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RESEARCH ARTICLE

STUDY ON THE USE OF MARKET, SALES AND MARKETING KEY PERFORMANCE INDICATORS IN EUROPE, FOR PRODUCTS OF ADDITIVE MANUFACTURING PROCESSES, IN PARTICULAR 3D PRINTING

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ABSTRACT

Additive manufacturing processes – particularly 3D printing – have experienced a huge amount of development in recent years. New fascinating studies and research reports are published on a daily basis. Additive manufacturing processes will represent one of the leading production technologies of our time in the coming years. However, the extent to which current studies also take into consideration a comprehensive market assessment of necessary sales, market and marketing key performance indicators has not yet been scientifically established in detail. Secondary research is to enable the current state of the technology in this field to be determined. Based on the findings of the literature review, a recommendation shall be developed regarding whether an in-depth study using primary research methods seems appropriate. This potential subsequent study should establish the suitable and effective use of sales, market and marketing key performance indicators that can be used to enable a comprehensive assessment of the market potential, market volumes and sales opportunities for products of 3D printing in Europe. These insights should allow a conclusive statement with respect to the market opportunities available to small and medium-sized enterprises across industries in Europe for 3D-printed products.

Keywords: 3D printing, additive manufacturing processes, 3D-printed products, key performance indicators, market assessment of 3D sales opportunities

INTRODUCTION

Additive manufacturing (AM) encompasses various computer-supported processes for the automated production of solid objects. It involves the creation of a digital model of the desired product which serves as input data. In contrast to conventional manufacturing processes that are typically based on the removal of materials, in additive manufacturing – for example 3D printing – material is successively added, combined or composed in consecutive stages in order to generate a solid object. AM is based on various technologies sub classified as material jetting, binder jetting, material extrusion, powder bed fusion, sheet lamination and directed energy deposition (cf. Fink, 2017). 3D printing technology is considered the driving force of the new production technologies. It is one of the key technologies that are significantly shaping the future of technological development and industrial renewal in Europe (cf. Duchéne, 2016). Used initially in medical technology and in the automotive industry, this innovative production method has since taken root in almost all sectors. Particularly in industry, its transition from a research technology towards an intensively applied standard commercial technology is currently underway. In many other sectors, there is still a long way to go before this step is achieved, but the technological development is progressing inexorably (cf. Keppner, 2018). Research teams worldwide are working on future areas of application for additive manufacturing processes. In this connection, 3D printing technology plays a central role: whether it is in bioprinting technology for producing 3D-printed models of lifelike tissue, the development of precise bone implants from the 3D printer, a start-up's development for generating plant-based food as a substitute for meat or innovative print products for the manufacturing industry (cf. Thum, 2018). Besides growing international competition around the globe and the constant price war with simultaneously increasing quality requirements, the demand of the consumer for more and more individual products and goods is also rising. 3D printing technology makes it possible to satisfy these consumer needs in a cost-efficient, creative and diverse manner (cf. Rosenstock, 2013), and it will revolutionise our conventional understanding of traditional value creation chains and work processes. The areas of application for 3D printing are manifold. Especially in the sectors of aviation, vehicle technology, medical technology, food technology, metal-processing industry, housing/ construction, education, fashion and luxury goods, sports and recreation as well as armaments, the development of this disruptive technology is being pushed at a rapid pace. In comparison with classic manufacturing methods, this technology additionally offers the possibility of opening up relevant business areas for the private market. For customers, individualisation, personalisation and the ability to add their own creativity are becoming increasingly important. These customer needs can be ideally met with the use of 3D printing. The self-printing of products used in daily life (cf. Gartner, 2018), lifestyle and art items, gifts, sport and recreational products, for example, will dominate the private retail and services market in a number of years. Providers like *Stratasys*, *3D-Systems* and *EOS* are currently serving around 70% of the market in production. In the services segment, *Materialise96* and *Proto Labors* are leading the way. Moreover, 3D printing technology has led to a veritable boom in start-ups. With this technology, creatives – innovative people with the drive to explore new avenues – are provided an ideal platform for founding enterprises (cf. Müller, 2016). In the field of additive manufacturing, Europe is considered to be at the forefront and

