Flores Ituarte, Inigo; Salmi, Mika; Ballardini, Rosa Maria; Tuomi, Jukka; Partanen, Jouni

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Additive Manufacturing in Finland: Recommendations for a Renewed Innovation Policy

Iñigo Flores Ituarte[a]*, Mika Salmi[a], Rosa Maria Ballardini[b], Jukka Tuomi[a], Jouni Partanen[a]

[a]*Aalto University, Department of Mechanical Engineering, Advanced Production Methods*
[b]*University of Lapland, Faculty of Law*

Abstract

The objective of this research is to define an optimal innovation policy and funding strategy to improve Additive Manufacturing (AM) capabilities in Finnish companies. To do so, we present an international review of innovation programs in the area of AM. In addition, the study replied upon a survey prepared to evaluate factors for AM implementation. The ultimate goal is to help in the definition of a national policy strategy in the area of AM based on the characteristics of the Finnish industrial ecosystem.

The methodology and data collection method involved defining the taxonomy of Finnish AM industry. The target group of the survey was a population of AM experts, and individuals with knowledge on AM and industrial processes. Overall, the survey revealed that research and innovation activities are well positioned in Finland. In order for future innovation policies to further support developments in the field, we estimated that policy strategies need to generate about 6-8 M€/year in national and EU-funding instruments for AM technology transfer, development, and innovation activities. Efforts should be targeted towards strengthening uses of AM in final production. In fact, only 36% of Finnish respondents declared to use AM for final production, while leading countries in AM use it in average more than 50%. Another area in need of development in Finland is the use of AM high performance materials. Moreover, outsourcing of AM services in Finland is 23 percentage point higher in national and 13 percentage point higher in international outsourcing to service bureaus and suppliers. In this regard, future policies and funding strategies should maintain the created momentum. However, there is a need to acquire high-end research and industrial equipment to stimulate AM integration to the existing production systems. This in the end can trigger the creation of new products, processes and intellectual property, enabling innovation and competitive advantage.

Peer-review under responsibility of the scientific committee of the Nordic Laser Materials Processing Conference 2017

Keywords: Additive Manufacturing; 3D Printing; Survey; Innovation policy; Technology applications; Rapid prototyping; Rapid Manufacturing

*Corresponding author. E-mail address: inigo.flores.ituarte@aalto.fi

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1. Introduction

In recent years, 3D printing (also known as additive manufacturing [AM]) technologies have come to the spotlight of manufacturing (Simpson et al. 2016). Improvements in AM systems along with new material processing capabilities have made the technology suitable for manufacturing applications. The hypothesis is that AM can coexist and, in certain cases, even replace conventional manufacturing techniques based on subtractive and formative methods. However, there are gaps between the technological projection and the practical constraints of the technology (Gibson 2017). To some extent, companies today have two different approaches to find innovative applications using AM. On the one hand, they are looking to replace or repair components for their legacy systems. Examples of these types of uses include spare part applications (Khajavi et al. 2014) and retrofitting existing machine components (Rylands et al. 2016). On the other, they also want to evaluate the impact of new AM designed components for improved functional performance (i.e. part consolidation, topology optimization and decreased weight) (Rosen 2014). In both cases, technology transfer decisions depend on multiple factors. As introduced by Lindqvist et al. (2016), issues such the taxonomy of the company, the country specific industrial ecosystem, the manufacturing practices and company culture, the production volumes and material requirements, as well as the supply chain structure of the companies are critical for the adoption of new AM methods. Indeed, AM systems are impossible to paint with a single brush (Petrovic et al. 2011), as they are able to process multiple materials, which range from plastics and metals to ceramics (Singh et al. 2017) for industrial applications in prototyping, tooling, or final production (Wohlers & Gornet 2016). Moreover, today AM is used in basic research and development activities (Jürgen Gausemeier et al. 2013), as well as medical applications (Tuomi et al. 2014).

To promote successful adoption of AM technologies in Finnish companies, the aim is to find areas in which Finland is underperforming in comparison to other countries and define concrete actions for innovation policy recommendations. In order to develop a suitable policy strategy to create competitive advantage and evaluate the transferability of AM into Finnish companies, the viability of AM applications must be preceded by the strategic alignment of business, manufacturing, and R&D strategy of firms (Mellor et al. 2014). Indeed, “one size does not fit all” and, as such, the same innovation stimulus cannot create the same effect in all companies, as their activities and processes are different in nature. Furthermore, in most cases, the underlining issue on AM implementation relates to technology transfer, technology push, and diffusion of innovation (Flores Ituarte, I. et al. 2016). As introduced by Bailey (1993), all changes in an organization’s technology has an influence on operational and administrative structures within the organization.

