf. the table below).

NEGOTIATION
Describe the most challenging negotiation in which you were involved.   • What did you do?   • How did you prepare for it?   • How did you present your position?   • How did you resolve it?   • How did you feel about this?   • What was the most difficult part?   • What were the results for you?   • What were the results for the other party?

5.4.1.2 Training and development

An OM competency model can be used as the basis for assessing the levels of competency achieved by individuals and, accordingly, for identifying their training and development needs (Armstrong, 2006).

Such a competency assessment can be performed by using different tools, from behavioral interviews or BEI, conducted by HR competency experts, to questionnaires, which can be filled in by employees who play roles that differ from that of the assessed person. The so-called 360° management competency assessment, for example, incorporates self-assessments and those of multiple colleagues. This allows for evaluating competencies from different organizational perspectives (e.g., supervisors, peer, subordinates) and provides incremental validity to the self-evaluation (Liang, Howard, & Leggat, 2017).

Then the training needs can be identified according to the OM competency assessment. If the OM does not possess the "differentiating" ICs or does not possess them at the expected level, the organization can create focused training programs to develop specific ICs.

Further, this consideration can be extended to policy makers, who can design education systems and training programs with the aim of raising

awareness about the ICs needed to work successfully in the mass customization context.

The mere presence of a competency model can help the OM understand which ICs the company pursuing the mass-customization strategy requires. This will help the OM plan his/her own self-directed learning programs.

5.4.2 Competency analysis for the interviewed operations managers

Each interviewed OM received a detailed report on his/her ICs, which emerged from the analysis of the BEI, as well as a comparison with the ICs that emerged from his/her responses in a self-assessment questionnaire. The feedback provided to the interviewed OMs on their competency portfolio helped them develop an awareness of their strengths and weaknesses.

6 CONCLUSIONS

As a result of the within-case and cross-case analyses, there emerged five ICs that the OMs in the "high MCC" subsample had used with a significantly higher frequency than the OMs in the "low MCC" subsample. These "differentiating" ICs are *information seeking* and *efficiency orientation*, within the "goal and action" IC cluster; *negotiation*, within the "people management" IC cluster; and *analytical/systems thinking* and *pattern recognition*, within the "analytic reasoning" IC cluster.

The results of this study corroborate some of the opinions of the practitioners interviewed by Forza and Salvador (2006) in their study on individual enablers of MCC. Specifically, *negotiation* and *efficiency orientation* were among the ICs most cited by the experts in Forza and Salvador's (2006) study. However, the results of this study also challenge other findings in Forza and Salvador's (2006) study. Specifically, *analytical/systems thinking* was one of the ICs least cited by the informants in that study. As for *pattern recognition* and *information seeking*, they were not even mentioned by the same informants. Therefore, it seems that the practitioners interviewed by Forza and Salvador (2006) underestimated the importance of the *information seeking* IC, which belongs to the "goal and action management" IC cluster, and of the two cognitive ICs of *analytical/systems thinking* and *pattern recognition*.

A secondary result of this research is the identification of a set of ICs that seem to be necessary to operate effectively in a product customization context, regardless of whether product customization is delivered efficiently and quickly, according to the definition of mass customization, or not. Specifically, *achievement orientation, efficiency orientation, planning, attention to detail, persuasiveness, leadership, customer-service orientation*, and *problem*

awareness are ICs that are common to the OMs of the "high MCC" subsample and to the OMs of the "low MCC" subsample.

Finally, a number of limitations of the present research must be recognized. Future studies could be designed to overcome these limitations.

The first limitation is the relatively small sample, which included only eight machinery manufacturers from a single European country. The limited number of cases is due to the fact that the BEI method is extremely time- and labor-intensive (cf. Section 3.3.1.2). Therefore, a research opportunity would be extending the study to other industries or sectors (e.g., business-to-consumer manufacturers, service companies) to assess the generalizability of the results. A further research possibility for evaluating the generalizability of this study's results would be to design large-scale, survey-based studies. This data collection method would have been inappropriate for the theory-building objective of this research because it would not have permitted identifying new competencies or providing detailed information about the nuances of competencies expressed by different people (Spencer & Spencer, 1993). The second limitation concerns the focus of this research on the OM role. The OM role is only one of the professional roles affected by mass customization in a company (Forza & Salvador, 2006). Other professional roles strongly influenced by product customization are those in the marketing/sales and technical functions. A future research opportunity, therefore, would be to extend the research on ICs to other managerial roles, such as marketing/sales manager and R&D manager. The extension of the research to these roles can additionally present the possibility of studying the impact of the overall set of ICs of these managers on a company's MCC.

REFERENCES

Åhlström, P., & Westbrook, R. (1999). Implications of mass customization for operations management: an exploratory survey. *International Journal of Operations & Production Management, 19*(3), 262–275.

