

## Three Stage Maturity Model in SME's towards Industry 4.0

Jaione Ganzarain , Nekane Errasti 

*Mondragon Unibertsitatea (Spain)*

[jganzarain@mondragon.edu](mailto:jganzarain@mondragon.edu), [nerrasti@mondragon.edu](mailto:nerrasti@mondragon.edu)

*Received: July 2016*

*Accepted: October 2016*

### **Abstract:**

**Purpose:** To address the challenges regarding the concept of Industry 4.0 and the diversification methodology and based on the strategic guidance towards Industry 4.0, we propose a process model as a guiding framework for Industry 4.0 collaborative diversification vision, strategy and action building. In this paper we suggest a stage process model to guide and train companies to identify new opportunities for diversification within Industry 4.0. Systematically carrying out the stages will take a company to their individual specific vision and collaborative vision between different companies in the Industry 4.0 scenario.

**Design/methodology/approach:** This new collaborative diversification methodology involves industry within the pilot program; from the diversification and capacity assessment analysis of the company's profile, skills and technologies that dominates, to identify the diversification opportunity map and its business modeling within the Industry 4.0 paradigm.

**Findings:** The application of maturity models to the Industry 4.0 may help organizations to integrate this methodology into their culture. Results show a real need for guided support in developing a company-specific Industry 4.0 vision and specific project planning.

**Originality/value:** Industry 4.0 promotes a vision where recent developments in information technology are expected to enable entirely new forms of cooperative engineering and manufacturing. The vision of industry 4.0 describes a whole new approach to business operations, and especially the production industries. To address the challenges regarding the

concept of Industry 4.0 and the diversification methodology discussed above, and based on the strategic guidance towards Industry 4.0 (Erol, Schumacher & Sihh, 2016), we propose a unique process model as a guiding framework for Industry 4.0 collaborative diversification vision, strategy and action building.

**Keywords:** SMEs, university-industry collaboration, industry 4.0, diversification strategy, maturity model

---

## 1. Introduction

The main goal of this innovation project in a research framework, is to develop new value propositions for new business opportunities within Industry 4.0 working in collaboration with different companies, exploiting the strengths of each of the companies. The aim is to support and sustain companies to be able to identify new opportunities for diversification in areas within Industry 4.0. These companies need to update and upgrade their competences and skills on Industry 4.0 and its opportunities to diversify into new industry sectors, by developing their innovation management operational and strategic capabilities.

Several organizations are realizing the importance of integrating industry 4.0 vision and comprehension into their organizational culture. This article attempts to define a stage process model to guide and train companies to identify new opportunities for diversification within Industry 4.0, and to describe a specific maturity model in order to define a company tailored vision for the Industry 4.0 and the project roadmap towards Industry 4.0.

## 2. Diversification Strategy towards Industry 4.0

### 2.1. Diversification As a Corporate Strategy in SME

Due to the rapid development of the global economy, many companies choose diversification as their strategic choice (Song & Wang, 2011) in addition to the incorporation of new economic activities, has become an essential fact to become or remain a dynamic company and future. Therefore, diversification has caught the attention of the business world, as well as numerous researchers from different areas in recent decades, seeking to identify the factors that affect it, and demonstrate its effects on business performance.

There are several ways the company can diversify, either because the new business you want to enter is related or unrelated to the sector which is currently the company, or because they are in different

geographical areas, or according to the input mode, either by internal development, acquisition or strategic alliances (Chiang, 2010).

Specifically, the strategy of diversification in this project is a related strategy with the new business to which the company wants to enter. For this purpose the existence of overlaps between the two value chains will be key to facilitate and lead the process of diversification.

The study of the diversification strategy is an important topic in studies on competitiveness, since it has been shown that their choice is critical for the success of this strategy. Some of these studies surrounding this election with barriers to entry, location, or the cultural effects involving the process of sinking into new businesses.