Consequently, innovation policies that aim at creating competitive advantage from the implementation of AM, need to consider the taxonomy of the technology users (i.e. company size, technology applications, and AM materials in use). Companies experience various bottlenecks for AM transferability, such as strategic factors, supply chain factors, technological factors, organizational factors, etc…. Considering this prospect, this research defines the taxonomy of Finnish industry regarding the use and practices of AM. We achieved this objective by designing a survey, which allowed us to classify the companies participating by (1) size and demographic groups, (2) technology parameters (e.g. technology applications in the organization and materials in use), (3) factors for AM implementation, and (4) suitable innovation strategies according to their view.

2. Material and Data Collection

The study begun with investigating and comparing public research and innovation investments in AM per country. The studied variables included, country population, GDP and filed patents from 2005 until 2011. The methods for the data collection involved specialized industry reports and different internet sources (i.e. primary sources specialized industry reports, articles and books, secondary sources include internet publications in the field). In addition, empirical data was collected via a survey aimed at defining the taxonomy of the respondents and supporting the drafting of policy recommendations (for more details on the survey see appendix A1).

The survey used complementary channels to gather information. These included email lists of professional organizations that have a relationship with AM technologies (e.g. Finnish Rapid Prototyping Association FIRPA ry), international professional groups using social media channels, such as LinkedIn (e.g. Additive manufacturing user group “AMUG”, Global Alliance of Additive Manufacturing Associations “GAAMA”, etc.), and sub-contracting survey promotion activities using international AM specialized magazines (i.e. TCT magazine). The target group was a population of AM experts, as well as individuals with knowledge of AM. The sampling methods involved a multistage approach: the initial stage involved targeting a cluster of AM users in Finland. Secondly, we surveyed international engineering and business professional groups and, finally, we collected answers from international AM experts. The survey was available during a period of 9 months, starting from March 2016. In total, we collected n=341 answers, of which 50% were respondents from Finland. The remaining 50% from other countries, which were grouped geographically by relevance to the topic of the survey, that is United States "US", United Kingdom "UK", the rest of Europe "EU" (e.g. Germany, France, Spain, Denmark, Belgium, Sweden, etc.) and others (e.g. China, South Korea, Singapore, Canada, etc.). (See Figure 1 for more details).

To define the taxonomy of the respondents, an initial set of questions allowed us to define the organization size, industry sector, and activity. The evaluation criteria for suitable answers included two 'filter questions', which helped to narrow down technically relevant answers. This, in the end, allowed collecting a clustered sample of n=331 individuals (i.e. 97.1%) that agreed on AM becoming a topic of interest in their organization. From which n=285 individuals (i.e. 83.6%) declared that AM-related matters were part of their work, or they were familiar with the technology capabilities as well as its industry.

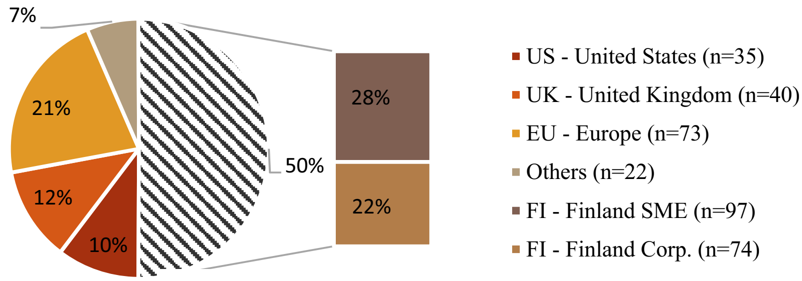

Fig. 1. Geographic representation of the survey sample

To analyze the possible issues hindering the adoption of AM technology in Finland, Table 1 shows the list of factors influencing the implementation of AM. These factors were adapted from research literature in the topic (Mellor et al. 2014). The answer to the questions presented in Table 1 and 2 included the view of all the survey respondents, including non-experts (n= 314).

