The Impact of Road Development on the Health of Pregnant and Parturient Women

1. Background and objectives

The Millennium Development Goals (MDGs), as the goals of international society for the 21st century, were adopted at the United Nations Millennium Summit in 2000 in New York. Of the eight agreed goals, three are related to the health sector, namely child mortality, maternal health, and the prevention of HIV/AIDS and other diseases. This reflects international recognition of the importance placed on people's health and also suggests an increased expectation for the role of aid organizations working in the health sector. In line with the MDGs' health targets, it has become necessary to evaluate the impact of infrastructure projects on the health sector so as to make concrete contributions in the area of health.

The Japan Bank for International Cooperation (JBIC) and the United Nations Population Fund (UNFPA) undertook a collaborative research project with the purpose of examining methods of evaluating the relationship between the goals of the health sector and infrastructure projects. As the UNFPA is one international organization involved in implementing projects related to women's health, we concentrated in particular on the area of "improving maternal health" so as to make full use of the UNFPA's expertise.

The objectives of the study were as follows:

1) Develop methods to evaluate the relationship between maternal health and infrastructure projects
2) Propose items for consideration and conditions at the initial stage for future projects based on the knowledge gained through this research

2. Methodology

2.1. Creating a "logic model"

2.1.1. Investigating the area of maternal health and infrastructure through a literature review

As a first step of the study, we sought to identify a method of infrastructure on which to create a logic model to guide our analysis. A literature review on the models and frameworks relating to maternal mortality and safe motherhood was conducted to investigate the areas of maternal health, to which infrastructure is related.

One of the well-recognized models of maternal mortality is the "three-delay model" (Thaddeus and Maine 1994). This model suggests that the three delays to determining maternal mortality are a delay in deciding to seek care, a delay in identifying and reaching medical facilities, and a delay in receiving adequate and appropriate treatment. The first delay concerns decision-making at the household level. The second delay relates to the accessibility of health facilities, and the third delay deals with the quality of care.

Since 1990, it has been widely discussed that reducing occurrences of the third delay (access to emergency obstetric care) is the most effective approach to improving the maternal mortality rate (Loudon 1992, Maine 1999). However, it has also been pointed out the importance of improving the access to the health facility at the community level and the importance of prenatal care as an only opportunity to have health services for women in developing countries (Matsuyama 2002).

In reference to the model and other studies, we decided that "accessibility to medical and health services" is the area to which infrastructure is directly related, and seems to influence the first and second delays. Though the impact of infrastructure on social and cultural factors was also considered, the association was thought to be too tenuous. Hence, taking the direct influence of accessibility into account, we chose road construction as the subject of our analysis concerning the relationship between maternal health and infrastructure projects.

Following the process, a logic model that indicates the logical flow of the relationship between road construction and maternal health was formulated based on the literature review (Figure 1). In creating the model, the negative aspects of road construction on maternal health, such as more traffic accidents, were also considered, but not included

