Indonesian Life Table: Evidence of demographic mortality from the 2010 Population Census

Aja Nasrun
S2104571
a.nasrun@student.rug.nl
aja.nasrun@bps.go.id

Abstract:

Life table is one of the important tools in demography. It has been used in many purposes and it can illuminate the past clarify the present and show the future. Moreover, we try to construct it with the novel prominent demographic data source in Indonesia, Population Census 2010 and 2000. Both censuses have an increasing quality that is showed by small number of Myers Index 3.0 and 7.3 respectively. We employ the indirect r-method and Trussell's variant of Brass method simultaneously. The r- method reveals that the Indonesian life expectancy at age five, e_5, is 66.57 years and it is decreasing gradually to 10.03 year at age 70. The most prominent and the smallest level of West Model life table is 17 at age 40 until 60 whereas level 21.2 is the highest level at age five. The Brass method yields probability of dying by age one, q(1), is greater at 0.0329 than age two, q(2), at 0.0290 and three, q(3), but then smaller up to age five, q(5), at 0.0328 until age 20, q(20), at 0.0635 corresponding with its time location. Those probability estimates transform into their new probability by age one. By assuming that new q(1) is equal with Infant Mortality Rate (IMR) the estimate of IMR in 2010 falls at 30.15 per 1000 or at level 21.65. The combination from r-method and the Brass method yield median level of all mortality estimate (childhood and adulthood mortality) at level 18.11. The median level as representative value is chosen to reduce the extreme and variation over the value of level. We employ level 18.11 and yield a new complete conventional life table. The expectancy of birth starts at 60.82 years then leaps to 64.21 before decrease gradually until 4.25 years at above age 85. The level of our estimate is lower than other official calculation and it is 10-year gaps from government target and around eight years of UNDP and WHO estimate. Maximum level (optimistic scenario value) in this work seems close to other estimate rather than to use the median.

Key words: Life table, Indonesia, indirect, Brass, r method.

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Chapter 1

Introduction

1.1 Background

Life table is one of the important tools in demography. It is a statistical device to present the previous mortality experience and survival of a population aggregate (Preston et al. 2002, Hinde, 1998, and Nambodiri, 1987). The life table uses for widely purposes from academic model to the social purposes. For instance, the life table employs for descriptive purposes, as a tool for deriving the expectation of life at birth or reveal the health status for specific period and for comparing mortality levels over time or space (Wunsch, et.al 2002). In other words, this table is the model or guidance of life since they give us the story of the past and envisage the event in the future.

Constructing a life table requires reliable data of mortality specifically the Age Specific Death Rates (ASDR). They are the main foundation calculating directly from information on deaths and population by age, and sex (Kosen 2002, Preston et al. 2002, and Nambodiri, 1987). Those mortality events or exposures and occurrences generally gain from vital registration system.

However, the registration data are not available and or reliable in every nation. According to the United Nations in the 2000 Revision of Population Estimates and Projection, the life table method was used for only 14 per cents of the developing world (Hill, 2003 in Hill et.al 2005) and this number expecting remain stable. Moreover, Indonesia is one of the developing countries in which data from vital registration are unavailable and poor in its quality. Vital events mostly collect at the village level. In rural area particularly, registration of vital event for adults is inadequate because it is not mandate by law and is not culturally normative (Muhidin, 2002). Every region can produce and collect their own information

based on their necessity. Lack of human resources and registration system complete the problem of reconciliation in the national level.

Consequently, census and survey primarily utilize to remedy in order to construct The Indonesian Life Table. Despite the information of death relatively easy to count due to it only happens once for every person in fact the information from the vital registration system cannot be used, deficient and disbelief and many other problems. As a result, Indonesia has often constructed the national life tables based on model life tables (Hidajat et al. 2004) or in other words to construct life table from incomplete information practically shove Indonesia to choose the West Model of Coale-Demeny Model Life Table. But the approximations from the Model West Life Table have been questioned (Heligman, 1975, Sinquefield and Kartoyo, 1977; Mcdonald, 1978, Gardiner, 1978; Agung et al. 1997, Muhidin, 2002 cited by Hidajat et al. 2004 p.1) since there are not based on the Indonesian's demographic experience.

Due to lack of mortality information in the past, some studies have endeavoured to construct or estimate the mortality rates or life table by difference sources in Indonesia. Instead of using the West Model Nitisastro (1970), Hull and Rohde (1978) used the United Nations and employed South Model Life Table. Then Heligman (1975) tried to use survival ratio between 1961 and 1971 Population Censuses meanwhile Djodi (1996) combined between childhood mortality and survival ratio between 1980 and 1990 Censuses. Moreover, surveys more utilize than other in Indonesia Mc. Donald (1978) built Indonesian Female Life Table based on Indonesian Interensal Population Census or Survei Penduduk Antar Sensus (SUPAS) 1976, Peter Gardinier (1978) observed the age-sex specific death rates from the Sample Vital Registration Project (SVRP) 1974-1977 (Muhidin, 2010). Kosen and colleges (2004) employed National Socio Economic Survey or Survei Sosial Ekonomi Nasional (SUSENAS) 2000 while Hidayat and colleges in 2004 built another model life table of Indonesia from the Indonesia Family Life Survey (IFLS). Moreover, Rajagukguk (2001) built from the three successive 1996, 1998 and 1999 SUSENAS. Recently Muhidin (2010) has examined the Indonesian adult mortality experience by using Indonesian Population Census 2000, SUPAS 2005 and SUSENAS 1998.

The previous studies have explored the Indonesian life table maximizing the information from the relevant data sources, census and survey, and it yields mortality level of certain age groups and by sex. The combination between census and survey has employed solely and or simultaneously in order to improve the method in constructing the 'truly' Indonesian Life Table and to depict mortality event or level in Indonesia. However, the availability of data requirement from the complete enumeration such as census or the incompleteness of surveys hampered the methods, which are taking into account. In short, the timing and data availability from different sources flourish Indonesian mortality research.

Therefore, this work not only tries to take a possible way in order to construct the Indonesian Life Table from the availability of the 'fresh' Indonesian decennial Population Census 2010 data set. Nevertheless, in other way it is also can to reveal the Indonesian mortality experience and its level employing simultaneously child and adult mortality estimate that is infrequent from previous approach.

1.2 Research Objective

Therefore, the objective of this paper is to construct Indonesian life table using possible indirect techniques for total of population by using the latest Population Census 2010 and or 2000.

1.3 Research questions

The objective above leads to a main and several sub research questions.
To what extend Indonesian Life Table base on the data of Population Census 2010?

- What does the method that might be appropriate with the data from the last Indonesian Population Census 2010 to construct the national Life Table?
- How does the Indonesian Life Table and the level of mortality for the total of population of the national level?

1.4 Structure

This piece of work presents into five chapters; in the beginning, we describe the main background of constructing life table in Indonesia at the first chapter, and the second one serves conceptual method and the theoretical framework. Data and method present at the third of this paper describing the demographics source that we use; Population Census 2010 and 2000 in Indonesia. Result of the research at the chapter four describes the calculation and the findings. In addition, discussion and conclusion furnish at the last chapter in this paper.

Chapter 2
Theoretical Framework and Conceptual Model

Every person will die, rise again in miracle or a sequence of previous life. In some believe when people had born they will die in a certain time. They believe that God decides for how long people will live in this earth. It writes in the Holy books. However, for statistical purpose United Nations has recommended the following definition the event of death as:

> *Death is permanent disappearance of all evidence of live at any time after life birth has taken place (postnatal cessation of vital function without capability of resuscitation). This definition therefore excluded the fatal death* (United Nations 2001, p.10)

As we mention in the beginning, study of mortality has started since seventeen century. In 1662, John Graunt (1620-1674), a merchant, started his 'Natural and Political Observation' for the London Bills of Mortality. He felt that it contained wealth information that never been used. He listed eighty-one causes of death from thirty-two of data from the annual Bills from 1629 through 1660 (Graunt, 1962). This consider as a milestone of today's mortality study that is the life table. Over the times, the methods have expanded complementary to provide various demographic data needs as the consequence of availability of data collection.

2.1 Mortality Experiences

The population growth in every region will increase or decrease with the change of balancing equation which are the shift of births deaths and mobility. It means that they will exhibit their demographic experience in a certain phase during the years. The phases are known as The Demographic Transition which was formulated by the Office of Population Research in 1944 with the assumption that there is no mobility among the regions. It starts with high stabilizing fertility and mortality events and it

mark with low population growth. Then mortality decline faster due to improvements in nutrition, hygiene and housing and recession of diseases than fertility at high level. It leads a high population growth. Then the next phase is fertility follows to fall. At the last stage, both fertility and mortality combine together decline at lower level (Kirk, 1996). Most developed countries are in this phase with zero population growth, meanwhile developing countries experiencing low mortality and fall of birth rates.