is also able to hold its own internationally in the segments of laser melting and biomedical AM research. Leading European countries include Germany, the United Kingdom, Spain and the Netherlands. Internationally, the USA and China are in the vanguard. As previously mentioned, additive manufacturing is still in the development phase in many sectors and manufacturing segments. Small and medium-sized enterprises in particular have a clear competitive disadvantage compared to large original equipment manufacturers, due to the limited resources and skills at their disposal. The final report of the EU study (cf. Duchéne, 2016) also clearly shows a significant bottleneck in application in the areas of negotiating power and strategy in selected value creation chains.

The economic implications of additive manufacturing technologies will be multiplex and their intensity will vary across different industries. Conventionally manufactured products could substantially lose value as a result of AM. On the other hand, AM could also represent an opportunity to gain a technological lead against the competition (cf. Lips, 2017). This is confirmed, for instance, by an *AUTONOMIC Industrie 4.0* study (cf. Richter, 2016). Here, the lack of reliable market assessments for products of additive manufacturing is also mentioned. Accordingly, as demonstrated in other scientific studies, a strongly positive development can be observed in the machines, installations and services required for the production of additive manufacturing products. Furthermore, global revenues from the sale of goods and services in the segment of additive manufacturing has increased almost eight-fold [Fig. 1]. Analysis of the studies has revealed that experts are generally anticipating a continued increase in the global revenues generated by these 3D printers and associated services, and that these revenues will reach the order of around USD 22 billion by 2020. A study by Roland Berger (cf. Langefeld, 2017) shows an annual global growth of more than 35% by 2022. Further studies likewise point to similar growth rates or confirm the cumulative global AM revenues by 2020 of over USD 20 billion. Moreover, it is striking that 90% of the approximately 1,000 companies that work with additive manufacturing in Germany are SMEs (cf. Richter, 2016). In general, experts argue that 3D printing technology will have a massive effect on all global trade. Services from low-wage countries (cheap labour) will be affected in particular. According to estimates, a fifth of global trade could be wiped out by 2040 – and around a quarter by 2060 (cf. Leering, 2017).

In a survey of 61 manufacturers [Fig. 2] of 3D printers, the actual use of such printers by their customers was ascertained. The surveyed companies came from industrialised countries in Europe, East Asia and North America. The results were explained in detail in Wohlers Report 2017 entitled "*3D printing and additive manufacturing, state of the industry, annual report*" (cf. Leering, 2017). These results and conclusions likewise focus on the 3D printer sales or the applications of various industries in the market assessment and future market development. Here too, however, there is a lack of a clear market, sales and marketing assessment on the basis of the actual product volumes that can be generated by 3D printers. No references to the comprehensible use of market, sales or marketing key performance indicators can be found. A KPMG study (cf. Eric Damotte, 2016) notes that in the metal-processing industry, 27% of surveyed companies are definitely investing in additive manufacturing technology – particularly 3D printing – in the coming 12 to 24 months, and a further 40% consider an investment in this area to be absolutely conceivable within this period. This is largely substantiated by the altered market requirements that call for swift, efficient and agile action in order to fulfil increasingly individual customer wishes. In addition, massive cost savings are also defined as an express goal in connection with the use of these new technologies. In a report by the Commission of Experts for Research and Innovation (EFI), the following conclusions are drawn with regard to the use of additive manufacturing methods: "Additive manufacturing (AM) represents an important technological basis for the industrial innovation and production processes of the future. AM may boost Germany's role as a location for industry and limit the outsourcing of value creation to abroad. Furthermore, it is recommended to closely examine the potential of AM for the promotion of Industry 4.0," (cf. Harhoff, 2015). The report subsequently states areas of application in industry and private use, as well as global revenues through the sale of AM goods and services. These figures also coincide with the cumulative future revenue projections for additive manufacturing made in other studies (cf. Harhoff, 2015).