Ahmad, S., Schroeder, R. G., & Mallick, D. N. (2010). The relationship among modularity, functional coordination, and mass customization: implications for competitiveness. *European Journal of Innovation Management, 13*(1), 46–61.

Armstrong, M. (2006). *A handbook of human resource management practice.* London, UK: Kogan Page Publisher.

Ashkenas, R., Siegal, W., & Spiegel, M. (2013). Mastering organizational complexity: a core competence for 21st century leaders. In *Research in Organizational Change and Development* (Vol. 21, pp. 2–29).

Badilescu-Buga, E. (2013). Knowledge behaviour and social adoption of innovation. *Information Processing and Management, 49*(4), 902–911.

Barney, J., & Felin, T. (2013). *What are microfoundations? The Academy of Management Perspectives* (Vol. 27).

Bartram, D. (2005). The great eight competencies: A criterion-centric approach to validation. *Journal of Applied Psychology, 90*(6), 1185.

Bendoly, E., Croson, R., & Schu, K. (2009). Bodies of knowledge for research in behavioral operations. *Production and Operations Management, 19*(4), 434–452.

Bendoly, E., van Wezel, W., & Bachrach, D. G. (2015). *The handbook of behavioral operations management: social and psychological dynamics in production and service settings.* Oxford, UK: Oxford University Press.

Bessant, J., & Francis, D. (1999). Developing strategic continuous improvement capability. *International Journal of Operations & Production Management, 19*(11), 1106–1119.

Birkinshaw, J., & Gupta, K. (2013). Clarifying the distinctive contribution of ambidexterity to the field of organization studies. *Academy Af Management Perspectives*, *27*(4), 287–298.

Boudreau, J., Hopp, W., McClain, J. O., & Thomas, L. J. (2003). On the interface between operations and human resources management. *Manufacturing & Service Operations Management*, *5*(3), 179–202.

Boyatzis, R. E. (1982). *The competent manager: a model for effective performance*. New York, NY: John Wiley & Sons, Inc.

Boyatzis, R. E. (1998). *Transforming qualitative information: thematic analysis and code development*. Thausand Oaks, CA: SAGE Publications, Inc.

Boyatzis, R. E. (2008). Competencies in the 21st century. *Journal of Management Development*, *27*(1), 5–12.

Boyatzis, R. E. (2009). Competencies as a behavioral approach to emotional intelligence. *Journal of Management Development*, *28*(9), 749–770.

Boyatzis, R. E., Cowen, S. S., & Kolb, D. A. (1995). *Innovation in professional education: steps on a journey from teaching to learning*. San Francisco, CA: Jossey-Bass Publishers.

Boyer, K. K., & Verma, R. (2000). Multiple raters in survey-based operations management research: a review and tutorial. *Production and Operations Management*, *9*(2), 128–140.

Bramham, J., MacCarthy, B., & Guinery, J. (2005). Managing product variety in quotation processes. *Journal of Manufacturing and Technology Management*, *16*(4), 411–431.

Campbell, J. P., Dunnette, M. D., Lawler, E. E., & Weick, K. E. (1970). *Managerial behaviour, performance, and effectiveness*. New York, NY: McGraw-Hill Book Company.

Campion, M. a, & Odman, R. B. (2011). Doing competencies well: best practice in competency modelling. *Personnel Psychology*, *64*, 225–262.

Camuffo, A., & Gerli, F. (2004). An integrated competency-based approach to management education: an Italian MBA case study. *International Journal of Training and Development*, *8*(4), 240–257.

Camuffo, A., & Gerli, F. (2018). Modeling management behaviors in lean production environments. *International Journal of Operations & Production Management*, *38*(2), 403–423.

Camuffo, A., Gerli, F., Borgo, S., & Somià, T. (2009). The effects of management education on careers and compensation. *Journal of Management Development*, *28*(9), 839–858.

Choi, B. C. K., & Pak, A. W. P. (2006). Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness. *Clinical and Investigative Medicine*, *29*(6), 351–364.

Choi, B. C. K., & Pak, A. W. P. (2008). Multidisciplinarity, interdisciplinarity, and transdisciplinarity in health research, services, education and policy: 3. Discipline, inter-discipline distance, and selection of discipline. *Clinical and Investigative Medicine*, *31*(1), 1–8.

Creswell, J. W. (2013). *Research design: qualitative, quantitative, and mixed methods approaches*. Thausand Oaks, CA: SAGE Publications.

Croson, R., Schultz, K., Siemsen, E., & Yeo, M. L. (2013). Behavioral operations: the state of the field. *Journal of Operations Management*, *31*(1–2), 1–5.

Da Silveira, G., Borenstein, D., & Fogliatto, F. S. (2001). Mass customization: literature review and research directions. *International Journal of Production Economics*, *72*(49), 1–13.