Abdel Omran (1971) has depicted those mortality declines as an epidemiology transition and put it as a central point of view of population dynamics. The decline of mortality is accompanied of different pattern of diseases whereby communicable disease and malnutrition are swapped by non-communicable disease and ageing problem. Alternatively, it changes from pandemic infectious diseases to an era in which chronic organ diseases (Riley, 2001). In the beginning, Omran's description of the epidemiology transition, death ruled by pandemic infectious or *The Age of Pestilence and Famine*, which was often seasonal in their effects, is characterized by high mortality and fluctuating, thus precluding sustained population growth. In this stage, the average of life expectancy at birth is low and facilitating between 20 and 40 years. The next stage Omran described as *The Age of Receding Pandemics* and it indicates with mortality declines progressively and average life expectancy at birth increases steadily from about 30 to about 50. The third is *The Age of Degenerative Diseases and Man-Made Diseases* whereas mortality continues to decline and eventually approaches stability at a relatively low level and life expectancy of birth rises gradually until it exceeds 50 years (Omran, 1971). The fourth stage and a possible future stage are added since mortality at old age has declined even further, which expected to be stable. The fourth stage is *The Age of Declining Cardiovascular Mortality, Ageing, Lifestyles Modifications, Emerging and Resurgent Diseases* marked with long longevity and large part of population in the old age. The last one is *The Age of Aspired with Paradoxical Longevity and Persistence Inequities* during this possible future stage of life expectancy can reaches 90 years (Omran, 1988).

Consequently, the transitions come along together carve demographic experience for every country in the world. It is complementary and alters with the change of time. Demographic transition depicts increasing population growth of fertility and mortality whereas epidemiology transition clarifies its mortality experience. (United Nation, 2012)

2.2 Mortality Data Sources

The increasing of demand for demography data source especially for mortality for many purposes provides with three main sources. They are census, survey and vital registration system. Vital registration system conducts to provide mostly official information of every person i.e. birth, death, and marriage. It is very update information that can use for demographic analysis. Nevertheless, in most of developing countries it cannot provide in a good manner. Statistically sample survey is a bridge to fulfil this

deficiency. The official statistic conducts a large sample survey every year with a various issues, namely Intercensal Population Survey, Demographic Health Survey (DHS) and Socio Economic Survey. Census completes the coverage among the country for the population demographic event including mortality occasion in every ten year. Albeit in particular time and in particular purpose every source conducts, but they completing each other and became a precious source for all demographic events in every region (Banda, 2003).

All the three main sources of demographic data sources that are mentioned above simultaneously and complementary have conducted to provide and harmonize for various demographics data needs i.e. population size, total fertility rates, infant mortality rates and number of migrants. Statistic-Indonesia or Badan Pusat Statistik (BPS) responsible for the Census and Survey for national or macro statistics, meanwhile Ministry of Home Affair supervises civil administrative system for many purposes. Many obstacles for the administrative system preclude this source such as un-standardized operational data collection, lack of human resources, and compilation in national level hamper the national report. Although this source is still running in every administrative region its uses are limited to the local or particular issue. Moreover, registration of vital events for adults is inadequate because it is not mandate by law and is not culturally normative (Muhidin, 2002). Therefore, those Census and Survey are bridging the demographic data sources especially mortality in Indonesia. Annual Socio economic survey, four-year IDHS, and SUPAS flourish the demographic data source in between population censuses that conduct also for every ten years.

2.3 Methods to Estimate Mortality

There are two types of method to construct life table, which are direct and indirect method. The gold standard mortality estimate is using direct method. However, this attempt needs information from the reliable demographic data sources. Moreover, the civil registration system that is the prominent source mostly available in the developed countries. Therefore, numerous indirect methods are available to estimate mortality from the incompleteness of death registration (Preston, 1984) from other sources, population census and surveys, in the undeveloped countries.

Direct method means that life table yields and directly from the mortality event and exposure that is Age Specific Mortality Rate (ASMR). Meanwhile indirect method signifies life table generates from various approximation. Moreover, it sometimes divides into certain age groups or regimes (childhood and adulthood mortality estimate). Mortality estimate may approach with decreasing of population between two periods, family member who is survive and or may follows a mathematical function or general experiences and accomplish several assumptions. Those indirect mortality methods for childhood and adulthood will explain in the next section.

The mathematical function estimate or method knows as empirical "universal" mortality models or model life tables. The model life tables present a set of mortality experiences from observed similarities in the age-patterns of mortality for different populations in the past and or function that assume that certain region will follow certain mortality experiences. Model life table does not built solely to study of age patterns of mortality or disease processes. Nevertheless, they are an aid to estimate demographic parameters for developing countries with limited data and for preparation of other issues such as population projection (United Nations, 1982). The best known are (i) the UN Model Life Tables, (ii) The Coale-Demeny Model Life Tables, (iii) the UN Model Life Tables for Developing countries, (iv) the Ledermann System of Model Life Tables and (v) the Brass Logit System (Murray et al. without year). Nevertheless, approximations from the Model as we mention above have questioned but it still helps.

2.4 . Indirect Mortality Estimate

Since direct method which uses complete registration statistic and incomparable with the indirect technique and mortality vary among ages, United Nations (2002) resumes from many scholars indirect manual in situation where reliable and complete data registration systems are not available in most of developing countries. In general, it separates into two parts; child mortality and adult mortality estimate.

2.4.1 Child Mortality

Over the past years, great advances have made to compensate for the lack of reliable vital registration data. A number of methods based on information obtained exclusively from censuses or surveys have developed, and census and survey data have commonly accommodated for childhood mortality information.

United Nations in 1991 had guided two main methods to handle this issue which are well known as Brass method (1964) and Brass-Macrae method (1984). Hill also in 1991 argued that in the developing countries child mortality can be obtained by variety of approaches. He concluded there is not single approach which is can satisfy all measurement purposes and that all approaches are sensitive to the quality of data collection. Nevertheless many needs can be met by relatively inexpensive data collection and analysis (Hill, 1991). Tabulation of data requirement and important assumptions that are employed to apply these methods can be seen in the box below (UNFPA 2012 and United Nations 1990):

<table>
<tr><td>Box 1. Tabulations of data required</td></tr>
</table>

- Number of women, by five-year age/duration of marriage/time since first birth group
- Number of children ever born alive by the women by corresponding five-year group
- Number of children born alive by the women that have died before (or are still alive at) the time of the survey, by corresponding five-year group
- Number of births in the year before the survey by five-year age group (optional)

<table>
<tr><td>Box 2. Important assumptions</td></tr>
</table>

- Population age patterns of fertility and child mortality are adequately represented by the model patterns used in developing the method
- In any time period, mortality of children does not vary by five-year grouping of mothers
- No correlation exists between mortality risks of children and survival of mothers (by mortality or migration) in the population (see Effects of HIV/AIDS on child mortality estimation)
- Any changes in child mortality in the recent past have been gradual and unidirectional
- Cross-sectional average numbers of children ever born by age (duration of marriage, time since first birth) adequately reflect cohort patterns of childbearing

2.4.2 Adult Mortality

a.   Distribution Death by Age

Furthermore four major methods have developed to provide adult mortality estimates. The first method derives from the Demographic Balancing Equation formulated by Brass based on the assumption of a stable, closed population. In that context, the rate of entry into the population aged x and over by those reaching age x is equal to the rate of departure from the population through death plus the stable population growth. If it assumed that the completeness of death reporting does not vary by age then the estimate of completeness of death reporting can be obtained by the slope of the line relating entry rate to the exit rate. The intercept is equal to the stable rate of population growth. If the two or more census enumerations are available the simple method can be generalized. Under such circumstances, the growth rate of each segment can be calculated from the census counts and the assumption of stability is no longer needed. The relation of entry rate minus the growth rate to the death rate, segment by segment, estimates an intercept that captures any chances in census coverage between two censuses, and the slope that estimates the coverage of death recording relative to an average of the coverage of two censuses (Hill, 1987 in Hill 2005). This method is referring as General Growth Balance (GGB). In short Tabulation of data and important assumptions that are required can be seen below (UNFPA 2012 and United Nations 2002)

- Number of deaths of women (men), by five year age group, and for open age interval $A+$ (preferably as high as possible), over a specific period
- Number of women (men), by 5-year age group, and for open age interval $A+$, at some time point at or close to the period over which the deaths were measured

- The population is stable, although this can be relaxed to some extent (see below)
- That the completeness of reporting of deaths is the same for all ages from a minimum age (usually age 15)
- The population close to migration, although this can be relaxed if net migration is not significant relative the mortality rates, or if one has reasonably accurate estimates of the number of migrants by age to allow for in the balance equation (which is very seldom the case).

Bennent and Hirouchi (1981:1984) propose an alternative way of using two censuses and a distribution of deaths by age. The age specific growth rates for the intercensal period are used to expand the observed the distribution of deaths by age to that which would have been observed for a stationary population or life table distribution. Since the life table deaths above age x are equal to the life table population of exact age x (everyone dies), the ratio of expanded deaths above age x to an estimate of the population aged x derived from the two age distributions estimates the completeness of death recording relative to census coverage. This method is referring as Synthetic Extinct Generation (SEG).

Application of these two methods to data containing stimulated errors indicate that GGB method is more sensitive to even to age reporting errors, whereas the SEG method is much more sensitive to even slight changes in census coverage that distort the growth rates. The process by applying the GGB in the first then SEG gives the results closest to the truths (Hill, 2003, Hill 2005).

