International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Predictors of Health Behavior against Maternal Mortality with Dynamic System Models in West Sulawesi

Andi Musdalifah[a*], Ridwan Amiruddin[b], M. Tahir Abdullah[c]

[a,b]*The Concentration of Epidemiologyy, Public Health Faculty, Hasanuddin University*

[c]*Concentration of Reproductive Health, Public Health Faculty, Hasanuddin University*

[a]*Email: fa.musdalifah@gmail.com*

Abstract

Estimates of Maternal Mortality Rate (MMR) is an important aspect for health policy planning. This research aims to estimate the Maternal Mortality Rate (MMR) in 28 years (2007-2035); and to find out the most suitable strategies in decreasing the MMR in West Sulawesi. The method used was the dynamic system model continued with simulation based on pre-determined scenarios and the use of closed causal (loops) diagrams resulted in dynamic system behavior. The analysis used Powersim version 2.5 for Windows. The research samples were all data related to the study variables, namely the number of maternal deaths and determinants of maternal mortality (the use of contraceptives, birth attendants, and place of birth). The results showed that the estimated MMR for 28 years in West Sulawesi increased 70% from 293/100.000 live birth in 2007 to 449/100000 live birth in 2035 This increase can be prevented with the intervention of various risk factors, namely the contraceptive intervention (able to suppress 4.124 (23,31%) pregnancy), intervention of birth attendant (able to suppress 13/100.000 live birth (4,38%)) and intervention of place of birth (able to suppress 17/100.000 live birth (4,4%)) The combination of intervention of the use of contraceptives, birth attendants, and place of birth is able to suppres 30/100.000 live birth (10,2%). Policy interventions with contraceptive intervention, intervention of birth attendant and intervention of place of birth capable of pressing 70/100,000 KH (23.8%) AKI.

Keywords*:* Estimates; Maternal Mortality Rate; Dynamic Systems.

---

* Corresponding author.

E-mail address: fa.musdalifah@gmail.com.

1. Introduction

Estimated globally 289.000 (210/100.000 live birth) women died during pregnancy and giving birth at 2013, with highest mortality rate in developing country reached 286.000 cases (230/100.000 live birth). In Southeast Asia Mother Mortality Rate (MMR) reached 69.000 cases (190/100.000 live birth), MMR is one of the target of Millenium Development Goals that has been made for sure that is the fifth goals, increasing the mother's health where the target will be reached by 2015 is reduce mother mortality rate to ¾ [1]. MMR in Indonesia base on the data of Base Health Research (Riskesdas) 2013 as much 359/100.000 live birth, rise compared to Riskesdas data 2010 as much 226/100.000 live birth [2].

West Sulawesi is one of province in Indonesia that has highest maternal mortality. MMR in West Sulawesi Province from year 2009-2013 illustrate fluctuative value. In 2009 as much 283/100.000 live birth, in 2010 underwent decline to 210/100.000 live birth, and in 2011 became 185/100.000 live birth. In 2012 again increase became 243/100.000 live birth, and again decline in 2013 as much 222/100.000 live birth [3]. In 2014 MMR in West Sulawesi again increase to 358/100.000 live birth. Those rate is being far from 2015 MDG's target that is 102 per 100.000/ live birth, the 2015 West Sulawesi (The Draft Medium-Term Regional Development) RPJMD target is 142/100.000 live birth (Health Departement West Sulawesi, 2015) [4].

Revealed if there are 3 factors that influenced to the mother mortality (near determinant) that is complication in pregnancy, giving birth and porturition. Near determinant is directly influenced by interval determinant they are mother's health status, reproduction status, access to health service, health service behaviour/utilization health service and other unknown or unexpected factors. Advanced determinant which will influence the maternal mortality through its influence to the interval determinant, that comprise socio-cultural factor and economical factor, such as women status in family and society, family status in society and society status [5].