Darafarin, T., Mousavi, S. M., & Javazi, M. (2016). Description of management competence criteria in learning organization (The proposed models). *International Journal of Pharmacy and Technology*, *8*(1), 10304.

Denzin, N. K., & Lincoln, Y. S. (2011). *The SAGE handbook of qualitative research*.

Thausand Oaks, CA: SAGE Publications.

Desai, P., Kekre, S., Radhakrishnan, S., & Srinivasan, K. (2001). Product differentiation and commonality in design: balancing revenue and cost drivers. *Management Science*, *47*(1), 37–51.

Dosi, G., Faillo, M., & Marengo, L. (2008). Organizational capabilities, patterns of knowledge accumulation and governance structures in business firms: an introduction. *Organization Studies*, *29*(8–9), 1165–1185.

Dubois, D., & Rothwell, W. (2004). *Competency-based human resource management: discover a new system for unleashing the productive power of exemplary performers*. London, UK: Quercus.

Duray, R., Ward, P. T., Milligan, G. W., & Berry, W. L. (2000). Approaches to mass customization: configurations and empirical validation. *Journal of Operations Management*, *18*(6), 605–625.

Edmondson, A. C., & McManus, S. E. (2007). Methodological fit in management field research. *Academy of Management Review*, *32*(4), 1246–1264.

Eisenhardt, K. M. (1989). Building theories from case study research. *The Academy of Management Review*, *14*(4), 532–550.

Eisenhardt, K. M., & Bourgeois, L. J. (1988). Politics of strategic decision making in high-velocity environments: toward a midrange theory. *Academy of Management Journal*, *31*(4), 737–770.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of Management Journal*, *50*(1), 25–32.

Erjavec, J., & Trkman, P. (2018). Behavioral operations management – identification of its research program. *International Journal of Services and Operations Management*.

Essex, A., Subramanian, N., & Gunasekaran, A. (2016). The relationship between supply chain manager capabilities and performance: empirical evidence.

Production Planning & Control, *27*(3), 198–211.

Feitzinger, E., & Lee, H. L. (1997). Mass customization at Hewlett-Packard: the power of postponement. *Harvard Business Review*, *75*(1), 116–121.

Felin, T., Foss, N. J., Heimeriks, K. H., & Madsen, T. L. (2012). Microfoundations of routines and capabilities: individuals, processes, and structure, *49*(8), 1351–1374.

Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. London, UK: SAGE Publications.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: an introduction to theory and research*. Boston, MA: Addison-Wesley Pub. Co.

Flanagan, J. C. (1954). The critical incident technique. *Psychological Bulletin*, *51*(4), 327–358.

Fogliatto, F. S., Da Silveira, G. J. C., & Borenstein, D. (2012). The mass customization decade: an updated review of the literature. *International Journal of Production Economics*, *138*(1), 14–25.

Forza, C., & Salvador, F. (2002). Managing for variety in the order acquisition and fulfilment process: the contribution of product configuration systems. *International Journal of Production Economics*, *76*(1), 87–98.

Forza, C., & Salvador, F. (2006). HRM Policies for Mass Customization. Understanding individual competence requirements and training needs for the mass customizing industrial company. In T. Blecker & G. Friedrich (Eds.), *Mass Customization: Challenges and Solutions* (pp. 251–269). Boston, MA: Springer US.

Forza, C., & Salvador, F. (2007). Product information management for mass customization.

Forza, C., Salvador, F., & Trentin, A. (2008). Form postponement effects on operational performance: a typological theory. *International Journal of Operations and Production Management*, *28*(11), 1067–1094.

Gang, A., & Tang, C. S. (1997). On postponement strategies for product families with multiple points of differentiation. *IIE Transactions*, *29*(8), 641–650.

Gans, N., & Croson, R. (2008). Introduction to the special issue on behavioral operations. *Manufacturing & Service Operations Management*, *10*(4), 563–565.

Gino, F., & Pisano, G. (2008). Toward a theory of behavioral operations. *Manufacturing & Service Operations Management*, *10*(4), 676–691.

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: notes on the Gioia methodology. *Organizational Research Methods*, *16*(1), 15–31.

Gök, O., & Hacioglu, G. (2010). The organizational roles of marketing and marketing managers. *Marketing Intelligence & Planning*, *28*(3), 291–309.

Grant, R. M. (1996). Prospering in dynamically-competitive environments: organizational capability as knowledge integration. *Organization Science*, *7*(4), 375–387.

Gunasekaran, A., & Ngai, E. W. T. (2005). Build-to-order supply chain management: a literature review and framework for development. *Journal of Operations Management*, *23*(5), 423–451.

Hall, R. D., & Rowland, C. A. (2016). Leadership development for managers in turbulent times. *Journal of Management Development*, *35*(8), 942–955.

