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Planning human resources and facilities to achieve Sustainable Development Goals: a decision-analytical modelling approach to predict cancer control requirements in Indonesia

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ABSTRACT

Objectives Indonesia aims to achieve universal health coverage (UHC) and Sustainable Development Goals (SDGs), including SDG 3 target 4, which focuses on cancer control, by 2030. This study aimed to forecast the human resources for health (HRH) and facilities required for cancer control in Indonesia over an 11-year period to support these goals.

Design A two-stage Markov model was developed to forecast the demand side of facilities and HRH requirements for cancer control in Indonesia over an 11-year period.

Setting Data sources used include the Indonesia Health Profile Report (2019), the Indonesian Radiation Oncology Society Database and National Cancer Control Committee documents (2019).

Methods The study involved modelling the current availability of HRH and healthcare facilities in Indonesia and predicting future requirements. The gap between the current and the required HRH and facilities related to oncology, and the costs associated with meeting these requirements, were analysed.

Results Results indicate the need to increase the number of healthcare facilities and HRH to achieve SDG targets. However, UHC for cancer care still may not be achieved, as eastern Indonesia is predicted to have no tertiary hospital until 2030. The forecast shows that Indonesia had a median of only 39% of the HRH requirements in 2019. Closing the HRH gap requires around a 47.6% increase in salary expenditure.

Conclusion This study demonstrates the application of decision-analytical modelling approach to planning HRH and facilities in the context of a low-to-middle-income country. Scaling up oncology services in Indonesia to attain the SDG targets will require expansion of the number and capability of healthcare facilities and HRH. This work allows an in-depth understanding of the resources needed to achieve UHC and SDGs and could be utilised in other disease areas and contexts.

Strengths and limitations of this study

⇒ The study employed decision-analytical modelling (using a Markov model as part of a health service development approach) to empirically forecast oncology workforce requirements on annual basis to provide evidence-based information to support human resources for health (HRH) and facilities planning and policy development in a low-and-middle-income country (LMIC) context.
⇒ The study used the case study of Indonesia to highlight some of the challenges experienced by LMICs in relation to HRH planning.
⇒ The study focused only on oncology services in the public sector for HRH of the ten most common cancers in Indonesia and forecasted the demand-side of the required HRH.
⇒ As the model was based on an annual planning cycle, which is a discrete-time process, the typical Markov model features such as discounting and half-cycles correction were not applied in this model.

INTRODUCTION

Health workforce provision and planning play a fundamental role in achieving universal health coverage (UHC) and the UN's health-related Sustainable Development Goals (SDGs).[1] Achieving these targets requires a robust healthcare delivery system with the health workforce as the core of the system.[2] The healthcare system relies heavily on its workforce, more than any other type of organisation.[3] Reducing premature mortality from non-communicable diseases, including cancer, by one-third by 2030 is one of the key areas of attention for the SDGs, with one of the SDGs (SDG 3 target 4) particularly focussing on cancer control. With cancer now being the second leading cause of death worldwide, the World Health Organisation (WHO) has highlighted the importance of effective human resources for health (HRH) planning as one of the essential interventions in addressing cancer.[4] HRH planning is particularly important in low-and-middle-income

countries (LMICs), where 70% of global cancer deaths are estimated to occur and healthcare systems are still in transition to achieve UHC.[4] In this context, population growth and cancer incidence often outpace the development of cancer services.

Indonesia provides a useful example of some of the challenges experienced by LMICs in relation to HRH planning. The exponential growth of the population has also put a strain on the national health insurance system to provide UHC for all the residents. Concurrently, the burden of cancer is growing in this country, with cases rising from 726 555 in 2014 to just under 1.8 million cases in 2018, representing a 97.5% increase over a 4-year period.[5] Although this increase is not only due to an increase in population growth and trends, but also due to improvements in awareness, data capture and reporting[6 7]; unfortunately, more than 70% of these patients with cancer are still diagnosed at a late stage,[8] resulting in a higher financial burden and lower survival rates. The limited access to oncology services is known to be a contributing factor, as the oncology workforce and healthcare facilities are inadequate in their volume and they are unequally distributed geographically.[9 10]

Despite these challenges, Indonesia has been making large strides towards controlling cancer through investments in healthcare facilities to improve access to oncology services. The National Cancer Control Plan and the Strategic National Cancer Plan of Action have also been developed in order to strengthen cancer control in Indonesia, with HRH planning as one of its core priorities.[11 12] As cancer care has one of the most complex HRH patterns, national level analyses to determine HRH-related oncology requirements on a year-by-year basis are crucial to ensure adequate planning and to enhance effective annual budgeting. However, many LMICs, including Indonesia, offer no official guidelines for calculating the number of oncologists needed.