Table 1. List of factors (F) influencing the implementation of AM

F1	Your organization has a developed strategic implementation roadmap to make use of new AM technologies and its novel applications in the near future.
F2	Your organization has a developed supply chain structure to obtain AM services, parts, and materials.
F3	Production costs and delivery time of AM parts are acceptable for using the technology as a production method.
F4	Technical performance of AM parts (e.g. dimensional stability, thermal, and mechanical performance) is acceptable for using the technology as a production method.
F5	Your company has a strong legacy in AM applications. New technology opportunities are understood and can be integrated into your organization.
F6	AM processes are standardized to satisfy the needs of my organization.
F7	Your organization can deal with the possible legal implications and intellectual property rights IPR from AM deployment.

Taking into consideration the presented list of factors, we analyzed the most suitable innovation policies that can support the adoption of AM technology depending upon the taxonomy of the survey's respondent. Table 2 shows the list of innovation instruments available and presents different strategies that can support AM implementation. These factors, as well as policy strategies were presented as statements in the survey. The answers to these statements were provided using a 7-point Lickert rating scale measuring either positive or negative responses to a statement.

Table 2. List of policy strategies (P) to promote the implementation of AM

P1	European-level innovation policies as well as financial support for business and technology development in companies (e.g. FP7, Horizon 2020, European Institute of Technology, etc)
P2	National-level public innovation policies as well as financial support for business and technology development in companies (e.g. Tekes programs, Vinnova)
P3	AM Clinics and professional training. Company-defined, problem-oriented projects. From 1 to 6 months with fixed budget, quick technology, and application evaluations.
P4	Industry consortiums to identify new business opportunities. AM strategx§y definition and pilot studies with a project duration from 1 to 2 years. Budget defined during the research plan application
P5	Research and development support. Research in materials and technology development for diversification of application. Funding for basic R&D with long duration from 2 to 5 years.
P6	Technology acquisition policies. Tax relief or support to purchase 3D printing equipment as well as incentives for staff training.

3. Results and Discussion

3.1 AM research funding, technology development and innovation programs

When looking at governmental investments in AM research and innovation (R&I) activities, for instance, the Netherlands government with industry partners and various research institutes planned to invest €134 million in R&I projects focusing only in AM (3ders 2016). In 2014 it has been estimated that governmental funding for AM in UK was around 30 million pounds (Richard Hague et al. 2016). In the U.S. the America Makes alone has received more than 1 billion dollar federal funding after starting in 2012 (America Makes 2017). Singapore government has invested $500 million over 2013 to 2017 to boost country's skills in advanced manufacturing, including in the rapidly emerging AM industry (3ders 2013). China has planned to invest $300 million in AM during 2016-2018 (3ders 2015). One of sixteen states in Germany, the State of North-Rhine-Westphalia and industry has planned to invest 11 million € in AM in a five year plan (Horizon 2020 FP7 2014). The EU set aside a total budget of EUR 225 million to fund AM research for 2007-2013 (World Intellectual Property Report "WIPO" 2015).

Table 3. Annual AM investments, population, GDP nominal and filed patents from 2005 to 2011, per country

Country	AM Public Investment (M€) [A]	Population (million) [B]	GDP Nominal (M€) [C]	Estimated patents filed [D]	Investment / Population [1]	Investment / GDP x 100% in ppm [2]	Patents / Investment [3]
US	160	235	199,591,397.8	900	0.68	0.0802	5.63
China	100	1388	122,494,623.7	780	0.07	0.0816	7.80
Japan	39	126	50,860,215.1	580	0.31	0.0767	14.87
Germany	35	80	37,580,645.1	680	0.44	0.0931	19.43
UK	46	65.5	28,494,623.6	120	0.70	0.1614	2.61
Netherlands	134	17	8,279,569.8	60	7.88	1.6184	0.45
Sweden	10	9.9	5,559,139.78	25	1.01	0.1799	2.50
Singapore	100	5.7	3,193,548.4	20	17.54	3.1313	0.20
Finland	5	5.5	2,569,892.5	10	0,91	0.1946	2.0

[A] Public investments in AM research and technology development. *(Authors estimations, different internet sources and cited public reports)*
[B] Population per country in millions of inhabitants *(http://www.worldometers.info)*
[C] Gross Domestic Product (GDP) nominal in M€ *(http://statisticstimes.com/economy/countries-by-projected-gdp.php)[Date: 23 Apr. 2017]*
[D] World Intellectual Property Report "WIPO," (2015)

[1] Ratio between AM investments and country population. [A] / [B]
[2] Percentage of AM related R&I public investment in relation to the nominal GDP. [A] / [C] x 100% in ppm
[3] Ratio between patent applications and AM related R&I public investment. [D] / [A]