- Number of women (men), by 5-year age group, and for open age interval $A+$, at two points in time, typically two censuses or surveys
- Number of deaths of women (men), by five year age group, and for open age interval $A+$, over the period between the two censuses/surveys

- That the coverage of each census is the same for all ages
- That the completeness of reporting of deaths is the same for all ages from a minimum age (usually age 15)
- The population close to migration. Although the method can be adapted to allow for migration, one usually does not have accurate enough estimates of the net numbers of migrants. For national populations net migration is often low enough to ignore, but for situations where migration is significant, one needs to consider this when deciding on an estimate of completeness.

b. Survival of Siblings

The second one is using information on the survival of siblings to estimate mortality arose from the consideration that, on average, the ages of siblings are likely to be very close to the age of a respondent. The proportion of a respondent's siblings who are still alive would be a good estimator of survival to the age of respondent. The problems are found first field experience suggest it was difficult to make clear to interviewers that respondent was not to be included among his or her siblings then siblings who died before or shortly after the birth of the respondent were likely to be omitted (United Nations 2002 p. 73). Application of the sibling methods requires that information on sibling survival be available for each respondent aged 15 years and over (or aged 15-49 years). Key assumptions of the method are that surviving siblings who have died are equally likely to be reported, and that the data are not affected by substantial selection bias. Comparison with other sources suggests that sibling survival tends to underestimate adult mortality (Stanton et.al 1997 in Hill 2003 p.3).

c. Survival of Parents

The third is estimation which drives information of survival of parents. In this method they do not assume a population closed to migration, and they are applicable units, to populations of urban and rural areas and other populations not closed to migration. This is a strong advantage. But this method is far widely available than census age distributions and data on intercensal deaths. This relative scarcity of data is a severe practical disadvantage, however this disadvantage can be reserved by the inclusion of the necessary questions in future population censuses and survey (United Nations 2002, p.55). Surviving parent is clearly and indicator of adult mortality – the higher the proportion, the lower the mortality, other things being equal. The first method is formalized by Brass and has been refined and improved by Timaeus among other (Brass and Hill in Hill 2003 p.3).

d. Intercensal Survival Method

The last method is Census survival methods which are the oldest and most widely applicable methods of estimating adult mortality. Two censuses conducted five or ten years apart provided information about intercensal cohort survival. The ratio of the second to the second to the first

population can be interpreted as a life table survivorship ratio, and such ratios can be combined across age groups to provide a summary measure of adult mortality. Apart from the census coverage (coverage improving from one census to the next appears to imply fewer intercensal death and hence lower mortality) and to age exaggeration (United Nations 2002 p.5 Hill, 2003 p.4). And since survival method should be used only for population in which migration is negligible, it can only be applied to national populations or to sub population whose characteristic does not change widely overtime. One method is known as Preston and Bennett method or variable *r* method. It is applicable whatever the length of intercensal period and since this census-based method does not required information on registered deaths or assumption of stability. The population is assumed to close to migration between the censuses, but simple correction is possible when it is not closed Spoorenberg 2008, Presston and Bennet 1983).

In short, the first consist of comparison with recorded age distribution. The second is alternative data collection methodologies which collect information about death and age. Then for the third approach is based on asking respondent about the survival or otherwise of close relatives. The last method estimates mortality from changes in age distribution, interpreting cohort attrition as mortality. Hill (2005) suggested that the first two and the last offer the best potential of adult mortality estimates for developing countries but the last methods is also relatively able to achieve. However the combination between availability of data and time of research can be hampered the work.

Moreover the possible attempt now to construct Indonesian Life Table by using the recent Population Census 2010 implying indirect method is using the combination between child and adult mortality. The rational of both methods expect to fulfill the shortage of each other. This venture has also presented by Djodi (1996) and she yielded a ten year apart of age group to control the ratio and assumed a stable population.

2.5 Indirect Life Table Estimation Techniques for Indonesian

In the previous, we have mentioned that due to lack of mortality data in the past some studies have endeavoured to develop with other way to estimates the mortality rates apart from West Model of Indonesia. The West model presumes as a general pattern of other models and a good compromise or an "average" model (UN, 1989). Again, their utilization has questioned nevertheless it is very useful. All possible methods from the various demographic data sources had tried to provide various needed.

Consecutively, In 1970 Nitisastro employed from the United Nations Life Table for the Indonesian population projection. The United Nations Model Life table was bridging the Indonesian demographic Life table analysis in the beginning. Afterwards Heligman (1975) initiated to construct Indonesian Life Table using the survival ratio between 1961 and 1971 Indonesian Censuses. Instead of

using the census, Sinquefield and Kartoyo (1977) operated Fertility Mortality Survey for 1965-1970 for Indonesian Life table. Afterwards Hull and Rohde (1978) introduced the new regime of mortality. They utilized the South model nevertheless the coverage only for Java. Mc Donald (1978) built a female life table from the SUPAS 1976 and followed by Peter Gardnier (1978) to observe the age specific death rates from the Sample Vital Registration Project (SVRP) (Muhidin, 2010). More recent, Djodi (1996) combined between childhood mortality and the survival ratio between Population Census 1980 and 1990. And their research inspired this paper by a different approach. Hidayat and colleges in 2004 with Indonesia Family Life Survey (IFLS) found that IFLS provides a stronger base for estimation of Indonesian mortality while there is no gold standard for Indonesian mortality. Using another survey Kosen and colleges in 2002 initiated that Indonesian life table based on National Socio Economic Survey (SUSENAS) 2000 still had some limitation. The ASDR as the basis for life table composition may also influence by age misreporting by respondents and it due to there are no other better data source. Rajagukguk (2001) presented another Life Table from the three successive SUSENAS 1996, 1998 and 1999. Recently Muhidin (2010) has examined the Indonesian adult mortality experience by using Indonesian population census 2000, SUPAS 2005 and SUSENAS 1998.

Various attempts have been trying but in fact, there is no gold standard for Indonesia mortality. The chance for every effort to construct the 'truly' Indonesian Life Table and to depict mortality event or level in Indonesia is increasing together with the complete of coverage for national and regional level of the Indonesia demographic data sources nevertheless there is no officially Life Table which is published by official institution. A lot of big question of Indonesian mortality but we focus on the constructing life table from the latest data and the possible method.

2.6 Conceptual Model

United Nations (2002) suggests the conceptual model in an attempt to explain the possible direct-indirect methods of mortality. The model life table shows in the figure 2.1 below. The three various data sources contribute indirect and direct mortality estimate, lastly they adjusts to construct life table with different methods

Indirect method of mortality estimate will employ the new Indonesian 2010 population census. Brass method is the appropriate way to produce probability of dying from the available data that covered by the census. Moreover, it will utilize to complete the table from adult mortality estimate.

Although Hill (2005) suggested that the first two (Distribution of death by Age and Sibling Survival Methods) nevertheless the last method (Intercensal Survival Method) offer the best potential and the only possible way now of adult mortality estimates for Indonesia from the new Indonesian 2010

population census. Furthermore r method is one of the methods that widely use and appropriate for adult mortality and in this case we use the Indonesian 2000 population census to utilize this technique.

We venture to combine simultaneously the both methods and produce the Indonesian Life Table. We argue that rather they moderately use only for child or adult mortality estimate solely, nevertheless they yield mortality estimates which can complete each other. Brass method will occupy the mortality under age five meanwhile r-method manages the rest of age. And abridge life table for five year age groups are set as a traditional pattern of table in our analysis.

Figure 2.1. Conceptual Model to Construct Life from different Demographic Data Sources
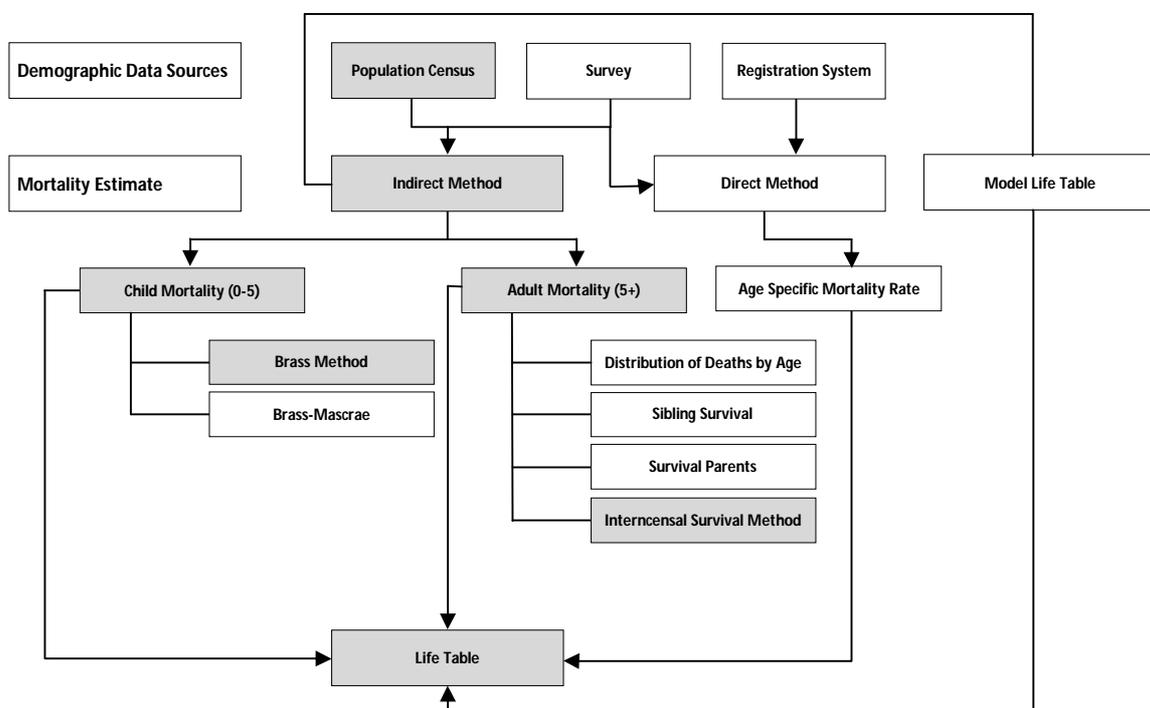
Chapter 3
Data and Method

We employ two main distinct indirect procedures to estimate mortality in Indonesia that are the Brass method for childhood mortality and the r method from intercensal survival method for adulthood mortality. Both methods will generate to build Indonesian life table. Moreover, the main procedures need data and information from the Indonesian 2000 and 2010 census to produce the objective of this work.

