Adoption of 3D Printing in Indonesia and Prediction of Its Application in 2025

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Abstract. Additive manufacturing, known as 3D printing (3DP) is currently growing rapidly in many countries. The applications of 3DP may vary in each country, depending on the country's 3DP development and local needs. This study aims to find out the adoption of 3DP in Indonesia and the prediction of its application in the future. Data were collected either by interviews or questionnaires. Data retrieval was done 3 times. First, data were collected from society with 109 respondents. The second data comes from 3DP user with 40 respondents, and the third data comes from the expert with 15 respondents. This study used a pairwise comparison method to predict the application of 3DP in the future. The results of this study indicate that 67% of respondents in society have known about 3DP. The number of 3DP users was increasing every year, a considerable increase in the last 3 years. From the pairwise comparison results, it was found that in the health sector, the highest prediction is in the fabrication of medical equipment. In the industrial sector, the highest prediction is fabrication for electronic and robotic. Then in the sociocultural sector, the highest prediction is education.

1. Introduction
Additive manufacturing (AM) technology is currently growing rapidly in various countries. Additive manufacturing or commonly referred to 3D printing has an important role not only in various fields of business but also in the daily lives of consumers[1]. Various countries such as the United States, New Zealand, Australia, Britain, Germany, Singapore, and China invest tremendous value for the developments of additive manufacturing[2]. In these countries, additive manufacturing is growing rapidly for various productions. However, the use of additive manufacturing in each country can be different. The use of AM in each country can vary depending on the development of additive manufacturing in the country and also depends on the local needs of the country[3]. Research on AM’s use is still growing in various countries. More research on the use of AM and the impact of this use is still needed for future development[4].

In addition to the great opportunities of this technological development, there is still uncertainty and speculation of this technology in the future[5]. This uncertainty can come from many things such as the development of new technologies, changes in demand, government policies, changed economic conditions, and so on. Research on the prediction of this technology is still rare. Existing research is predicting AM technology in 2030 but with experts in European and South African respondents. Further research is needed on the prediction of this AM technology in the future in Asian
This study would like to see how large the use of 3D printing in Indonesia now and prediction the future of its use. From this research, the use of 3DP in Indonesia and predictions of use in what fields will be optimally potential in Indonesia with the local character of the Indonesian people can be seen.

2. Review References

Additive manufacturing is a technology that has long been researched and developed. There have been many studies on this technology. However, this additive manufacturing still has strengths and weaknesses. Research on additive manufacturing is still needed so that additive manufacturing can overcome its weaknesses[6]. Many researches on 3D printing have been carried out, but more research is needed on the adoption of 3D printing and the impact of adopting this technology to find out more about the consequences of using this technology[7].

One of the studies on the adoption of 3D printing was carried out by Kianian et al.[2] examined the adoption of 3D printing technology in Sweden with respondents being users in companies, universities, and research institutions. The research would like to see variations in the use of 3D printing in the country and the cause of the variations. Another study conducted by Schniederjans[7] tried to see the adoption of 3D printing in the manufacturing sector. In this study investigated factors that influence the speed of adoption of 3D printing in companies. However, the speed of adoption and the impact of the use of 3D printing will differ depending on the socio-economic conditions of the country[3]. In the condition of developed and developing countries, the implications of 3D printing can show the opposite pattern[3].

A lot of research on 3D printing prediction is going forward. Various studies have been conducted to predict how 3D printing technology will be in the future. McKinsey Global Institute [8] tried to provide a review of 3D printing predictions in 2025. Gebler et al.[3] then used this data to see the sustainability of these 3D printing products in the future. The 3D printing application areas seen are consumer goods, aviation industry, automotive industry, health components, and equipment. Other study conducted by Jiang et al.[5], in the study, predicted the implications of 3D printing for industry, policy, and future research. This research was conducted with expert respondents from countries in Europe and Africa using the Real-Time Delphi method. One of the weaknesses of the research is that the respondents are not yet representative, one of them is the absence of representatives of Asian countries in it[5].

