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Is a digital transformation framework enough for manufacturing smart products? The case of Small and Medium Enterprises

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Abstract

Companies, and especially manufacturers, are facing today a truly complex scenario, with technology developing at a fast speed and demanding a digital transformation to face the many challenges. The aim of this paper then is to assess the fitness of digital maturity models in their role of assisting manufacturers of smart products in their digital transformation journeys and propose a set of recommendations to improve the usability of the tool in this *scenario*. To achieve this, an analysis of a selection of seven maturity models is performed, applying several design principles to the specific case of manufacturers of smart products. According to the most relevant findings, the recommendations suggested for the models are related to the need for a wider scope for the tool, a prescriptive condition, and a broad business perspective in the definition of their dimensions. Validation of the applicability of the recommendations in the small and medium enterprises scenario is also presented through an illustration of the manufacturers of the Arve Valley.

Keywords: Smart products; small and medium enterprises; digital transformation; industry 4.0; maturity models

1. Introduction

In today's environment, the speed in the evolution of technology is seen as a powerful source of change, whose disruption has produced the start of the 4th industrial revolution [1], one that is "characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres" [2].

This 4th revolution, in terms of business impact, with the developments made possible with digital technologies like Artificial Intelligence (AI), Quantum Computing (QC) and 5G networks, is not only changing the way companies around the world are doing business and the collaboration between customers and providers, but also the products that are being produced and the customer expectations of those products [2].

In fact, it is, among other considerations, the customer expectations of products and services and the changes in consumer trends that will define the requirements of this new economic era [3], demanding from companies the agility and flexibility needed to respond to the ever-changing market needs [4].

Aside from the challenges that they represent, digital technologies possess the capability of enabling sophisticated products, full of functionalities, but also provided with the intelligence to autonomously interact during their entire lifecycle [5], opening new possibilities of efficiency and flexibility to their production process.

In this *scenario*, manufacturing companies have a key role as the producers of this new breed of smart and connected products and the change is starting with a strategic shift in their competitive advantage from one that is based on cost only to one focused on technological value-added [6].

In consequence, the digital business strategy of such smart product manufacturing companies has to be based on the

creation of differential business value, which means using the digital resources to create new business models, going beyond the use of technology to improve performance to provide the strategic differentiation of a business [7].

Literature [8], as well as practice, show, however, that the changes needed to implement the digital technologies to support the new strategy, also called digital transformation, represent a real challenge for manufacturing companies, whereas they want to produce smart products or put in place smart factories. These companies naturally lack the knowledge and the tools to implement change [9].

As companies are aware of the potential value of new technologies, the key challenge for them is in understanding what digital transformation means to their companies and how to translate that in a suitable strategy that helps them reach their business objectives [10].

Given the relevance of the subject, there has been, during the past five years, a growing interest in research surrounding digital transformation that has produced interesting works respectively regarding the definition of the term, the framework of implementation and its scope of application, even when there is not much consensus about them yet [4].

At the same time, even when it is possible to find different proposals in literature to approach digital transformation, there is naturally still a lack of real knowledge about how it looks a successful journey of a manufacturing company towards the realization of the possibilities of the digital technologies [11].

The intention of this paper then is to perform a preliminary analysis of the available frameworks and other guides of implementation designed to assist manufacturing companies in their digital transformation efforts. The overall idea of this work subscribes to the definition of a framework that will be dedicated to the particular case of small and medium companies that look for transforming their products into smart products.

This analysis will thus lead to the formulation of a series of recommendations based on the findings of the analysis of the models. An illustration will follow with the case of a group of small and medium manufacturers located in the Arve Valley, a small region in France. This group represents an industry that developed at the end of the 19th century and has had to adapt to many technological changes since then [12].

Therefore, the organization of the paper is as follows: In Section 2, the requirements concerning the digital transformation of companies that manufacture smart products are introduced. In Section 3, an analysis of completeness of the frameworks selected and a series of recommendations are provided. A particular focus will be made on the maturity model concept. Hence, before concluding on this preliminary analysis, Section 4 presents the illustration of the small and medium manufacturers of the Arve Valley.