Table 3, shows a summary of annual R&I in AM, population in millions of inhabitants, GDP nominal and filed patents per country. The result of the studied ratios show that Finland is the third highest regarding the ratio of AM investment per population, and the fifth highest regarding the ratio AM investment per GDP. Top two scores are Singapore and Netherlands. However, this does not appear to be reflected in the generation of new intellectual property (IP) (i.e. there are 10 AM related patents filled between 2005 and 2011). The ratio between patents and AM investment also shows how other countries with lower investments have better performance regarding IP generation, example of Germany. To some extent, this can be explained by the fact that the other better performing countries (e.g. Germany, Japan, China, US, etc.) have much stronger legacy in AM related businesses, having leading companies positioned in the value chain of the AM industry. When comparing Finland to the other countries, the public funding seem to be at very good level. However, there are still some issues that need to be answered to cover the topic of this research: What is the most suitable funding strategy for the Finnish industrial ecosystem? What would be the shape of a renewed innovation policy to maximize impact (i.e. generation of new IP or creating AM related business), and what would be the most interesting focus areas in the years to come?

3.2 Survey results - taxonomy of AM applications, materials and innovation strategies.

Based on the results of the survey, and comparing the data presented in Figure 2, in contrast to the other geographic groups, Finnish companies do not largely implement AM in production of the final product components (only 36% of the respondents acknowledged using AM for final production). On the other hand, the UK, US, and other EU countries have higher utilization rates for AM as a manufacturing solution (in average, 48% of the respondents of these countries acknowledge using AM for final production). In addition, other trends show that applications in tooling are also lower among Finnish companies, specially, when comparing to the US and UK companies, where AM is more frequently used to produce patterns for casting applications and investment casting, as well as to produce actual tools or tooling components respectively.

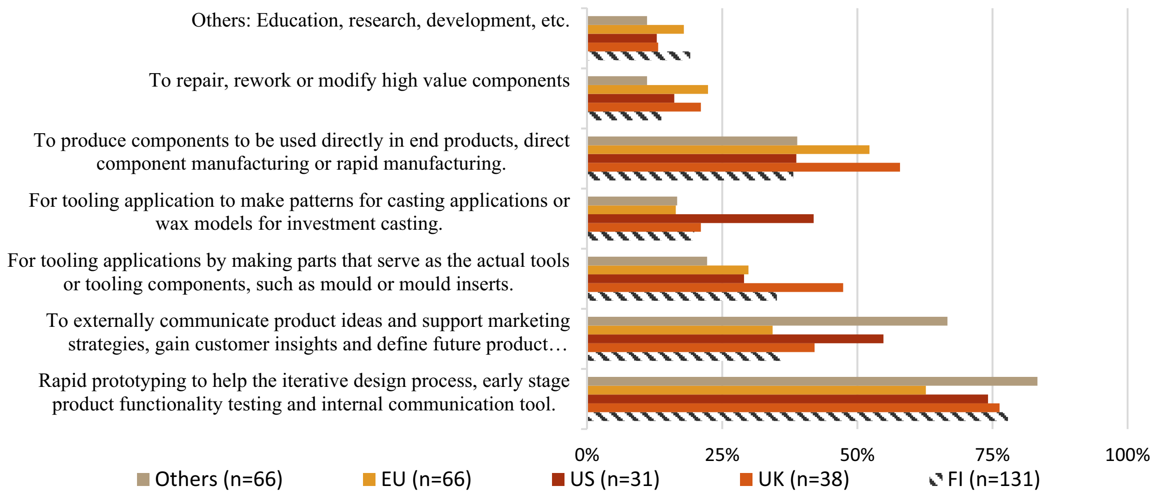

Fig. 2. How is AM used in your organization? Applications of AM per geographic groups (multiple selection).

The types of materials in use play a fundamental role in the adoption of the technology. In this regard, Figure 3 show that Finnish companies underutilize materials, such as high-performance plastics and high-performance metals. On average, Finnish companies underuse 13 percentage points and 8 percentage points less in these materials respectively. This data correlates with the fact that these materials are typically used in end-use applications, of which, according to the survey, Finnish companies underutilize by an average of 12 percentage points. On the other hand, the utilization rates of materials, such as plastic filaments for material extrusion equipment and standard metal or plastic powders for powder bed fusion systems, seem to be at the same level as other countries. Regarding the high utilization rates of plastic filaments, this might be explained by the proliferation of consumer 3D printer manufacturers and resellers, which has made the technology available to a wider audience. In addition, in recent years, national AM service bureau capabilities have been strengthened. New companies have come to the scene, which provide services to end users to manufacture parts using mostly sintered powder polyamides and standard powder metals.