3. Research Methodology

Objects in this study were divided into 3 groups. The first group was the community to find out how much people's understanding of 3DP. The second group was 3D printing users in educational institutions, companies, businesses, and individuals in Indonesia. The third group was experts in the fields of 3D printing, government, manufacturing, health, arts, and education. Data collection was performed 3 times. The stages of this research can be seen in Figure 1.
The following is an explanation of each of the stages in this research.

1. Literature study and observation
   Literature studies and observations were made to find out things related to the use of 3DP in Indonesia and other countries through journals, books, social media, articles, websites, and previous research.

2. Data collection from society (questionnaire I)
   The first data collection was done online with non-probability sampling method (snowball sampling).

3. Data collection from 3DP users (questionnaire II)
   The second data collection was done online and offline with nonprobability sampling (purposive sampling method). Data collection at this stage was carried out mainly through the Facebook group “3D Printer Indonesia”, which consist of about 5800 members from various region in Indonesia.

4. Development framework of 3DP applications
   Data on various types of 3DP applications were used as factors and subfactors then AHP hierarchy structure was made from these factors. This structure was used to pairwise comparison data collection.

5. Data Collection from the pairwise comparison (questionnaire III)
   Data collection at this stage was done online and offline with expert respondents.

6. Data processing and factor weighting
   Data processing and factor weighting were done with software Expert Choice 11. After all of the data was consistent, then weighting each factor and subfactor was carried out.

7. Prediction sequence of 3DP applications
   From the weight obtained, then the order of priority prediction of 3DP usage in 2025 was obtained.

4. Result and Discussion

4.1. Indonesian People’s Knowledge of 3D Printing
Respondents in the first questionnaire were the general population of 109 respondents with respondent’s age range from 20 to 38 years (25.65 ± 4.18). These respondents were spread from various regions in Indonesia. From the 109 respondents, 73 people (67%) know about 3D printing, 22 people (20%) do not know, and 14 people (13%) might know. The respondent who know about 3DP mostly get information about 3DP from the internet, campus, school, friends, television, and community. With so many people who know information about 3DP technology, this will be the catalyst of 3DP adoption in Indonesia. Figure 2 is the distribution of respondent’s knowledge about 3DP.
From 109 respondents, 100% of respondents did not have 3DP. From the 73 respondents who knew about 3DP, only 43 respondents (59%) were interested in having 3DP, others were not interested or not yet decided. From the 43 interested respondents, 22 people (51%) were interested in the price of 3DP below Rp. 5 million, 15 people (35%) were interested in printers at the price of Rp. 5 million - Rp. 10 million, and 6 people (14%) were interested in printers with prices> Rp. 10 million.

4.2. Adoption of 3D Printing in Indonesia
Respondents in the second questionnaire were 40 people with 39 men and 1 woman. The age range of respondent was from 16 to 49 years, with an average age of 28.48 ± 7.82 years. Respondents of 3DP users were spread in various provinces in Indonesia, with most users still concentrated in Java (75%). Figure 3 shows the distribution of 3DP users respondents in this research. Most of respondents were in Yogyakarta because data collection in Yogyakarta was searched offline and online and in other cities data collection was only searched offline.

![Distribution of 3DP users respondents](image)

**Figure 3.** Distribution of 3DP users respondents

Most respondents of 3DP users worked as private employees and 3DP entrepreneurs. 3DP users had a monthly income ranging from less than Rp. 1,500,000 to more than Rp. 10,000,000. Most respondents were direct owners of 3DP (65%), while 32% use the company's 3DP. The type of 3DP that most respondents have (86%) is FDM (Fused Deposition Modeling). FDM printers were affordable in the community, materials were easy to get and easy to use. In addition to FDM, several users who pursue 3DP also have SLA (Stereolithography), and SLS (Selective Laser Sintering).

The highest percentage of 3DP prices owned by respondents in the price range of Rp. 5 million to Rp. 10 million with a percentage of 51% while 31% of respondents have a 3DP with a price range of <Rp. 5 million. For the duration of knowing 3DP, most users (80%) know 3DP in the last three years. Figure 4 shows the duration of the respondents knowing 3DP.
Figure 4. The duration of respondents knowing 3DP

Ownership of 3DP was increasing year by year. In the last two years, the increase in ownership of respondents can reach 137.5%. This shows that 3DP was increasingly popular in the community. Figure 5 shows the duration of 3DP ownership of respondents.