Family planning (KB) efficient to reduce maternal mortality either directly or indirectly [6]. Research to the benefit of using contraception also conducted by doing global analysis in 172 countries he found that using contraception efficient to reduce almost 44% globally mother mortality, with decline rate 27 per 100.000 live birth annually [7].

People who help during giving birth also play an important role, because mother who does not have a help from health career are at risk greater 4,32 times suffering obstetri complication[6]. The increasing coverage of trained rescuer who help giving birth efficient to reduce maternal mortality rate that caused by obsetry bleeding [8]. Previously that mother who were helped by shaman higher at death risk compared to the mother who were helped by health workers. Riskesdas data 2013 shows that there are still 12,9 % giving birth process are not helped by health workers [6].

Estimated 15% pregnant women will suffer a complication that threatening their life, who need immediate care, so giving birth in health facility give a chance to have a recommendation service if a complication occur[9]. Hernawati research outcome (2012), found that giving birth in health facility give a contribution in effort to lower MMR as much as 39 % [10].

Maternal mortality is a dynamic problem, the more increase population pregnant women, the more increase amount of maternal mortality [11]. The increasing population pregnant women should be followed by the increasing of health service providing [12]. There are many factors contributing to maternal mortality rate they are: poverty, maternal education level, disease that she suffer, the amount availability of health workers force, the health service she obtained (during pregnancy, giving birth, and after giving birth) [13].

The expectation of constructing dynamic system model is to help in compiling intervention program that suit in an area in pursuing MDG's attainment target. This research is aiming to estimate the number of maternal mortality as long as 28 years (2007–2035) and control strategies most appropriate risk factors in reducing the rate of increase in the number of maternal deaths by a dynamic model approach in West Sulawesi approach.

2. Method and Material

2.1 Research Design and Type

Research type that being used is observational by using study planning cross sectional with secondary data usage. This research is using Dynamic System method, that is a computer simulation begin with making a system operational model according to the existing problem, than be simulated to gain a model similar to the real condition.

2.2 Research Time and Location

This research were conducted in West Sulawesi Province and took time on February to June 2015.

2.3 Research Sample and Population

Population is all West Sulawesi Province data from 2007 to 2013. Research sample are all data that related to the research variable, they are: Maternal Mortality Rate, maternal mortality determinant such as contraception device, giving birth support, and where the giving birth took place.

2.4 Data Collecting

Maternal mortality determinant data were gained from West Sulawesi Province health profile. Resident data were attained from West Sulawesi Province Central Bureau of Statistics (BPS), and Family Planning data were taken from West BKKBN West Sulawesi Province.

2.5 Data Analysis

The research was conducted with several phases: case definition and identification, model formulation, model simulation, model validation and policy implementation. Methods usage are dynamic system approach modeling continued with simulation base on scenario that has been decided and then using a support device causal simple diagram (figure 1) resulting dynamic system behavior, and then research outcome data were analyzed using Powersim version 2.5 for Windows creating model plot diagram (figure 2).