3.1 Indonesian 2010 and 2000 Population Censuses

The last decennial Indonesian Population Census is in 2010. The 2010 Indonesian population census is the novel complete enumeration. The Indonesian Population Census 2010 (SP2010) was undertaken during 1 until 31 of May 2010 with the census date was 15 of May 2010. It covered all person including foreigners who had stayed or intended to stay more than six months or more. Moreover, that was one of the most successful modern censuses in Indonesia.

The main source for this work is from this census. Two types of information that we need are: (1) For the Brass method, we want the information of proportion of death of children by women age group 15 until 49. Instead of by using the information of that proportion (death) which is commonly inconsistence, those indicators are approached by the difference of the average of child ever born and child surviving by women of that age group. Mother usually reports under estimate of their children who had died. They forget, some time it is a sorrow story or they do not know whether their children still alive or not. Therefore, those differences believe as the best approximation of the proportion of death. (2) the r-method is one of the technique which is use the growth between two periods to produce the probability of dying. Therefore, beside we need the total of population by age group in 2010 we need the total in 2000. The fair source for this work is using the information of 2000 Indonesian population census.

The Indonesian Population census 2000 (SP2000) was carried out within official period of June 1st through June 30th 2000 and Census Day was on 30th of June 2000. It was the fifth census since independence. Unlike previous censuses that based on sampling, the 2000 enumeration process covered entire population of Indonesia. But accessibilities forced sample enumerations in some regions i.e. northern parts of Aceh, southern parts of Maluku, Poso in Middle Sulawesi, Jaya Wijaya in Papua where political and ethnical turbulence occurred and the size of population in that areas were estimated (Muhidin, 2002 and BPS, 2002).

3.2 Quality of the Data

Population census ideally is a complete enumeration. However, accessibilities for SP2000 forced sample enumerations in some regions as we mention above. However in 2010 Population Census can be held in peace and complete across the countries. Therefore, both censuses have a different quality and surely time reference.

Moreover age is an important variable in this study. The accuracy of age data collected by house-to house surveys varies in different time and depends on numerous factors. A variety of irregularities and misstatements have been noted with respect to age-related data. Misstatement of age is a common example of content error in census and surveys. Of these irregularities, age heaping is a common phenomenon. Age data frequently display excess frequencies at round or attractive ages, such as even numbers and multiples of 0 or 5 leading to age heaping (Shyrock et.al. 1976). Age heaping is considered to be a measure of data quality and consistency and investigate through the calculation of Myer index.

A high Myers' index implies poor age reporting whereas a low Myers' Index indicates good age reporting. The maximum value of Myers' Index is 90 and the minimum value is 0. In the case of Indonesia, Myer index gives 7.3 and 3.0 point for 2000 and 2010 census respectively (Rahmat, et all. 2011) in all the two censuses (2000 and 2010), the index is on the lower side (less than 10), which implies that the age reporting is good for both and the 2010 population census has a better quality than 2000.

Although the index reveals in a good manner we also employ a survival ratio indicator. Preferably the survival ratio between two censuses will produce value less than one. That means in a close population or small migration the population at certain age due the death will decrease at the next period. But several overwhelming problems such as age heaping, under coverage as we mention above will make the value greater than one. Nevertheless since we employ the r-method which is use the growth the shortcoming of the ratio neglected. The ratio may indicate that our raw material is not clean from the defect but in some degree the improvement is needed. And we will show the Indonesian survival ratio assessment in the next discussion.

3.3 Data Preparation

Indonesian population in 2000 was more than 205.132 million this number has increased to 236.641 million in 2010. In some reasons, capturing total number of population in census may produce unstated number. This means that this person known in number but lack of individual of information in detail. Moreover, this number can be noise for our analysis. Prorate technique to distribute the 'unknown' or non-stated person into certain age group will employ for first time.

Differ with the Brass method which is does not need any data adjustment the r-method need the population 'exact' ten years apart. Both data (SP2010 and 2000) have different time reference. Therefore for the convenience the middle of the year is the consensus of this work and also commonly applicable in the demographic method. The 30 of July is the date, consequently we shift or estimate the population 2010 which had 15 of May as the position to the date.

We compute the multiplier factor as the exponential of the initial total growth with the exact shortage of ten year apart for both censuses. Afterward we estimate the population for every age group with the number. The population in the new date is a multiplication of the population and the factor and it shows in the following equation:

$$k = \exp\left(r \cdot (10 - (t2 - t1))\right)$$
$$Pt = P0 \cdot k$$

Another issue is to handle the survival ratio which is grater than one. At certain age group (10-14 and 30-35) reveals a value greater than one. There are two suspicions, first thing is the population in 2000 was under coverage as we mention previously or a high immigration at the age groups during ten years. We think that the second rationale is easy to handle. Therefore we subtract the population in 2010 with the recent migration (2005-2010). Nevertheless this reduction is not change the survival ratio whether it with or not recent migration. However we keep the subtracted population in our analysis. We want to treat and follow our initial population in 2000 until next ten year even though we cannot handle the immigration between 2000 until 2005. Since the PC2010 did not ask the migration over 10 years and using other survey (SUPAS 2005) presumes less coverage.

In short, we do pro-rate PC2000 then we subtract PC2010 with the recent migration and afterward we move the PC2010 to the 30 of June 2010.

**Table 3.1 Population of Indonesia According to the Age Group
and Survival Ratio 2000 and 2010**

| Age Group | Population Census | | Population Census | | | Survival Ratio[*] |
	Pro rate 2000	Subtracted 2010	2000[*]	2010[*]		
0-4	20,719,467	22,678,702	20,719,467	22,721,775		
5-9	20,920,775	23,244,312	20,920,775	23,288,459		
10-14	20,843,710	22,665,497	20,843,710	22,708,545		**1.0960**
15 – 19	21,533,083	20,876,055	21,533,083	20,915,704		0.9998
20 – 24	19,651,943	19,874,267	19,651,943	19,912,014		0.9553
25 – 29	19,031,885	21,277,715	19,031,885	21,318,127		0.9900
30 – 34	16,737,052	19,799,431	16,737,052	19,837,036		**1.0094**
35 – 39	15,195,931	18,480,909	15,195,931	18,516,009		0.9729
40 – 44	12,701,551	16,509,224	12,701,551	16,540,580		0.9883
45 – 49	9,837,589	14,032,118	9,837,589	14,058,769		0.9252
50 – 54	7,527,522	11,556,100	7,527,522	11,578,048		0.9115
55 – 59	5,786,291	8,445,710	5,786,291	8,461,751		0.8601
60 – 64	5,403,863	6,057,226	5,403,863	6,068,730		0.8062
65 – 69	3,614,661	4,693,282	3,614,661	4,702,196		0.8126
70 – 74	2,872,057	3,455,933	2,872,057	3,462,497		0.6407
75+	2,755,077	3,834,204	2,755,077	3,841,486		0.4157
Total	**205,132,458**	**237,480,685**	**205,132,458**	**237,931,726**		

Note :
* 30 June

3.4 Method

3.4.1 Trussell version of the Brass method

T.J. Trussell developed this version and it base on the Coale and Demeney model life table and has the advantage over earlier versions of producing estimates both of probabilities of dying from birth to different ages in childhood and of the time point to which probability refers (United Nations. 1990).

To employ the Brass method we need information of total number of child ever born and, number of children surviving reported by women in age group 15 until 49. These numbers can be yield from the questions of total number of children from women ever married that are living in the household and or living elsewhere.