2. Manufacturing Smart Products

2.1. General Considerations

Digital transformation comprises a complex process that considering the technological factor, supposes a considerable investment of resources, economic and others [13,14], which makes the selection of the right strategy decisive for success.

Companies of all sectors are dealing with these pressures of digital transformation, but they are not facing them in the same way [6], and for that reason, it is important to first understand the specific needs of each sector when approaching the subject.

For the manufacturing sector, the challenges are more critical as the original scope of their transformation has grown from operational efficiency through smart manufacturing to the creation of new value through smart manufacturing of smart products [6].

Smart products are products that make use of Information Technology (IT) to add to its functionality and connectivity [15] and have the ability to communicate and interact with their users and their environment during their entire life cycle [16].

However, even though smart products offer exciting possibilities, their complex and changing nature are disrupting the core of the companies as they will demand new business models that in turn, will transform the whole operation model of the companies [17].

2.2. The observed global requirements

Manufacturing companies face growing complexity in approaching digital transformation and find it difficult to make sense of the change in their particular *scenario* and their financial implications in terms of cost and benefits of the change [18].

Additionally, companies seem to feel they do not have the elements to define their current state that will become their starting point (namely the *As-is* situation) of their transformation journey or how to select the expected state (namely the *To-be* situation) that will allow them to reap the best benefits and the best strategies to achieve it [18]. They have also to determine the trajectory or the action plan to follow for moving from one state to another. Hence, the issue will concern the achievement of an overall objective, knowing a current state and some intermediary steps to reach.

From a general point of view, manufacturers need an instrument that brings light to the meaning of the digital transformation for their industry in particular in a clear, practical and simplified manner.

An instrument that will also allow the decision-makers in the companies to establish their point of departure of their transformation projects and their current capabilities and their expected state and the requirements to achieve it, considering a broad business perspective. Consequently, it should present the possible strategies or roadmaps to achieve the expected state taking advantage of the digital technologies in different business *scenarii* and taking into account the specific nature and characteristics of the company and its strategy.

Furthermore, this instrument will also need to include the possibility to measure the advancement of the strategic actions that needed to be implemented and their effectiveness. In addition, it also needs to provide the elements to build a business case for the evaluation of the initiatives of change that are proposed.

A summary of the requirements of manufacturers of smart products regarding the qualities of digital maturity models can be found in Table 1.

Table 1. Requirements for maturity models.

Id	Requirement description
R01	MM should characterize the digital transformation journey for an industry in particular, with a broad business perspective.
R02	MM should allow establishing their point of departure for their transformation projects and their current capabilities.
R03	MM should present the possible strategies or roadmaps to achieve an expected state.
R04	MM should include the possibility to measure the advancement of strategic actions and their effectiveness.
R05	MM should provide the elements to build a business case for the evaluation of the initiatives of change that are proposed.

3. Review and Recommendations

3.1. Maturity models rather than frameworks

The instruments or tools that are used to approach a digital transformation take many forms and shapes. In literature often, they are referred to as indexes, roadmaps, models, frameworks or assessments [19].

Regardless of the name, they are frequently used to describe the level of maturity of specific dimensions of a company in the road to achieving digital transformation, understanding the maturity concept as "The state of being complete, perfect or ready" [20].

As a result, maturity models stand out as the tool used to characterize the key stages in the digital transformation journey of a company [19] and as a point of reference to guide the improvement efforts of companies [21]. These models can be formally defined as representations of "an anticipated, desired, or typical evolution path of a class of objects shaped as discrete stages.", where the objects in questions could be either an organization or a process [21].

Despite its popularity and acceptance as an important tool in management, there is still a need for more research efforts focused on developing the theories for building them with a methodological approach [22]. It is, even more, the case in the current digital context.

For this reason, even when literature is not lacking proposals of digital maturity models, there is also literature focused on analyzing the quality and effectiveness of the available models from different perspectives to point out their improvement areas [19].

In this sense, this analysis will differentiate from previous works by studying the proposed digital maturity models regarding their adequate design as a tool and their fitness to satisfy the requirements of the intended user, in this case, companies manufacturing smart products.