Overall, diversification involves the participation of the same company in different businesses. Therefore, a company decides to expand its business lines into related or different sectors, called diversified company, while those who choose to keep their operations in one segment is known as specialized company.

The diversification strategy can be described by the degree of participation in different businesses and the underlying pattern of relations between the various business enterprises. Already in more recent studies Lichtenthaler (2005), define diversification as the “Increasing in products and markets within a company” while others such as Lin and Su (2008) define it as a means by which a company expands from its field in other markets products or services. Martinez and Fernandez (2009) describe as a “Growth of a company through the entry into new lines of business” and Andrés-Alonso and Fuente-Herrero (2004) diversification like a source of growth options.

In summary we can confirm that the strategy of diversification means when a company decides to expand its line of business, with new products in new markets, which is also known as product diversification, and that when these markets are external geographically, is refers to an international, global, or geographic diversification.

Understanding the conceptualization of diversification and their different strategies to address business competitiveness, we need to frame this project through focusing the reality of the business world and specifically through the prism of Basque SMEs.

## 2.2. The Challenge of Industry 4.0

Europe's industry is facing substantial economic challenges due to an increasing pace of societal and technological development, such as a decreasing availability of natural resources, increasing energy prices, increasing age of employees and globalization of markets. Moreover, customer increasingly demand for improved product-service innovation, product variety, quality standards, support services and immediacy of satisfaction.

These challenges need industrial enterprises that are capable of managing their whole value-chain in an agile and responsive manner. Companies need virtual and physical structures that allow for close cooperation and rapid adaption along the whole lifecycle from innovation to production and distribution (Walters & Rainbird, 2007).

The fourth industrial revolution or Industry 4.0 is called to pull applications and push technologies enabling a high degree of sustainability needed in the factories of the future (Kagermann, 2015; Lasi, Privatdozent, Kemper, Feld & Hoffmann, 2014). As explained by Kagermann, Wahlster and Helbig (2013b), Industry 4.0 solves today challenges related with resources and energy efficiency, urban production and demographic change, enabling continuous resource productivity and efficiency.

One of the main pushed technologies are Internet-based and Internet of Services, favoured by new developments in computational power, leading to cloud computing and services. These technologies have the potential to give rise to a new generation of service-based industrial systems whose functionalities reside on-device and in-cloud. In order to succeed developing these technologies and applications, talented personnel, comprehensive IT infrastructure, economic strength and enlightened manufacturers will be needed (Karnouskos, Colombo & Bangermann, 2014), closing the loop for sustainable production systems.

Kagermann, Wahlster and Helbig (2013a) describe Industry 4.0 as a collection of following seven concepts: smart factories, cyber-physical systems, self organization, new systems in distribution and procurement, new systems in the development of products and services, adaptation to human needs and corporate social responsibility.

Hermann states that one characteristic of an Industry 4.0 factory is its ability to foresee future products and to respond to the variety and complexity intensification with low cost and low environmental impact (Hermann, Schmidt, Kurle & Thiede, 2014).

The internet and supporting technologies serve as a backbone to integrate physical objects, human actors, intelligent machines, production lines and processes across organization boundaries to form an intelligent, networked and agile value chain.

The National Academy of Science and Engineering states that Industry 4.0 is interpreted as new level of organization and control over the entire value chain of the lifecycle of products, which describes Industry 4.0 as a paradigm shift in business operations, rather than a technology based improvement of production capabilities. Companies tend to focus too much on the technological aspect in Industry 4.0 in order to attain short term market advantages.

So, the Industry 4.0 will change the design, manufacture, operation and service of products and production systems. Connectivity and interaction between parts, machines and people will make the production system to be 30% faster and 25% more efficient and strengthen mass customization at peak levels. Thus, manufacturing undergo a major transformation from isolated individual cells to a full and complete integration of elements that are interconnected and communicate getting a flexible, fast, and high quality production system. And as a result is expected to have a major benefit, employability and manufacturing investments impact.

