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BIOMEDICAL ENGINEERING AND ITS POTENTIAL FOR EMPLOYMENT IN INDONESIA

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ABSTRACT
Indonesia, as cited by the World Health Organization (WHO), is still listed as one of the countries who spend less of its GDP on health services, despite the urgent need to overcome the high rate of medical cases in several diseases. In order to develop its health and medical services, innovation in health technology has already been implemented through modern medical instrumentation and devices. Consequently, the biomedical engineering field is urgently needed, as its role is also comprised as being one of the most important areas in the National Strategy Policy of Science and Technology (*Kebijakan Strategis Pembangunan Nasional IPTEK*). The aim of this paper is to present the potential of biomedical engineering to create job in Indonesia. This paper presents the statistical analysis of the latest biomedical engineering employment figures in Indonesia and finds a relatively low number of medical technicians using a comparative analysis from the government standards and country counterparts: the United Kingdom (UK), Japan and Malaysia. This paper concludes that in the future, along with the development of biomedical engineering in Indonesia, there will be a significant increase of biomedical engineering jobs in hospital, industry and academia. This paper also concludes that significant job creation is likely to occur with biomedical engineers as highly skilled professions, in other words, more engineers with advanced qualifications are required to fulfil the future needs in health and medical expertise field.

Keywords: Biomedical Engineering; Employment; Indonesia; Jobs Creation

1. INTRODUCTION
Technology plays a very important role in the health services sector. Health technology, as noted by the World Health Organization (WHO), is essential to increase the quality of health services, including solving health problems and improving the quality of people's lives (WHO, 2010). World Health Statistics report WHO (2011) mentions that lower-middle income countries spent less on health services as a percentage of their GDP. As reported by WHO on World Health Statistics 2011, the total expenditure on health in Indonesia was 2.3 % of the GDP by 2008, compared to 4.3 % in Malaysia, 4.1 % in Thailand, 8.7% in the UK, 15.2% in the USA, 8.3% in Japan and 10.5% in Germany. Besides, the total health expenses per capita in Indonesia is one of the lowest among the other countries with USD 99 PPP compared to USD 132 PPP in India, USD 308 PPP in China and USD 3,445 PPP in the UK (OECD, 2011).
Statistics also show that Indonesia's standing, as one of the lower-middle income countries, still lacks medical facilities. In particular, it had only 6 hospital beds per 10,000 population from

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2000 to 2009, a very low health infrastructure indicator compared to all lower-middle income countries, which on average have 22 hospital beds per 10,000 population. Indonesia's hospital bed statistics are even lower than all of the low income countries and this is the case, even among the South East Asian countries which respectively have 11 and 13 hospital beds per 10,000 population.

Another indicator of health infrastructure is the number of radiotherapy units, in which, Indonesia has only 0.1 radiotherapy units per 1,000,000 population in the year 2010 compared to 0.3 units in all South East Asian countries and 0.6 units in all lower-middle income countries (WHO, 2011). In addition, a high rate of medical cases occurs in several disease categories e.g. Malaria, Tuberculosis, Pneumonia as the third highest rate of occurence in all medical cases (Biro Pusat Statistik, 2011). This is additional evidence that the government needs to improve the health system in order to provide a better service for its 250 million people. One of the solutions is to improve the health technology by innovation and breakthroughs for health (medical) instruments.

Various medical instruments are used in a variety of health services today, from diagnosis until treatment, to facilitate a better method and quality of curing patients. As a result, the role of medical engineers and technicians are urgently needed with the aim of maintaining the devices effectively, besides developing the future medical technology applications which are broadly needed in many fields of medical specialization, such as medical imaging, tissue engineering, medical rehabilitation and minimally invasive treatment. Moreover, the increasing demand of health instruments has a potential to develop the field of biomedical engineering in Indonesia, including its need in industry for producers/manufacturers and researchers or academicians.

The aim of this paper is to analyse the potential impact of biomedical engineering to create jobs in Indonesia. The analysis starts from the review of health regulations and statistics in Indonesia, focusing on the biomedical engineering profession which consists of two different streams: biomedical engineers and medical technicians. Biomedical engineers are categorized as highly skilled professionals from biomedical field; they are considered as experts on engineering, biology and medicine fields. Their aims are to solve problems and improve the quality of patient care. Meanwhile, medical technicians are considered as a profession for those who are certified and able to operate medical instrumentation used in medical treatment such as surgery, radiology, x-ray and medical imaging laboratories. Our paper includes a comparative analysis (mainly a statistical comparison) of the biomedical engineering profession referring to government standards among country counterparts (UK, Japan and Malaysia). The analysis then continues to suggest the possible areas to create jobs from the standpoint of the development of biomedical engineering.

