How Additive Manufacturing Adoption Would Influence a Company Strategy and Business Model

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Abstract
Advanced manufacturing technologies such as Additive Manufacturing (AM) are rapidly revolutionizing business processes within European and Italian SMEs. A clear example is represented by the success of 3D printers that are achieving a huge impact on the market from both the companies and the customers' point of view.
This paper aims at investigating how manufacturing and logistic processes have changed drastically in the last years according to the introduction of the above-mentioned advanced manufacturing technologies.
Recent academic literature is focusing on the integration of any advanced technology with other infrastructures and technologies already implemented in a company. By considering 3D printing adoption, both in the product design and in the production management processes, it turns out to be necessary a proper integration with other technologies such as the software used to design a product (CAD) and the manufacturing control cameras adopted to control the production process.
At the same time, a proper strategic alignment has to be assured between the implementation of advanced manufacturing technologies and the company innovation strategy. Consistency and coherence among all the strategic decisions must be guaranteed in order to create and increase the company business value. Furthermore, the acquisition of new assets, either tangible (e.g. 3D printers) or intangible (e.g. know how), has to be properly integrated with other tangible and intangible resources in order to combine them in the best way, so that the goal of gaining a sustainable competitive advantage would be reached.

Keywords: additive manufacturing, business model innovation, sustainable competitive advantage

JEL classifications:

- L21 – Firm Objectives, Organization, and Behavior - Business Objectives of the Firm
- L23 – Firm Objectives, Organization, and Behavior - Organization of Production
- L69 – Industry Studies: Manufacturing – Other
- O32 – Innovation, Research and Development, Technological Change, Intellectual Property Rights – Management of Technological Innovation and R&D
- O33 – Innovation, Research and Development, Technological Change, Intellectual Property Rights – Technological Change: Choices and Consequences, Diffusion Processes

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Introduction

Additive Manufacturing has gained a central role within the recent literature. Presented as one of the elements that drive the third industrial revolution, Additive Manufacturing takes its name according to how products are manufactured: the material (e.g. PLA or ABS) is added layer by layer (Piller et al. 2015). Additive Manufacturing is enabling product and process innovation especially at the manufacturing level, thus creating new avenues of value and reducing costs of traditional processes. At the same time the opportunity to 3D print objects starting from a digital file is disrupting the traditional ways on which customers are engaged: they can become makers given the low cost of acquiring a 3D printer for individual use (De Jong & De Bruijn, 2013). Hence, this new production technology can be considered either for individuals or for enterprise uses. From the consumers' side, the rise of "Makers" (i.e. digital artisans) communities that can 3D print their objects starting from a 3D model is disrupting the traditional way how products are designed and distributed. As a consequence, new supply chains models, where the exchanged products are at the same time physical and digital, are arising. Authors refer to Additive Manufacturing as an enabler of "a digital value chain where activities relate to the creation and distribution of digital products" (Piller et al., 2015).

This big change on the consumers' side is impacting on enterprises too and especially among SMEs. In fact, the development of these new value chains offers unprecedented opportunities. The venture of digital marketplaces, for example, can provide to SMEs low unit costs either for products or services even in markets where they compete with big companies. Indeed, new economies of scale are emerging as a result of the new value chain. Furthermore, a single design of a digital asset can be launched in different virtual marketplaces. Eventually, companies accomplish new economies of scope exploiting the same input for different products (Rayport & Sviokla, 1995). Hence, the manufacturing industry is changing worldwide due to the introduction of additive technology. Indeed, it is becoming more and more common and it is expected to be mainstream in maximum four years, so by 2020 (Gartner, 2014b). Recently, Gartner confirmed this hypothesis based also on the evidence of the growing of the low-cost 3D printing market (Gartner, 2014a). This paper aims at understanding how an additive manufacturing strategy could be pursued by companies in such a way to – first – make new strategic decisions and – second - ensure an alignment of them with the company strategic goals. The paper is structured as follows: section 2 will present a literature review on additive manufacturing, business models innovation within the SMEs context; section 3 will present the methodology used for collecting data; section 4 will discuss data in light of the literature reviewed; section 5 will address conclusions and future research directions.