Figure 5. Duration of 3DP ownership of respondents

The use of 3DP in the user respondents was mostly in the fields of electronics and robotics, toys and the creation of miniature art objects. Table 1 shows the 3DP application by respondents.

4.3. Development the Use of 3DP Framework

After taking data on 3DP users, the next step was the selection and identification of the expert. From the results of literature studies, respondent data, and interviews obtained various kinds of 3DP usage. These various kinds of 3DP usage were divided into three sectors, health, industrial, and sociocultural [9]. In the health sector, users use 3D printing to help the healing process, for example replacing organs, assistive devices and medicines. In the health sector, the use of 3DP was divided into more detail based on the characteristics of its use into three sub-sectors, bio-printing, medical equipment, and medicine.

In the industrial sector, 3DP was used for economic and business activities in both small and large companies. In this industrial sector, the use of 3DP was divided into seven sub-sectors, fashion, construction and architectural, military, food printing, automotive and aerospace, electronics, and robotics, and toys.
Table 1. 3DP application by respondents

| Field                                | Number of users |
|--------------------------------------|-----------------|
| electronic and robotics              | 28              |
| toys                                 | 27              |
| miniature                            | 24              |
| construction and architecture        | 19              |
| education                            | 19              |
| manufacture                          | 18              |
| households                           | 15              |
| automotive and aerospace             | 11              |
| historical and cultural heritages    | 10              |
| 3D selfies                           | 9               |
| military                             | 7               |
| fashion                              | 5               |
| jewelry                              | 5               |
| medical equipment                    | 5               |
| environmental objects                | 1               |
| musical instrument                   | 1               |

The use of 3DP in the third sector was sociocultural. With the growing development of 3DP, the use of this machine also expanded to personal, especially hobbies. This personal use covers various aspects of social, art, culture, environment, and education. The use of the sociocultural sector was divided into eight subsectors, miniature art objects, jewelry, 3D selfish, musical instruments, household, education, environmental objects, then historical and cultural heritage. Existing sectors and sub-sectors are then formed in the structure into factors and sub-factors. In Indonesia, not all of these fields have developed. This is because of various factors such as local potential, government, society and technological progress[10]. Figure 6 shows the sector and sub-sector of 3DP applications.

4.4. Data Collection and Processing of Pairwise Comparison
Ratings through pairwise comparison (1-9) conducted by the expert. Experts were asked to provide an assessment of 3DP usage predictions in 2025 totalling 15 people from various backgrounds such as academia, businessmen, government, industry, and health who lived in various cities in Indonesia. Table 2 shows the respondents of pairwise comparison. Data from pairwise comparison processed by software Expert Choice 11.

4.5. Prediction the Use of 3D Printing in 2025 in Indonesia
After the data from each respondent is combined, then the weight of each sub-factor is obtained. This weight was then sorted and made a priority sequence. Table 3 shows combined pairwise comparison data from all respondent in all sector.

In the comparison of level 1 factors, it was found that the industrial sector was predicted to be the sector with the highest use compared to other sectors, followed by the sociocultural sector and then health. An overview of the priority order can be seen in Figure 7.
4.5.1. Predictions in the Health Sector
In the health sector, the prediction of the largest 3DP use was medical equipment. Medical equipment was also already widely manufactured by several companies 3DP in Indonesia and also by individuals. This medical equipment was predicted to continue increase in use until 2025. Some example of the medical equipment is prosthetic, dental equipment, assistive devices and others. Figure 8 shows prediction the use of 3DP in health sector.