2. HEALTH REGULATION AND STATISTICS IN INDONESIA

Biomedical engineering, according to the Ministry of Health Decree No. 371/Menkes/SK/III/2007, is a multi-disciplinary field which implements various engineering, science and technological methods to improve public health services. In Indonesia, the profession in biomedical engineering is referred as medical technicians by the Government Regulation No. 32 Year 1996 about the Healthcare Profession based on the Law of Republic Indonesia No. 23 Year 1992 on Health. Medical technicians, as further stated in the Government Regulation No. 32 Year 1996 Article 2 Section 8, that covers radiography, radiotherapy, dental technicians, electromedical technicians, health analysts, refraction opticians, orthopedic and prosthetic technicians, transfusion technicians and medical record technicians.

We notice that the profession's emphasis is placed on technicians rather than engineers. We suggest one of the reasons is an inadequate educational establishment to prepare biomedical engineers. This supports our argument that biomedical engineering in Indonesia has not fully developed its potential to meet the country's needs. Yet, despite the acknowledgement of the profession of medical technicians in the Indonesian regulations, there is still a low number of medical technicians in Indonesia. Statistics show that there are 9,099 medical technicians in Indonesia as of December 2010, (Ministry of Health, 2010). Table 1 describes medical technician statistics in Indonesia. As far as we know, we have not found any specific data about biomedical engineers in Indonesia. Based on our analysis, we mainly use data of technicians, unless otherwise stated.

Regarding the health infrastructure, the Ministry of Health (2010) explains that total number of hospitals in Indonesia, including general hospitals and specialist hospitals was 1,632 hospitals in 2010. From the total number of hospitals, there were 794 government-owned hospitals. There were also 1,857 *Puskesmas* (local government clinics) in Indonesia as of 2010. Table 2 presents the hospital and *Puskesmas* statistics in Indonesia. The Ministry of Health (2010) also notes that 4,519 medical technicians work in government-owned hospitals, thus, according to our estimation, the ratio of medical technicians per government-owned hospitals was 5.7. We estimate that 4,580 medical technicians work in private hospitals, thus, the ratio of medical technicians per private hospital was 5.5. We estimate that in 2010, in general, the ratio of medical technicians per hospital was 5.6. The ratio of medical technicians per *Puskesmas* was 0.2. Table 3 presents the ratio analysis of medical technicians in Indonesia.

Table 1 Medical Technicians Statistics in Indonesia, 2010
(Ministry of Health of the Republic of Indonesia, 2010)

Statistics	**(in person)**
Total Medical Technicians in Indonesia	9,099
Medical Technicians in Government-owned Hospitals	4,519
Medical Technicians in *Puskesmas* (Local Government Clinic)	1,857

Table 2 Hospital and *Puskesmas* Statistics in Indonesia, 2010
(Ministry of Health of the Republic of Indonesia, 2010)

Statistics	**(in unit)**
Total Hospitals in Indonesia	1,632
Total Government-owned Hospitals	794
Total *Puskesmas* (Local Government Clinic)	9,005
Total General Hospitals	1,299
Total Special Hospitals	333

Table 3 Ratio Analysis of Medical *Technicians* per Hospital in Indonesia, 2010
(Ministry of Health of the Republic of Indonesia, 2010)

Ratio Analysis	
Ratio Medical Technician per Hospital	5.6
Ratio Medical Technician per Government-owned Hospital	5.7
Ratio Medical Technician per *Puskesmas*	0.2

The regulation and statistics in Indonesia, in our opinion, emphasize the measurement of medical technicians needed. If we compare the government standards as stated in The Ministry of Administrative Decree (*Keputusan Menteri Pendayagunaan Aparatur Negara*) No.KEP/75/M.PAN/7/2004 about the Manual Calculation of Workers Needed based on Work Load in Composing Civil Servant Formation, the reality of the number of medical technicians is lower than what the government sets. Table 4 presents the standard of medical technicians needed based on government regulations.