We use the procedure and use the sheet (CM_indirect) which is using the adjustment factor developed by Trussel to gain probability of dying from age 0 to x from UNFPA Tools of Demography for indirect estimation of child mortality and check its calculation with the Mortpak 4. Furthermore, the calculation can follow as:

Step 1 Calculate of average parity per women

Average parity is the average number of children ever borne by women in a given five-year age group. It is calculated as

$$P(i) = \frac{CEB\ (i)}{FP(i)}$$

Where P(i) is the average parity of women of age group i, CEB (i) is the total number of children ever borne by this women, and FP (i) is the total number of women in the age group irrespective of their marital or reporting status. Although parity values are needed only value for age groups 15-19, 20-24 and 25-29 – P(1), P(2) and P(3) respectively – it is worth calculating the whole set up to age group 45-49 in order to check the quality of the basic data. Note that the denominator, FP (i) should include even those women who did not respond to the questions on children ever born (those of not-stated parity). Their inclusion is based on the assumption that they are childless, an assumption supported by evidence from a large number of surveys showing that the vast majority of younger women reported as being of not-stated parity are, in fact, childless.

Step 2 Calculation of the proportion dead among children ever born

The proportion of children dead is given simply by the ratio of the total number of dead children to the total number of children ever born (including those who have died) for each group. Thus

$$D(i) = \frac{CD\ (i)}{CEB\ (i)} = 1 - \frac{ACS(i)}{P(i)}$$

Where D(i) is the proportion of children dead for women of age group i, CD (i) is the number of children dead reported by those women, and CEB (i) is the total number of children ever borne by those women.

As we mention in previous part, instead of by using the information of proportion death which is commonly inconsistence. Another approach is using the average of child surviving (MCS) and average child ever born P(i) as the equation above. The P(i) is the result of the step one meanwhile the MCS (i) is the total number of child surviving or CS (i) divided by total number of women of age group i or FP(i).

Step 3 Select a model life table family

The age pattern of child mortality has an important bearing on the translation of a proportion dead into a standard *q(x)*, and on the translation of that *q(x)* into a common index such as U5MR. For this chance, we follow West model of Coale-Demeny as previous studies had done moreover, it is a good compromise as an "average" model (UN, 1989) as we mention above.

Table 3.2. Coefficient value for estimation of child mortality multipliers, k(i), Trussell version of the Brass method, using the Coale-Demeny West Mortality Model

Age group of mother	Age group index	Age x of children	Coefficients		
	i	x	a(i)	b(i)	c(i)
15-19	1	1	1.1415	-2.707	0.7663
20-24	2	2	1.2563	-0.5381	-0.2637
25-29	3	3	1.1851	0.0633	-0.4177
30-34	4	5	1.172	0.2341	-0.4272
35-39	5	10	1.1865	0.308	-0.4452
40-44	6	15	1.1746	0.3314	-0.4537
45-49	7	20	1.1639	0.319	-0.4435

Source: United Nations 1990

Steps 4 Calculation of the multiplier, k(i)

The basic estimation equation for the Trussell method is

$$q(x) = k(i).D(i)$$

Where

$$k(i) = a(i) + b(i)\frac{P(1)}{P(2)} + c(i)\frac{P(2)}{P(3)}$$

Thus the mortality measure q(x), the probability of dying by exact age x, isrelated to the proportion dead D(i) by multiplying factor k(i) that is determined by the parity ratios P(1)/P(2) and P(2)/P(3) and there coefficient a(i), b(i) and c(i). These coefficient were estimated by regression analysis of simulated model cases. Table 3.2 shows the coefficients for the seven age groups of women, from ages 15-19 trough ages 45-49 (i = 1, 2, ... 7) for west Coale-Demeny model life table.

Step 5 Calculation of the probabilities of dying by age x, q(x)

Once D(i) and k(i) have been calculated for each age group i, estimates of q(x) are obtained simply as their product, as already indicated in equation :

$$q(x) = k(i).D(i)$$

Step 6 Calculation of the reference dates for q(x), t(i)

Under condition of steady mortality change over time, a reference time, t(i) can be estimated for each q(x). This reference time is expressed in terms of number of years before the survey or census and is estimated using coefficient applied to parity ratios. As before, the coefficients were estimated by regression analysis of simulated model cases. The estimating equation is :

$$t(i) = e(i) + f(i)\frac{P(1)}{P(2)} + g(i)\frac{P(2)}{P(3)}$$

Table 3.3 shows the coefficient e(i), f(i) and g(i) for use in equation above for each age group of women. Once the value of t(i) are obtained, they can be converted into actual dates by subtracting them from he reference date of the survey or census expressed in decimal terms.

Table 3.3. Coefficient value for estimation of the time reference, t(i), for the value of q(x) Trussell version of the Brass method, using the Coale-Demeny West Mortality Model

Age group of mother	Age group index	Estimated q(x)	Coefficients		
	i	X	e(i)	f(i)	g(i)
15-19	1	q(1)	1.097	5.5628	-1.9956
20-24	2	q(2)	1.3062	5.5677	0.2962
25-29	3	q(3)	1.5305	2.5528	4.8962
30-34	4	q(5)	1.9991	-2.4261	10.4282
35-39	5	q(10)	2.7632	-8.4065	16.1787
40-44	6	q(15)	4.3468	-13.2436	20.199
45-49	7	q(25)	7.5242	-14.2013	20.0162

Source: United Nations 1990

Step 7 Convert each estimate of q(x) into a new estimate of $\hat{q}(1)$

Each of the probabilities of dying by exact ages of childhood, *q(x)* , is converted into a new value of α, the level parameter of a system of relational logit model life tables, and the α is then used to estimate the corresponding probability of dying between birth and exact age x, :

$$\alpha = 0.5\left(\ln\left(\frac{q(x)}{1-q(x)}\right)\right) - Y^s(1)$$

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Where the estimates of *q(x)* come from Step 5 and the *Y$_s$(1)* values are logit transformations of the standard life table. Thus, one obtains a series of values of α corresponding to the probabilities of dying estimated from data on the different age groups of respondents. Then for each a:

$$\hat{q}(1) = \frac{e^{2(\alpha+Y_1^s)}}{1 + e^{2(\alpha+Y_1^s)}}$$

To apply the relational model approach, it is necessary to choose a standard life table. In order to apply the indirect estimation procedure, it is necessary for Steps 4 and 5 to identify an appropriate model pattern, and the standard should draw from the same family model. The precise level of mortality within the family is less important than the family itself (the appropriate selection of which allows β to be assumed to be 1 in the relational logit model life table), so we are choosing a standard with a life expectancy of 60 years as recommend.

3.4.2   The r-method

Then To gain adult mortality with the step of computational the r method describes as follow:

Step 1. Variable r method
Bennet and Hirouchi (1981) have shown that at any moment in time the following relation obtains in any closed population:

$$N(x) = N(a) \, _{x-a}P_a \, exp\left[-\int_a^x r(u)du\right] \tag{1}$$

Where N(x) is the number of people aged x at moment, $_{x-a}P_a$ is the probability of surviving from age a to age x according to period mortality rates, and r(u) is the growth rate of population aged u at that moment. If equation (1) were zero, the equation may be written as:

$$N(x) = N(0) \, exp\left[-\int_a^x r(u)du\right] p(x)$$

Or

$$p(x) = \frac{N(x) \, exp\left[-\int_a^x r(u)du\right]}{N(0)}$$

Since *p(x)=l$_x$/l$_0$* in conventional life table notation , it s clear that *N(0)* is directly analogous to l$_0$, the radix of a period life table and $N(x) \, exp\left\{-\int_a^x r(u)du\right\}$ is directly analogous to l$_x$,

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the number of surviving to birthday x. Since the size of the radix is arbitrary. We may choose $l_0 = N(0)$. Therefore,

$$_nL_y = \int_y^{y+n} N(x)\, exp\left[-\int_a^x r(u)\,du\right] p(x)$$

This may approximate for five-year age group as

$$_5L_y = \ _5N_y^* \, exp\left\{5 . \ \sum_0^{y-5} \ _5r_x + 2.5 \ \ _5r_y\right\}; \tag{2}$$

Also

$$T_j = \sum_{y-j}^{\infty} \ _5L_{y'}$$

$$l_j \cong \frac{_5L_j + \ _5L_{j-5}}{10},$$

And

$$e_j = \frac{T_j}{l_j}.$$

A life table may be constructed with only one pass through the data. But the life table will lack of l_0 and e_0, however unless an independent estimate of $N(0)$ is available. To use equation (2) a census is needed to provided the set of 5Ny and presumably, intercensal growth rates provide the set of $_5r_x$'s. Since growth rates relate to the intercensal period, it advisable to use an estimate of the mid-interval age distribution, such as the mean of two census age distribution at the beginning and end of period, as the value for $_5N_y$. The estimate of average number of intercensal person-years lived in a particular age group x to x+5 applies to the geometric mean of quantities pertaining at two points in time:

$$_nN_x^* = [\ _nN_x(t1). \ \ _nN_x(t2)]^{1/2}$$

The transformation of the Brass method will produce the probability of dying by exact age 1. While the r-method finally shows the distribution of expectancy of life above age five. Those values are interpolating into a level of the West Model Life Table. We do standardize those results into same family of life table for comparability and convenience. Afterward, the age specific mortality rates $_nm_x$ from the representative level are also imputing to construct the Indonesian life table.