Research and development directions

Based on an analysis of the current state of the technology regarding the use of key performance indicators for products of additive manufacturing, the aim is to investigate whether primary studies are required in order to examine the use of market, sales and marketing key performance indicators for products of additive manufacturing, particularly 3D printing, in the coming years. To answer this question, the following in-depth research questions will be considered:

- Which key performance indicators are used for the market assessment of products of additive manufacturing, particularly 3D printing technology, in the European Economic Area?
- Which key performance indicators for sales and marketing controlling are used for products of additive manufacturing, particularly 3D printing technology, in the European Economic Area?
- What does the use of additive manufacturing processes, particularly 3D printing technology, mean for the market opportunities of small and medium-sized enterprises in the European Economic Area?

Methodology of research

The method of *secondary research* is applied. Valid data material from relevant specialist literature, statistics and studies in the European Economic Area are used as the data basis. Moreover, published articles in the two largest German-language online magazines are analysed. The applied data were selected in consideration of an objective, valid data basis which enables a sufficiently reliable answer to the research question.

In the first phase, a systematic examination of the currently available studies and data on 3D printing was performed and a corresponding decision was taken regarding the usability of these data for secondary research. The data were then examined for the clear presentation and use of market, sales and marketing key performance indicators from a product perspective. The results were subsequently analysed and discussed. Finally, the corresponding conclusions and recommendations were formulated on this basis.

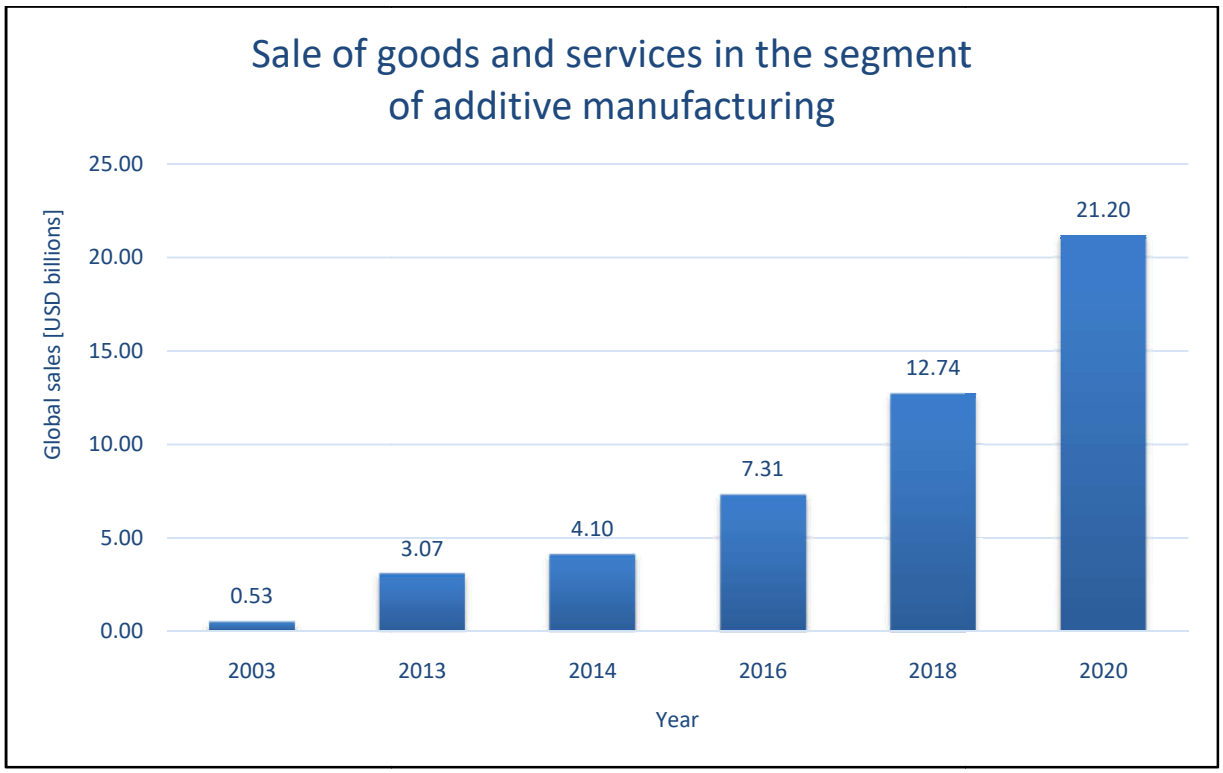

Fig. 1. Global sales of goods and services of AM, [Richter, 2016], author's own diagram