Table 4 Standard Medical Technicians Needed in Hospital and *Puskesmas* as Stated on No.KEP/75/M.PAN/7/2004 (Ministry of Administrative Decree of the Republic of Indonesia, 2004)

Standard Medical Technicians	**(in person)**
Standard Medical Technicians per General Hospital Class A	52
Standard Medical Technicians per General Hospital Class B	23
Standard Medical Technicians per General Hospital Class C	7
Standard Medical Technicians per General Hospital Class D	2
Standard Medical Technicians per Special Hospital Class A	8
Standard Medical Technicians per Special Hospital Class B	7
Standard Medical Technicians per Special Hospital Class C	4
Standard Medical Technicians per Special Hospital Class D	3
Standard Medical Technician per *Puskesmas*	1

If we compare Table 3 and Table 4, it is clear that medical technician employment is below the (government) standard. Medical technicians per government-owned hospitals (Table 3) do not achieve Class C standard in terms of quantity of medical technicians per general hospitals (Table 4). In general, the ratio of medical technicians per hospital achieves the standard of Class D General Hospital or Class C Special Hospital. The medical technicians number per *Puskesmas* is inferior in that it only achieves 20% of the standard.

There is, however, no international standard of what is the acceptable ratio of medical technicians as far as our knowledge is concerned. We, therefore, use a comparative analysis among country counterparts: the United Kingdom (UK) and Japan as developed countries, and Malaysia as a South East Asia regional counterpart. Table 5 shows the result of comparative analysis of Indonesia with the UK, Japan and Malaysia. We used the latest publications in the United Kingdom for the year 2011, Japan for the year 2012 and Malaysia for the year 2010; and compared them with the latest publication in Indonesia, up to 2010.

As of October 2011, the Department of Health lists 1,484 hospitals operating in England (Department of Health, 2011a). We used the Standard Occupational Classification (SOC) 3218 for Medical and Dental Technicians and based on the data from the Office for National Statistics (2011), the number of medical and dental technicians as of Quarter 2 (April-June) 2011 is a 32,154 person labour force. We, however, can find neither the breakdown data for the English-based labour force, nor the data for all hospitals in the United Kingdom. Nevertheless, we presume that the difference with the available data is modest.

As of 2012, the total number of hospitals in Japan is 8,739, while the total number of medical technicians is 48,343 (Japan Statistical Yearbook, 2012). For Malaysia, as of 2010, the total number of hospitals is 399, while the total number of medical technicians is 7,768 (Ministry of Health Malaysia, 2010).

Our analysis suggests that the ratio of medical technicians per hospital in the UK is 21.7, almost four times the ratio in Indonesia. For Malaysia, with ratio of medical technicians to hospitals is 19.5, it is more than three times the same ratio in Indonesia. Japan, however, has almost similar results with Indonesia. The ratio of medical technicians per hospital in Japan is 5.5, slightly lower than Indonesia. It has to be said cautiously that Japan is one of the countries with the largest number of hospitals and hospital beds.

The alternative way to draw a comparison is using number of hospital beds as the baseline. In Indonesia, the total number of hospital beds available, according to the Ministry of Health (2010), was 163,680, while there were 9,099 medical technicians. Thus the ratio of medical technicians available per 100 hospital beds was 5.6. The total number of hospital beds available in the UK in 2011 were 173,948 beds. If the total number of medical technicians in the UK was counted as 32,154, then, the ratio of medical technicians per 100 hospital beds was 18.5, three times higher than the ratio in Indonesia.

The total number of hospital beds in the UK from four regions: in England, the number of hospital beds available as of Quarter 2, 2011 comprised 138,714 beds (Department of Health, 2011b) while in Scotland as of September 2011, the number was 16,353 beds (Information Services Division NHS Scotland, 2011), in Wales as of October 2011 was 12,149 beds (Statistics Wales, 2011) and in Northern Ireland as of March 2011 was 6,732 beds (Department of Health, Social Services and Public Safety, 2011).

In the UK, moreover, the dental and medical technicians are considered to be the highest growing occupation in Science, Engineering and Technology (SET) based technicians, with an estimated growth rate of 3.3% from 2001-2003 to 2007-2009 (Jagger *et al*., 2011). The Home Office (2011) also lists radiotherapy and nuclear medicine technologists in the occupational shortage list – for dental and medical technicians (SOC). The growth and shortlisted occupation lists reflect the demand for biomedical engineers even in the economic downturn when the demand for the other occupations has declined.

For Malaysia, the ratio of medical technicians per 100 hospital beds is 14.1, two and a half times that of the ratio in Indonesia. Nevertheless, Indonesia has a higher ratio compared to Japan where the ratio of medical technicians per 100 hospital beds is only 3.0. (2012) But, again the lower ratio in Japan is due to the large number of hospital beds available in Japan.