Hoffmann, T. (1999). The meanings of competency. *Journal of European Industrial Training*, *23*(6), 275–286.

Hofrichter, D. A., & Spencer, Jl. M. (1996). Competencies: the right foundation for effective human resources management. *Compensation & Benefits Review*, *28*(6), 21–26.

Horney, N., Pasmore, B., & O'Shea, T. (2010). Leadership agility: a business imperative for a VUCA world. *People and Strategy*, *33 No. 4,*(4), 32–38.

Huang, X., Kristal, M. M., & Schroeder, R. G. (2008). Linking learning and

effective process implementation to mass customization capability. *Journal of Operations Management*, *26*(6), 714–729.

Huang, X., Kristal, M. M., & Schroeder, R. G. (2010). The impact of organizational structure on mass customization capability: a contingency view. *Production and Operations Management*, *19*(5), 515–530.

Hyer, N. L., & Wemmerlov, U. (1989). Group technology in the US manufacturing industry: a survey of current practices. *International Journal of Production Research*, *27*(8), 1287–1304.

Iansiti, M. (1995). Technology integration: managing technological evolution in a complex environment. *Research Policy*, *24*, 521–542.

James, L. R., Demaree, R. G., & Wolf, G. (1984). Estimating within-group interrater reliability with and without response bias. *Journal of Applied Psychology*, *69*(1), 85–98.

Kashani, K. (1995). Marketing futures: priorities for a turbulent environment. *Long Range Planning*, *28*(4), 87–98.

Kim, S., Mabin, V. J., & Davies, J. (2008). The theory of constraints thinking processes: retrospect and prospect. *International Journal of Operations and Production Management*, *28*(2), 155–184.

Klein, K. J., & Kozlowski, S. W. J. (2000). *Multilevel theory, research, and methods in organizations: foundations, extensions, and new directions*. New York, NY: John Wiley & Sons, Inc.

Knight, W. A. (1998). Group technology, concurrent engineering and design for manufacture and assembly. In N. C. Suresh & J. M. Kay (Eds.), *Group technology and cellular manufacturing: a state-of-the-art Synthesis of research and practice* (pp. 15–36). Boston, MA: Springer US.

Kortmann, S., Gelhard, C., Zimmermann, C., & Piller, F. T. (2014). Linking strategic flexibility and operational efficiency: the mediating role of ambidextrous operational capabilities. *Journal of Operations Management*,

32(7), 475–490.

Kotzab, H., Teller, C., Bourlakis, M., & Wünsche, S. (2018). Key competences of logistics and SCM professionals – the lifelong learning perspective. *Supply Chain Management, 23*(1), 50–64.

Kristal, M. M., Huang, X., & Schroeder, R. G. (2010). The effect of quality management on mass customization capability. *International Journal of Operations & Production Management, 30*(9), 900–922.

Kumar, A. (2004). Mass customization: Metrics and modularity. *International Journal of Flexible Manufacturing Systems, 16*(4 SPEC. ISS.), 287–311.

Lai, F., Zhang, M., Lee, D. M. S., & Zhao, X. (2012). The impact of supply chain integration on mass customization capability: an extended resource-based view. *IEEE Transactions on Engineering Management, 59*(3), 443–456.

Lau, R. S. M. (1995). Mass customization: the next industrial revolution. *Industrial Management, 37*(5), 18–19.

Lawler III, E. E. (1994). From job-based to competency-based organizations. *IEEE Engineering Management Review, 22*(3), 83–90.

Leffakis, Z. M., & Dwyer, D. J. (2014). The effects of human resource systems on operational performance in mass customisation manufacturing environments. *Production Planning & Control, 25*(15), 1213–1230.

Liang, Z., Howard, P. F., & Leggat, S. G. (2017). 360° Management competency assessment: is our understanding adequate? *Asia Pacific Journal of Human Resources, 55*(2), 213–233.

Liu, G., Shah, R., & Babakus, E. (2012). When to mass customize: the Impact of environmental uncertainty. *Decision Sciences Journal of Innovative Education, 43*(5), 851–887.

Liu, G., Shah, R., & Schroeder, R. G. (2006). Linking work design to mass customization: a sociotechnical systems perspective. *Decision Sciences, 37*(4), 519–545.

Liu, S.-N., Lin, Y.-T., & Chen, Y.-C. (2011). Professional competencies for marketing managers in Taiwan: an application of the Analytic Hierarchy Process (AHP). *World Transactions on Engineering and Technology Education*, *9*(4), 215–220.

Lloyd-kelly, M., Gobet, F., & Lane, P. C. R. (2005). The art of balance: problem-solving vs. pattern-recognition. In *International Conference on Agents and Artificial Intelligence*.

