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# Market, Sales and Marketing Key Performance Indicators for Products of Additive Manufacturing Processes

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## Abstract

Additive manufacturing processes – particularly 3D printing – have experienced a huge amount of development in recent years and they will represent one of the leading production technologies of our time in the coming years. Current it is not clear, if the used analyses are containing a comprehensive market assessment by using sales, market and marketing key performance indicators. It is interesting to know if current studies have been using sales, market and marketing KPIs in detail. A secondary research has enabled the current state of the knowledge in this field to be determined. Based on the findings of the literature study, a recommendation was developed regarding whether an in-depth scientific study to analyse the usage of Market-, sales and marketing KPIs to identify the market and sales potentials of additive manufacturing technologies in future by using primary research methods is necessary. The insights allowed a conclusive statement about the current quality of studies in behalf of market potentials for additive manufacturing technologies and allowed a clear recommendation for a scientific primary study in this field.

## Key words

3D printing, additive manufacturing processes, AM products, key performance indicators, additive manufacturing technologies

**JEL Codes:** M21, O33

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## 1. 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 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 (Fink *et al.*, 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 (Duchéne *et al.*, 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 (Keppner *et al.*, 2018). Based on a literature search of published studies and documents, the extent to which current market forecasts have been made because of standardised market assessment mechanism with the aid of market, sales and marketing performance indicators were determined. Depending in this, corresponding recommendations were made for the implementation of necessary scientific primary studies.

## 2. Literature review

Research teams worldwide are working on future areas of application for additive manufacturing processes. In this connection, 3D printing technology plays a significant role: whether it is in bio printing 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 (Thum and Mann, 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 (Rosenstock and Wirth, 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 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 (Gartner and Sowka, 2018), lifestyle and art items, gifts, sport and recreational products, for example, will dominate the private retail and services market in several years.

Providers like *Stratasys*, *3D-Systems* and *EOS* are currently serving around 70% of the market in production. In the services segment, *Materialise* and *Proto Labs* 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 (Müller *et al.*, 2016). In the field of additive manufacturing, Europe is 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 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 (Duchêne *et al.*, 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 because of AM. On the other hand, AM could also represent an opportunity to gain a technological lead against the competition (Lips *et al.*, 2017). This is confirmed, for instance, by an *AUTONOMIC Industrie 4.0* study (Richter and Wischmann, 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 to produce additive manufacturing products. Furthermore, global revenues from the sale of goods and services in the segment of additive manufacturing have increased almost eight-fold (Figure 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 (Langefeld *et al.*, 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.

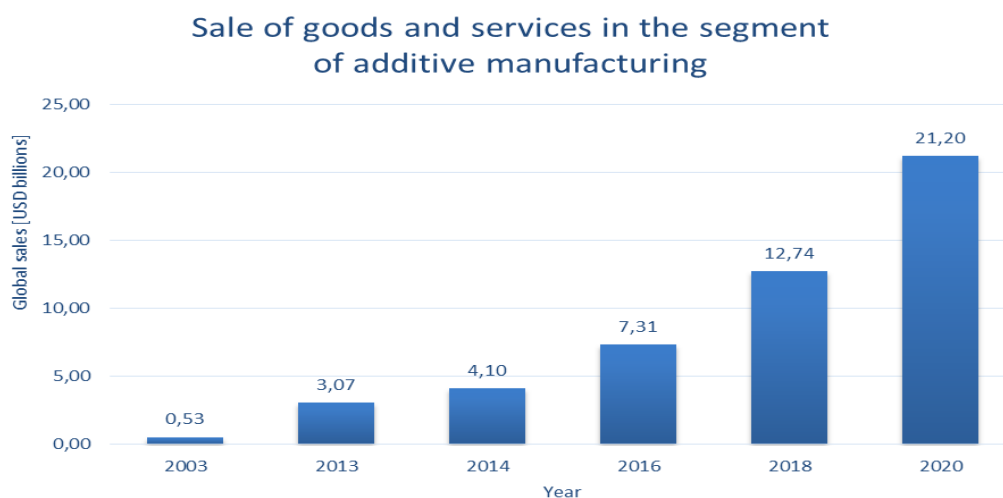


Figure 1. Global sales of goods and services of AM, (Richter and Wischmann, 2016), author's own diagram

Moreover, it is striking that 90% of the approximately 1,000 companies that work with additive manufacturing in Germany are SMEs (Richter and Wischmann 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. According to estimates, a fifth of global trade could be wiped out by 2040 – and around a quarter by 2060 (Leering, 2017).