We also used population figures as a baseline for our comparative analysis. When the ratio of medical technicians per 10,000 population is derived (Table 5), it is clearly seen that Indonesia has the least favourable conditions compared to its counterparts. Indonesia has only 0.4 medical technicians per 10,000 population; this is an extremely low number compared to the UK, Malaysia and Japan which have respectively 5.2, 2.7 and 3.8 medical technicians per its 10,000 population.

We fully note that our comparative analysis mainly covers technicians rather than biomedical engineers. In such a case our argument simply relates in the availability and easy-access of data. We left room in our research for further analysis on using biomedical engineers-based data.

Table 5 Comparative Analysis of Hospitals, Hospital Beds and Medical Technicians **(**Ministry of Health, 2010; Department of Health, 2011a-b; NHS Scotland, 2011; Statistics Wales, 2011; Office for National Statistics, 2011**;** The Statistical Research and Training Institute, 2012; Ministry of Health Malaysia, 2010**)**

Comparative Analysis	**Indonesia (2010)**	**UK (2011)**	**Japan (2009)**	**Malaysia (2010)**
Total Hospital (unit)	1,632	1,484	8,739	399
Total Hospital Bed (unit)	163,680	173,948	1,601,476	55,059
Total Medical Technicians (person)	9,099	32,154	48,343	7,768
Ratio Medical Technicians per Hospital	5.6	21.7	5.5	19.5
Ratio Medical Technicians per 100 Hospital Beds	5.6	18.5	3.0	14.1
Ratio Medical Technicians per 10,000 Population	0.4	5.2	3.8	2.7

3. DISCUSSION ON BIOMEDICAL ENGINEERING POTENTIAL TO CREATE JOBS

Despite the high demand in biomedical engineering profession in hospitals, we also acknowledge that medical technicians and biomedical engineers are also needed in areas other than hospitals. In the US, the US Bureau of Labor Statistics (2012) estimate that the employment growth rate for biomedical engineers is projected to reach 62% from 2010 into 2020, significantly higher than the average growth for all occupations, which is estimated at 14%. Biomedical engineers are likely to work in universities, hospitals, manufacturing facilities, research and development units in companies, educational institutions, and in government regulatory agencies (US Bureau of Labor Statistics, 2012). Barbenel (2005), using the data from the Institute of Physics and Engineering Medicine (IPEM) – the leading professional body in the UK for biomedical engineering and medical physics, states that among 310 engineers subscribed to the IPEM, 219 (71%) work in hospital trusts, 46 (15%) in universities, 30 (10%) in community health trusts, 8 (3%) in commercial purchasing agencies, 4 (1%) in private hospitals and 3 (1%) in industry. Although it cannot be generalized that the same conditions will apply in Indonesia, there is a huge potential to create jobs (other than hospital jobs) from the development of biomedical engineering. At least our analysis suggests that industry and university (including research) are potential areas to create jobs that arise from the development of biomedical engineering in Indonesia.

The Ministry of Health (2010) illustrates that there are 204 companies in Indonesia that produce health instruments in 2010, a decline from 214 companies from the previous year. Table 6 illustrates the Ministry of Health data on the number of health instrument manufacturers including the small scale industries. The Indonesian Statistics Bureau (BPS), on the other hand, lists an estimated 69 companies in the medium and large scale industries in relation to the manufacture of medical, measuring, navigational and optical instruments, watches and clocks during 2009 (Table 7). The BPS data, however, shows only a few number of medium to large scale companies in Indonesia that produce health instruments. Our analysis suggests that, in general, more than 50% of all the Indonesian health instrument manufacturers are small-sized companies (Figure 1). Analysis supports the disappointing argument that although the trade volume of health instruments increased by 49.5% per year from the period 1997 to 2007, many of the instruments were dominated by imported goods. The fact that Indonesia contributes to only 0.5% from the total world trade volume of electro-medics, which reaches US$ 800 billion (*Detik* Finance, 2007), leads to a convincing analysis that the industry has not yet developed its potential, thus, government action is needed to fully support local health instrument production.