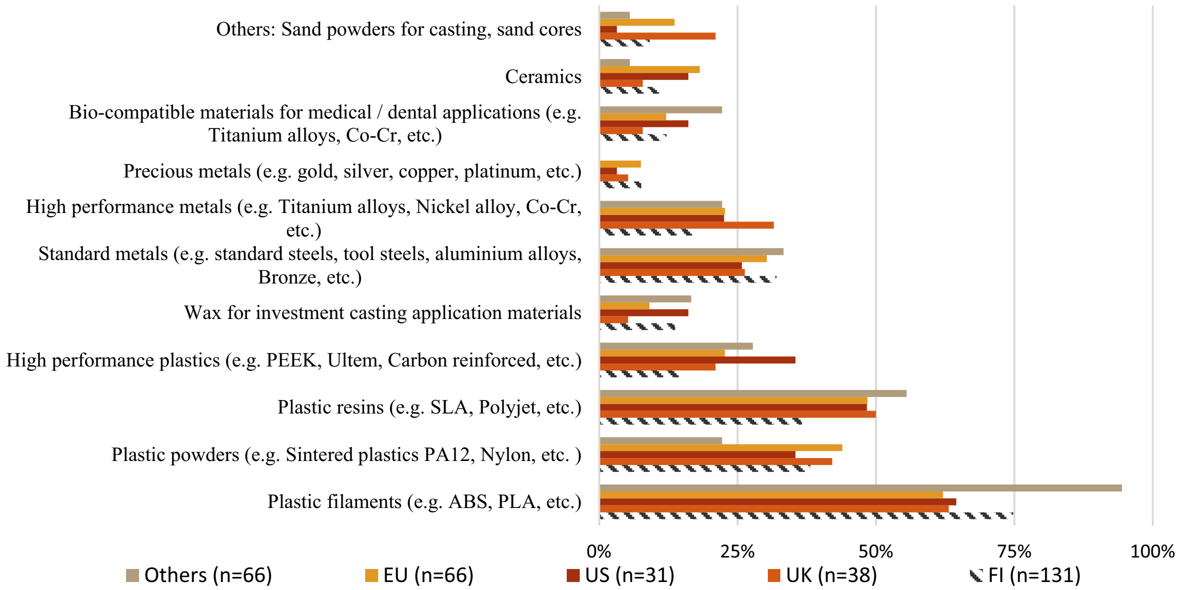

Fig. 3. What are the AM materials used in your organization? Utilization of AM material per demographic group (multiple selection)

Looking at the data in Figure 4, 75% of Finnish respondents declared to have in-house AM services; this data is comparable to the other countries. In contrast, however, the need for outsourcing AM services is higher in Finland than in other countries. On average, Finnish companies outsource 23 percentage points more than other countries. In addition, the data shows that Finnish companies are also using international services more than UK or other EU countries. In this case, the need for international supply of AM parts to Finland is on average 13 percentage points higher in comparison to other countries.

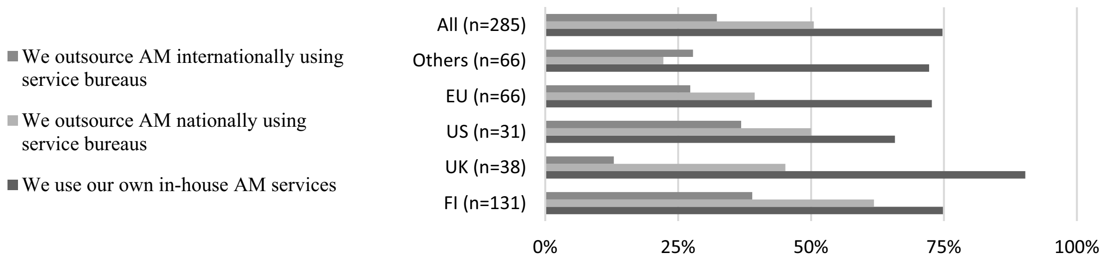

Fig. 4. How are AM parts supplied in your organization? Supply of AM parts per demographic group (multiple selection)

Considering all the mentioned issues, it can be concluded that Finnish companies still have the opportunity to implement final production in processing high-performance metals and plastics to produce components that can improve their products, services, or processes. In addition, companies in Finland may soon have the need to look at their AM outsourcing costs and evaluate the possibility to purchase equipment to fill those needs and reduce operating costs at the same time. At the same time, however, there are other constrains that might be hindering the adoption of the technology in Finland. Figure 5 shows a radar chart with a list of seven factors for AM implementation (F) and the optimal innovation policy strategies (P) based on the view of the survey respondents. The first glance at the factors for AM implementation (F) at Figure 5 shows that Finnish companies fit inside all other groups. This can be understood as the Finnish respondents are more cautious with the role of AM in their companies.