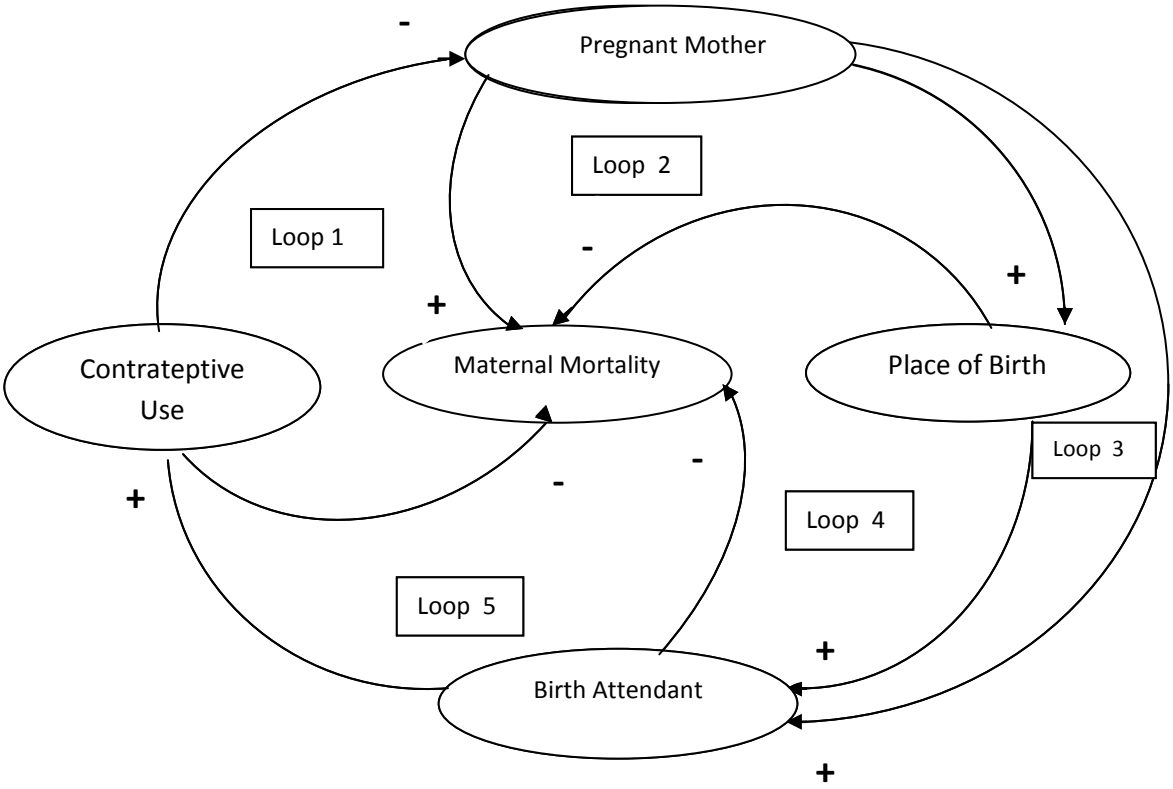

Figure 1: Causal Loop Maternal Mortality

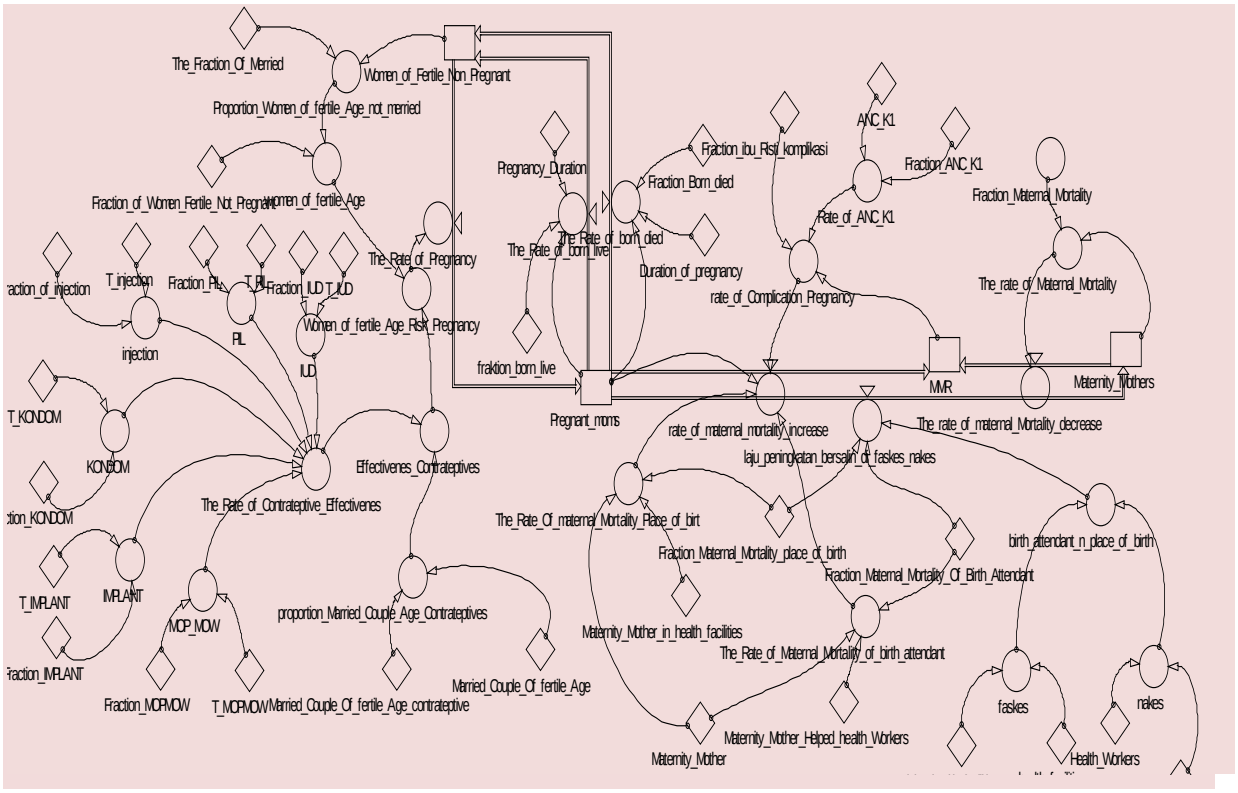

Figure 2: Flowchart Maternal Mortality

3. Results

3.1 Validation

Table 1 MAPE (Mean Absolute Percentage Error) test calculation were matched toward stimulation result MMR estimation 2007–2013 and we have value as much 34%. This mean that there is a deviation as much 34% between simulation outcome and actual data. Base on the model accuracy criteria MAPE value simulation outcome is satisfying. So it can be concluded that the model is accurate and acceptable. Table 2 is the outcome of the estimation model validation pregnant maternal with MAPE test as much as 1,4%. This mean that there is a deviation as much as 1,4% between stimulation outcome to the actual data. Base on model accuracy criteria MAPE value simulation outcome maternal death is very satisfying. So it can be concluded that the model is accurate and acceptable. Base on the outcome of MMR simulation in 2013 shows value as much as 325/100.000 live birth. While the actual data of MMR in 2013 is 207/100.000 live birth.

Table 1: Maternal Mortality Model Validation with the Test Mape

Year	Actual Value (X_i)	Simulation Value (F_i)	$(X_i - F_i)/X_i$
2007	294	294	0
2008	284	300	-17
2009	283	304	-26
2010	210	310	-106
2011	185	315	-139
2012	243	321	-88
2013	207	325	-132
2014	358	331	0
		Mape	**34%**

Source: Health Profile Data of West Sulawesi, 2007

3.2 Simulation 1 (No Intervention)

Simulation 1 (Table 3) is a simulation base on research variable value (usage of contraception device, birth attendant and place of birth) due to the real data without intervention is 294/100.000 live birth. Base on MMR, which than assumed stable during 2013–2035. Simulation outcome shows that during 28 years MMR estimation undewent 70% increase from 294/100.000 live birth 2007 become 449/100.000 live birth in 2035.

3.3 Simulation 2 (Intervention with contraception device usage)

Simulation 2 is intervention to the rising number of contraception device usage to the fertile couple (PUS).

Amount 44% of 141.961 PUS in West Sulawesi who utilize contraception device will be increased to reach 65% (Strategic Plan Target for the Ministry of Health Indonesia, 2010–2014), become 92.274 PUS KB. Stimulation outcome shows that during 28 years estimation as much as 37.708 pregnant mother before the intervention and become 33.583 pregnant mother after the intervention simulation 2. This shows that simulation 2 efficient to suppress pregnancy as much as 4.124 pregnancy.