In LMICs, where data and evidence availability are one of the major constraints, decision-analytical models can be extremely useful for HRH planning. Such models use mathematical relationships to synthesise evidence from various sources and can be used to extrapolate information over defined time periods.[13 14] A Markov model is one kind of modelling framework that is often used to model disease evolution and treatment. However, the application of this model for HRH planning has only been explored recently. This type of model is able to describe the behaviour of a system in dynamic situations over time and can be adapted to incorporate the key components of HRH planning.[15] Therefore, this type of model can provide a flexible tool for planners to analyse the changing number and distribution of facilities and workers required in different situations.[16]

Using a Markov model, this paper aims to forecast the HRH and facilities required for cancer control in Indonesia over the next 11 years, in order to support the goal of achieving UHC and SDG targets by 2030. The results will provide evidence-based information to support HRH planning and policy development to support cancer control in the country. This study will also examine the strengths and limitations of such modelling methods in this context.

METHODS
Indonesian context
Indonesia is the world's largest archipelago country, comprising more than 16 000 islands. Administratively, it is divided into 34 provinces and can be further grouped into seven regions based on geographical location. With an annual population growth rate of 1.43%, the population was estimated to reach over 260 million people by 2019.[17] However, there is uneven population growth and distribution among provinces, with the Java region being the most densely populated area. Most of the healthcare facilities and the oncology workforces are also concentrated in this area.

In Indonesia, cancer services operate as a multilevel system, starting from the outpatient and inpatient *Puskesmas* at the primary level, followed by type D, C and B hospitals at the secondary level, and capped by type A hospitals as the highest tertiary level provision. Healthcare facilities are categorised according to their scope and capacity per head of population (online supplemental appendix 1). The status of services can change annually based on the assessment of their resources, plans and scope by the Ministry of Health (MoH). Lower-level healthcare facilities can be upgraded to higher level facilities to improve access, quality, capacity and the number of HRH.[18] However, hospitals can also be downgraded if they do not meet the standard criteria due to their inability to maintain their facilities or HRH on annual inspection.[19]

Modelling approach
There is no universally accepted conceptual approach to forecasting HRH requirements. Each approach relies on assumptions and the approach adopted usually depends on data availability, the planner's capacity and the nature of the healthcare system.[20 21] For this study, the health service development analysis approach was selected and applied for demand-side forecasting of HRH and facilities for Indonesia's context, given the relatively simple data requirements.[21] It also allows a realistic consideration of the infrastructural expansion plan. Moreover, Indonesia-specific staffing standards could be used to generate aggregate oncology workforce requirements.

A two-stage model was conducted. First, a Markov model was analytically used to estimate the future number of healthcare facilities. Staffing standards were subsequently used to translate the number of healthcare facilities in each level into HRH requirements. The forecasting analysis was conducted using Microsoft Excel V.16.33. Patients or the public were not involved in the design, conduct, or reporting of this study, as the focus was on applying the analytical techniques to a particular case study.

Model structure and assumptions
The model structure reflects the system of facilities and is illustrated in figure 1. The patient movement from one

Figure 1 Model structure of healthcare facilities for cancer service in Indonesia. iPKM, inpatient *Puskesmas*; oPKM, outpatient *Puskesmas*; tAH, type A Hospital; tBH, type B Hospital; tCH, type C Hospital; tDH, type D Hospital.

health state to another in the typical Markov model is analogous to the transition from one type of facility to another in this model. Each type of health facility is deemed as a 'state', resulting in six possible states including outpatient Puskesmas, inpatient Puskesmas, type D hospital, type C hospital, type B hospital and type A hospital. The healthcare facilities were modelled in one state during one cycle and could switch to another category or 'state' (according to transition probabilities) in the following cycle.

Although the downgrading of facilities is theoretically possible, this model assumed that healthcare facilities could only transition to the next higher level or remain in the same category. This assumption was based on the fact that cases of downgrading are rare, and staff are not usually expelled from one facility due to a downgrading in a given year. It was further assumed that healthcare facilities would not be closed down because the unmet oncology service needs are still high in Indonesia.[9 22] Based on these assumptions, the average number of new facilities at each level each year was derived and taken into account in the model structure. In figure 1, straight arrows show the transition pathways over successive cycles. Circular arrows indicate that the healthcare facilities can remain in the same category for more than one cycle.

Cycle length, time horizon and transition probabilities

As the healthcare facilities and HRH data are usually analysed annually, a 1-year cycle length was used in the model. The time horizon was 11 years to ensure the achievement of SDGs by 2030. The literature also suggests that HRH forecasting tends to lose value if the time horizon is much longer than 10 years because of the dynamics of the rapidly changing health industry.[20] As the model was based on an annual planning cycle, which is a discrete-time process, the typical Markov model features such as discounting and half-cycle correction were not applied in this model.