3.2. Overview and Analysis

The seven models selected for the analysis comply with the previous definition of maturity models, even though the name may reflect otherwise. Only a selection of the models from the total found is presented to focus the analysis in the ones deemed the more complete and formal. A summary of the selected models is presented in Table 2.

Table 2. The considered digital Maturity Models.

ID	Model's Name	Description
M01	Maturity and Readiness Model for Industry 4.0 Strategy by Akdil et al. [13]	Model of 4 maturity stages, 3 dimensions
M02	PwC Maturity Model Industry 4.0 by Geissbauer et al. [23]	Model of 4 maturity stages, 7 dimensions
M03	Smartness Assessment Framework for Smart Factories by Lee et al. [24]	Model of 5 maturity stages, 4 dimensions
M04	IMPULS Industrie 4.0 Readiness Model by Lichtblau et al. [25]	Model of 6 maturity stages, 6 dimensions
M05	ACATECH Industrie 4.0 Maturity Index by Schuh et al. [10]	Model of 6 maturity stages, 4 dimensions
M06	Industry 4.0 Maturity Model by Schumacher et al. [26]	Model of 5 maturity stages, 9 dimensions
M07	I4.0 Maturity Assessment Framework by Scremin et al. [27]	Model of 5 maturity stages, 6 dimensions

Three of the selected maturity models come from practice and are included in the analysis because they are based on studies of the industry [10, 23, 25].

Regarding the set of criteria used to perform the analysis, they were based on the framework of design principles of maturity models created by Pöppelbuß et al. [28] and the Assessment Criteria defined by Gökalp et al. [29].

The list of the criteria and their expected value according to the identified needs of the manufacturers of smart products is presented in Table 3.

Table 3. Criteria for Maturity Models Analysis.

Id	Criteria	Value Expected and Meaning
C01	Scope of Model	A model that considers the business objective of digitalization of (smart) products.
C02	Target Group	A model that is developed for manufacturers of smart products.
C03	Purpose of Use	A prescriptive model that shows how to identify and achieve desirable maturity levels.
C04	Maturity Levels	A number of levels ≥ 5 (Likert scale) to depict the detail of the maturation path.
C05	Maturity Dimensions	A model that includes the dimensions that reflect a broad business perspective.
C06	Assessment Methodology	Availability of a procedure model that guides model users through the steps of the assessment.
C07	Improvement Measures	A model that propose improvement measures for each maturity level, detailed and specific to the situation of the company.
C08	Decision calculus for proposals	A model with a calculus that helps decision makers to evaluate different alternatives of improvement.
C09	Decision Methodology	Availability of a procedure model that guides model users through the use of decision calculus.

The analysis was performed using a binary score in which if the point is present in the model is classified as Fully Achieved

(FA) and if not as Not Achieved (NA). The only exception of this rating is the criterion of Maturity Dimensions (C05) in which a rating of Partially Achieved (PA) is granted when some business dimensions are mentioned, but the technological ones are dominant. Finally, a rating of NA is assigned to those cases in which the related information was not available. The results of the application of the criteria in the analysis of each model can be found in Table 3.

Table 3. Analysis of the Digital Maturity Models.

Criteria /Model	M01	M02	M03	M04	M05	M06	M07
C01	NA	FA	NA	FA	NA	NA	FA
C02	NA	NA	FA	FA	FA	FA	FA
C03	NA	NA	NA	NA	NA	NA	NA
C04	NA	NA	FA	FA	FA	FA	FA
C05	FA	FA	PA	PA	PA	FA	PA
C06	FA	FA	NA	FA	FA	FA	FA
C07	NA	NA	NA	NA	NA	NA	NA
C08	NA	NA	NA	NA	NA	NA	NA
C09	NA	NA	NA	NA	NA	NA	NA

The most relevant findings are related to the criteria Scope of Model (C01), Purpose of Use (C03) and Maturity Dimensions (C05).

First, related to the Scope of the Model (C01) and aligned with the need of manufacturers of producing smart products, it is expected that the models consider in their scope the maturity of product creation.

Therefore, there is still a lack of this aspect in more than half of the models (4/7) and it is worth noticing that 2 of the 3 considering the product and/or service dimension come from practice.