Tabel 2: Pregnancy Mother Model Validation with the Test Mape

Year	Actual Value (X_i)	Simulation Value (F_i)	$(X_i - F_i)/X_i$
2007	27.235	27235	0
2008	28256	27613	643
2009	27264	27991	-727
2010	27502	28370	-868
2011	28154	28747	-593
2012	28426	29125	-699
2013	28856	29501	-645
		Mape	**1,4%**

Source: Simulation Data, 2015

3.4 Simulation 3 (Intervention with birth attendant)

Simulation 3 is an intervention to the increasing number of pregnant mother birth attendant by health workers. Amount 73,6% of 22.404 birth attendant in health facilities will be increased to reach 88% (Strategic Plan Target for the Ministry of Health Indonesia, 2010–2014), become 19.715 giving birth mother. Simulation outcome shows that during 28 years MMR estimation as much as 294/100.000 live birth before any intervention become 486/100.000 after the intervention simulation 3 given. This shows that simulation 3 efficient to suppress MMR as much as 13/100.000 live birth.

3.5 Simulation 4 (Intervention with Place of Birth)

Simulation 4 is an intervention to the increasing number of pregnant mother who place of birth in health facilities. Amount 73,6% of 22.404 giving birth mother were supported by health worker will be increased to reach 90% (Strategic Plan Target for the Ministry of Health Indonesia, 2010–2014), become 20.164 giving birth mother. Simulation outcome shows that during 28 years MMR estimation as much as 294/100.000 live birth, before any intervention become 482/100.000 after the intervention simulation 4. This shows that simulation 4 efficient to suppress MMR as much as 17/100.000 live birth.

Table 3: Results Simulation 1 maternal mortality estimation for 28 years (2007- 2035) in West Sulawesi

Year	Pregnant Woment	MMR
2007	27235	294
2008	27614	301
2009	27992	308
2010	28371	315
2011	28750	322
2012	29130	328
2013	29505	335
2014	29882	342
2015	30259	349
2016	30635	356
2017	31012	362
2018	31387	369
2019	31763	376
2020	32138	383
2021	32513	389
2022	32887	396
2023	33262	403
2024	33635	409
2025	34009	416
2026	34382	423
2027	34755	429
2028	35127	436
2029	35499	443
2030	35871	449
2031	36242	456
2032	36613	462
2033	36984	469
2034	37355	476
2035	37725	482
Average/ Year	**374**	**7,34**
percentage increase	**38,5**	**70%**

Source: Simulation Data, 2015

3.6 Simulation 5 (Intervention Combination KB Usage to PUS, Birth Attendant and Place of Birth)

Simulation 5 (Table 4) is an intervention base on Rencana Strategis Kementrian Kesehatan RI, 2010-2014 target. On the increasing amount of contraception device user to PUS as much 65% of total PUS, the increasing amount pregnant mother who giving birth with support by health care as much 88% of total giving birth mother and the increasing amount of giving birth mother as much as 90% who giving birth in health facilities of the total giving birth mother. Stimulation outcome shows that during 28 years MMR estimation as much as 294/100.000 live birth before any intervention become 469/100.000 after the intervention simulation 4 given. This shows that simulation 4 efficient to suppress MMR as much as 30/100.000 live birth.

Table 4: Simulation results for maternal mortality estimation for 28 years (2007- 2035) in West Sulawesi

Year	Pregnant Woment	MMR
2007	27235	294
2008	27613	301
2009	27991	309
2010	28370	316
2011	28747	324
2012	29125	331
2013	29501	339
2014	29878	346
2015	30254	353
2016	30630	361
2017	31005	368
2018	31381	376
2019	31755	383
2020	32130	390
2021	32505	398
2022	32879	405
2023	33252	412
2024	33625	420
2025	33988	427
2026	34370	434
2027	34742	441
2028	35145	449
2029	35486	456
2030	35857	463
2031	36228	470
2032	36599	477

2033	36969	485
2034	37339	492
2035	37708	499
Average/ Year	**374**	**7,34**
percentage increase	**38,5**	**70%**