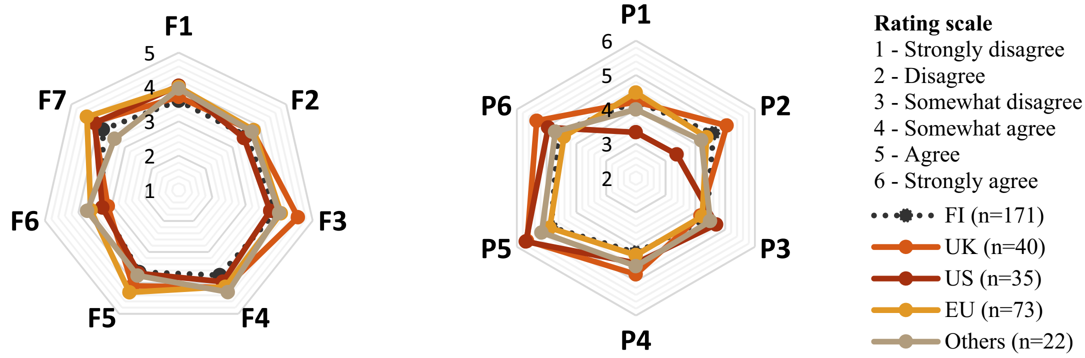

Fig. 5. Left radar chart, factors for AM implementation (F). Right radar chart, optimal innovation policy strategies (P) per geographic groups. See Table 1 and Table 2 to refer to (F) and (P) respectively.

Nevertheless, according to the survey results, Finnish firms somewhat have an undefined view regarding the strategy development activities for AM implementation (F1) (mean [m.] 3.6, Standard deviation [Std.] 1.75). On the opposite side, there are significant differences with EU respondents and the US (m. 4, std. 1.85 and m. 4.5, Std. 2.19 respectively). Other EU countries, as well as the US respondents perceive that their organizations have rather developed a company strategy for AM implementation. In relation to supply-chain factors (F2), Finnish companies score the lowest (m. 3.52, Std. 1.68), but in average the difference with the rest is small (m. 3.69, Std. 1.72). Results related to production costs and delivery time (F3) show that the UK is leading when considering AM suitable for production (m. 4.56, Std. 1.39). Although the perception is rather positive, Finnish respondent score the lowest (m. 3.9, Std. 1.58). Regarding the technical feasibility of AM for production (F4), EU countries score the highest (m. 4.3, Std. 1.55). EU respondents, the US and UK score the highest to the question related to the legacy of AM in their companies (F5). Regarding AM standardization (F6), the data from the survey indicates this factor as critical, as all respondents disagree the most with this statement (m. 3.37, Std. 1.55). Finally, Finnish companies are skeptical regarding the fact that they will be able to deal with the IPR related issues related to the use of AM in their organization (F7), scoring the lowest (m. 3.82, Std. 1.51). This might indicate that Finnish companies are aware of the challenges related to IPRs and the use of AM (both, in general and, in particular, in final production). On the other hand, it might also show that Finnish companies are generally not well equipped for handling legal issues internally, while prefer to outsource them to law firms and legal consultants.

Now looking at the optimal policy strategies (P) at the right radar chart in Figure 5. Results indicate that national support for innovation (P2) becomes more relevant for Finnish firms rather than EU instruments for innovation (P1) (m. 4.6, Std. 1.26 > m. 4.23, Std. 1.31). The same phenomena repeat for the UK as well as the US. However, other EU countries (e.g. Germany, France, Spain, Denmark, Belgium, Sweden, etc.) see EU funding more suitable for their needs, when evaluating the duration and format of innovation projects from a Finnish perspective (P3 and P4). Results show that firms in Finland are more positively looking for short duration projects (i.e. from 1 to 6 months with fixed budget targeting quick technology and application evaluations) rather than longer consortium-type research projects (i.e. pilot studies with a project duration from 1 to 2 years). Although the difference is small, looking at all the respondents (n=222), AM clinics and professional training (P3) score higher in comparison to longer-duration consortium projects (P4) (m. 4.25, Std. 1.33 > 4.17, Std. 1.34).