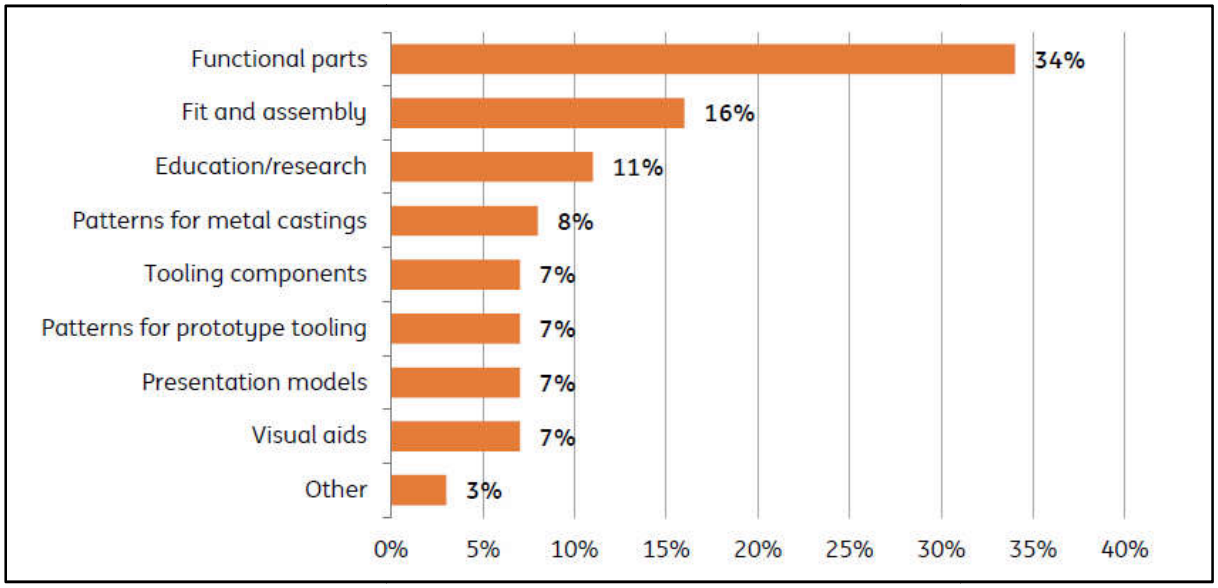

Fig. 2 Utilisation of 3D printers, [Leering, 2017]

RESULTS AND DISCUSSION

3D printing will also radically alter our previous understanding of value creation chains. As a result of the ability to manufacture products on site (such as for construction trades, plant construction, industrial production systems, automotive construction and aerospace), conventional service providers will have to anticipate substantial changes in the fulfilment of customer needs, work processes and entire value creation chains. The business process models of companies must be reconsidered, revaluated and reorganised accordingly. New customer and usage behaviours will have significant impacts on the sale and marketing of additive manufacturing products. For example, previously protracted, costly and environmentally damaging storage and transport activities will become far less important in the future. Across all industries, the established business models will have to change fundamentally in order to achieve long-term economic success. No conclusion regarding market, sales and marketing developments from a product perspective could be found in any of the studies. A market assessment of products of additive manufacturing based on valid data has so far been lacking. Thus, no references to corresponding market, sales and marketing key performance indicators for manufactured products could be found in the course of data analysis. The potentials of the competition differentiators *differentiation* and *cost leadership* were ascertained based on a number of limited interviews and observed market impressions; they are oriented on the sales figures of 3D printers and the associated services. Responses for market volumes, revenue development and

market potential on a product basis could not be systematically obtained (cf. Rosenstock 2013). With the aid of selected industries (aerospace, automotive, healthcare, machines and tooling, electronics and electronic devices, consumer lifestyle and fashion, oil and gas, energy, construction, military, transportation, and food), additive manufacturing processes were documented highly extensively in the EU final report (cf. Duchéne, 2016) regarding their technological significance and developments. However, no comprehensive information is available in these documents and study findings, nor in all other analysed studies and data, which indicates the specific use of market, sales and marketing key performance indicators for assessing the situation of products of additive manufacturing, in particular 3D printing technology.