Literature review

This section presents the literature review carried out for this study. A systematic literature review approach was used (Myers, 1997; Okoli & Schabram, 2010). First, journals regarding the state of art of additive manufacturing worldwide have been investigated. Therefore,

journals regarding innovative technologies and market changes were analyzed. In addition, articles regarding technology strategy and strategic innovation were checked. Journals and articles were retrieved from relevant databases: Passport, Marketline, Sage, Ebsco and Emerald Insight. In addition, databases and journals focused on Business & Management, and Business Information Systems were queried. Articles were selected on the basis of the publication year and, with regard to additive manufacturing topic. Given its recent breakthrough only articles over the past three years have been selected. Each article was analyzed in the full text with the aim to highlight relevant theories, methodologies and findings. Therefore, with the aim to find research gaps in which to position this study, articles were clustered among main topics dealt with. Therefore, the following sub-sections deals with five categories emerged as relevant during the literature review.

Strategic drivers: innovation and technology

For a firm focused on the adoption of advanced manufacturing technologies, innovation is a critical point mainly because it is considered as a way to gain or improve a competitive advantage. Internal factors on which innovation performance index (rate of new products development) and external actors (i.e. such as technological opportunity and conditions of property) depend can be identified. An additional, relevant, external factor is the demand: final purpose is anyway to satisfy customers' demands, even if it is not constant.

Placing innovation as the center of each initiative means that a firm would adopt a technology implementation strategy. A very important part of this strategy is related to the research projects the company decides to investigate. Hence, the key point is to select the right research projects (i.e. the ones that allow to create a sustainable competitive advantage) that can bring a business success. Taking into consideration additive manufacturing, and 3D printing, within SMEs context, it allows to exploit economies of scope instead of economies of scale. Indeed, this new technology has to adapt to the market and product specifications and align with the current businesses, manufacturing and R&D strategy.

Literature reports that firms that can exploit the application of additive manufacturing are characterized by low quantity and high customization.

A new manufacturing paradigm is coming up: personalization. Firms are asked to perform a value differentiation strategy since, in this way, an exploitation of varieties against volumes is reached. A shift from old manufacturing paradigms to new ones based on the relation between volumes and variety is happening. In fact, the concept of modularity was created as a consequences of mass customization, since varieties were created through the various combinations of modules. This is the application of the product family architecture concept that allows standard construction of different modules, and then different combinations of them. The results are customized products. Nowadays, the introduction of 3D printing created a new manufacturing paradigm: personalization, where products are based on the individual needs and desires of customers. Products are almost always designed (and then, produced) to fulfill a specific individual requirement; hence as a result firms compete. Therefore, adoption of additive manufacturing is appropriate for firms focused on innovation and aiming at gaining a durable, technology-based, competitive advantage.

Business Model: value added product and higher revenues

The second building block regards the business model, which explains how the company provides value to its customers, and answers the two questions: how the business is designed in order to satisfy customers' needs and desires; how the company can convert the acquired customer satisfaction into profit. Therefore, in order to gain a profit from innovation, it is important to keep into consideration the evolution of technology as long as the related changes on customers' demands. Nevertheless, from a practice-based point of view, customers do not really consider the value proposition provided by a firm. Indeed, they just acquire the product if the price is feasible and the product will satisfy their needs. Hence, a good business model is the one that fulfill customers' needs and requirements. In this way, it is easy to notice how additive manufacturing is a key point since it allows companies to satisfy a specific customer individual need providing a value added product.

In addition, it is important to think about the linkage between business model and technology. Indeed, business model design will influence decisions about technology development and complementary technologies, and these decisions will allow a higher or lower profit. As a result, the linkage between business model and technology influences profits based on making the right choice (e.g. which research project to develop first).

As it is already stated, changing and adapting their own business model is very important for firms since it allows them to decrease their costs. Consequently, they would be more competitive in the market. One example of how 3D printing can reshape a business model is the consumer technology business model, which considers 3D printers as a key component for the support services given their flexibility and wideness of fields of application. An example is the printing of replacement parts: it is a new value proposition in the market due to the venture of additive manufacturing.