Table 1 Model input parameters

Parameters for transition probability	Base value	SE	95% CI
Region 1 (Sumatera)		0.002	
▶ oPKM to iPKM	0.121	0.004	0.113 to 0.129
▶ iPKM to tDH	0.031	0.002	0.027 to 0.035
▶ tDH to tCH	0.296	0.006	0.285 to 0.307
▶ tCH to tBH	0.008	0.001	0.006 to 0.010
▶ tBH to tAH	0.013	0.001	0.011 to 0.016
Region 2 (Java)			
▶ oPKM to iPKM	0.112	0.003	0.105 to 0.118
▶ iPKM to tDH	0.043	0.002	0.039 to 0.047
▶ tDH to tCH	0.247	0.004	0.238 to 0.255
▶ tCH to tBH	0.032	0.002	0.029 to 0.036
▶ tBH to tAH	0.010	0.001	0.008 to 0.012
Region 3 (Bali and the Nusa Tenggara)			
▶ oPKM to iPKM	0.056	0.006	0.045 to 0.068
▶ iPKM to tDH	0.014	0.003	0.008 to 0.020
▶ tDH to tCH	0.241	0.011	0.219 to 0.263
▶ tCH to tBH	0.023	0.004	0.015 to 0.031
▶ tBH to tAH	0.000	0.000	0.000 to 0.000
Region 4 (Kalimantan)			
▶ oPKM to iPKM	0.088	0.006	0.076 to 0.100
▶ iPKM to tDH	0.018	0.003	0.012 to 0.023
▶ tDH to tCH	0.315	0.010	0.296 to 0.335
▶ tCH to tBH	0.012	0.002	0.007 to 0.017
▶ tBH to tAH	0.012	0.002	0.007 to 0.016
Region 5 (Sulawesi)			
▶ oPKM to iPKM	0.039	0.004	0.032 to 0.046
▶ iPKM to tDH	0.019	0.002	0.014 to 0.023
▶ tDH to tCH	0.364	0.009	0.347 to 0.382
▶ tCH to tBH	0.012	0.002	0.008 to 0.016
▶ tBH to tAH	0.008	0.002	0.005 to 0.011
Region 6 (Maluku)			
▶ oPKM to iPKM	0.151	0.012	0.128 to 0.173
▶ iPKM to tDH	0.032	0.006	0.021 to 0.043
▶ tDH to tCH	0.041	0.006	0.029 to 0.054
▶ tCH to tBH	0.027	0.005	0.017 0.037
▶ tBH to tAH	0.000	0.000	0.000 to 0.000
Region 7 (Papua)			
▶ oPKM to iPKM	0.170	0.009	0.152 to 0.188
▶ iPKM to tDH	0.040	0.005	0.030 to 0.050
▶ tDH to tCH	0.087	0.007	0.073 to 0.101
▶ tCH to tBH	0.000	0.000	0.000 to 0.000
▶ tBH to tAH	0.000	0.000	0.000 to 0.000

Source: Indonesia Health Report 2019 (MoH, 2019b).
iPKM, inpatient *Puskesmas*; MoH, Ministry of Health; oPKM, outpatient *Puskesmas*; tAH, type A Hospital; tBH, type B Hospital; tCH, type C Hospital; tDH, type D Hospital.

Movements between states are defined by transition probabilities, which indicate the chance of a healthcare facility status changing within a 1-year time cycle. Transitions from one category of healthcare facility to another were analysed to derive transition probabilities which

are presented in table 1. The transition probabilities were derived from routine data on healthcare facilities from 2015 to 2019,[23] which were then converted into the annual probabilities used in the model. As the development of each region varies, different transition probabilities were used for each region.

Existing number of healthcare facilities and projections for future years

The number of existing healthcare facilities in Indonesia from 2015 to 2019 was taken from the Indonesia Health Profile Report 2019. However, there were several hospitals that had not been classified each year from 2015 to 2019. Therefore, those hospitals were assumed to be classified as a particular type based on the proportion of each hospital within each category within each year to obtain the baseline number of healthcare facilities. The number of healthcare facilities was calculated based on the possible movements of health facilities in the model structure and the associated transition probabilities.

HRH requirements computation

The HRH requirements were estimated reflecting national staffing norms. The staffing norm defines the minimum number and type of HRH required in each type of facilities to deliver healthcare. The staffing norms used in this model were taken from MoH staffing standard and from the guidelines developed by the National Cancer Control Committee (NCCC) (online supplemental appendix 2). Estimates of the required HRH were then the results of the calculated staffing levels and the total number of each type of healthcare facilities in a certain year as projected using the predictive model (online supplemental appendix 3). Furthermore, the national HRH requirement was calculated as a summation of HRH requirements in the seven regions in Indonesia.