The second relevant finding is related to the criterion of Purpose of Use (C03) in which it is expected to find a prescriptive condition that delivers value by showing how to identify and achieve desirable maturity levels [21].

This key condition is not present in any of the models even when some of them present proposals for improvement, they are generic and/or general; therefore a translation to a particular case is needed in order to use them.

The findings related to this criterion are even more critical as the absent prescriptive condition automatically cancels the possibility of the existence of C07, C08 and C09.

Finally, regarding the criterion Maturity Dimensions (C05), the expected values include apart from the technical ones, the business dimensions that are affected by the technological change and that provide a broad business perspective.

The findings show, however, that the vision of the dimensions considered in the models still is mostly technical, which makes sense when compared with the results of C01.

3.3. Recommendations

According to the findings of the maturity models analysis is possible to resume it in three main recommendations to improve their design, content and related tools.

First, it is key to the user group of focus that the models expand their scope and consider a digital transformation journey in which the business objective includes not only the operational excellence but also the expansion of the portfolio of products and services through the creation of smart products.

Secondly and strongly related to the first recommendation, the dimensions included in the design of the model should include all the ones that are impacted by the transformation of the business.

This second point is particularly important given that the dimensions define the level of granularity of the improvement proposals and therefore allows the model to consider all the aspects subject to improvement.

Thirdly, it is critical to the usability of the models that they accomplish the prescriptive condition and that this is paired with the tools that generate the proposals for improvement and assist in the selection of the right one for each particular case.

4. Illustration

The case selected is not of one company alone, but explores instead the case of a group of manufacturing companies that share a set of common characteristics that makes them one of the most vulnerable in the middle of this technological change.

The manufacturers of the Arve Valley, composed mostly by family business, work as subcontractors of other industries, providing them with pieces of high precision in which technology plays a key role. [12].

This group of manufacturers belongs to the small and medium category of business, which is composed by business of less than 250 staff headcount and with equals or less of 50 million in turnover.

The manufacturers in the Arve Valley are in the low of the spectrum of small and medium enterprises, with less than ten employees, and their relevance is that businesses of that size account for 96% of business in France.

As a result of this fact, their success has the potential to be an important source of growth for the economies of the country [30], but they will also have digitally transform to take advantage of the new market opportunities.

It is precisely because of their characteristics of size, technological focus and the changes experienced through their history, that they could be a good example of the needs of manufacturing in this moment regarding a framework of implementation of a digital transformation.

The manufacturers of this region as a subcontractor of industries like car manufacturing and aerospace are also being force to transform and produce smart products as their clients are also transforming themselves and demanding these complex products.

Nevertheless, they have special characteristics that distinguish them from the other manufacturers and that could influence this radical change [19]

- Lack of resources (financial and technical).
- Informal strategy definition and decision-making.
- Lack of organizational flexibility.
- Low standards consideration.

Regarding the requirements for a digital transformation instrument that guides them through the change, the same applies to these small and medium manufacturers.

Reviewing the three general recommendations stated for the improvement of the digital maturity models in the context of the manufacturers of the Arve Valley we can agree on the same recommendations, but some precisions must be made.

First, as these small and medium manufacturers are also required to start the manufacturing of smart products, they need a model with a scope considering this *scenario*.

The second remark is related to the inclusion of the necessary business dimensions in the model to get a broad perspective of the magnitude of the change in their organization as the situation is more sensible for this group.

Their special characteristics previously enlisted make crucial this last point, as they are operating in an informal setting and do not have the resources, especially knowledge, to deal with change, these dimensions allow them to see all the implications of change.

The final point and related to the last one, an adequate design of the affected dimensions will generate comprehensive plans for them to apply them and increase their chance to succeed in models with a true prescriptive purpose of use.

Additionally, a real prescriptive purpose in a digital maturity model will adapt to the special conditions, characteristics and strategies of small and medium manufacturers.

To conclude, the recommendations are kept the same no matter the size of the manufacturers, but only get more critical to the usability of the models.