Nevertheless, results indicate that there is still a clear need for long-term view research and development (R&D), supporting AM basic research (P5). Looking at all the respondents (n=242), long-term duration R&D project scores the highest (m. 4.9, Std. 1.24). Basic R&D activities are perceived by the industry as the mean to obtain competitive advantage. Regarding the development of technology acquisition policies (P6), the UK and US score the highest and perceive that tax relief in the purchase of AM can create innovation possibilities for their firms. If we explore in more detail and compare the needs of Finnish SMEs in contrast to larger companies, Figure 6 differentiates the factors for

AM implementation and the most suitable innovation policies depending upon the taxonomy of Finnish companies, which is divided into SMEs (i.e. size < 250 employees) and large or corporation-sized companies (i.e. size >250 employees).

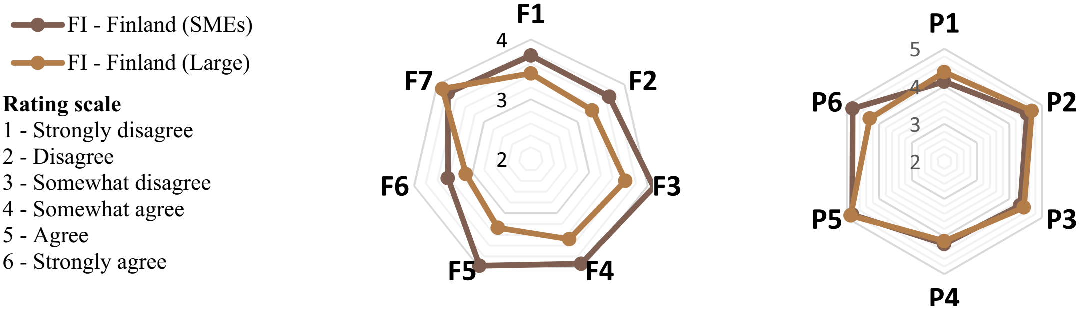

Fig. 6. Left radar chart, factors for AM implementation (F). Right radar chart, optimal innovation policy strategies (P) for SMEs and large companies in Finland

Looking at the factor affecting AM implementation, the major discrepancy is found in F5. Respondents from large Finnish companies declare (n=63) not having a strong legacy in AM applications, which means that new technology opportunities are not understood or rapidly integrated in their organization. In addition, the biggest concern for both large companies (n=53) and SMEs (n=62) relates to F6. Respondents declare that AM processes are not standardized to satisfy the needs of their organization. Overall, large companies (n=56) score lower for most of the factors compared to SMEs (n=72) (m. 3.44, Std. 1.55 < m. 3.80, Std. 1.67, respectively) for F6.

Table 4. Three-stage innovation policy strategy and proposal for action

AM Clinics and professional education	Innovation and strategy actions	Research of materials and technology development
Budget: 1.2 – 1.6 M€/year **Target group:** Large companies and SMEs in product development **Funding strategy:** Incentives for professional education, local and regional funding instruments and Tekes support **Type of actions:** (1) Industry-defined, short application projects. (2) Professional training and AM continuous education. (3) Connection to technology advisory services (e.g. research institutions) **Objectives:** (1) Promotion of AM as a manufacturing solution. (2) Technical and economic feasibility studies of problem-oriented AM applications	**Budget:** 2.4 – 3.2 M€/year **Target group:** SMEs, research institutions, and industry at large **Funding strategy:** Tekes innovation instruments and EU instruments (H2020, EIT, etc.) **Type of actions:** (1) Research with industry consortiums for AM strategy definition. (2) Support and tax relief to purchase high-end AM equipment for industrial applications and research **Objectives:** (1) Systematic mapping of AM applications for industry participants and definition of technology roadmaps. (2) Strategic purchase of high-end industrial equipment and research equipment to process high-value materials (e.g. Metal alloys, PEEK, Ultem, Ceramics, Biomaterials, etc.).	**Budget:** 2.4 – 3.2 M€/year **Target group:** Research and technology development organization and universities **Funding strategy:** EU instruments (H2020, EIT, etc.), Academia of Finland (R&D actions) and Tekes support **Type of actions:** (1) Basic technology development and application research. (2) Promote joint applications to EU instruments. (3) Support for spin-off and technology scale-ups **Objectives:** (1) Research in AM and materials science for diversification of applications. (2) New technology developments and IP protection. (3) Digitalization of manufacturing and AM integration (industry 4.0)