Lyall, C., & Meagher, L. R. (2012). A masterclass in interdisciplinarity: research into practice in training the next generation of interdisciplinary researchers. *Futures*, *44*(6), 608–617.

Marrelli, A. F. (1998). An introduction to competency analysis and modeling. *Performance Improvement*, *37*(5), 8–17.

McClelland, D. C. (1973). Testing for Competence rather tah for intelligence. *American Psychologist*, *28*(1), 1–40.

McClelland, D. C. (1998). Identifying behavioral-event interviews, *9*(5), 331–339.

McLagan, P. A. (1997). Competencies: the next generation. *T and D*, *51*(5), 40–41.

Melaia, S., Abratt, R., & Bick, G. (2008). Competencies of marketing managers in South Africa. *The Journal of Marketing Theory and Practice*, *16*(3), 233–246.

Meredith, J. (1998). Building operations management theory through case and field research. *Journal of Operations Management*, *16*(4), 441–454.

Miles, M. ., & Huberman, A. . (1994). *Qualitative data analysis: an expanded sourcebook*. Thausand Oaks, CA: SAGE Publications.

Morris, M. H., Webb, J. W., Fu, J., & Singhal, S. (2013). A competency-based perspective on entrepreneurship education: conceptual and empirical insights. *Journal of Small Business Management*, *51*(3), 352–369.

Müller-Seitz, G. (2012). Leadership in interorganizational networks: a literature review and suggestions for future research. *International Journal of*

Management Reviews, 14(4), 428.

Murphy, C., Klotz, A. C., & Kreiner, G. E. (2017). Blue skies and black boxes: the promise (and practice) of grounded theory in human resource management research, *27*(2), 291–305.

Nybø, G. (2004). Personnel development for dissolving jobs: towards a competency-based approach? *International Journal of Human Resource Management, 15*(3), 549–564.

O*NET online. (2018). Retrieved August 10, 2018, from https://www.onetonline.org/link/summary/11-1021.00

Peng, D. X., Liu, G., & Heim, G. R. (2011). Impacts of information technology on mass customization capability of manufacturing plants. *International Journal of Operations & Production Management, 31*(10), 1022–1047.

Peng, D. X., Schroeder, R. G., & Shah, R. (2008). Linking routines to operations capabilities: a new perspective. *Journal of Operations Management, 26*(6), 730–748.

Perera, H. S. C., Nagarur, N., & Tabucanon, M. T. (1999). Component part standardization: a way to reduce the life-cycle costs of products. *International Journal of Production Economics, 60*, 109–116.

Phillips, D. C., & Burbules, N. C. (2000). *Postpositivism and educational research*. Lanham, MD: Rowman & Littlefield Publishers.

Pine, B. J. (1993). *Mass customization: the new frontier in business competition*. Cambridge, MA: Harvard Business School Press.

Popper, K. R. (1969). *Conjectures and refutations: the growth of scientific knowledge*. London: Routledge & K. Paul.

Puccio, G. J., Mance, M., & Murdock, M. C. (2007). *Creative leadership: skills that drive change*. Thausand Oaks, CA: SAGE Publications, Inc.

Rankin, N. (2004). The new prescription for performance: the eleventh competency benchmarking survey. *Competency & Emotional Intelligence*

Benchmarking Supplement, 2005, 181–191.

Rothwell, W. J., & Lindholm, J. E. (1999). Competency identification, modelling and assessment in the USA. *International Journal of Training and Development, 3*(2), 90–105.

Rousseau, D. (2012). Multilevel competencies and missing linkages. In *K. J. Klein & S. W. J. Kozlowski (Eds.), Multilevel theory, research, and methods in organizations: foundations, extensions, and new directions* (pp. 572–582). San Francisco, CA: Jossey-Bass.

Rudloff, A. (2007). Complete list of behavioral interview questions. Retrieved August 10, 2018, from https://www.hsu.edu/Career/completelistofbehavioral.pdf.

Ryan, G., Emmerling, R. J., & Spencer, L. M. (2009). Distinguishing high-performing european executives: the role of emotional, social and cognitive competencies. *Journal of Management Development, 28*(9), 859–875.

Salvador, F. (2007). Toward a product system modularity construct: literature review and reconceptualization. *IEEE Transactions on Engineering Management, 54*(2), 219–240.

Salvador, F., Martin de Holan, P., & Piller, F. (2009). Cracking the code of mass customization. *Sloan Management Review, 50*(3), 71–78.

Salvato, C., & Rerup, C. (2011). Beyond collective entities: multilevel research on organizational routines and capabilities. *Journal of Management, 37*(2), 468–490.

Sandrin, E. (2016). An empirical study of the external environmental factors influencing the degree of product customization. *International Journal of Industrial Engineering and Management, 7*(4), 135–142.