Table 6 Total Companies Manufacturing Health Instruments
(Ministry of Health of the Republic of Indonesia, 2004-2010)

Year	Total Companies	% change
2001	163	-
2002	272	66.87%
2003	366	34.56%
2004	505	37.98%
2005	451	-10.69%
2006	191	-57.65%
2007	125	-34.55%
2008	164	31.20%
2009	214	30.49%
2010	204	-4.67%

Table 7 Total Medium and Large Scale Companies and Labour in the Sectors of Medical, Measuring, Navigational and Optical Instruments, Watches and Clocks (BPS,2001-2009)

Year	Total Companies	% change	Total Labour	% change
2001	69	-	(unavailable)	-
2002	52	-24.64%	(unavailable)	-
2003	49	-5.77%	(unavailable)	-
2004	47	-4.08%	13,784	-
2005	47	0.00%	17,521	27.11%
2006	61	29.79%	20,275	15.72%
2007	70	14.75%	23,412	15.47%
2008	70	0.00%	25,071	7.09%
2009*	69	-1.43%	21,020	-16.16%

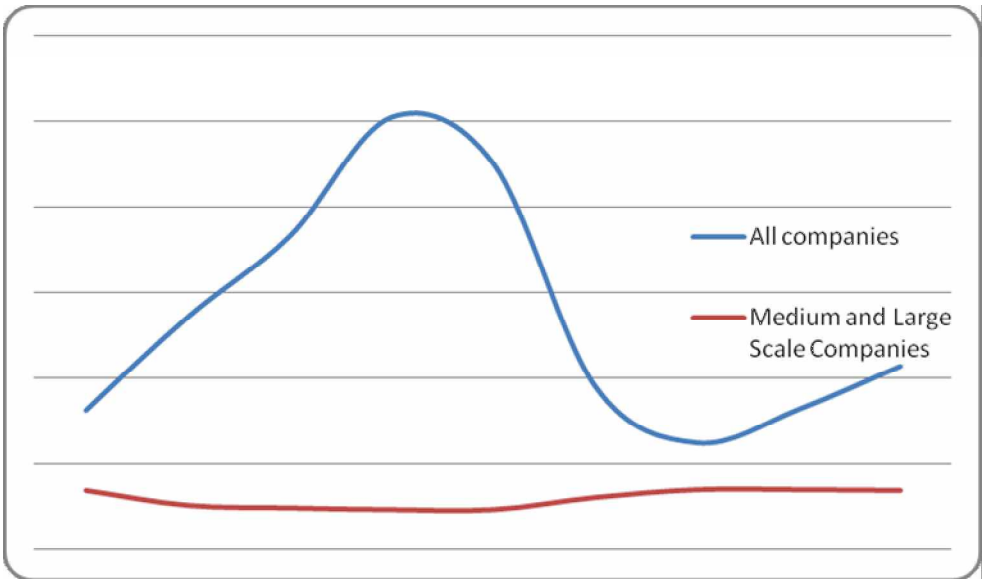

Figure 1 All Companies, Medium and Large Scale Companies of Health Instruments (BPS, 2004-2010)

We also pay attention to the Road Map of Health Instruments for medical use in Indonesia. From 2005 to 2025, the Road Map clearly specifies the resources, research and development, and technology needed to create health instrument products to be used by the potential market (Figure 2). In this case our analysis suggests that there are at least three potential areas of job creation from the development of health (medical) instruments according to the Road Map plan. The first area is hospitals in which the growing clinical needs encourage more hi-tech medical instruments with the availability of medical technicians to be able to operate and maintain the instruments. The second area is academia, including research and development, in which researchers and lecturers in the biomedical engineering field have to be increased in order to establish a strong foundation as well as sustainability in the biomedical engineering field. The third area is industry where encouragement to increase domestic production of health instruments, including the using of domestic raw materials, leads to the increasing need for labour. Total labour input for the biomedical engineering industry was estimated to reach only 21,020 jobs in 2009 (Table 7), a 0.48% from a total labour force in all medium and large scale industries.