Overall, the vision of industry 4.0 describes a whole new approach to business operations, and especially the production industries.

The Basque Government launched in 2014 the Basque Industry 4.0 initiative - *Lantegi adimendua / Smart factory* to boost competitiveness and industrial innovation in Basque companies.

Given this scenario, our project aims to seek collaborative opportunities among companies in the following fields related to the Industry 4.0: advanced manufacturing, energy, advanced electronics and digital business

### **3. Process Model towards Industry 4.0**

#### **3.1. Description of the Model**

Many SMEs have a need to know how to detect future growth markets. They do not know where to start from in order to generate new growth opportunities or even do not know how to enface the challenge toward Industry 4.0 and how to visualize the Industry 4.0 paradigm in their specific situation.

So far, companies seem to struggle transforming the visionary ideas of industry 4.0 to a missionary level of increasing the productivity on the shop floor. Practically, only the collaborative implementation of all the concepts of Industry 4.0 has to be followed to increase the collaborative productivity in production industries (Schun, Potente, Wesch-Potente, Weber & Prote, 2014).

Many companies, therefore, realize that a more holistic approach towards the management of diversification and growth is needed, but in most SMEs, the preconditions needed for a systematic diversification process do not exist (awareness, knowledge, process, techniques, tools, etc.). Therefore, this contribution describes a systematic approach towards the identification of new diversification opportunities.

To address the challenges regarding the concept of Industry 4.0 and the diversification methodology discussed above, and based on the strategic guidance towards Industry 4.0 (Erol, 2016), we propose a process model as a guiding framework for Industry 4.0 collaborative diversification vision, strategy and action building.

We develop a stage process model to guide companies in their Industry 4.0 vision and strategy finding process. The goal of the model is to guide and train companies identifying new opportunities for diversification in areas within Industry 4.0. Systematically carrying out the stages will take a company to their individual specific vision and collaborative vision between different companies in the Industry 4.0 scenario. In the following figure each stage of the model is described in detail.

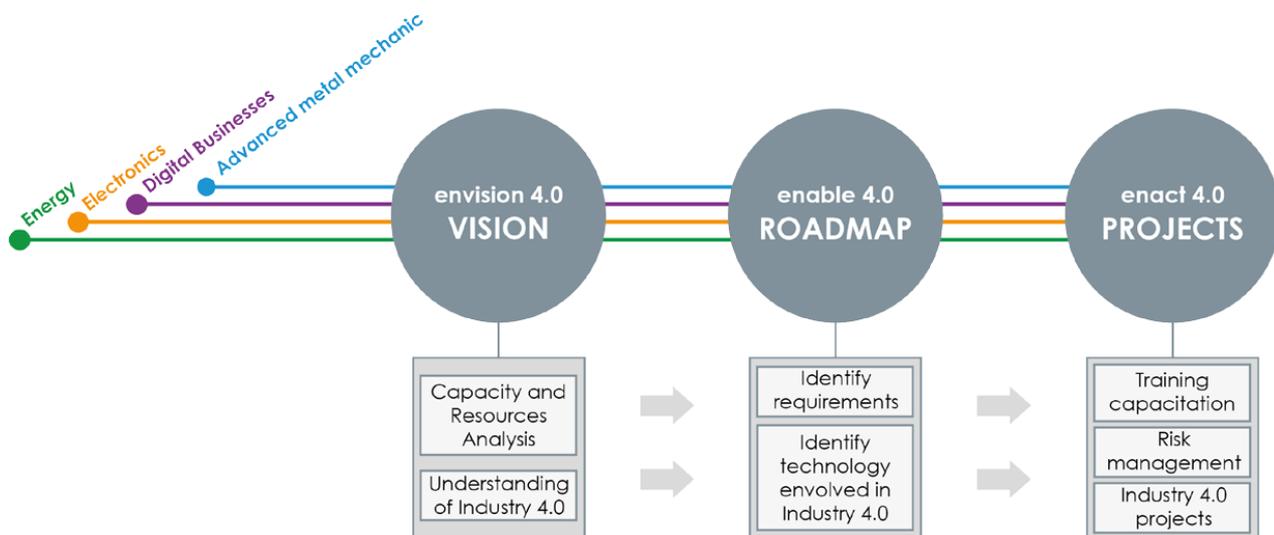


Figure 1. Description of the Methodology for Industry 4.0 Collaborative Diversification