Unique Resources: Production Know-How

Know-how can be defined as accumulated skills and competencies that allow to perform a task in the most efficient and smart way. It is important to point out that know-how must be always improved to keep performing innovation and keep the competitive advantage sustainable. Hence, the production know-how is one of the most valuable intangible resources for a company, since it is a critical point in order to deliver a good product and it is a resource difficult to imitate. So, a proper know-how is a key complementary asset in order to gain a sustainable competitive advantage.

With the implementation of additive manufacturing, firms could develop a new production know-how. Of course, it is necessary to take into consideration also the knowledge creation effort and the time needed to develop this new knowledge. In this way, the firm would increase its resources, both intangible and tangible. In particular, regarding the intangible resources it would gain a better know-how, which would be fundamental for the future to not only be competitive, but to survive in the market environment.

Emergent Strategy: adapting to market changes

Performing an emergent strategy is the critical point for a firm in order to be competitive in the market not only in the present, but also in the future. Indeed, this strategy guides the company to adapt to market changes. Hence, adapting means being competitive. Therefore, a sustainable approach can be reached through an innovative attitude, which reckons on a continuous analysis of the external environment in order to promptly identify new opportunities to start new activities. This ability of a firm to bundle its resources as a continuous process in order to adapt to changes in the business environment are defined as dynamic capabilities, and they actually refer to the capability of a firm to identify new sources of a competitive advantage. It is also important to point out that in this way current decisions will influence the future ones; given that they will allow the development of certain competencies on which future decisions will be based. Hence, firms' attention must focus on trying to not make decisions which would decrease the range of possibilities in the future.

Sustainable Competitive Advantage

On the basis of previous concepts, a sustainable advantage will be created if customers prefer that product of that firm over others. In this way, the firm will be able to perform a differentiation strategy, since customers will relate to that technology more value. In this way, new sources of competitive advantage can be identified in design which are both simple and easy to assemble or complex and high customized products.

As a result, the flexible design and the high level of customization allow the firm to deliver a value added product. The aim is to get it recognized by the customers as different. In this way, clients will choose that product instead of the ones of competitors.

So, there are evidences that 3D printing allows companies to gain a competitive advantage. In detail, regarding this competitive advantage we can identify the following factors: process innovation, costs, consumers' value, incomes, profits, sustainability of the competitive advantage.

The research gap

This research aims to investigate in order to solve the gap identified in literature, analyzing the potential correlation between additive manufacturing implementation and a valid strategy development. Once successful factors for a good strategy have been clearly related to additive manufacturing, further step is to verify the feasibility of the proposed collaboration framework, which aims to promote the implementation of additive manufacturing among Italian SMEs.

- RQ 1: How can the process of identifying and developing a strategy based on additive manufacturing be described?

Within this question the analysis aims to identify corporate strategies that have been adopted by manufacturing companies nowadays in order to adapt to the introduction of additive manufacturing and what is the rationale beyond it (Boccardi et al., 2014; Carrus et al., 2014). In addition, it aims to identify the level of competitiveness a firm

need in order to implement additive manufacturing. Thus, the questions aim to identify the expectations and goals of the firms.

- RQ 2: How the business model and product development have been affected?

The purpose of this question is to verify if additive manufacturing achieved the expected effects and how is its performance going. So, within this question an analysis of the effects on the business model will be performed. In this way, it will be studied how the value proposition has been affected in relation to the creation of a value added product (Chesbrough & Rosenbloom, 2002; Jiao, Simpson, & Siddique, 2007; Sheng-zhou & Rui, 2011). As a consequence, it will be to analyze to which extent the product now competes on value differentiation.

- RQ 2.1: How additive manufacturing succeed to support the achievement of a competitive advantage?

The aim of this question is to identify if the implementation of additive manufacturing created the desired effect of achievement of a competitive advantage and to which extent this competitive advantage is sustainable.

- RQ 3: How a collaboration model can be applied among companies, research organizations and government in order to make Italy competitive internationally?
- RQ 3.1: How can we make Italian companies collaborating each other's in order to compete together worldwide instead of singularly and nationally?

In detail, this question will verify if it is possible to apply nationally a collaboration model within the Italian context. The aim of this model would be to make Italy able to compete with other countries not only within the European environment, but also worldwide. However, also companies need to collaborate each other's (Cautela et al., 2014; Lee et al., 2010; Zhao et al., 2014). This fact may require them to change the strategy they have been adopted until now, if their strategy was focused on competing in the national market.