Source: Simulation Data, 2015

3.7 Simulation 6 (Intervention Combination KB Usage to PUS, Birth attendant ***and Giving Birth Place)***

Simulation 6 is an intervention base on Strategic Plan Target for the Ministry of Health Indonesia, 2010–2014. On the simulation 6 will be simulated with additional to 100% amount of pregnant mother who giving birth in health facilities and helped by health care. After increasing the amount of giving birth mother to 100% birth attendant in health worker, amount of the mother who giving birth in health facilities and helped by health worker as much 27.235 people and increase amount of PUS follow KB program as much 63% (Strategic Plan Target for the Ministry of Health Indonesia, 2010–2014), equal to 89.434 PUS. Simulation outcome shows that during 28 years estimation from 294/100.000 live birth before any intervention become 469/100.000 after the intervention simulation given. This shows that simulation 6 efficient to suppress MMR as much as 70/100.000 live birth.

4. Discussion

Simulation outcome 1 (without any intervention to variable that influence the incident maternal mortality shows that during 28 years (2007–2035) are estimated the amount of MMR in West Sulawesi increase 70% from 294/100.000 live birth in 2007, become 449/100.000 live birth in 2035. Estimation for pregnant mother in West Sulawesi increase as much 38,5% from 27.235 people in 2007 become 37.708 people in 2035. Simulation outcome 1 shows that during 28 years increasing the amount of maternal mortality along with the increasing amount of maternal pregnancy. This suitable with Campbell and Wendy's research, 2006; the more increase amount of maternal pregnant the more increase of maternal mortality rate. About one third of one million women pass away every year relate to pregnancy condition [14]. Due to their life, probability risk of a woman in certain society will suffer a death caused by pregnancy [15].

Mother who giving birth in health facility in West Sulawesi 2007 as much 73,64% and in 2013 as much 85,74% [3]. Estimated 15% of pregnant women will suffer a complication that threatening life, who needs immediate care, so giving birth in health facilities give a chance to have a recommendation service if a complication occur [9].

Connection between giving birth place in health facility in suppressing maternal mortality rate can be seen at

simulation outcome 4 with intervention to increase the rate of giving birth mother in health facility as much as 73,6% of 22.404 giving birth mother in health facility at first condition (2007) be advanced to reach 90% of 20.164 giving birth mother in health facility. Stimulation outcome shows that the increasing of giving birth mother in health facility efficient to suppress maternal mortality rate as much 17/100.000 live birth.

Research outcome along with those above by Diana (2014), found that there is a correlation between giving birth place to mother obesity complication [5]. Mother who suffers obesity complication has maternal mortality risk 80% [9]. This case was supported by Hernawati research (2011), which has analyzed mother mortality in Indonesia and found that mother who giving birth and supported by health care has a contribution as much as 45% to lower MMR [10]. This research also in accordance with who conducted a research in South Ethiopia found that as much as 53 maternal mortality (489/100.000 live birth) and 83% (44 of 53 maternal mortality) take place at home, one of the MMR cause that increase if the villages do not have access road (P = 0,039) [5]. Scott research in 2013, found that women seeking professional care only when in emergency situation and probably cannot reach the facility at the right time if they live far from health center [17].

One of factor that influences many pregnant women who have difficulties to reach health facility and get helped by health workers and become a cause factor the rising of mother mortalility due to the cause of late to reach health service that also causing late to have assistance. Topography condition data of West Sulawesi that consist of many mountains and rivers they are 193 mountains with height reach 3.037 MdPL and consist of 8 stream rivers with each stream long 150 kilo meters [3]. concerning prevention recommendation delay to maternal in Majene district, found that geographical factor, distance and road infrastructure greatly influence toward public acces to arrange a recommendation particularly for remote area society and they have to use traditional transportation means to arrange maternal recommendation to the healthh facility [18].