5. Conclusions

Maturity models are key tools in the digital transformation process of manufacturing companies and especially in the case of SMEs, they could have a fundamental role in clarifying the concept and the paths for success.

In this sense, the contribution of this paper is focused on identifying the improvement areas of maturity models and proposing a set of recommendations to evolve them from being purely descriptive to being prescriptive.

The importance of the prescriptive condition in a maturity model relies on that it allows them to guide the companies in their transformation journey through maturity improvement proposals adapted to their specific characteristics and situation.

This research work differentiates from previous ones by combining in the analysis of the models the design principles of the tool and the requirements of a particular group of companies of a determined sector of the economy.

The result of this type of analysis brought to light also the importance that the design of the levels and dimensions of the maturity model is closely connected to the specific group that is intended to be the user of the model.

It seems to be still much work to do regarding the usability of this instrument. Therefore future works can be focused on a deeper analysis of the prescriptive condition of the models, as it is the center of the definition of maturation paths for the companies.

The road is not easy as improving the models will probably mean they will become more complex; therefore, an assessment must be made to reach a point in which the balance between complexity and value gets the optimum benefit.

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References

[1] Xu, M., David, J. M., & Kim, S. H. (2018). The Fourth Industrial Revolution: Opportunities and Challenges. International Journal of Financial Research, 9(2), 90.

[2] Schwab, K. (2017). The fourth industrial revolution. London: Portfolio Penguin.

[3] Hozdic, E. (2015) “Smart Factory for Industry 4.0: A Review”, International Journal of Modern Manufacturing Technologies, Vol. 7, No. 1, pp. 28-35.

[4] Warner, K. S., & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. Long Range Planning, 52(3), 326-349.

[5] Mühlhäuser, M. (2008). Smart Products: An Introduction. Communications in Computer and Information Science Constructing Ambient Intelligence, 158–164.

[6] Issa, A., Hatiboglu, B., Bildstein, A., & Bauernhansl, T. (2018). Industrie 4.0 roadmap: Framework for digital transformation based on the concepts of capability maturity and alignment. Procedia CIRP, 72, 973–978.

[7] Bharadwaj, A., Sawy, O. A. E., Pavlou, P. A., & Venkatraman, N. (2013). Digital Business Strategy: Toward a Next Generation of Insights. MIS Quarterly, 37(2), 471–482.

[8] Stoldt, J., Trapp, T. U., Toussaint, S., Süße, M., Schlegel, A., & Putz, M. (2018). Planning for Digitalisation in SMEs using Tools of the Digital Factory. Proceedings of the Conference 51st CIRP Conference on Manufacturing Systems, pp. 179-184. May 16-18, Stockholm (Sweden).

[9] Frank, A. G., Dalenogare, L. S., & Ayala, N. F. (2019). Industry 4.0 technologies: Implementation patterns in manufacturing companies. International Journal of Production Economics, 210, 15-26.

[10] Schuh G, Anderl R, Gausemeier J, Hompel M, Wahlster W. Industrie 4.0 maturity index. Retrieved September 2019 from: http://www.acatech.de/fileadmin/user_ upload/Baumstruktur_nach_Website/Acatech/root/de/Publikationen/Projektberichte/acatech_STUDIE_Maturity_Index_eng_WEB.pdf.

[11] Fitzgerald, M., Kruschwitz, N., Bonnet, D., Welch, M., 2014. Embracing digital technology: a new strategic imperative. MIT Sloan Manage. Rev. 55 (2), 1–12.

[12] Gide, C., Houssel, J. Le décolletage dans la vallée de l'Arve : un district industriel face à la mutation contemporaine / The bar turning industry in the Arve Valley (Haute-Savoie) : contemporary change in an industrial region. In: Revue de géographie de Lyon, vol. 67, n°3, 1992. L'industrialisation en milieu rural dans la région Rhône-Alpes. pp. 199-208.

[13] Akdil KY, Ustundag A, Cevikcan E. Maturity and readiness model for industry 4.0 strategy. Industry 4.0: managing the digital transformation. Cham: Springer; 2018. p. 61-94.