Methodology

According to M. D. Myers (1997), qualitative research is used in order to analyze social and cultural phenomena. In detail, it can be executed through action and case study research, interviews and questionnaire. Data set are usually composed of words, texts and stories. Hence, the main point of qualitative research is understanding the context from the point of view of the participants (Myers, 1997). Within this methodology there is a social constructionist ontology, and an inductive approach is performed. In detail, it can be defined as building a theory based on certain data through inferences after observations (Maxwell, 2013; Miles & Huberman, 1994).

Hence, based on the nature of desired output of this research a qualitative approach has been selected. Indeed, the outcome of this research is strictly connected with the process of knowledge creation in terms of know-how improvement. In detail, it aims to identify the process and rational of building a strategy based on additive manufacturing and how this can be a tool in order to gain a sustainable competitive advantage. Hence, not numerical variables but text and words are main actors in this research.

However, it is possible to define a cluster of key words in order to narrow down this research: strategic innovation; technological advantage; additive manufacturing; Italy; SME strategic alliances.

According to Yin (2014), an opportune research method can be identified based on the type of research questions. In detail, three factors must be taken into analysis:

- Form of research question
- Control of behavioral events
- Focus on contemporary events

An analysis of these factors allows the identification of the research method most appropriate. However, setting the research questions is the most important starting point in order to then identify the research method. Indeed, research question with "how" or "why" are more easily answered through a case study since the frequency of the data are more likely to be taken over time. In addition, applying the case study research method does not require control over behavioral events, but it requires focus over contemporary events (Yin, 2014).

For these reasons, case study research method has been selected to be applied in this research. Indeed, research questions focus on contemporary events, and they do not consider control over behavioral events, such as effects of additive manufacturing implementation. Furthermore, they are about "how" can additive manufacturing support a company to gain a competitive advantage.

In order to perform this empirical research four Italian firms have been selected. This study has been performed through the observation and investigation of these four case studies. Firms have been selected based on their technology and manufacturing capabilities. So, they all give particular importance to innovation and new technologies implementation. As a result, they also already achieved a high-specialized level of know-how. Firms who adopted innovative technologies in outsourcing have also been considered within this research.

Furthermore, it is important to point out that the selected firms share a common Italian entrepreneurial approach, which make them to compete each other avoiding collaboration and knowledge sharing. This affects their willingness to collaborate either with other firms or with academia and research centers.

Data collection and analysis

Once the research method and the firms cluster have been identified, the next step is the choice of the data collection method. This section explains the activities carried out in order to gather the required data according to the data collection plan. Basically, according to Yin (2014) the selection depends on three factors:

- Research method chosen
- Research topic
- Availability of data

In the same way, according to Yin (2014) six sources of evidence can be identified. Interviews have been selected as the main data gathering technique since it allows to gather various and rich data from

different people and in different contexts. It fits with the previous decision of case study as a research method and with the topic chosen, since it regards more concepts and words rather than numbers. In addition, two types of secondary resources have been selected in order to perform the research properly.

A questionnaire has been implemented as a guideline to perform the interviews. In detail, the purpose of the questionnaire is to identify which innovative technologies as additive manufacturing have been implemented and in which phases of the production process, and what have been the effects on the strategy of the firm. The questionnaire is composed of 11 questions and it is divided in three main parts, one in respect of each research question. In detail, it has been developed as a set of open questions, which can be defined as questions that allows freedom and spontaneity in the answer. The reason beyond this decision is the size of the sample. Indeed, open questions are usually used for smaller sample because it is easier to categorize then the answers.