Sandrin, E., Trentin, A., & Forza, C. (2014). Organizing for mass customization: literature review and research agenda. *International Journal of Industrial Engineering and Management, 5*(4), 159–167.

Sandrin, E., Trentin, A., & Forza, C. (2018). Leveraging high-involvement practices to develop mass customization capability: a contingent configurational perspective. *International Journal of Production Economics*, *196*, 335–345.

Scarlata, A. N., Stone, D. N., Jones, K. T., & Chen, C. C. (2011). The O*NET: a challenging, useful resource for investigating auditing and accounting work. *Accounting Horizons*, *25*(4), 781.

Schilling, M. (2000). Toward a general modular systems theory and it's application to inferfirm product modularity. *Academy of Management Review*, *25*(2), 312–334.

Selim, H. M., Askin, R. G., & Vakharia, A. J. (1998). Cell formation in group technology: review, evaluation and directions for future research. *Computers Ind. Engng*, *34*(1), 3–20.

Senge, P. M. (1990). *The fifth discipline: the art and practice of the learning organization.* New York, NY: Doubleday.

Shippmann, J. S., Ash, R. A., Batjsta, M., Carr, L., Eyde, L. D., Hesketh, B., … Sanchez, J. I. (2000). The practice of competency modeling. *Personnel Psychology*, *53*(3), 703–740.

Shunk, D. L. (1985). Group technology provides organized approach to realizing benefits of CIMS, *17*(4), 74–76,78.

Slack, N., Chambers, S., & Johnston, R. (2010). *Operations management.* Upper Saddle River, NJ: Financial Times Prentice Hall.

Sloman, S. A. (1996). The empirical case for two systems of reasoning. *Psychological Bulletin*, *119*(1), 3–22.

Spencer, L. M., & Spencer, S. M. (1993). *Competence at work: models for superior performance.* New York, NY: John Wiley & Sons, Inc.

Squire, B., Brown, S., Readman, J., & Bessant, J. (2006). The Impact of mass customisation on manufacturing trade-offs. *Production and Operations*

Management, *15*(1), 10–21.

Stiehm, J. H., & Townsend, N. W. (2002). *U.S. Army war college: military education in a democracy*. Philadelphia, Pennsylvania: Temple University Press.

Sun, J. (2012). Why different people prefer different systems for different tasks: an activity perspective on technology adoption in a dynamic user environment. *Journal of the American Society for Information Science & Technology*, *63*(1), 48–63.

Suzić, N., Forza, C., Trentin, A., & Anišić, Z. (2018). Implementation guidelines for mass customization: current characteristics and suggestions for improvement. *Production Planning & Control*, 1–16.

Tett, R. P., Guterman, H. A., Bleier, A., & Murphy, P. J. (2000). Development and content validation of a "hyperdimensional" taxonomy of managerial competence. *Human Performance*, *13*(3), 205–251.

Tognazzo, A., Gubitta, P., & Gerli, F. (2017). Fostering performance through leaders' behavioral competencies: an Italian multi-level mixed-method study. *International Journal of Organizational Analysis*.

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review, *14*(3), 207–222.

Trentin, A., Forza, C., & 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*, *169*, 253–276.

Trentin, A., Perin, E., & Forza, C. (2012). Product configurator impact on product quality. *International Journal of Production Economics*, *135*(2), 850–859.

van Dun, D. H., Hicks, J. N., & Wilderom, C. P. M. (2017). Values and behaviors of effective lean managers: mixed-methods exploratory research. *European*

Management Journal, 35(2), 174–186.

Voss, C. A. (1995). Operations management- from Taylor to Toyota- and beyond? *British Journal of Management, 6*, 17–29.

Voss, C. A., Tsikriktsis, N., & Frohlich, M. (2002). Case research in operations management. *International Journal of Operations & Production Management, 22*(2), 195–219.

Wang, Q., Wang, Z., & Zhao, X. (2015). Strategic orientations and mass customisation capability: the moderating effect of product life cycle. *International Journal of Production Research, 53*(17), 5278–5295.

Wang, Z., Chen, L., Zhao, X., & Zhou, W. (2014). Modularity in building mass customization capability: the mediating effects of customization knowledge utilization and business process improvement. *Special Issue: Value of Design for Competitiveness, 34*(11), 678–687.

Wang, Z., Zhang, M., Sun, H., & Zhu, G. (2016). Effects of standardization and innovation on mass customization: an empirical investigation. *Technovation, 48–49*, 79–86.

Watkins, M. (1999). In theory: negotiating in a complex world. *Negotiation Journal, 15*, 245–270.

Weilbaker, D. C. (1990). The identification of selling abilities needed for missionary type sales. *Journal of Personal Selling & Sales Management, 10*(3), 45–58.

Whetten, D. (1989). What constitutes a theoretical contribution? *Academy of Management Review, 14*(4), 490–495.