HRH gaps and aggregate salaries cost

The HRH gap was analysed by comparing the current HRH availability with the projected HRH requirements. This analysis is useful especially for the recruitment and deployment of HRH planning and the management of wage bills.[24] A ratio of the current HRH availability to projected requirements, which is also called the Staff-Availability-Ratio (SAR), was also presented. The annual gross salaries were taken from the January 2020 payroll in one national public referral hospital in Indonesia (Indonesian Radiation Oncology Society, Staff Salary Survey 2019, Unpublished). A 10% annual increase in salary level was assumed based on the increasing salary in previous years. All costs were converted from Indonesian Rupiah (IDR) to British Pounds Sterling (£) based on 20 July 2020 exchange rate of £1 to IDR18 478.29.[25]

Sensitivity analysis

A series of deterministic sensitivity analysis (SA) were conducted to explore the uncertainty around the point estimates of HRH requirements and costs. A series of one-way SA were undertaken. This involved varying the transition probabilities in the predictive health facilities model according to their 95% confidence intervals (CIs) while the remaining values were held at their baseline values. Only one input was varied at a time. The model output produced, including the number of healthcare facilities, HRH requirements and salary costs, represented the lower and upper limits of the predictive interval which depict a range within the observed value is expected.[26] Probabilistic SA was not carried out in this model as it would produce various results that would not be meaningful in this context to guide a decision. An extension of one-way SA in the form of best-case and worst-case scenarios was also conducted, and these were defined as the lowest and highest cost estimates that the government would need to provide in order to meet the future required HRH, respectively. The combination of the lower estimates of healthcare facilities and estimated HRH requirements as well as the minimal standard staffing salaries were used to calculate the 'best-case' scenario, while the combination of the upper estimates and maximal staffing salaries were assumed to represent the 'worst-case' scenario.

Patient and public involvement

Study participants or the public were not involved in the design, conduct, reporting or development of the dissemination plans of our research. The study was unfunded and involved the modelling of the HRH and facilities required for cancer control using published data.

RESULTS

Healthcare facilities forecasting

The forecast (table 2) shows a significant increase in the total number of healthcare facilities, from 13 011 in 2019 to 27 935 facilities in 2030 (a 114.7% increase over the 11-year period). A steady increase is estimated across all healthcare facilities, excluding the outpatient Puskesmas. The number of outpatient Puskesmas is predicted to decrease by almost half compared with the baseline level, from 4048 in 2019 to 2064 in 2030, as they expand and move into inpatient Puskesmas. This reflects the fact that at the primary care level, the number of outpatient Puskesmas has decreased over the last 5-year period from 6358 in 2015 to 4048 in 2019 and the number of inpatient Puskesmas has increased almost twofold at the same time from 3396 in 2015 to 6086 in 2019. Consequently, the number of inpatient Puskesmas is predicted to increase from 6086 in 2019 to 14 015 in 2030.

The continued growth of healthcare facilities is also predicted at the secondary level, where the requirement for type C hospitals will rise by almost 400% from the baseline in 2019, followed by type B and type D hospitals. At the tertiary level, the number of type A hospitals is also estimated to increase steadily from 61 in 2019 to 87 in 2030, representing an increase of 42.6%. However, significant differences exist at the regional level (online supplemental appendix 4–10), particularly for the development

Table 2 Projected healthcare facilities and the aggregate HRH-related oncology requirements in Indonesia 2019–2030

Health facility/year	Baseline 2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Outpatient Puskesmas	4048	3745	3475	3236	3024	2835	2667	2517	2384	2265	2159	2064
Inpatient Puskesmas	6086	7066	7978	8829	9625	10370	11070	11729	12350	12936	13490	14015
Type D hospital	867	1108	1324	1519	1697	1862	2015	2158	2293	2420	2540	2655
Type C hospital	1514	1892	2322	2794	3302	3840	4402	4987	5590	6208	6840	7483
Type B hospital	435	492	559	634	720	815	922	1040	1170	1311	1466	1632
Type A hospital	61	65	67	69	70	72	75	77	79	82	85	87
Total health facilities	13011	14368	15725	17081	18438	19795	21152	22508	23865	25222	26579	27935
Staff type												
General practitioner	33855	39362	45047	50901	56916	63083	69396	75850	82439	89160	96007	102978
Nurse	301257	353246	408891	468153	530893	596998	666372	738934	814609	893329	975033	1059660
Paediatrician	5880	7121	8470	9919	11462	13092	14806	16599	18467	20409	22420	24498
Obstetrician and gynaecologist	5880	7121	8470	9919	11462	13092	14806	16599	18467	20409	22420	24498
Internist	5880	7121	8470	9919	11462	13092	14806	16599	18467	20409	22420	24498
General surgeon	5880	7121	8470	9919	11462	13092	14806	16599	18467	20409	22420	24498
Anesthesiologist	3991	4802	5656	6559	7510	8510	9556	10649	11787	12971	14199	15471
Radiologist	3434	4180	4964	5787	6650	7549	8485	9455	10459	11496	12565	13664
Clinical pathologist	3434	4180	4964	5787	6650	7549	8485	9455	10459	11496	12565	13664
Anatomical pathologist	2938	3623	4338	5085	5860	6662	7489	8339	9211	10103	11015	11944
Surgical oncologist	557	622	692	771	860	960	1071	1193	1328	1475	1635	1807
Medical oncologist	496	557	625	703	790	888	996	1117	1249	1393	1550	1719
Paediatric medical oncologist	496	557	625	703	790	888	996	1117	1249	1393	1550	1719
Gynaecological oncologist	557	622	692	771	860	960	1071	1193	1328	1475	1635	1807
ENT oncologist	496	557	625	703	790	888	996	1117	1249	1393	1550	1719
Urological oncologist	496	557	625	703	790	888	996	1117	1249	1393	1550	1719
Pulmonological oncologist	496	557	625	703	790	888	996	1117	1249	1393	1550	1719
Radiation oncologist	496	557	625	703	790	888	996	1117	1249	1393	1550	1719
Medical physicist	496	557	625	703	790	888	996	1117	1249	1393	1550	1719
Radiation therapy technologist	496	557	625	703	790	888	996	1117	1249	1393	1550	1719
Total workforce	377512	443574	514126	589114	668366	751741	839119	930397	1025481	1124286	1226732	1332745