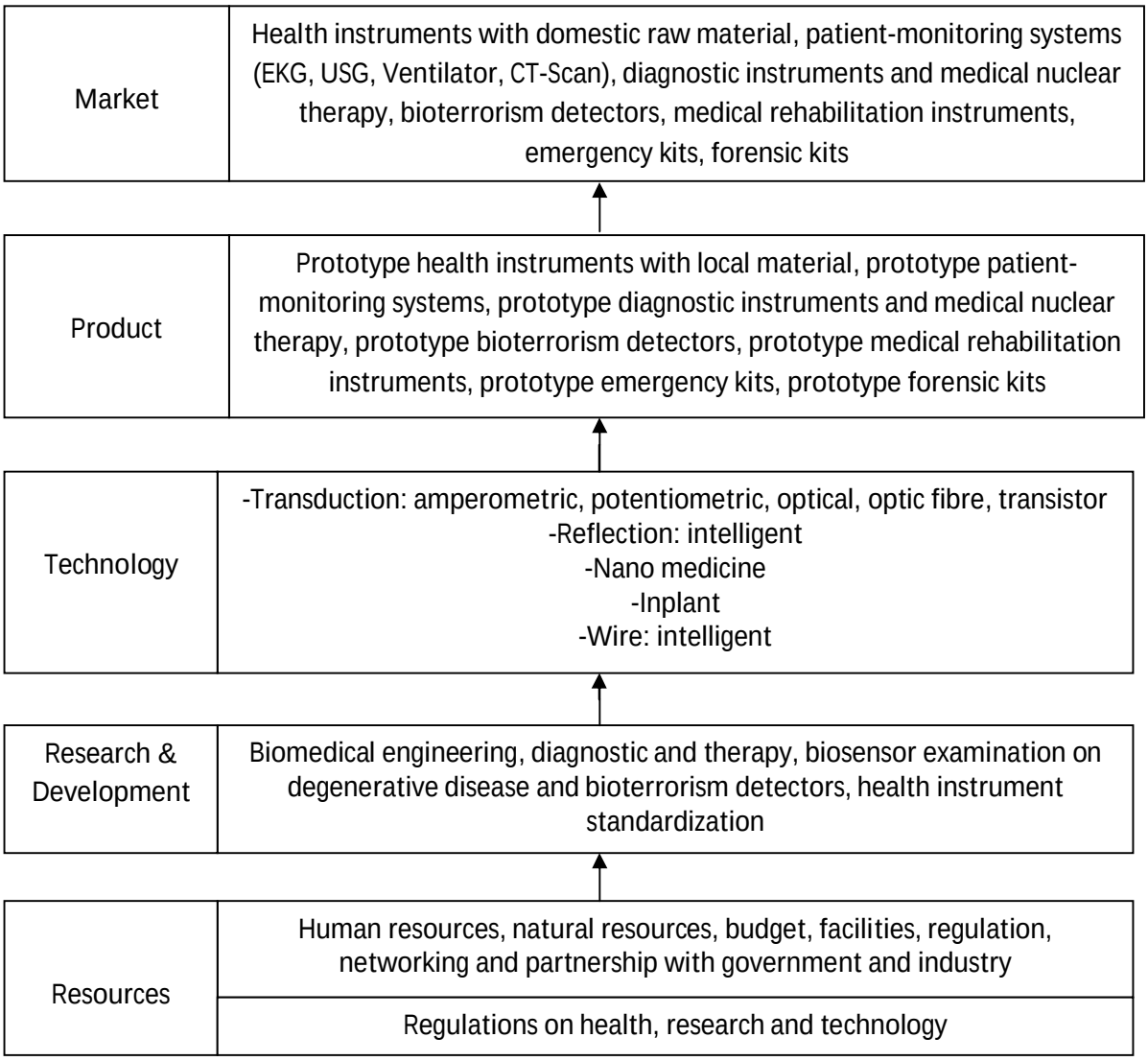

Figure 2 Road Map Health (Medical) Instruments 2006 to 2025
(Ministry of Research and Technology, 2006)

We calculated estimates of the current job intake conditions of the biomedical engineering profession available in the hospital, industry and university/academic fields in Indonesia. Figure 3 describes our estimated proportion of the biomedical engineering profession (for both technicians and engineers) in hospital, industry, and university/academic fields in Indonesia. We also estimate our projections for UK-based biomedical-engineer proportions for hospital, industry and university/academic fields (Figure 4) using IPEM data from Barbenel (2005).

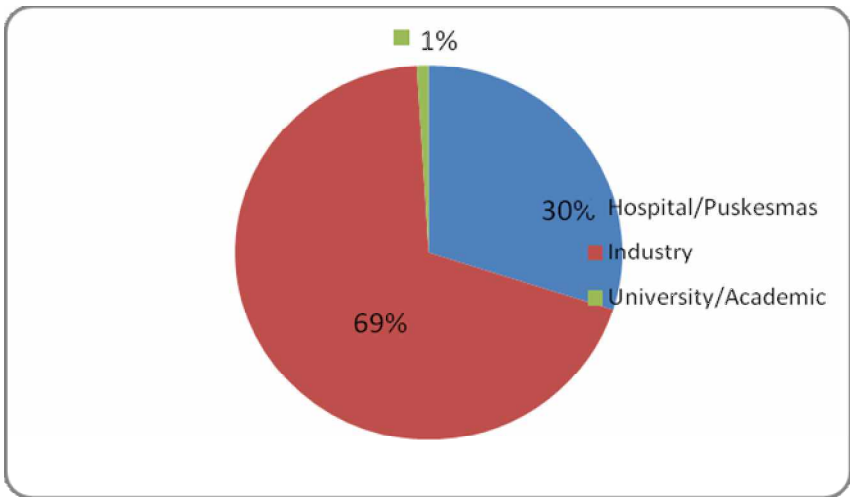

Figure 3 Estimation of Biomedical Engineering Employment Profile in Indonesia (Ministry of Health, 2010; BPS, 2011)