Intervention to birth attendant to suppress maternal mortality were designed in simulation 3, that is intervention toward birth attendant variable with increasing amount giving birth mother be supported by health care, while other Constanta/variable value stay constant as much as 73,65% of 22.404 giving birth mother first condition (2007) be increased to 88% will be 19.715 giving birth mother. Simulation outcome shows that the rising giving birth mother rate be supported by health career have ability to suppress maternal mortality rate as much as 13/100.000 maternal mortality.

The existing of health worker will give useful contribution health career due to giving birth process can be any time either day time or night time, so the existence of midwife in place facilitate to get help quicker and handy [18]. Ideally trained health worker stay and be part from the society she serve. It will be more efficient if every village there is one midwife, in fact there is still one midwife who serves several villages. This argument be supported by the health profile data West Sulawesi Province 2007 the number of midwife as much as 271 people while the number of villages as big 379 villages, meaning one midwife can be serving two villages. Without health system that function well including quick emergency transportation and access to arrange operation reference and blood transfusion, complication that occurs at home with no supporting circumstance will worsen the risk in giving birth [19].

Maternal mortality relate to the existing intervention combination birth attendant and place can be seen simulation outcome 4, that is the intervention to the usage variable contraception device on PUS as big 65% of 141.960 is as big 92.274. Birth attendant intervention by increasing the number of giving birth mother be helped by health career, is as big 73,65% of 22.404 giving birth mother first condition (2007) be risen become 88% is 19.715 giving birth mother and increasing the number of giving birth mother in health facility as big 73,65% of 22.404 giving birth mother first condition (2007) be risen become 90% is 20.164 giving birth mother.

After combining treatment outcome simulation shows that the increase KB usage on PUS, increasing the number of giving birth mother be supported by health career and in the facility are the number of PUS follow KB program have ability to suppress the mortality rate 30/100.000 live birth. Intervention packet should be suited by the local condition, including local level and cause of death born, service accessibility and health resource system and the skill of health provider that is the skill of the midwife [19]. The declining maternal mortality rate require a cooperation with other several factor dother than individual determine factor including political ability, national resource reallocation (particularly health resource) in education and government sector [20].

Simulation 2 that is intervention to increase the number of contraception device user on PUS. Simulation outcome 2 toward pregnant mother estimation has ability to suppress the number of pregnant mother from 27.235 pregnant mother 2007 with estimation 2035 as big 38.288 to stimulation 1 (no intervention) become 33.584 pregnant mother. Stimulation outcome shows that the increasing number of KB participants on PUS without doing intervention to birth attendant and place have ability to suppress the number of pregnancy as much 6.349 pregnant mother that become a cause of MMR decline. Maternal mortality rate from 35 mortality per 100.000 women age of reproduction in KIA-KB area are 37% lower than in the area that does not have KIA-KB service (56 death per 100.000), so intervention for increasing contraception usage can lowering the maternal mortality rate in Bangladesh and the same countries [20].

5. Ethical Considerations

The study approved by the institutional ethics committee of health research Medical Faculty, Hasanuddin University, Indonesia (Number registry: UH15020108).

6. Conclusion and Suggestion

Simulation outcome toward the model that has been developed shows that if it is not given an intervention toward maternal mortality risk factor, MMR in West Sulawesi 2035 will undergo an increasing as big 70% that is 449/100.000 live birth. Some intervention simulation that can lower the MMR are: 1) raising the number of contraception device user on PUS as big 65%, 2) raising the number of giving birth mother be supported by health care as big 88%, 3) raising the number of giving birth mother in health facility as big 90% will be able to lower MMR as big 30/100.000 live birth. If all pregnant mother giving birth in health facilities and supported by health care will be able to suppress as much 70/100.000 live birth. An effective policy strategy is adding the number of giving birth helper (midwife) and controlling the fertility as the core to lower MMR. For model

verification and validation the more complete data are needed so we get the data more close to the actual condition.