The questionnaire, as previously mentioned, is divided into three main parts plus introduction and conclusion. The main parts can be summarized in the following points according to the three research questions:

- Rationale beyond the adoption of additive manufacturing
- Effects of the implementation of additive manufacturing
- Verification of the feasibility of a collaborative model

Table 1: Data summary of firms studied

	FIRM 1	**FIRM 2**	**FIRM 3**	**FIRM 4**
# employees	100	30	900	15
€ turnover:	2013: 24M€ 2014: 17M€	2013: 7M€ 2014: 8M€	2013: 200M€ 2014: 210M€	2013: 1.5M€ 2014: 1.6M€
Investments in R&D [% of the total revenue]	5-6%	20%	4-5%	6-7%
Core Business	Textile Machinery	Heat-Exchangers	Firearms	Machine Tools (ex: sleeve and spool valves)
Market Served	More than 35 countries	Italy	Worldwide, in particular USA.	Italy
Materials	Resins similar to polymers	Metals	Metals and polymers	Metals
Type of Technology used	Selective Laser Sintering (SLS)	Stereo lithography (SLA)	Selective Laser Sintering (SLS) and Stereo lithography (SLA)	Selective Laser Sintering (SLS)

One round of interviews has been made and the interviewed were 4 in total. All interviews have been tape-recorded and then transcribed.

Durations of the interviews are from half an hour to one hour, and the audio material is of 170 minutes in total. Due to the limited number of interviews, they all have been at the same timing.

A further set of secondary sources has been gathered for the research such as materials that have been already published. Hence, web pages and documentations have been gathered in respect to each firm.

The data were encoded and structured into "projects" using the software NVivo 10 following a grounded theory approach (Strauss 1987, Glaser 1992) that aims at finding properties or links between data.

Discussion

According to the data collected and analyzed it is possible to review the main points identified within the literature review presented within previous sections.

Process innovation

The first and main factor influenced by the adoption of additive manufacturing is the delivery time of the product, since the time to market is extremely reduced. Actually, it might become in real time. Indeed, this is one of the objectives for the implementation of an additive manufacturing strategy. Indeed, based on defects on prototypes adjustments are made immediately until all requirements are satisfied. In this way, these corrections are made within the product development phase instead of once the product is developed. Hence, the product development process is optimized because adjustments are made in a faster and less costly way. As a result, product costs are reduced (Lindemann & Jahnke, 2012; Vayre, Vignat, & Villeneuve, 2012). Furthermore, defects on the prototypes are identified both by developers and the client, who gives immediate feedback. Eventually, a spiral project model is applied and it facilitates quality assurance and the flexibility of the product.

Consumers' value

Customers' perception of the firm product is influenced by the higher quality and flexibility. As a consequence, brand awareness is strength and customers' loyalty is established. Customers recognize the product as high quality and personalized according to their single request, and this make them to become usual clients (Design, Berkiov, & He, 2015; Hu, 2013). Indeed, a close collaborative relationship is established between the firm and the customers thanks to usability testing.

Product Platform Enhancement

It is already renowned that new manufacturing technologies have pushed limits of traditional manufacturing machines: now new products can be developed also in a different approach and materials are added instead of subtracted. However, it is necessary to point out that still not any product can be developed.

Nevertheless, not only products are developed applying a different approach, they are also developed with an enhancement of the product platforms in terms of types of modules. Indeed, due to the application of the spiral project model and the satisfaction of the single custom-

er demand, personalized product are added to the platform (Hu, 2013; Petrick & Simpson, 2013).

Sustainable Competitive Advantage

Carrying out projects on demand make the firm to perform a differentiation strategy: it aims at delivering the most technologically advanced product, which is a unique solution with a unique design for each customer. Hence, firms do not compete anymore on costs, but on differentiation (Chu & Su, 2014; Grant, 2010). Products do not compete on a cost advantage, but on differentiation advantage. For these reasons, it is important to point out that firms might exploit additive manufacturing in order to create new business opportunities. According to this, a high specialized production know-how is what allows companies to provide a high quality and unique product (Berman et al., 2002; Lei, Slocum, & Pitts, 1992). Also, the development of production know-how through additive manufacturing allows companies to actually integrate AM in the product life cycle, and consider it as an additional service provided.