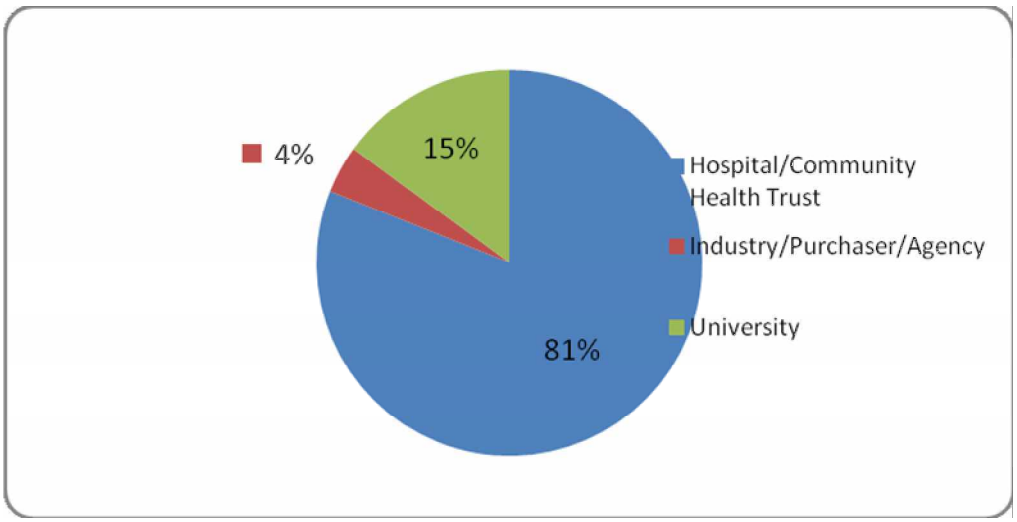

Figure 4 Estimation of Biomedical Engineers Profile in the UK (Barbenel, 2005; IPEM, 2012)

Although it is not suitable for a direct comparison, looking at Figure 3 and Figure 4, we may simply draw conclusions about the two conditions concerning biomedical engineering job creation in Indonesia. Firstly, that biomedical engineering employment in Indonesia is dominated by fewer highly skilled occupational workers. In other words, the labour force is composed of operators and technicians (low to medium skilled jobs) that are dominant in

Indonesia, whereas in the UK, the labour force is dominated by medium to highly skilled jobs. Secondly, in the light of the first condition, we suggest that in the future, along with the development of biomedical engineering, we expect more highly skilled jobs will be created in Indonesia. Thus, biomedical engineers as experts are potentially needed; for example, in areas of research in university/academia and industry.

4. CONCLUSION

Health regulations and statistics in Indonesia acknowledge the importance of the biomedical engineering profession as the core healthcare profession alongside doctors and paramedics. The Road Map of health (medical) instruments clearly shows the significance of biomedical engineering for the future development of Indonesian science and technology. Moreover, the urgency to develop biomedical engineering is seen as a top priority from the government to improve health services. The improvement of medical instrumentation is deemed necessary as one of the government priorities, as it is stated in the national strategic policy, to solve health problems and most importantly to deal with a high rate of medical cases in relation to several aforementioned diseases in Indonesia.

From the employment point of view, our analysis suggests that the availability of medical technicians in Indonesia is still 'unsatisfactory' if we compare the data to the government standards or to the availability of medical technicians from counterpart countries. In this case we use a comparative analysis between the United Kingdom, Japan and Malaysia. The ratio of medical technicians per hospital in Indonesia, in 2010, on overall, only achieved a Class D standard of the number of medical technicians per general hospital, or a Class C standard per special hospital. Indonesia rates are far below the UK, Japan Malaysia for the ratio of medical technicians per population. Overall, Indonesia is below the UK and Malaysia for its ratio of medical technicians per hospital and per hospital beds. It is, moreover, suggested that the biomedical engineering itself has not fully developed its potential. It is suggested that there are at least three possible areas of job creation as a result of biomedical engineering development; these areas are: industry, university/academia and hospital (healthcare). We also estimate that in the future, alongside with the development of biomedical engineering, the type of jobs that will significantly increase is the highly skilled engineers, that is, biomedical engineers with advanced skills and qualifications to fulfil the needs of highly skilled occupations in industry, university/academia and healthcare.