Witt, P. W., & Baker, T. (2018). Personality characteristics and six sigma: a review. *International Journal of Quality and Reliability Management, 35*(3), 729–761.

Yeung, A. K. (1996). Competencies for HR professionals: an Interview with Richard E. Boyatzis. *Human Resource Management, 35*(1), 119–131.

Yin, R. K. (2009). *Case study research: design and methods.* Thausand Oaks, CA:

SAGE Publications.

Zhang, M., Qi, Y., & Guo, H. (2017). Impacts of intellectual capital on process innovation and mass customisation capability: direct and mediating effects. *International Journal of Production Research*, *55*(23), 6971–6983.

Zhang, M., Zhao, X., Lyles, M. A., & Guo, H. (2015). Absorptive capacity and mass customization capability. *International Journal of Operations and Production Management*, *35*(9), 1275–1294.

Zhang, M., Zhao, X., & Qi, Y. (2014). The effects of organizational flatness, coordination, and product modularity on mass customization capability. *International Journal of Production Economics*, *158*, 145–155.

APPENDIX: EMPIRICAL RESULTS

Table A1. Analytical/Systems thinking and MCC

CASE (MAIN PRODUCT LINE(S)) – MCC LEVEL	CONTEXTUAL INFORMATION	BEI EXCERPTS CODED INTO ANALYTICAL/SYSTEMS THINKING (BEHAVIORAL INDICATOR)	LINKAGE BETWEEN ANALYTICAL/SYSTEMS THINKING AND MCC (SUMMARY)
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." *(The OM's ability to order multiple causal events helped her identify a critical action to take [i.e., giving all production supervisors visibility of the master production schedule and the progress of its implementation] to improve collaboration among production departments and ultimately enhance delivery performance.)*

C (electric motors and generators) – High MCC	"Now, we work with daily time buckets [in our master production schedule] instead of weekly ones. This means we have a schedule that defines, for each day from now to five–six weeks ahead, the types and quantities of machines [i.e., motors and generators] we plan to complete."	"This [more detailed 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, such as printing orders, delivering them to [production] departments, controlling that completed orders have the correct status in our MES,…" (b)	"We had had a few problems with on-time delivery with one of our biggest customers of large machines [...] These are very complex, highly customized machines. So, you can have everything completed except for a small part that is missing, and you end up delivering late." "Knowing the sequence of large machines to complete each day of the next five–six weeks allows us to identify automatically, through the MRP system, the materials to which we must give priority in production – –a priority that derives from the fact that we want to complete a certain machine before another one." "With this customer, we are now above 90% of on-time deliveries, which is very good for this kind of machine." *(The OM's ability to order multiple causal events helped him identify a critical action to take (i.e., redefining jobs within the production-planning department) to improve delivery performance for highly customized products.)*
Analytical/Systems thinking – Behavioral indicators (Boyatzis et al., 1995) 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).			

Table A2. Pattern recognition and MCC

CASE (MAIN PRODUCT LINE(S)) – MCC LEVEL	CONTEXTUAL INFORMATION	BEI EXCERPTS CODED INTO PATTERN RECOGNITION (BEHAVIORAL INDICATOR)	LINKAGE BETWEEN PATTERN RECOGNITION AND MCC (SUMMARY)
C (electric motors and generators) – High MCC	"So, the left-most part of this table [i.e., spreadsheet] reports all [production] constraints, both for individual frame sizes and for combinations of sizes [cf. Table A5, case A]."	"To synthesize these [production] 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 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)	"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 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." *(The OM's ability to identify a common denominator—the equivalent machine—in the capacity requirements for highly customized, engineered-to-order motors and generators allowed for creating a simple tool to support order promising for such products, thereby improving delivery dependability.)*

D (static converters for the control of electric motors) – High MCC	"A few years ago, the company entered the world of renewable energy [with a variety of solutions, including cabinets with energy storage capacity...] After the early contacts between the [new potential] customer and our salespeople, I took part in a few meetings [with the customer]."	"I said, Okay, now you need 1,000-volt batteries. With 1,000 volts, we [already] have similar solutions for the world of ski lifts, chair lifts, cable cars." (c)	"Most of all, we manage to exploit synergies among our product solutions. Usually, [as regards] our custom products, we strive to keep as many common parts as possible and to change the 'clothes'. For example, electronic cards [...] or power devices... These parts, which are the core of the product, are common [...] Then, the 'clothes' around [this core] could be blue, could be red, could have the radiator outside the electric cabinet." *(The OM's ability to see similarities between a new customer's request and product solutions previously developed for other customers helped the organization reuse existing product components instead of developing new ones. Component carry-over reduces costs, shortens delivery lead-times, and improves product reliability.)*

Pattern recognition – Behavioral indicators (Boyatzis et al., 1995)

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).