3.5 Life Table Method

The simple measure of mortality is the number of deaths. However, this is not much use for practical purpose since the number of people who are at risk of dying heavily influence. Because of this, demographers typically measure of mortality using rates (Hinde, 1998). Death Rate is counted by the number of death or event divided with the number of people exposed to the risk of dying during that period. But death rate or crude death rate as the total number of deaths in a given time period divided by the midyear population (as the approximation to the correct exposed to risk) or number of person-years lived does not provide a great deal of information about mortality which in particular the risk of dying varies greatly with age. Because of this, demographers often find it useful to use age-specific death rate. Age-specific death rate at age x to n years or $_nM_x$ [O,T] is defined as number of deaths of people aged range x to $x+n$ between time O to T divided by number of person years lived in the age time O to T. This age rate theoretically will transform into probability in the life table methods.

Subsequently, life table is another way to depict mortality experience. The construction of life table might be outdated, unavailable or incomplete; but scholars have developed in two types of life table. First is cohort or generation life table recorded the mortality experience of the group of persons born during a given year. Then the second is period life table, which is a synthetic construction that show what the mortality experience of a hypothetical group of person, or cohort would be if they experienced the death rates observed in a population during a given year or other period (United Nation, 2002 and 1991). Period life table will present exactly same with the cohort life table. It attempts to show what would happen to a cohort if it were subjected for all of its life to the mortality conditions of that period. It is a model of what would happen in the hypothetical cohort if a certain set of mortality conditions pertained through its life (Preston et al. 2002). Cohort life table have the advantage of conceptual simplicity, but the advantage of requiring data, and referring to mortality risk over a very long time span. They represent an amalgam of mortality experience over a very long period. Albeit mortality condition of period table is conceptually, more complex but they have advantages of providing mortality measures in particular time. Then most life table available for human population are period life table (United Nation, 2002).

The period's mortality condition can be produced into a period life table by the set of age-specific death rates for that period and these rates transformed into columns of probability in the life table (Keyfitz, 1977). The probability of surviving from birth to age x is designed as $l(x)$ for a continuous function of x and x as l_x for discrete x. Life table usually present the probability multiplied by 100.000, which to say, on a radix l_0, equal to 100.000 birth. If l_x is a probability what a life table show is $100.000l_x$, but it would be pedantic to repeat the 100.000 each time. When the l_x is interpreted as surviving members of a cohort, the radix is arbitrary and the setting $l_0 = 100.000$ enables to think as the number of persons reaching the given age. The difference in number of survivors for successive ages, l_x-l_{x+1}, is designated as

d_x and more generally the difference for ages n years apart l_x-l_{x+n} is $_nd_x$. This divided by l_x is the probability of dying during the next n years for a person who has reached age x:

$$_nq_x = \frac{l_x-l_{x+n}}{l_x} = \frac{_nd_x}{l_x}.$$

The total number of years lived during the next n years by those who have attained age x is:

$$_nL_x = \int_x^{x+n} l(a)da,$$

Which is also the number of persons aged exactly x to $x+n$ (or x to $x+n-1$ at last birthday) in the stationary population. Setting n equal to infinity to $\infty-x$, where ∞ is the highest age to which anyone lives, gives

$$_\infty L_x = T_x = \int_x^\infty l(a)da.$$

The quantity T_x is the total number of years remaining to the cohort, when it reaches age x until the last member dies at age ∞. Dividing by l_x gives the average share in this total person age x:

$$e_x^0 = \frac{T_x}{l_x} = \frac{\int_x^\infty l(a)da}{l_x}.$$

In terms of probabilities e_x^0 is the mean of the distribution of years to death for a person age x and is called the expectation of life.

The age-specific death rate in the life table population is $_nm_x=_nd_x/_nL_x$ and this may be compared with the probability $_nq_x=_nd_x/l_x$ and one can think of $_nq_x$ as something else than n times $_nm_x$. It is distinct from $_nM_x$ the observed death rate in a real population; $_nM_x<_nm_x$ for increasing population at certain ages.

In briefly, the conventional set of life table functions include: (1) probability of death within elementary age interval (x, $x+1$) $_xq_1$, (2) probability of survival from birth to exact age x l_x, (3) number of deaths within the elementary age interval (x, $x+1$) $_1d_x$, (4) central death rate for the age interval $[x,x+1)$ $_1M_x$, (5) number of person-years lived within the elementary age interval ($x,x+1$) $_1L_x$, (6) number of person years lived after the exact age x T_x, (7) and life expectancy at exact age x e_x. The first three functions are frequency (or intensity) measures since they show frequencies of events (deaths or survival). The last three functions are duration measures since they show amounts of lifetime and measured in person-years (Preston et. al. 2002 and Brass, 2008).

3.6 Assumptions and the Rational of the Method

As we highlight at the second chapter before, several assumptions constrain the both methods. The Brass method is assumed that population age patterns of fertility and child mortality are adequately represented by the model patterns used in developing the method. Then in any time period, mortality of children does not vary by five-year grouping of mothers, afterward there is no correlation exists between

mortality risks of children and survival of mothers (by mortality, migration or even Effects of HIV/AIDS on child mortality estimation) in the population. Any changes in child mortality in the recent past have been gradual and unidirectional and cross-sectional average numbers of children ever born by age (duration of marriage, time since first birth) adequately reflect cohort patterns of childbearing.

The survival method (r-method) should be used only for population in which migration is negligible or assumed extremely small number; it can only be applied to national populations or to sub population whose characteristic does not change widely overtime. And the national level is one of the reasons for this work beside the availability of data set. And it is applicable since this census-based method does not required information on registered deaths or assumption of stability (Spoorenberg 2008, Presston and Bennet 1983). And those assumptions are desirable in developing country such as Indonesia.

This work is different with previous study. The research of Djodi in 1996 seems quite similar with this study nevertheless we combine two different methods rather than we assume in stable population furthermore both methods strongly applicable when they employ solely. So this attempt in some how reveals the child and adult mortality analysis. And simple correction is possible when the assumption in Brass is not closed we can initiate the net migration in the equation (Spoorenberg 2008, Presston and Bennet 1983).

And briefly the figure 2 below depicts the procedure that we try to estimate mortality.

Figure 3.1. Procedure indirect method child and adulthood mortality estimate
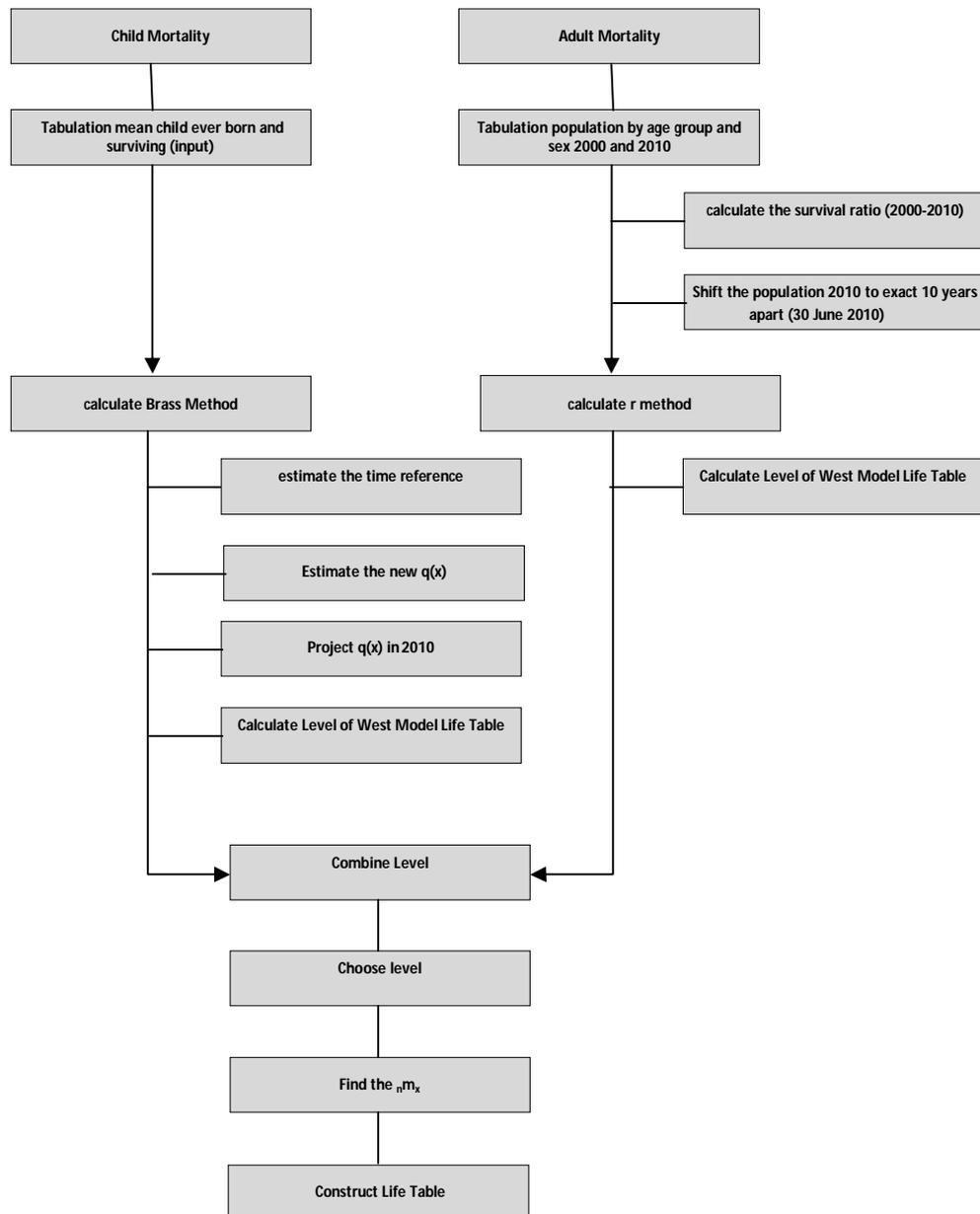
Chapter 4

Finding

Due to the lack of information that we get, we only can examine the national mortality indirect estimate for total of population. However, we consider that mortality may vary between sex and place. Moreover, we start our finding with the r-method to get the better insight of the combination of both methods.