The Vision 4.0 stage is dedicated to define a tailored Industry 4.0 vision, developing its own understanding general Industry 4.0 ideas with company specific capabilities and resources.

At this stage, external experts and technological partners are involved to show relevant results and best practices and to support the process towards the Industry 4.0 vision building. The output of this stage is

a company tailored vision for a future end state supporting the future challenges proclaimed by the new industrial revolution.

Within the Enable stage the company starts from a substantial Industry 4.0 vision and based on this vision, the company try to define the technology portfolio and capabilities needed to give support to the new product-service solutions identified in the previous stage. The Sectorial Roadmap Industry 4.0 will facilitate the strategy planning and alignment process to visualize and structure the different strategies. Roadmapping allows drawing strategies and constraints on separate layers against a common timeline. There are four strategic perspectives: market, product, process, and value network.

The output of this stage is a timely ordered and multi perspective map of the overall strategy towards the Industry 4.0 vision that builds the strategic frame for concrete actions.

### **3.2. Description of the Maturity Model to Industry 4.0**

In order to apply the Maturity Model to implement Industry 4.0 scenario (Figure 2), we define this maturity scale for the three stage process model with the next levels:

1. Initial: It doesn't exist a company specific industry 4.0 vision
2. Managed: There exist a Roadmap of industry 4.0 strategy
3. Defined: customer segments, value proposition and key resources defined
4. Transform: Transform the strategy into concrete projects.
5. Detailed BM: Transformation of Business Model

The analysed organizations, which have not adopted the Industry 4.0 philosophy, and are at level 1 and progress through the levels of maturity by adopting the goals and practices which are defined for the processes at each level.

	V 	B 	A 
	ENVISION	ENABLE	ENACT
	It doesn,t exist a company specific industry 4.0 vision		
	Tailored Undustry 4.0 Vision 	Customer segments and customer expectation defined	Portfolio projects without prioritize
	Develop its understanding I4.0 with specific capabilities and resources	Customer segments and expectation defined and value proposition defined	Projects evaluated and resource and collaboration needed identified
	Opportunity map described in I 4.0	Customer segments and expectation, VPM and technologies/resources defined	Actual and Future portfolio Project detailed
	Future challenges by the I4.0  	 	 

Figure 2. Maturity Model to the Industry 4.0 revolution

#### 4. Conclusions

Most of organizations do not consider the Industry 4.0 revolution in their own culture in order to detect and visualize new opportunities to diversify. In a first analysis, with a representative sample of SMEs in the Basque Country, a few companies use any Industry 4.0 holistic methodology.

The project will be applied in a specific County of the Basque country in which the panel participants is consisted by companies, regional development agencies and the University. The companies provide a real need to diversify, the need to define an Industry 4.0 approach and all the information in order to develop a deep market, product technology analysis.

Specifically, the pilot program project had been carried out, in which the scalable method had been implemented in the case of SMEs of the Basque Autonomic Region and follows the process identified and defined before. Implementation of a set of PILOT in several companies in one county of the Basque Country based on the application of the method search of new opportunities worked in the training sessions.