Therefore, the summary of points of a firm strategy influenced by AM can be listed as follow:

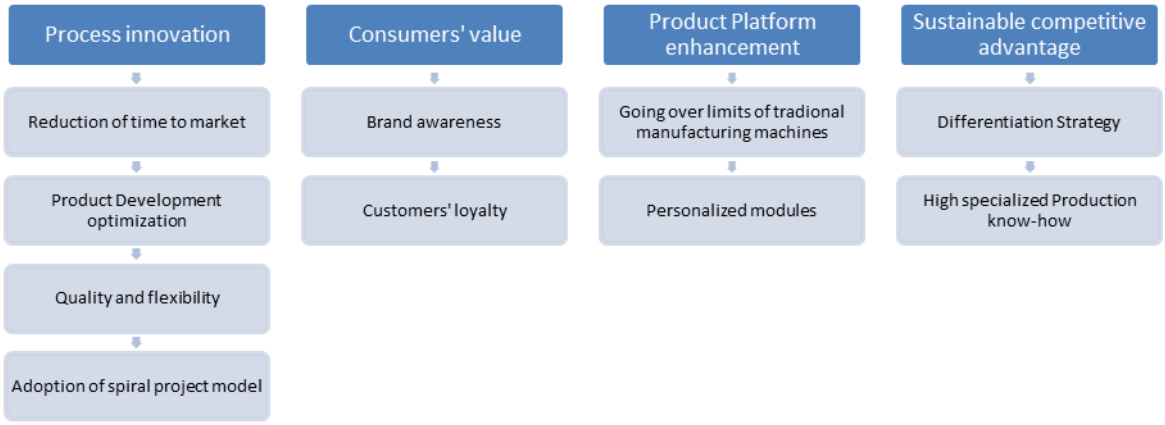

Figure 1: Summary points of a firm strategy

Addressing Research gap

This research aims to fill the gap between the adoption of additive manufacturing and a firm business strategy. The Italian context has been taken in deeper consideration and the influence of additive manufacturing adoption can be summarized in the following discussion.

Taking in consideration the implementation of 3D printers in the product design and production process, it would be necessary to ensure a proper integration with other technologies such as the software used to design a product (CAD), and cameras in order to control the outgoing of the production process (Raley & Gaertner, 2014). However, it is also important to be aware that it is necessary to ensure a proper alignment of the implementation of advanced manufacturing technologies such as additive manufacturing with the innovation strategy of the firm. This alignment has to be a priority and has to be consistent in all the strategic decisions in order to create and increase the business value for the company (Pisano, 2015). Furthermore, the acquisi-

tion of this new resources both tangible (3D printers) and intangible (know-how) has to be properly integrated with other tangible and intangible resources in order to combine them in a best and unique way. Also, the firm would need to develop dynamic capabilities in order to be able to adapt promptly to market changes, and so adopt with good timing further new manufacturing technologies (Cohen & Levinthal, 1994; Teece, Pisano, & Shuen, 1999; Teece, 2010). As a consequence, the goal of gaining a sustainable competitive advantage would be reached. Moreover, in order to ensure not only a proper combination of additive manufacturing with other resources, but also an appropriate alignment with the company strategy, all elements within the model below have to be taken into consideration.

Answering research Questions

In order to present results of this study research questions previously presented are here answered and discussed.

- RQ 1: How can the process of identifying and developing a strategy based on additive manufacturing be described?

  First, a firm would need to recognize the business opportunities that a strategy based on additive manufacturing would create. Then, further step is to integrate them with the current corporate and business strategy (Pisano, 2015). Firms recognize that the possibility to optimize the product development process, with a consequential reduction of the time to market is a common need. Also, SMEs are interested in establish customer loyalty as a result of close partnerships with customers through immediate usability testing. Moreover, SMEs with low volumes and high product mix not only would aim to provide new unique products, but also to get more flexibility and quality assurance.

- RQ 2: How the business model and product development have been affected?

  The product development process has been influenced mainly by the adoption of rapid prototyping. Indeed, a prototype would be created quickly and required adjustments of the product can be made immediately, and in a very efficient way. Moreover, these adjustments are made first based on feedback from developers, and then from customers. As a result, value proposition would be affected since the main features of the product would be its uniqueness and quality. Then, also the relationships with customers would change since it would be an actual collaboration.

- RQ 2.1: How additive manufacturing succeed to support the achievement of a competitive advantage?