4.1 Adulthood Mortality

In the absence of accurate life table estimates in which to compare the results of this application, careful examination becomes important in assessing the reliability of the life expectancy estimates. Table 4.2 presents the application of indirect procedure of r method for Indonesian population in 2000 and 2010 with corresponding with interpolated West mortality level (Coale and Demeny, 1983) implied by the estimated life expectancy at age x (e_x).

Albeit Indonesian population censuses counted for its good coverage; the age distributions of population are irregular and age specific rates of growths are roughly similar. Between 2000 and 2010 annual growth rates ranged from 0.0431 at ages 50-54 to -0.029 at ages 15-19.

This estimate is starting at age five. The set of these estimated e_x follows an expected smooth and declining trend with age, roughly indicating that the estimates are consistent. In both sex mortality levels are steady for the range 10-70, except for the values corresponding to e_5, which are higher than the following values. The mortality level is 2-4 levels higher than lower value.

Table 4.2 Application of the r method to Indonesians Population: 2000-2010

Start of age interval	2000	2010	Mean number of person year lived in Interval	Average annual growth rate in Interval	Sum of age specific growth rates from age 5 to mid point of interval	Stationary population in interval	Stationary population above age x	Number surviving to age x in stationary population	Estimate life expectancy at age x	Implied West mortality level
X			5Nx	5rx	Sx	5Lx	Tx	lx	ex	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
0	20,719,467	22,721,775	21,697,536	0.0092	0.0231	22,203,751	328,083,876	-	-	
5	20,920,775	23,288,459	22,072,893	0.0107	0.0729	23,742,795	305,880,125	4,594,655	66.57	21.2
10	20,843,710	22,708,545	21,756,156	0.0086	0.1212	24,558,344	282,137,330	4,830,114	58.41	18.8
15	21,533,083	20,915,704	21,222,149	-0.0029	0.1353	24,296,930	257,578,987	4,885,527	52.72	18.0
20	19,651,943	19,912,014	19,781,551	0.0013	0.1313	22,557,521	233,282,057	4,685,445	49.79	19.2
25	19,031,885	21,318,127	20,142,595	0.0113	0.1630	23,707,769	210,724,536	4,626,529	45.55	19.4
30	16,737,052	19,837,036	18,221,237	0.0170	0.2338	23,020,746	187,016,766	4,672,852	40.02	18.3
35	15,195,931	18,516,009	16,774,028	0.0198	0.3257	23,231,827	163,996,020	4,625,257	35.46	18.0
40	12,701,551	16,540,580	14,494,517	0.0264	0.4411	22,530,885	140,764,194	4,576,271	30.76	17.3
45	9,837,589	14,058,769	11,760,289	0.0357	0.5964	21,351,610	118,233,309	4,388,250	26.94	17.7
50	7,527,522	11,578,048	9,335,631	0.0431	0.7933	20,637,963	96,881,698	4,198,957	23.07	17.8
55	5,786,291	8,461,751	6,997,296	0.0380	0.9959	18,943,673	76,243,735	3,958,164	19.26	17.7
60	5,403,863	6,068,730	5,726,656	0.0116	1.1200	17,550,861	57,300,062	3,649,453	15.70	17.6
65	3,614,661	4,702,196	4,122,723	0.0263	1.2147	13,891,147	39,749,202	3,144,201	12.64	18.1
70	2,872,057	3,462,497	3,153,488	0.0187	1.3272	11,890,567	25,858,055	2,578,171	10.03	19.3
75+	2,755,077	3,841,486	3,253,243	0.0332	1.4571	13,967,487	13,967,487	-	-	

4.2 Childhood Mortality

To complete mortality evidence for every age group, the Brass method is deployed. Probability of dying is gained by mean of childbearing and child surviving. The number of mean child ever born and dead can check several numbers of data quality should increase with five-year group.

Table 4.2 Indirect childhood mortality estimate for Indonesia, 2010

| Age of mother	Age group index (i)	Mean children ever born	Mean children surviving	Proportion dead		Age x	Prob of dying by age x q(x)	Time location	$\hat{q}(1)$
(1)	(2)	(3)	(4)	(5)		(6)	(7)	(8)	(9)
15-19	1	0.0647	0.0628	0.0289		1	0.0329	2009.5	0.329
20-24	2	0.5194	0.5054	0.0269		2	0.0290	2008.2	0.242
25-29	3	1.1974	1.1634	0.0283		3	0.0287	2006.4	0.221
30-34	4	1.9043	1.8429	0.0322		5	0.0328	2004.2	0.232
35-39	5	2.4511	2.356	0.0388		10	0.0400	2001.6	0.258
40-44	6	2.8458	2.7041	0.0498		15	0.0507	1998.9	0.306
45-49	7	3.1381	2.9411	0.0628		20	0.0635	1995.9	0.350

Table 4.6 presents the means of children ever born, surviving and dead are increasing by the age of mothers and those (column 3, 4 and 5) are the basic input of the method. The column 7 lines up the estimate probabilities of dying. The probability of dying by age one, $q(1)$, from the women age 15-19 is 0,0329 and this mortality level would refer to June 2009 (2009.45).

From those mortality estimates we convert each estimate into an estimate of q(1) which will make it possible to compare across the age groups (UNFPA). Each q(1) is converted into its logit Y(n) by means of the identity $Y(n)=0.5 \ln(q(x)/(1-q(x))$. The value of α is then found by subtracting with the standard logit $Y^s(1)$, from the West model life table with expectancy of life at birth of 60 years. Each α is then used with the standard $Y^s(1)$ to get the new estimate of q(1). Column 9 indicates a declining trend in infant mortality over time, from around 35 per 1000 in the middle 1990s to around 24.2 in 2008. The apparent uptick in 2009 is likely exaggeration of mortality estimated from very young mothers.

Assumption that mortality does not vary by five-year grouping of mothers is generally incorrect when time dimension is age. Children of young mothers appear to have systematically higher mortality that was born to women after age 25. As a result indirect estimates derived from women aged 15-19 (particularly) and 20-24 (to some extent) tent to over-estimate the population level child mortality (UNFPA). Corrections for these effects are not widely used (Collumbian and Slogget 2001 in UNFPA). This distortion based on duration of marriage or time since first birth. However, these variants are not without their limitations.

The probability of dying by exact age 1, q(1), are identical as infant mortality rate (IMR). Therefore, we use our result and try to find the trend line from previous data sources. The sources are from 17 Indonesian demographic different census and survey and it has been collected from year 1971 of direct and indirect method. Moreover, the database containing of the latest child mortality estimates (in 2007) based on the research of the United Nations inter-agency group for child mortality estimation (www.childmortality.or). The Indonesian child mortality is depicted on the figure 4.1 below :