Conclusion

Currently, small and medium-sized enterprises in Europe have significant competitive disadvantages compared to large companies. The main reasons for this lie in the lack of adequate funding for research and development, insufficient expertise, a shortage of respectively trained staff for implementation as well as the insufficient willingness to innovatively and consistently advance technological and sales-related further development despite the associated risks. Across all industries, companies will have to fundamentally change their established business process models in order to achieve long-term economic success. Many cherished services that have so far been necessary will become redundant through the use of additive manufacturing technologies, particularly 3D printing. This change will affect all corporate divisions and departments that are involved in the manufacturing process. Substantiated data and key performance indicators are still missing in order to assess the market opportunities and risks associated with products of additive manufacturing. This lack is present in all sectors relevant to 3D printing. The information available for assessing market volume and market potential is limited largely to sales figures of manufacturing machines, installations and services in these segments. For companies that explicitly wish to create products using additive manufacturing methods and sell them successfully, valid data are missing for evaluating the market. It is therefore extremely difficult, for instance, to conduct a risk assessment before actually entering the market for 3D-printed products. In relation to the marketing of 3D-printed products, there is a lack of essential key performance indicators for assessing the market, for efficient sales controlling, as well as for reviewing and coordinating sales and marketing expenses. Accordingly, this represents a substantial increase in risk – especially for small and medium-sized enterprises as well as start-ups. It is strongly recommended to conduct primary research regarding the market assessment, sales opportunities and marketing possibilities associated with products of additive manufacturing, particularly 3D printing, alongside technological ongoing development over the next three to five years. A focus of these studies is likewise encouraged on the SME segment in order tosupport the European Economic Area and maintain regionally established economic output and value creation.Furthermore, primary research will have to be performed for the purpose of identifying and also generating new, useful market, sales and marketing key performance indicators for products of additive manufacturing and 3D printing. In addition, it is also advisable to specifically examine the differences between applicable key performance indicators across different branches in the course of these studies.

REFERENCES

Rosenstock Frieda, Marco Wirth, *3D-Druckereien in Europa – Eine Marktanalyse*, Julius Maximilians University of Würzburg, Professorship for Business Informatics and System Development, Centre of Digital Fabrication, http://cedifa.de/wp-content/uploads/2013/07/02-3D-DruckereienInEuropa.pdf, online research, downloaded as a PDF file on 19.11.2018, 12:32, Würzburg, 2013.

Leering Raoul, *3D printing: a threat to global trade,* International Trade Analysis Amsterdam,
https://www.ingwb.com/insights/research/3d-printing-a-threat-to-global-trade,online research, downloaded as a PDF file on 19.11.2018, 13:12, Amsterdam, 2017.

Duchéne Vincent Dr, Padilla Pierre Dr, Van de Velde Els Dr et al, *Identifying current and future application areas, existing industrial value chains and missing competences in the EU, in the area of additive manufacturing (3D-printing),* ISBN 978-92-6202-202-0, online research, https://ec.europa.eu/growth/content/report-3d-printing-current-and-future-application-areas-existing-industrial-value-chains-0_en, downloaded as a PDF file on 20.11.2018, 09:35, Brussels, 2016.

Fink Mathias Univ.-Prof. Dr, Gartner Johannes Univ.Acc. DI Dr, Maresch Daniela Assoc. Prof. Dr, *Additive Fertigung: Potenziale für den Standort Österreich*, online research, https://www.rat-fte.at/files/rat-fte-pdf/publikationen/2017/1708_RAT_Additive%
20Manufacturing_FinkGartnerMaresch_Endbericht_P1.pdf, downloaded as a PDF file on 20.11.2018, 10:03, Institute for Innovation Management, Johannes Keppler University, Linz, 2017.