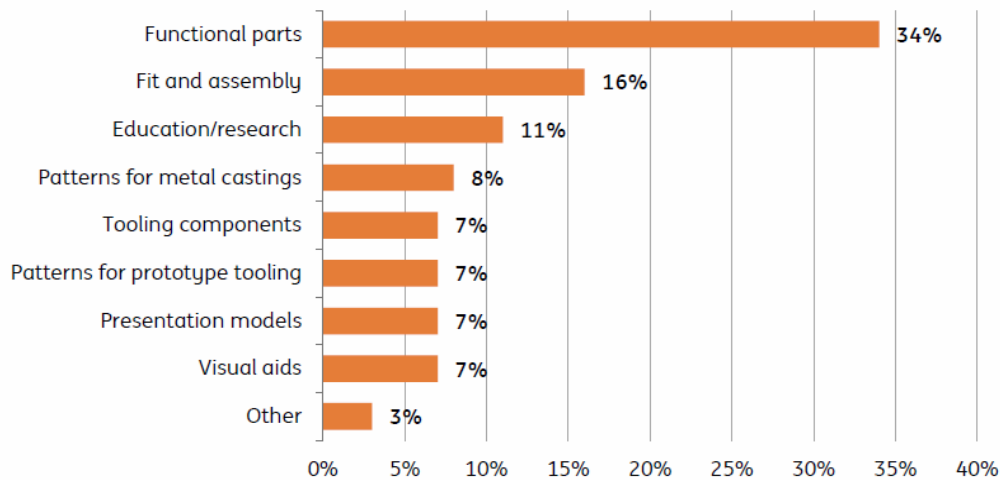


Figure 2. Utilisation of 3D printers, (Leering, 2017)

In a survey of 61 manufacturers (Figure 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” (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 because 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 (Damotte and Sharman, 2016) notes that in the metal-processing industry, 27% of surveyed companies are 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 conceivable within this period. This is largely substantiated by the altered market requirements that call for swift, efficient and agile action 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 innovative technologies. In a report by the Commission of Experts for Research and Innovation (EFI), the following conclusions are drawn regarding 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,” (Harhoff *et al.*, 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 (Harhoff *et al.*, 2015).

### 3. Methodology of research

Based on an analysis of the current state of the technology regarding the use of market, sales and marketing key performance indicators for products of additive manufacturing, the aim is to investigate whether primary studies are required 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?

The method of secondary research was applied. Valid data material from relevant specialist literature, statistics and studies in the European Economic Area were used as the data basis. Moreover, published articles in the two largest German-language online magazines were analysed. The applied data were selected in consideration of an objective, valid data basis which enabled 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.

#### 4. Results and discussions

Additive manufacturing technologies, especially 3D printing will also radically alter our previous understanding of value creation chains. Because 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 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 analysed studies. A market assessment of products of additive manufacturing technologies based on valid data has so far lacking. Thus, no references to corresponding market, sales and marketing key performance indicators for additive manufactured technologies products could be found during analysed studies and documents. The potentials of the competition differentiators' differentiation and cost leadership were ascertained based on several 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 (Rosenstock and Wirth, 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 (Duchéne *et al.*, 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, 3D printing technology.

#### 5. Conclusions

Currently, small and medium-sized enterprises in Europe have in the field of additive manufacturing technologies 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 to achieve long-term economic success. Many cherished services that have so far been necessary will become redundant using 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 to assess the market opportunities and risks associated with products of additive manufacturing. This lack is present in all sectors relevant to additive manufacturing processes. 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, to conduct a real risk assessment for market, sales and marketing activities, before entering the market for additive manufactured products. In relation to the marketing of additive manufactured 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 agendas. 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 a primary scientific study for market, sales and marketing KPIs of additive manufacturing technologies in Europe. A focus of these

studies should be encouraged on the SME segment to support the European Economic Area and maintain regionally established economic output and value creation in future. Furthermore, primary research will have to be performed for identifying and generating new, useful market, sales and marketing key performance indicators for products of additive manufacturing. In addition, it is also advisable to specifically examine the differences between applicable key performance indicators across different branches during these studies. To maintain and sustainably develop the competitiveness of the European economy about the use of additive manufacturing technologies and their products, the following is recommended.

- Definition of key market indicators for the uniform assessment of the market for additive manufacturing technologies and their products.
- Definition of sales and marketing key performance indicators for a targeted analysis and control of the market for additive manufacturing technologies and their products.
- Development of a catalogue of key performance indicators for small and medium sized enterprises active in the field of additive manufacturing technologies and their products. With this KPI catalogue small and medium-sized enterprises can carry out targeted markets, sales and marketing analyses and European comparability is made possible.

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