ENT, ears, nose and throat; HRH, human resources for health.
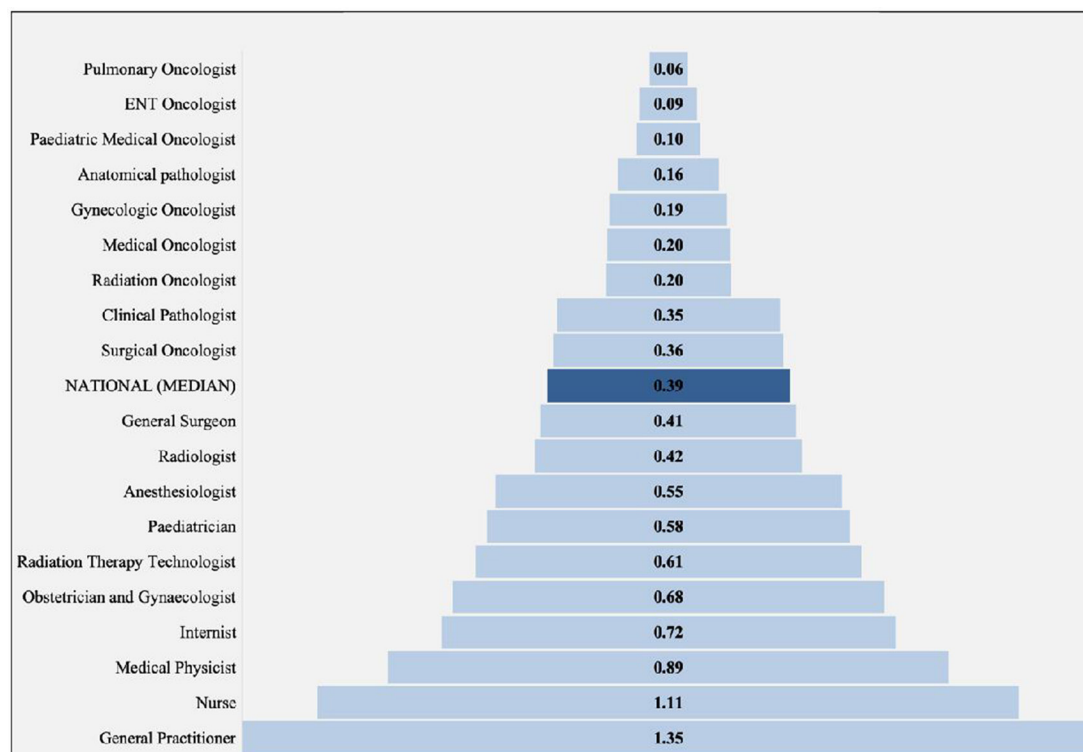
Figure 2 Staff-availability ratio. ENT, ears, nose and throat.

of secondary and tertiary healthcare facilities. Disparities are even greater in eastern Indonesia, such as the Maluku and Papua regions. Both regions are predicted to have no type A hospital and Papua region is expected to remain with the same number of type B hospitals (only two) until 2030.

HRH requirements forecasting, gaps and cost implications
The projected HRH requirements over the 11-year period can be seen in table 2. This model predicts a steady increase in HRH requirements across all staff categories from 2019 to 2030, except for the oncologist group in the Papua region (online supplemental appendix 4–10). The number of oncologists required in this region is estimated to be only two until 2030. Due to the regional disparities in the development of healthcare facilities as explained above, distributional imbalances in the health workforce are also expected. Health workers are concentrated in the Java region compared with other regions, and this trend is observed until 2030.

The SAR in figure 2 indicates the proportion of staff requirements that are met given these projections. Generally, the median national SAR (as of December 2019) was 39%. However, it varied widely from 3% to more than 100%. General practitioner (GP), nurse, internist and medical physicist were found to have an SAR of more than 70%. While radiation therapy technologists (RTTs) and other specialists, excluding general surgeon, were shown to have an SAR between 50% and 70%. The largest gap existed between the availability and requirements of oncologists. All the oncologists and general surgeons

considered in this forecast were found to have an SAR below 50%, which is considered a severe shortage.