References

[1] WHO, UNICEF and UNFPA. (2014). Population TUN.Trends in Maternal Mortality. Geneva: WHO, UNICEF, UNFPA, the World Bank and the United Nations Population Division.

[2] Riskesdas. (2013). 2013. Indonesian Basic Health Research: Research and Development Agency, Ministry of Health of the Republic of Indonesia.

[3] Health Office West Sulawesi. (2013)Health Profile West Sulawesi province from 2007 to 2013. Mamuju, West Sulawesi, West Sulawesi Provincial Health Office.

[4] Health Office West Sulawesi. (2015). Health Profile West Sulawesi Province. Mamuju, West Sulawesi, West Sulawesi Provincial Health Office.

[5] Diana *et al.* (2014). Analysis of factors associated with obstetric complications in the mother and baby western districts of Bandung district Parongpong. Journal of Padjadjaran University.

[6] Stover and Ross. (2010). How Increased contraceptive use has reduced maternal mortality. Maternal Child Health Journal. 14 (5): 687-95.

[7] Ahmed S. *et. al.* (2012). Maternal Deaths averted by Contraceptive Use: Results from a Global Analysis of 172 countries. Johns Hopkins University Bloomberg School of Public Health. Thesis.

[8] Montgomery A. et al. (2014). Maternal mortality in India: causes and healthcare service use based on a nationally representative survey. PLoS ONE Journal. 9 (1): e83331.

[9] WHO. (2012). Trends in maternal mortality: 1990 to 2010 WHO, UNICEF, UNFPA and the World Bank estimates the world. Geneva: WHO

[10] Hernawati. (2011). Analysis of Maternal Mortality in Indonesia in 2010. Bandung: Maternal Health Bina Bakti Husada.

[11] Campbell and Wendy. (2006). Strategies for reducing maternal mortality: getting on with what works. Lancet Journal. 368: 1284-99.

[12] Pettersson and Lidbom. (2014). Midwifes and maternal mortality: evidence from a Midwifery policy experiment in sweden in the 19th century. Sweden: Stockholm University.

[13] Sooka *et al.* (2011). Modeling the dynamics of maternal lhealth care in Uganda: asystem dynamics approach. World Journal of Modelling and Simulation. 3: 163-172.

[14] Karlsen S. (2011). The relationship between maternal education and mortality Among women giving birth in health care institutions: Analysis of the cross sectional WHO global survey on maternal and perinatal health. BMC Public Health Journal, 11: 606.

[15] Bale J. R. (2014). Reducing maternal mortality and morbidity. NCBI Journal. Yaya Yaliso, Tadese Data & Lintjom Bernt. (2015). Maternal Mortality in Rural South. PLoS One Journal. 10 (3).

[16] Scott E. (2013). Maternal Maternal Mortality, birth with a health professional and distance to obstetric care in Indonesia and Bangladesh. PubMed Journal. 11: 4. 18 (10): 1193-20

[17] Irasanty. (2008). Prevention of Maternal Referral Delays in Majene. Journal of Health Services Management. Vol. 11, No. 3 September 2008. Djama N. (2011). The utilization of childbirth assistance provided by health professionals by of participants of health care insurance program for poor community. Journal of Medical Society News, Vol. 27, No. 1, March 2011.

[18] Bhutta Z., Darmstadt G.L., Haws R.A, Yakoob M.Y. & Lawn J.E. (2009). Delivering interventions to reduce the global burden of stillbirths: improving service supply and community demand. BMC Pregnancy and Childbirth Journal. 9 (Suppl 1): S7

[19] Sajedinejad S., R. Majdzadeh, Vedadhir A., Tabatei MG & Mohammad K. (2015). Maternal mortality: a cross-sectional study in global health. PubMed Journal. 11: 4.

[20] Rahman M., Davanzo Razzaque J. & A. (2010). The Role of Pregnancy Outcomes in the Maternal Mortality Rates of Two Areas in Matlab, Bangladesh. International Perspectives on Sexual and Reproductive Health Journal, 36 (4): 170-177.