## References

- Andrés-Alonso, P., & Fuente-Herrero, G. de la (2004). Opciones reales y diversificación corporativa: evidencia para el caso español. *Cuadernos de economía y dirección de la empresa*, 19.
- Chiang, C.C. (2010). Product diversification in competitive R&D-intensive firms: An empirical study of the computer software industry. *Journal of Applied Business Research (JABR)*, 26(1), 99-108. <https://doi.org/10.19030/jabr.v26i1.280>
- Erol, S., Schumacher, A., & Sihm, W. (2016). Strategic guidance towards Industry 4.0 – a three-stage process model. *International Conference on Competitive Manufacturing*.
- Hermann, C., Schmidt, D., Kurle, S., & Thiede, S. (2014). Sustainability in Manufacturing and Factories of the Future. *International Journal of precision engineering and manufacturing-green technology*, 1, 283-292. <https://doi.org/10.1007/s40684-014-0034-z>
- Kagermann, H., Wahlster, W., & Helbig, J. (2013a). *Securing the future of German manufacturing industry. Recommendations for implementing the strategic initiative Industrie 4.0*. Frankfurt: Acatech-National Academy of Science and Engineering.
- Kagermann, H., Wahlster, W., & Helbig, J. (2013b). *Recommendations for implementing the strategic initiative Industrie 4.0*. Frankfurt: Acatech-National Academy of Science and Engineering.
- Kagermann, H. (2015). Change Through Digitization-Value creation in the Age of the Industry 4.0. In: H. Albach, H. Meffert, A. Pinkwart & R. Reichwald (Eds.), *Management of Permanent Change* (pp. 23-45). New York: Springer.
- Karnouskos, S., Colombo, A.W., & Bangermann, T. (2014). *Trends and Challenges for Cloud-Based Industrial Cyber-physical Systems*. London: Springer. [https://doi.org/10.1007/978-3-319-05624-1\\_11](https://doi.org/10.1007/978-3-319-05624-1_11)
- Lasi, H., Privatdozent, P.F., Kemper, H.G., Feld, T., & Hoffmann, M. (2014). Industry 4.0. *Business & Information Systems Engineering*, 6, 239-242. <https://doi.org/10.1007/s12599-014-0334-4>
- Lichtenthaler, E. (2005). Corporate diversification: identifying new businesses systematically in the diversified firm. *Technovation*, 25, 697-709. <https://doi.org/10.1016/j.technovation.2003.12.005>
- Lin, C., & Su, D. (2008). Industrial diversification, partial privatization and firm valuation: Evidence from publicly listed firms in China. *Journal of Corporate Finance*, 14, 405-417. <https://doi.org/10.1016/j.jcorpfin.2008.05.001>

- Martínez, A., & Fernández, R. (2009). ¿Qué factores determinan la decisión de diversificar?: El caso de las empresas españolas (1997-2000). *Investigaciones Europeas de Dirección y Economía de la Empresa*, 15, 15-28. [https://doi.org/10.1016/S1135-2523\(12\)60075-6](https://doi.org/10.1016/S1135-2523(12)60075-6)
- Schun, T., Potente, T., Wesch-Potente, C., Weber, A.R., & Prote, J. (2014). Collaboration Mechanism to Increase Productivity in the Context of Industrie 4.0. *Procedia CIRP*, 19, 51-56. <https://doi.org/10.1016/j.procir.2014.05.016>
- Song, H.X., & Wang, F.S. (2011). Research on the relationship between corporate governance structure and diversification strategy. *International Conference on Management and Service Science (MASS)*. <https://doi.org/10.1109/icmss.2011.5998565>
- Walters, D., & Rainbird, M. (2007). *Strategic operations management: a value-chain approach*. New York: Palgrave Macmillan.

Journal of Industrial Engineering and Management, 2016 ([www.jiem.org](http://www.jiem.org))



Article's contents are provided on an Attribution-Non Commercial 3.0 Creative commons license. Readers are allowed to copy, distribute and communicate article's contents, provided the author's and Journal of Industrial Engineering and Management's names are included. It must not be used for commercial purposes. To see the complete license contents, please visit <http://creativecommons.org/licenses/by-nc/3.0/>.