Salary costs
As the required staff volume is projected to increase each year, the rise in salary costs along the forecast period is also expected. In 2020, the annual salary cost for HRH of the ten most common cancers in Indonesia is estimated to reach about £3.9 billion. The cost for the predicted staffing requirement is found to steadily increase each year, to reach about £31.5 billion by 2030.

Sensitivity analysis
The aggregate salary costs to meet the required HRH annually within 95% CIs are presented in figure 3, in the form of the best and worst scenarios. In the best-case scenario, the salary cost to meet all the required HRH in 2020 is predicted to reach about £2.9 billion and is increasing up to £22.1 billion in 2030. While in the worst-case scenario, the cost is estimated to reach almost £5 billion in 2020 and is rising to approximately £41 billion in 2030. The SA demonstrates that the model results are relatively robust in relation to the narrow predictive intervals within the forecast.

DISCUSSION
Development of healthcare facilities
The model shows that attaining SDGs by 2030, particularly UHC for cancer care, requires an increase in the number and capacity of healthcare facilities. However, this model
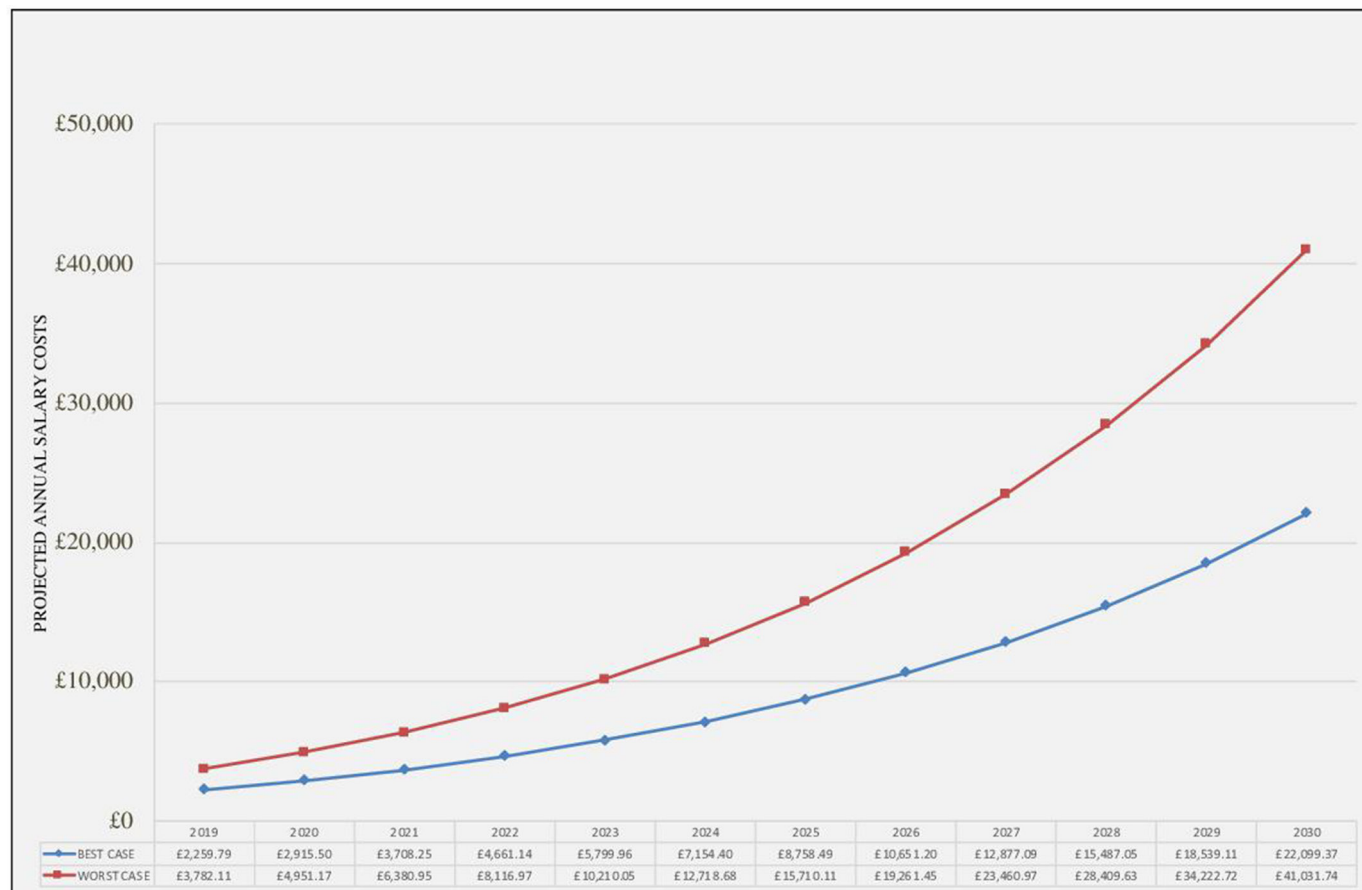
Figure 3 Projected aggregate salary cost range, 2019–2030 (best and worst case scenarios).

predicts a decrease in the number of outpatient *puskesmas* over time as they are assumed to be upgraded into inpatient *puskesmas*. With one-third of all cancer being preventable and another third treatable if detected early,[4] primary healthcare centres (PHCs) are expected to play an important role not only in raising cancer awareness, but also in cancer screening and early detection. The predicted expansion in the number and capacity of inpatient *puskesmas* over 11-year period will improve patient access to care as the PHC acts as the cornerstone and the first contact of access to the public health system in Indonesia.