4.5.2. Predictions in the Industrial Sector
In the industrial sector, the most predicted fields for use were electronics and robotics. In this field, 3DP was usually used for making drones, 3DP replication, manufacturing robots, and various other electronic devices. The increasing need for automation made this electronic and robotics field more widely used. Even today, electronic and robotics were also ranked first in their use. Figure 9 shows prediction the use of 3DP in the industrial sector.
Table 2. Respondents of pairwise comparison

| Fields         | Profession                                                      | Domicile |
|---------------|-----------------------------------------------------------------|----------|
| 3D Printing   | Co-founder of 3D printing maker and medical devices company      | Bandung  |
|               | Founder of 3D printing maker company                              | Tangerang|
|               | Engineer in 3D printing company                                   | Yogyakarta|
|               | CEO 3D printing maker and services company                       | Tangerang|
|               | CEO 3D printing maker and services company                       | Malang   |
| Manufacture   | RND Engineer in an automotive manufacturing company              | Jakarta  |
|               | Engineer FMCG company who use 3DP                                 | Tangerang|
|               | Senior Engineer aerospace company                                 | Bandung  |
|               | RND in an automotive manufacturing company                       | Tangerang|
|               | Technology material and process staff in the aerospace company   | Bandung  |
| Government    | Researcher in Industrial Minister                                 | Yogyakarta|
| Academics     | Robotics and automation lecturer in a state university           | Yogyakarta|
|               | Design lecturer in private university                            | Jakarta  |
| Health        | Dentist and lecturer in a state university                       | Yogyakarta|
|               | Doctor and lecturer                                              | Wonosobo |

Table 3. Combined pairwise comparison data

|        | Health   | Industrial | Sociocultural |
|--------|----------|------------|---------------|
| Health | 1,000    | 0,318      | 0,782         |
| Industrial | 3,145    | 1,000      | 2,520         |
| Sociocultural | 1,278    | 0,397      | 1,000         |

Figure 8. Prediction the use of 3DP in health sector (inconsistency= 0.00048)
4.5.3. Predictions in the Sociocultural Sector
In the sociocultural sector, education was the highest prediction priority for the use of 3DP in the future. At present it has been seen that in the education sector there have been many formal and informal institutions that began holding 3DP. From the results of weighting, the highest priority sequence after education was 3D selfish. 3D selfish were currently not very high in use in Indonesian society, but with the tendency of the Indonesian people in the selfish, 3D selfish were predicted to grow rapidly in the future after the education factor. Figure 10 shows prediction the use of 3DP in sociocultural sector.

4.6. Prediction the Use of 3DP in All Sector
After prediction in each sector gained, then this value can be used to get the order value for all subsector. The prediction sequence for 3DP usage in all sector can be seen in Figure 11 and the framework prediction based on each sector can be seen in Figure 12.

4.7. Factors that Encourage the Development of 3DP Usage in Indonesia
Some of the things that encourage the development of 3DP use in Indonesia are the introduction of 3DP in the community, the increasingly mature of 3DP technology, the ease of getting 3DP (marketplace), affordable 3DP prices, growth of local companies that sell 3DP, and the community's need for 3DP technology. With the 3DP, items that must initially be printed in conventional can be printed with 3DP at a lower cost, faster work, better results, and safer.
Figure 11. Prediction the use of 3DP in all subsector

Figure 12. Prediction priority of 3DP’s use in all sector
4.8. Factors that Inhibit the Development of 3DP Usage in Indonesia

Some obstacles to the development of 3DP technology in Indonesia are regulation (tax), infrastructure, government policy, SNI license, material, public knowledge of 3DP, and lack of research collaboration in 3DP fields.

5. Conclusion

Based on research that has been done in this study, it can be concluded that the use of 3DP in Indonesia increasingly widespread in the last 3 years. The number of 3DP users was increasing, the high increase has occurred in the last 3 years. 3DP users were spread throughout Indonesia with the most users still on Java. The most types of machines owned by 3DP users were FDM. The use of 3DP in Indonesia was increasingly widespread with the highest use in the manufacture of electronic and robotic, making toys, and making miniature art objects. By using pairwise comparison, obtained prediction priority order of 3DP’s use in 2025 in Indonesia. In the health sector, the highest prediction is fabrication in medical equipment. In the industrial sector, the highest prediction is fabrication for electronic and robotic. Then in the sociocultural sector, the highest prediction is in the education sector, followed by 3D selfish.

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