[14] Naskali, J., Kaukola, J., Matintupa, J., Ahtosalo, H., Jaakola, M., & Tuomisto, A. (2018). Mapping Business Transformation in Digital Landscape: A Prescriptive Maturity Model for Small Enterprises. Well-Being in the Information Society. Fighting Inequalities Communications in Computer and Information Science, vol 907. Springer, Cham.

[15] Heppelmann, M. E., Iansiti, M., Lakhani, K. R., & Porter, M. E. (2017). How Smart, Connected Products Are Transforming Competition. Harvard Business Review. Available from: https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition [accessed 17 Jul 2019].

[16] Schmidt, R., Möhring, M., Härting, R.-C., Reichstein, C., Neumaier, P., & Jozinović, P. (2015). Industry 4.0 - Potentials for Creating Smart Products: Empirical Research Results. Business Information Systems Lecture Notes in Business Information Processing, 16–27.

[17] Paulus-Rohmer, D., Schatton, H., & Bauernhansl, T. (2016). Ecosystems, Strategy and Business Models in the age of Digitization - How the

Manufacturing Industry is Going to Change its Logic. Procedia CIRP, 57, 8–13.

[18] S. Erol, A. Schumacher, and W. Sihn, “Strategic guidance towards Industry 4.0 - a three-stage process model,” in Proc. of International Conference on Competitive Manufacturing 2016 (COMA16), Stellenbosch, South Africa.

[19] Mittal, S., Khan, M. A., Romero, D., & Wuest, T. (2018). A critical review of smart manufacturing & Industry 4.0 maturity models: Implications for small and medium-sized enterprises (SMEs). Journal of Manufacturing Systems, 49, 194–214.

[20] Soanes, C and Stevenson, A. (2006). The concise Oxford English Dictionary.

[21] Becker, J., Knackstedt, R., & Pöppelbuß, J. (2009). Developing Maturity Models for IT Management. Business & Information Systems Engineering, 1(3), 213–222.

[22] De Bruin, T., Freeze, R., Kaulkarni, U., & Rosemann, M. (2005). Understanding the Main Phases of Developing a Maturity Assessment Model. Australasian Conference on Information Systems (ACIS), (February 2017), 8–19.

[23] Geissbauer R, Vedso J, Schrauf S. industry 4.0: building the digital Enterprise: 2016 global industry 4.0 survey. Retrieved September 2019 from: https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf.

[24] Lee J, Jun S, Chang TW, Park J. A smartness assessment framework for smart factories using analytic network process. Sustainability 2017; 9(5):794–808.

[25] Lichtblau K, Stich V, Bertenrath R, Blum M, Bleider M, Millack A, et al. IMPULSindustrie 4.0-readiness. Impuls-stiftung des VDMA, Aachen-köln Retrieved September 2019 from: http://www.impuls-stiftung.de/documents/3581372/4875835/Industrie+4.0+Readniness+IMPULS+Studie+Oktober+2015.pdf/447a6187-9759-4f25-b186-b0f5eac69974.

[26] Schumacher A, Erol S, Sihn W. A maturity model for assessing industry 4.0 readiness and maturity of manufacturing enterprises. Procedia CIRP 2016;52:161–6.

[27] Scremin L, Armellini F, Brun A, Solar-Pelletier L, Beaudry C. Towards a framework for assessing the maturity of manufacturing companies in industry 4.0 adoption. Analyzing the Impacts of Industry 4.0 in Modern Business Environments 2018:224–54.

[28] Pöppelbuß, Jens and Röglinger, Maximilian, "What makes a useful maturity model? A Framework of General Design Principles for Maturity Lodels and its Demonstation in Business Process Management" (2011). ECIS 2011 Proceedings. 28. https://aisel.aisnet.org/ecis2011/28.

[29] Gökalp E, Şener U, Eren PE. Development of an assessment model for industry 4.0: industry 4.0-MM. International Conference on Software Process Improvement and Capability Determination 2017:128–42.

[30] Müller, J., Maier, L., Veile, J. and Voigt, K. (2017). Cooperation Strategies among SMEs for Implementing Industry 4.0. Proceedings of the Conference Hamburg International Conference of Logistics, pp. 300-318. October 12-13, Hamburg (Germany).