5. ACKNOWLEDGEMENT

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6. REFERENCES

Barbenel. 2005. Biomedical Engineering in the United Kingdom, in Nagel, *J. ed. Biomedical Engineering Education in Europe – Status Report*, BIOMEDEA, pp.223-234.

Biro Pusat Statistik (BPS) – Indonesia Statistics Bureau. 2012. Subject *Statistik: Industri*. Available from http://www.bps.go.id, accessed on 03 February 2012.

Biro Pusat Statistik (BPS) – Indonesia Statistics Bureau. 2011. *Statistik Indonesia 2011*: Statistical Yearbook of Indonesia 2011, BPS – Statistics Indonesia.

Detik Finance. 2007. 50% Alat Kesehatan di Indonesia Masih Diimpor, *Detik Finance*, 11 December 2007.

Department of Health. 2011a. Hospital and Facilities Statistics 2010/11, Department of Health - NHS, October 2011.

Department of Health. 2011b. Beds Open Overnight, Department of Health – Beds and Facilities Team, November 2011.

Department of Health - Social Services and Public Safety. 2011. Northern Ireland Hospital Statistics: Inpatient and Day Case Activity 2010/11, August 2011.

Government Regulations of the Republic of Indonesia. 1996. *Peraturan Pemerintah* No.32 Year 1996 about the Healthcare Profession.

Home Office. 2011. Tier 2 Shortage Occupation List – Government-approved Version, UK Border Agency Home Office, 2011.

Information Services Division NHS Scotland. 2011. Available Beds by Specialty & NHS Board of Treatment, Information Services Division NHS Scotland, December 2011.

Jagger, N., Sigala, M., Sumption, F. 2010. SET Based Technicians: Lessons from the UK and European Labour Force Surveys, Institute for Employment Studies, Report No.475.

The Statistical Research and Training Institute. 2012. Japan Statistical Yearbook, the Statistics Bureau, Japan.

Law of the Republic Indonesia. 1992. Law of the Republic Indonesia No. 23 Year 1992 on Health.

Ministry of Administrative Decree of the Republic of Indonesia, (2004), *Keputusan Menteri Pendayagunaan Aparatur Negara* No.KEP/75/M.PAN/7/2004 about Manual Calculation of Worker Needed based on Work Load in Composing Civil Servant Formation.

Ministry of Health Decree of the Republic of Indonesia. 2007. *Keputusan Menteri Kesehatan Republik Indonesia* No.371/Menkes/SK/III/2007 about Standard Profession of Electro Medic Technician.

Ministry of Health Malaysia. 2010. Health Indicators: Indicators for Monitoring and Evaluation of Strategy Health for All, Health Informatics Centre Planning and Development Division Ministry of Health Malaysia.

Ministry of Health of the Republic of Indonesia. 2004. *Indonesia Health Profile 2004*, Jakarta: Ministry of Health.

Ministry of Health of the Republic of Indonesia. 2007. *Indonesia Health Profile 2007*, Jakarta: Ministry of Health.

Ministry of Health of the Republic of Indonesia. 2008. *Indonesia Health Profile 2008*, Jakarta: Ministry of Health.

Ministry of Health of the Republic of Indonesia. 2009. *Indonesia Health Profile 2009*, Jakarta: Ministry of Health.

Ministry of Health of the Republic of Indonesia. 2010. *Indonesia Health Profile 2010*, Jakarta: Ministry of Health.

Ministry of Research and Technology. 2006. *Indonesia 2005-2025 the White Book: Research, Development and Application of Science and Technology in Health and Medicine*. Jakarta: Ministry of Research and Technology.

OECD. 2011. *Health at a Glance 2011: OECD Indicators*, OECD Publishing.

Office for National Statistics. 2011. Labour Force Survey Employment Status by Occupation, April-June 2011, Released August 2011.

Statistics Wales. 2011. NHS Beds 2010-11, Knowledge and Analytical Services – Welsh Government, October 2011.

US Bureau of Labour Statistics. 2012. Occupational Outlook Handbook: 2012-13 Edition, Biomedical Engineers, available on: <http://www.bls.gov/ooh/architecture-and-engineering/biomedical-engineers.htm> [accessed on 03 February 2012].

World Health Organization – WHO. 2010. Innovative Technologies that Address Global Health Concerns: Outcome of the Call Global Initiative on Health Technologies, WHO 2010.

World Health Organization – WHO. 2011. World Health Statistics 2011, WHO 2011.