Table A3. Negotiation and MCC

Case (main product line(s)) – MCC level	Contextual information	BEI excerpts coded into negotiation (behavioral indicator)	Linkage between negotiation and MCC (summary)
A (electric motors) – High MCC	"We have changed: Now, we have two-and-a-half [work] shifts [a day], sometimes three. Two-and-a-half shifts means there are shift extensions […] In the past, people knew that they would be working always on the first shift [for some time] and then always on the second shift [for some other time], so their lives were organized around this […] Personnel were not used to night shifts."	"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." (b)	"What I have observed is that, by doing this, I have then found availability from workers even for requests [for shift extensions] on very short notice." "People were helpful, and this is not always easy with workers. Someone accepted to work on a Friday evening even though it was not his/her duty." *(The OM's ability to resolve conflicts associated with requests for shift extensions or night shifts has improved the organization's volume flexibility.)*

| 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 tailor-made product components…] We found a good compromise." (b) | "The 'Chinese' product has the adjustment and all the electronic cards in common with our standard products [...] if I had had to throw away all the electronic cards [when the Chinese customer zeroed its orders], the damage would have been much higher."

(The OM's ability to find a compromise with the sales department regarding the degree of product customization to be provided to customers helped the organization increase parts commonality among its products, thus ultimately reducing inventory obsolescence costs.) |

Negotiation – Behavioral indicators (Spencer and Spencer, 1993)

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.

Table A4. Efficiency orientation and MCC

CASE (MAIN PRODUCT LINE(S)) – MCC LEVEL	CONTEXTUAL INFORMATION	BEI EXCERPTS CODED INTO EFFICIENCY ORIENTATION (BEHAVIORAL INDICATOR)	LINKAGE BETWEEN EFFICIENCY ORIENTATION AND MCC (SUMMARY)
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." *(The OM's concern for increasing the efficiency of action led him to devise a solution for implementing pull production in spite of the difficulties due to product customization, thus ultimately improving both cost and delivery performance.)*

B (heat exchangers) – High MCC	"Our machines were flexible, but not that efficient [...] My goal was to improve efficiency while preserving flexibility [... To that purpose,] I started with a survey to understand which [process] technologies our competitors were using. Since I could not visit our competitors, I visited their suppliers [of process technologies]."	"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." (a)	"Always with flexibility in mind, I succeeded in identifying the process technologies we needed." *(The OM's concern for increasing the efficiency of action led the organization to adopt process technologies that were more productive and, at the same time, had the right level of mix flexibility.)*
Efficiency orientation – Behavioral indicators (adapted from Boyatzis et al., 1995) 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.			

Table A5. Information seeking and MCC

CASE (MAIN PRODUCT LINE(S)) – MCC LEVEL	CONTEXTUAL INFORMATION	BEI EXCERPTS CODED INTO INFORMATION SEEKING (BEHAVIORAL INDICATOR)	LINKAGE BETWEEN INFORMATION SEEKING AND MCC (SUMMARY)
C (electric motors and generators) – High MCC	"[In the past,] order promising for these [large, highly customized] machines [i.e., motors and generators] was a big challenge. Why? Because 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 know the machine is a generator for a certain application, with a certain frame size, but we do not know many [product] features that will be specified by our technical office [subsequently…] The bill of materials is not fully specified, and the variety [of possible items] is huge, and, for the items that are still to be specified, I cannot determine workloads. So, what did I do?"	"I interviewed the supervisors of our [production] departments to understand the main [production] constraints in their [respective] departments. For example, the head of the cutting department, which also produces die-cast rotors, told me we cannot make more than 15 die-cast rotors a week for either of the two frame sizes X and Y [actual figures are not reported for confidentiality reasons]. So, we have constraints that apply to a certain frame size, but also constraints that apply to a combination of frame sizes. For example, the generator assembly line cannot build more than 20 generators a week among Y, Z, and W frame sizes." (e) "The information provided by supervisors, I checked it using information from production planners and ERP data." (c)	"These constraints were not easy to determine... They depend on the characteristics of our production equipment—we have 200 production facilities here [in this plant]—and they also depend on what you want to produce with these facilities. Production supervisors and production planners were those who could help me [understand these constraints]." (The effort made by the OM to collect information to understand production constraints was a prerequisite for creating a tool to support order promising for highly customized, engineered-to-order products, thereby improving delivery performance [cf. Table A2, case C].)

| 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."

(The OM's ability to collect reliable information from salespeople about customer orders that are likely to arrive in the short run helped the organization ensure relatively short delivery lead-times for its customized products without building excess inventory.) |

Information seeking – Behavioral indicators (Spencer and Spencer, 1993)

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 kind of information gathering.
g) Involves others who would not normally be involved and gets them to seek out information.