Figure 4.1 Indonesian child mortality estimate (IMR) 1971-2010
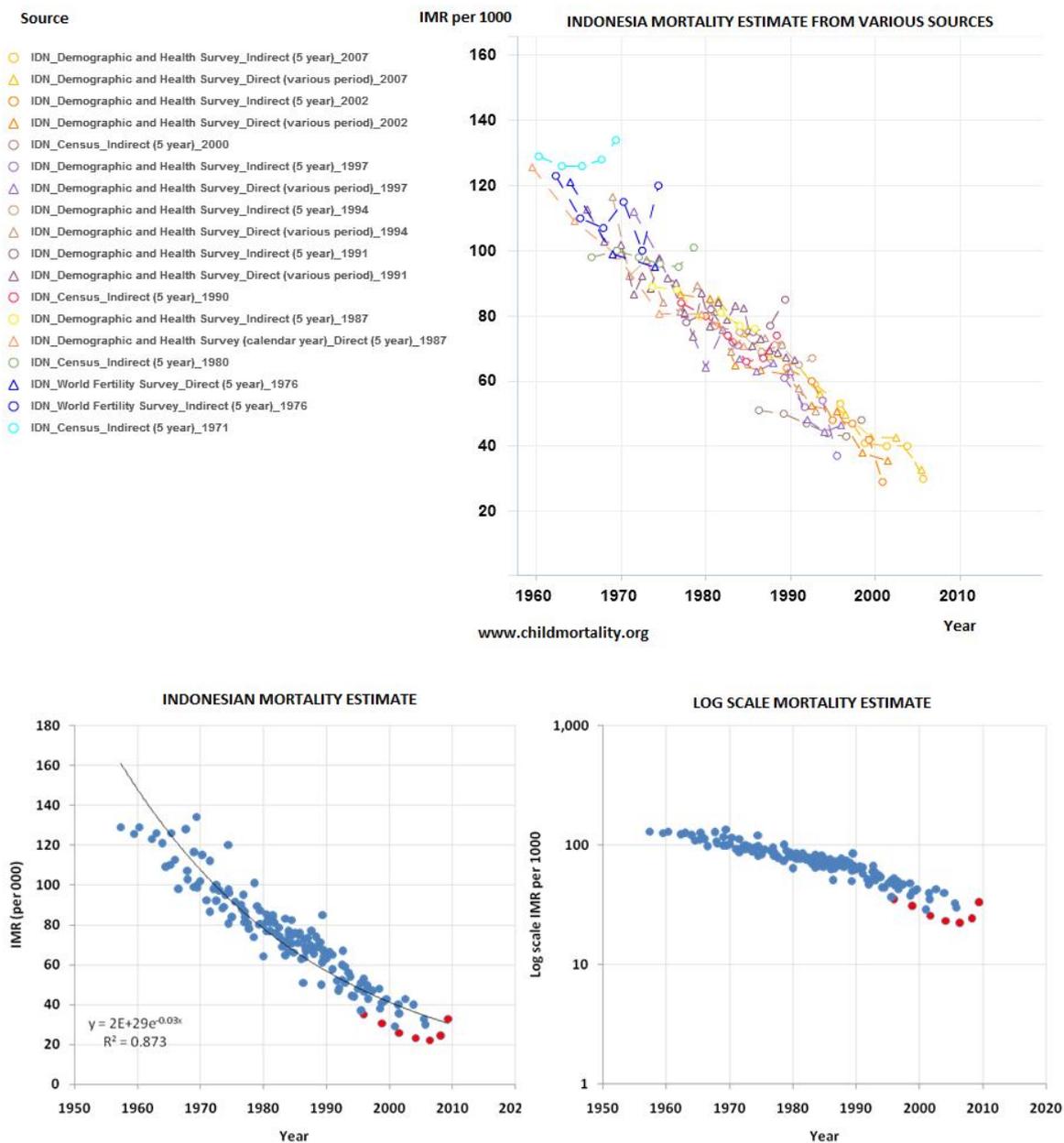
Top part of figure 4.1 tells the decreasing of Infant Mortality Rate (IMR) of Indonesia. The IMR slides down from 130 per 1000 in 1960s to 30 deaths per 1000 in 2000s. The bottom part combines IMR from previous estimate with our Brass new estimate of q(1) (column 8 of table 4.3) showed with the red

dots. We assume that probability of dying from birth to age one is equal to total number of death between birth to age one divided life birth or Infant Mortality of Rate (IMR)

We employ and assume that observe value will follow the exponential regression over the year and the log scale of the data shows appropriate direction. Moreover, infant mortality rates (IMR) have a strong negative correlation over the years. Consequently, the approximated IMR is estimated by 30.15 per 1000 in 2010. Furthermore, the value will complete the missing cell of adult mortality estimate. Due to comparison degree, again we find the appropriate level in the West model life table by 21.65.

4.3 Indonesian Life Table

For both methods, we connect the e_x for r method and IMR for method with the level in West model (column 11 at Table 4.2). Then we find the median value across all age and argue that it will give a better representative value across the levels. Median will reduce the extreme value of level estimate in young age (0 and 5) by more than 21. The median yields less value by 18.11 than the average by 18.68.

Table 4.4 Indonesian Life Table in 2010 (Level 18.11 West Model)

Age	$_nm_x$	$_na_x$	n	$_nq_x$	$_np_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x	e_x From r method	Deviation
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
0	0.07005	0.5	1	0.067676	0.932324	100000	6768	96616	6081969	60.82		
1	0.00670	2	4	0.026453	0.973547	93232	2466	367997	5985353	64.20		
5	0.00186	2.5	5	0.009243	0.990757	90766	839	451733	5617356	61.89	66.57	-4.68
10	0.00142	2.5	5	0.007093	0.992907	89927	638	448041	5165623	57.44	58.41	-0.97
15	0.00221	2.5	5	0.010975	0.989025	89289	980	443997	4717582	52.83	52.72	0.11
20	0.00305	2.5	5	0.015121	0.984879	88309	1335	438209	4273585	48.39	49.79	-1.40
25	0.00338	2.5	5	0.016737	0.983263	86974	1456	431231	3835377	44.10	45.55	-1.45
30	0.00387	2.5	5	0.019174	0.980826	85518	1640	423493	3404146	39.81	40.02	-0.21
35	0.00468	2.5	5	0.023114	0.976886	83879	1939	414546	2980653	35.54	35.46	0.08
40	0.00596	2.5	5	0.029372	0.970628	81940	2407	403682	2566107	31.32	30.76	0.56
45	0.00801	2.5	5	0.039287	0.960713	79533	3125	389854	2162425	27.19	26.94	0.25
50	0.01145	2.5	5	0.055678	0.944322	76408	4254	371406	1772571	23.20	23.07	0.13
55	0.01658	2.5	5	0.079615	0.920385	72154	5745	346409	1401165	19.42	19.26	0.16
60	0.02517	2.5	5	0.118416	0.881584	66410	7864	312388	1054755	15.88	15.7	0.18
65	0.03839	2.5	5	0.175148	0.824852	58546	10254	267093	742367	12.68	12.64	0.04
70	0.06038	2.5	5	0.262289	0.737711	48291	12666	209792	475274	9.84	10.03	-0.19
75	0.09581	2.5	5	0.386493	0.613507	35625	13769	143704	265483	7.45		
80	0.14984	2.5	5	0.545025	0.454975	21856	11912	79501	121779	5.57		
85+	0.23521	4.25		0.000000	1.000000	9944	9944	42278	42278	4.25		

We use linier interpolation and then finally, from appropriate age specific mortality rate (ASDR) at level 18.11 we can calculate the abridged life table for Indonesia that can be seen on the Table 4.4. The expectancy of birth stands at 60.82 and then increase to 64.2 when people reach exact age one decreasing by increasing of age. The mortality at young age especially at birth at this level (18.11) still high so that the expectancy falls before reaches their first birthday.

Chapter 5

Conclusions and Discussion

This paper tries to construct Indonesian life table or estimate mortality during intercensal period using possible indirect techniques for total of population by using the latest Population Census 2010 and or 2000.

5.1 Conclusions

Indonesian population in exact ten years apart has increased from to 237.931 million from 236.641 million in 30 of June 2010. We count that survival ratio between those two censuses has value greater than one at age group 10 to 14 and 30 to 34. Under coverage of the previous census (2000) can be the trigger of the result. Nevertheless the ratio is resulted to show the census coverage but we utilize the population and the growth in analysis. The r method produces life expectancy starting at age five until age 70. The e_5 starts at 66.57 years then decreases gradually until 10.03 year at age 70. We check whether the expectancy of life has a same degree, the expectancy at age x is implied into West model life table. The level 17 is the most prominent among the sequence of age 40 until 60 and as the minimum level. Moreover, the maximum level stands at level 21.2 at age group 5-9. Probability of dying by age one is greater than age two and three but then smaller up to age five until age 20 corresponding with its time location. Time location or reference for every estimate retreats according their probability of age. Probability by age one, q(1) is predicted in 2009.5 meanwhile probability by age two q(2) is in 2008.2. Those probability estimates transform into their new probability by age one and depicts a U shape probability during 1995.9 until 2009.5.

By assuming that q(1) is equal with Infant Mortality Rate (IMR) the estimate of IMR in 2010 falls at 30.15 per 1000 or at level 21.65. Median level of all mortality estimate (childhood and adulthood mortality) places at level 18.11 whereas the average at level 18.68. We employ level 18.11 and yield a new complete conventional life table. The expectancy of birth starts at 60.82 years then leaps to 64.21 before

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decrease gradually until 4.25 years at above age 85. Level of our estimate is lower than other official calculation and it is 10-year gaps from government target and around eight years of UNDP and WHO estimate. Maximum level (optimistic value) seems close to other estimate rather than to use the median or average to implement this effort.

5.2 Discussion

The Indonesian official mortality level or life table is estimated mostly by projecting previous trend using the logistic function and adapt the Millennium Development Goals (MDGs) target (UNFPA, BAPPENAS, BPS, 2008). The Indonesian expectancy at birth (e_0) was projected by 70.45 during 2005 - 2010 (2007) and 71.35 in between 2010 and 2015 (2012). Other international organizations also give a various estimate of life expectancy of birth for instance United Nations Development Program (UNDP) Indicator 67.8 in (2007) and 68.9 (2010), World Health Organization (WHO) produced 68.3 year in 2009. In addition, all those projections are higher from our estimate 60.82 years.

A high level of mortality means a high life expectancy of birth. We consider that r method reveals a different level for every age group, projection from Brass method deceives the child level and median completes the all reduction. Therefore, our combination between child and adulthood mortality and median reduces the level of mortality to construct Indonesian life table. Another issue is that the level shows a constant mortality experience during 2000-2010 rather than single year (2010). We assume that combination of child and adulthood will reveal a better estimate but we produce a differ level with official publication. Three scenarios can also be inferred which are optimistic level at level 21.65, moderate level by 18,11 and pessimistic at level 17,7. Nevertheless, we must consider that we have a different method.

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