While PHCs are the main pillars in the early detection of cancer, secondary and tertiary hospitals are the main providers of cancer diagnostic and curative care. This model shows that although provision at these levels is set to increase in general, there are likely to be differences in hospital development between regions. The distribution of healthcare facilities is concentrated in the Java regions. The model predicts the increasing of type B, C and D hospitals across all regions, except for Maluku and Papua regions given the model assumptions. Given the previous 5-year trend of service development in Indonesia, the provision of type B hospitals in the easternmost region of Indonesia, the Papua region, is expected to remain at the status quo until 2030, with only two hospitals to cover its residents. Of the estimated 42.6% increase of type A

hospital nationally from 2019 to 2030, no type A hospital is predicted to be available in the Maluku and Papua regions until 2030. Although the government has stated that there is an aim to provide at least one type A hospital in each of the Maluku and Papua regions,[27] this aim has not yet been implemented or developed any further. This implies that the equitable UHC for cancer care may not be fulfilled by 2030 unless concrete action is taken to address severe regional disparities. This paper, therefore, highlights a major challenge for Indonesia in terms of enabling equal access across the regions while suggesting the general needs for infrastructure expansion.

HRH requirements and gaps

Based on this model, the availability of GPs and nurses to meet the minimal requirement standard for health facilities set by MoH guideline is considered sufficient, even more than required in 2019, with SAR 1.35 and 1.11, respectively. It was also recently reported that the domestic supply of nurses is higher than the absorption capacity of the national healthcare market. During 2014–2019, approximately 2445 Indonesian nurses were sent to work abroad in Japan.[17]

A minimum SAR of 70% is considered an important milestone for achieving and sustaining health service provision.[21] However, of the 20 types of staff considered in this model, only four had an SAR of more than 70%

in 2019, which are internist, medical physicist, GP and nurse. The SARs among other basic medical specialists in 2019 were observed to be below 70%. The SARs among medical support specialists were found to be even lower than 50%, except for anaesthesiologists, which had around a 45% shortage. The current forecast has also indicated a shortage in para-clinical staff such as medical physicists (38% shortage) and RTTs (46% shortage). A more serious shortage was observed among oncologists. This shortage ranged from 54% for surgical oncologists to 97% for pulmonary oncologists. These shortages, particularly among oncologists, can be explained by various factors. First, the lack of subspecialist training programmes in Indonesia has become one of the barriers in meeting the need for a greater number of oncologists.[11] Second, the considerable length of time needed to complete the training, ranging from 6 to 8 years, causes a lack of interest among doctors to pursue a career in the oncology field.[11] Third, economic factors are important considerations as instead of receiving incentives, candidates have to pay for tuition fees for university-based training. This is in contrast to developed countries where doctors who undergo education through hospital-based services still receive incentives in the form of salaries. Therefore, it appears that the required increase in the number of oncologists is difficult to address over the short term.

This paper also shows that the geographical distribution of staff varies greatly. HRH prefer not to work in less developed services.[17] Compared with other regions, Java region has the largest of workforce of all types and most of the oncologists are concentrated here. On the contrary, there is no oncologist observed in the Maluku region, while the Papua region only has one surgical oncologist and one gynaecological oncologist. Hence, if the previous 5-year trends continue, this study predicts that the persistence of inadequate facilities and HRH provision may remain as the key drawbacks in attaining SDG targets and achieving UHC in cancer care.

Salary costs

The cost to meet the required 20 types of staff included in this model is estimated at just under £4 billion in 2020 and it is predicted to increase up to £31.5 billion in 11 years, in line with the additional number of staff needed. Of this, approximately £1.2 billion additional expenditure is needed to eliminate the current staffing gaps by 2020. This represents a 47.6% increase from the estimated 2019 salary cost (online supplemental appendix 11). This massive expansion in expenditure may not be viable in the short-term as the BPJS is currently suffering a huge financial deficit, which has existed since its first implementation in 2014.[28] Therefore, even if the required expanded workforce was available in the labour market, the budget space may be too limited to address all the new vacancies in the short-to-medium term.

Policy implications

This analysis demonstrates that an increase in investment is needed for medium-to-long term in the health sector, if SDG and UHC aims are to be met. Investments are required to increase HRH availability and must precede a considerable increase in health service coverage. Although it is estimated that there will be 42.6% increase in the number of type A hospitals between 2019 to 2030 nationally, this study also predicts that none of this increase will occur in the Easternmost regions by 2030 given the previous trends in Indonesia. Therefore, a significant part of this investment should focus on establishing more healthcare facilities in eastern Indonesia and expanding the capacity of existing facilities to cope with the increasing demand that will accompany population growth. A minimum of one type A hospital needs to be built in the Maluku and Papua regions to make sure that no regions are left behind in the move towards the UHC for cancer care.