  Thanks to the adoption of additive manufacturing a firm do not compete anymore on cost, but on differentiating its product from competitors. Thanks to the possibility of providing a unique personalized product of high quality, the firm would perform a differentiation strategy, and could gain a differentiation advantage (Battistella, Biotto, & Toni, 2012; Grant, 2010).

- RQ 3: How a collaboration model can be applied among companies, research organizations and government in order to make Italy competitive internationally?

  It is feasible to consider the application of a collaboration model among SMEs, academia, services and bigger firms in order to promote the adoption of new manufacturing technologies, and in particular of additive manufacturing. However, it is easily noticeable a total absence of the government. Hence, collaboration is mainly with consulting companies, bigger firms and sometimes academia. Collaboration with academia and research centers is not stable due to a lack of young graduates specialized in specific technologies. Furthermore, it has been recognized the possibility of acquisition of the production know-how from a supplier as an additional service.

- RQ 3.1: How can we make Italian companies collaborating each other's in order to compete together worldwide instead of singularly and nationally?

  The reason why Italian SMEs are not collaborating is mainly based on the risk of competitive advantage attenuation, since once the production know-how is shared, a competitor might find the way to provide the same product at a lower price. Hence, making SMEs competing together worldwide would motivate them significantly to collaborate with each other's' in order to gain a common competitive advantage.

Conclusions

One of the main limits of this research is the fact that it is only based on four case studies. It would be very interesting to expand the research on more cases. Indeed, it might be that new factors emerge.

In the same way, another limit of this research is that due to timing only one round of interviews has been done. Hence, it would be interesting to do a second round of interviews, in order to investigate in more detail about the result of additive manufacturing adoption. Thus, it would be useful to both update the current state to art of the adoption and the results of the adoption.

Eventually another limit of this research is the fact that is based on case studies from different sectors. Hence, it is complex to compare them. However, the decision of the selection of firms from different industries have been made in order to make this research more complete, and to identify in what sectors additive manufacturing can be exploited the most.

Drawing relevant contributions of this study it is at first possible to identify influences on the competitiveness of a firm due to the implementation of 3D printing and based on the rule it plays in its business model. Mainly, factors affected are the added value provided to customers and the improvement of the speed to market. As a result, even revenues are influenced in a positive way thanks to the willingness of customers to pay more for a better product. Moreover, thanks to additive manufacturing product innovation can be performed in a more easily way, and so the competitiveness of the firm would be stronger, since the firm would be able to adapt more quickly to market changes. As already stated, the fastness of catching up with the mar-

ket is a critical point. Also, this phase can be decreased through knowledge sharing, and so does the collaboration with Academia.

References

Battistella, C., Biotto, G., and Toni, A. F. De., 2012, "From design driven innovation to meaning strategy," *Management Decision*, 50. doi:10.1108/00251741211220390.

Berman, S.L. et al., 2002, "Tacit Knowledge As a Source of Competitive Advantage in the National Basketball Association," *The Academy of Management Journal*, 45(1), 13–32.

Boccardi, A. et al., 2014, "Gli effetti della Stampa 3D sulla competitività aziendale. Il caso delle imprese orafe del distretto di Arezzo," *In Manifattura: quale futuro?*, 215–228.

Cautela, C., Pisano, P. and Pironti, M., 2014, "The emergence of new networked business models from technology innovation: an analysis of 3-D printing design enterprises," *International Entrepreneurship and Management Journal*, 1–15.

Chesbrough, H. and Rosenbloom, R.S., 2002, "The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies," *Industrial and Corporate Change*, 11(3), 529–555.

Christensen, C.M., Roth, E.A. and Scott, D.A., 2004. "Seeing what's next 1st edition," *Harvard Business Review Press*.

Chu, Y., & Su, H., 2014, "Understanding Patent Portfolio and Development Strategy of 3D Printing Technology," *IEEE*, 1407–1415.

Cohen, W. M., and Levinthal, D. A., 1994, "Absorptive Capacity: A New Perspective on and Innovation Learning," *Administrative Science Quarterly*, 35(1), 128–152.

De Jong, J.P. and De Bruijn, E., 2013, "Innovation Lessons From 3-D Printing," *MIT Sloan Management Review. MIT Sloan Management Review*, 54(2), 43–52.