Lips Patricia, Lengsfeld, Philipp Dr, Röspel René, Lenkert Ralph, Ebner Harald et al, German Bundestag, *Bericht des Ausschusses für Bildung, Forschung und Technikfolgenabschätzung gemäß §56a der Geschäftsordnung – Technikfolgenabschätzung – Additive Fertigungsverfahren (3-D-Druck)*, TAB working report no. 175, online research, http://dipbt.bundestag.de/doc/btd/18/134/1813455.pdf, downloadedas a PDF file on 19.11.2018, 12:11, printed material 18/13455, 2017.

Langefeld Bernhard Dr et al, *Additive Manufacturing in Aerospace and Defense*, Roland Berger Study, online research, https://www.rolandberger.com/publications/
publication_pdf/roland_berger_additive_manufacturing.pdf, downloaded as a PDF file on 08.12.2018, 09:23, Frankfurt, 2017.

Richter Stephan, Wischmann Steffen Dr, *Additive Fertigungsmethoden – Entwicklungsstand, Marktperspektiven für den industriellen Einsatz und IKT-spezifische Herausforderungen bei Forschung und Entwicklung*, Begleitforschung AUTONOMIK für Industrie 4.0, iit-Institut für Innovation und Technik in der VDI/VDE Innovation + Technik GmbH, online research, https://vdivde-it.de/publikation/additive-fertigungsmethod en-0, downloadedas a PDF file on 01.12.2018, 15:34, Berlin, 2016.

Keppner Bruno, Kahlenborn Walter, Richter Stephan, Jetzke Tobias, Lessmann Antje, Bovenschulte Mark, *Die Zukunft im Blick: 3D-Druck – Trendbericht zur Abschätzung der Umweltwirkungen*, Federal Environment Agency, field I

1.1: fundamental questions, sustainabilitystrategies and scenarios, resourceconservation, online research, https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/fachbroschuere_3d_barrierefrei_180619.pdf, downloaded as a PDF file on 01.12.2018, 16:39, Dessau-Roßlau, 2018.

Damotte Eric, Sharman Richard, *Global Metals and Mining Outlook 2016 – Making the best of a challenging environment*, online research, https://assets.kpmg.com/content/dam/kpmg/co/pdf/co-bt7-3en-global-metals-and-mining-outlook-report.pdf, downloaded as a PDF file on 07.12.2018, 16:50, UK, 2016

Harhoff, Dietmar Prof. Ph.D., Backes-Gellner Uschi, Prof. Dr, Böhringer Christoph Prof. Dr, Cantner Uwe Prof. Dr, Ott Ingrid Prof. Dr, Schnitzer Monika Prof. Dr et al, *Gutachten zu Forschung, Innovation und Technologischer Leistungsfähigkeit Deutschlands 2015*, Commission of Expertsfor Research and Innovation (EFI), online research, https://www.e-fi.de/fileadmin/Gutachten_2015/EFI_Gutachten_2015.pdf, downloaded as a PDF file on 07.12.2018, 17:15, Berlin, 2015.

Müller Andreas Dr, Karevska Stefana, Wienken Robert Dr, Kilger Christoph Dr, *How will 3D printing make your company the strongest link in the value chain – EY's Global 3D printing report 2016*, online research, https://www.ey.com/Publication/vwLUAssets/ey-global-3d-printing-report-2016-full-report/$FILE/ey-global-3d-printing-report-2016-full-report.pdf, downloaded as a PDF file on 07.12.2018, 18:25, Mannheim, 2016.

Thum Marcel, Christoph Mann, *Das 3D-grenzenlos Magazin*, Marcel Thum & Christoph Mann GbR, online research, https://www.3d-grenzenlos.de, downloaded on 08.12.2018, 09:48, Saalfeld/Saale, 2018.

Gartner Johannes Mag., Sowka David, *3Druck.com – Das Magazin für 3D-Drucktechnologien*, online research, https://3druck.com, downloaded on 08.12.2018, 10:15, Vienna, 2018.

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