If we now look at the definition of policies for large and SME companies in Finland, P6 shows the biggest discrepancy. Tax relief or support to purchase AM equipment appears to be more important for Finnish SMEs than larger companies. This might be grounded on the fact that a big percentage of Finnish SME respondents (45.4%) are specialized AM service providers, research organizations, and engineering consultancy services. Regarding innovation instruments, larger companies perceive more possibilities for access to EU innovation instruments (P1);

however, both large and SMEs think that national support becomes more relevant (P2). In relation to project format and duration (P3 and P4), large companies are more eager to participate in AM clinics and training with company-defined, problem-oriented projects with a short duration (from 1 to 6 months). In this case, the format and duration become less relevant for SMEs. Finally, both SMEs and large companies identify the need for long-term view (R&D) (P5). This policy strategy scores the highest (n=109) (m. 4.45, Std. 1.54). In order to address all the mentioned issues, we propose three areas for action in a renewed innovation policy targeted for Finnish industrial ecosystem. Table 4 shows the innovation policy strategy, budget, target group, funding strategy, proposal for action and objectives. To this end, a renewed innovation policy should focus on: (I) Improving and increasing the supply of skills by means of professional training, (II) Increasing input for R&D for material and technology development activities in order to diversify applications and create new IP, (III) Adapting the format and duration of innovation projects depending upon the needs of the organizations.

4. Conclusions

Overall, this study indicates that Finnish companies are still on the process of mapping systematically possibilities for AM integration. Finnish companies still have the opportunity to implement final production using AM. However, there is the need to invest in high-end industrial and research equipment in order to stimulate AM integration with existing production systems and provide Finnish companies a state-of-the-arts testing platform. The common goal for Finnish companies is to digitalize manufacturing operation and supply chain while taking the advantages of AM as manufacturing solution when feasible. In this process, companies will need to redesign their production and logistic systems and be able to process on-demand and near-demand high-performance metals and plastics (e.g. steel, titanium, Co-Cr alloys as well as plastics, such as Ultem, Peek, etc.) and be able to improve their products and services while gaining competitive advantage.

Finnish research and innovation activities in AM expended approximately 4-5 M€ in Finland during 2016. The challenge now is to coordinate a national innovation strategy to help private and public organizations to attract EU funding instruments to develop new technology and applications. Based on the comparison presented in Table 3, we estimate that a new policy strategy should be designed to generate 6-8 M€/year (i.e. national and EU funding instruments) for AM technology transfer, technology development, and innovation activities. To some extent, development activities in Finland have created new startups focused on AM. However, this has been limited to (1) AM service providers that incorporate new machines to process basic materials, (2) development of consumer level material extrusion technologies and (3) small companies that provide all kind of services related to consulting, basic AM services or 3D scanning. To some extent, a holistic industrial plan of AM development and integration is lacking in Finland. These plans are to a great extent marginal; and therefore, we might not see high capital investments to purchase high-end machinery or stablish new companies near soon. In relation to this, national funding is dedicated to applied research and short-term development of AM technical and strategic training. However, based on the result of the survey mid and long term research programs will become an essential foundation for growing competitiveness of AM ecosystem in Finland. On top of this, to remain competitive in AM competences, there is a clear need to invest in high-end industrial and research equipment, which can help research and private organizations to develop new applications and obtain competitive edge.

As concluded by Lindqvist et al. (2016), manufacturing in Finland has been concentrated in large bulk pieces and prototyping series, whereas production in other countries, such as US, Germany, UK and other European countries focus more on small series production of complex and special parts for aerospace and automotive industry. To some extent, these are the key industries who are driving AM adoption (Flores Ituarte I. et al. 2016). Nevertheless, there is potential for growth of AM applications in traditional OEMs, especially in manufacturing applications from which complete new products and processes can be innovated. To achieve new objectives, future innovation activities at companies will need to be coordinated with technology advisory services and research institutions, which can provide technical assistance, AM manufacturing capabilities, consulting, mentoring, and other services to support the firm in the adoption of new AM processes. From the data presented in Table 3, it is possible to conclude that R&I activities in the area of AM have a strong position in the Finnish innovation agenda. In this regard, future policies and funding strategy should maintain this momentum by generating and exploiting connections and complementarities between past and future innovation projects.

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