Furthermore, the establishment of timely and accurate population-based cancer registries is needed to allow appropriate population-level policy decisions to address cancer. This data is crucial for determining the true cancer burden and it is currently not available in all regions in Indonesia.

Strengths and limitations

To date, this study is the first to empirically forecast specialist workforce requirements using a Markov model with a health service development analysis as the conceptual approach. Using this model, this study produces the first forecast of the healthcare facilities and oncologists needed annually in Indonesia over an 11-year horizon. This study highlights the way that a decision-analytical modelling approach can be used to inform workforce planning as a component of achieving UHC.

Inevitably, this model is also associated with limitations. First, this forecast focused solely on oncology services in the public sector for HRH of the 10 most common cancers in Indonesia. The private sector and other staff categories outside this sector were not considered due to data constraints. Thus, one should be aware when using or interpreting this forecast, that it does not necessarily represent the whole picture for either oncology services or the Indonesian health system. Second, this study only focused on forecasting the demand-side, not the supply-side. Consequently, the gaps do not represent the labour market equilibrium of supply-demand gaps but compares the staff currently employed against the staff needed. Third, the source of salary costs used in this model was taken from only one referral hospital in Indonesia (the largest), as most of the oncologists are concentrated in this hospital and discounting was not applied in the model. Also, the shortage calculation is only based on the need to meet the HRH minimum standard requirements for each facility level, which are still not well-defined, particularly for the oncologist group, regardless of local conditions. Thus, these uncertainties should always be

taken into consideration when using the forecast as a decision-making aid. Lastly, the model did not account for the wider disease burden associated with the cancers considered.

Comparison of study findings to the existing literature

This study contributes to the literature in two main areas. First, the study provides valuable insights into the future requirements to meet important aims related to UHC and important SDGs (particularly SDG 3 target 4) in Indonesia. Several studies exist to analyse the current situation and the requirements of HRH in general in Indonesia.[11 17] However, the forecasting of the number of oncologists needed on annual basis has not yet been explored. Second, there are methodological contributions in terms of the use of decision-analytical approaches to inform HRH planning. In this study, decision-analytical modelling (a Markov model as part of a health service development approach) was used to inform HRH planning. This method has been applied in Ghana and has demonstrated the capability of projecting general HRH requirements.[21] This study adapted and developed this method in a specific sector (the oncology field) in Indonesia. While the application of this method in this area is still underutilised, this study demonstrates the potential scope of such modelling approaches.

Most countries, including Indonesia, offer no official guidelines for calculating the number of oncologists needed. One international guideline by the National Cancer Institute (NCI) estimated the number of oncologists needed in LMICs based on the estimated number of cancer patients.[29] However, this guideline estimated a nearly twofold higher oncologist requirement in 2019 for Indonesia than is estimated by the current model. For instance, an estimated of minimum 557 surgical oncologists are needed in 2019 according to the current model, compared with 994 using the NCI guideline. This guideline target is unlikely to be feasible and realistic in the short term given the long training period and limited subspecialty training places in Indonesia. Moreover, the slow economic growth in Indonesia, estimated at 5% gross domestic product growth,[30] is unlikely to permit the massive increase in workforce needs as calculated by this guideline. The requirements estimated by the current study are more plausible than those of these existing guidelines, given the current level of economic growth in Indonesia.

Conclusion

Scaling up oncology services in Indonesia to attain the targets set out in the SDGs, especially SDG 3 target 4 will require expansion and/or increase in the number and capability of healthcare facilities, especially in eastern Indonesia. If the trend of service development from the previous 5 years continues, equitable UHC for cancer care may not be fulfilled, as the Maluku and Papua regions are predicted to have no tertiary hospital even until 2030. This study predicts that the persistence of inadequate and inequitable access to facilities and HRH provision may remain a major barrier to attaining the SDG targets and achieving UHC in cancer care. Indonesia has a median of 39% of its HRH-related oncology requirements. Substantial staff shortages have been observed among healthcare professionals based on model requirements and these shortages are even more severe among oncologists. Addressing this issue requires at least a 47.6% increase in HRH expenditure, which may be difficult to meet due to budget constraints. Therefore, the government needs to prioritise investments to improve the quality and quantity of certain staff groups in more disadvantaged regions, particularly in Maluku and Papua.

This study demonstrates the application of decision-analytical modelling approach to planning HRH and facilities in a LMIC context. Such methods allow a in depth understanding of the resources needed to achieve UHC and allow a focus on particular gaps and challenges. Such methods could be utilised more widely in different disease areas and contexts to facilitate a detailed analysis of the HRH and facility requirements needed to achieve health-related SDGs.

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