Design, P. P., Berkiov, S. D., and He, J., 2015, "Modular Architecture in Personalized Manufacturing".

Gartner, 2014a, "Gartner Identifies the Top 10 Strategic Technology Trends for 2015", Available at: http://www.gartner.com/newsroom/id/2867917 [Accessed February 13, 2015].

Gartner, 2014b, "Gartner's 2014 Hype Cycle for Emerging Technologies Maps the Journey to Digital Business", Available at: http://www.gartner.com/newsroom/id/2819918 [Accessed February 13, 2015].

Glaser B., 1992, "Basics of grounded theory analysis", *Mill Valley, CA: Sociology Press*.

Grant, R.M., 2010, "Contemporary Strategy Analysis," *7th ed., Barcelona: John Wiley & Sons*, Ltd.

Hu, S. J., 2013, "Evolving paradigms of manufacturing: From mass production to mass customization and personalization," *Procedia CIRP*, 7, 3–8. doi:10.1016/j.procir.2013.05.002.

Jiao, J., Simpson, T.W. and Siddique, Z., 2007, "Product family design and platform-based product development: A state-of-the-art review," *Journal of Intelligent Manufacturing*, 18(1), 5–29.

Lee, S. et al., 2010, "Open innovation in SMEs-An intermediated network model," *Research Policy*, 39(2), 290–300.

Lei, D., Slocum, J., and Pitts, R. a., 1992, "Designing organizations for competitive advantage: The power of unlearning and learning,". *Organizational Dynamics*.

Lindemann, C., and Jahnke, U., 2012, "Analyzing product lifecycle costs for a better understanding of cost drivers in additive manufacturing," *Manufacturing*, 177–188.

Maxwell, J.A., 2013, "Qualitative Research Design An interactive Approach," *3th Edition, Thousand Oaks: SAGE Publications, Inc*.

Miles, M.B. and Huberman, A.M., 1994, "Qualitative Data Analysis: An Expanded Sourcebook," *2nd Edition, SAGE Publications, Inc*.

Myers, M.D., 1997, "Qualitative Research in Information Systems," *MIS Quarterly*, 241–242. Available at: http://www.qual.auckland.ac.nz/ [Accessed March 13, 2015].

Okoli, C. and Schabram, K., 2010, "A Guide to Conducting a Systematic Literature Review of Information Systems Research," *Working Papers on Information Systems*, 10(26), 1–51.

Petrick, I. J., and Simpson, T. W., 2013, "Point of View: 3D Printing Disrupts Manufacturing: How Economies of One Create New Rules of Competition," *Research-Technology Management*, 56, 12–16. doi:10.5437/08956308X5606193.

Piller, F.T., Weller, C. and Kleer, R., 2015, "Advances in Production Technology," pp. 39–48.

Pisano, G.P., 2015, "You Need an Innovation Strategy," *Harvard Business Review*, (6), 16.

Raley, C. D., and Gaertner, P. S., 2014, "Methodologies for the Identification and Integration of Emerging and Disruptive Technologies," 177–182.

Rayport, J.F. and Sviokla, J.J., 1995, "Exploiting the virtual value chain," *Harvard Business Review*, 73(6), 75–87.

Sheng-zhou, W. and Rui, N.I.E., 2011, "Paths of Business Model Innovation for Manufacturing Enterprises Based on Value Chain," *Social Science*.

Strauss, A.L., 1987, "Qualitative analysis for social scientists," World, 1, 319.

Teece, D.J., 2010, "Business models, business strategy and innovation," *Long Range Planning*, 43(2-3), 172–194.

Teece, D.J., Pisano, G. and Shuen, A., 1999, "Dynamic Capabilities and Strategic Management," (7), 77–115.

Vayre, B., Vignat, F., and Villeneuve, F., 2012, "Designing for additive manufacturing," *Procedia CIRP*, 3, 632–637. doi:10.1016/j.procir.2012.07.108

Yin, R. K., 2014, "Case Study Research: Design and Methods (5th Edition," *Thousand Oaks: SAGE Publications, Inc*.

Zhao, F. et al., 2014, "A holistic and integrated approach to theorizing strategic alliances of small and medium-sized enterprises," *Business Process Management*, 20, 887–905.