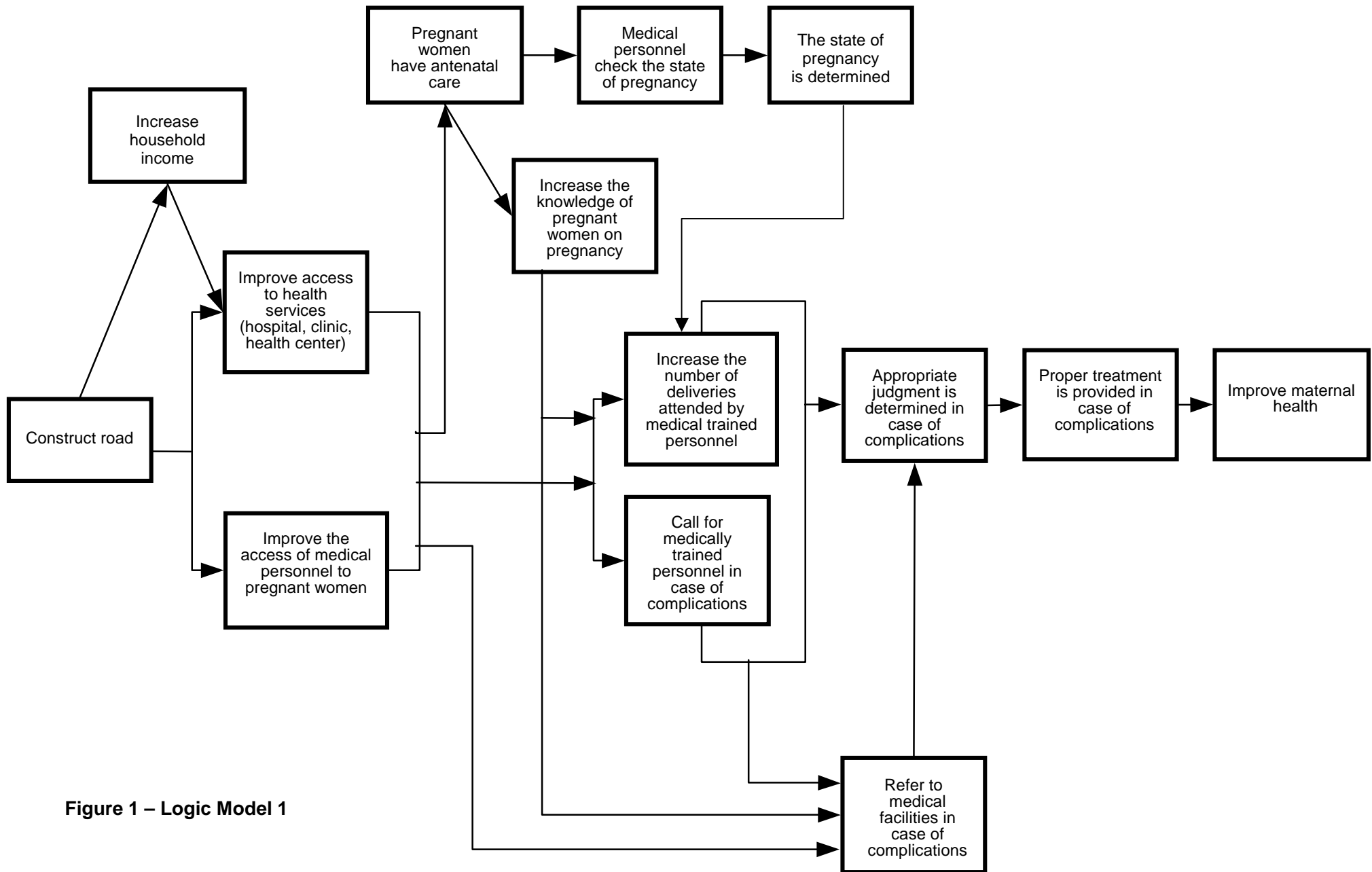since there are few studies that can justify this relationship.

Figure 1 – Logic Model 1

2.2.1. Choosing indicators

In terms of an evaluation indicator for maternal health, many studies have already indicated that maternal mortality rate has limitations as an indicator to reflect on maternal health and to evaluate the effect of intervention (Ronsman 2001). Instead, process indicators have been proposed as evaluation indicators by international organizations such as the WHO, UNICEF and UNFPA (Maine et al. 1997, Goodburn 2002). As process indicators, Ronsman (2001) suggested the effectiveness of "provision" and "utilization" of medical and health services. In reference to this discussion, we chose the "utilization of medical or health services" as a process indicator. In particular, "antenatal care," "attendance of medically-trained personnel at the delivery" and "referral to emergency obstetric care" were examined in this study. With these indicators as a base, we analyzed the relationship between the improvement of access to medical and health services through road construction and the actual utilization of health services.

2.2. Case study of Indonesia

2.2.1. Framework of the study

Considering time limitations of the field surveys, we adopted a cross sectional survey framework that compared the utilization of medical and health services between two sample groups of women who had been pregnant or given birth in the previous two years: one group was in an area that had a paved road and the other group was in an area that had an unpaved road.

The study focused on the differences in access to medical/health services between the two groups depending on the condition of their respective roads. A medical facility was set as the access point since such health centers are hubs of human activity thought to have a major influence on pregnant women. Two groups were then located, one which had easy access to the health center and one which did not.

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Access, for the purpose of the study, was defined as "availability of services whenever and wherever patients need them (WHO 1976). Hence, access consisted of availability, accessibility, affordability, and acceptability. In particular, we focused on accessibility and affordability, both of which could be improved by road construction.

2.2.2. Method of field research

A case study was carried out in Indonesia, in accordance with the outlined framework. The field study consisted of a first stage preliminary investigation, followed by a second stage household survey. In the first stage, research sites were selected and interviews were held with the people involved. Based on the results of the preliminary investigation, three villages in Ciomas in Serang Province, Banten State were selected and the Ciomas Health Center was set as the access point. Households with a paved road were selected as "easy access" locations, while households with an unpaved road were selected as "difficult access" locations.

In the second stage of the survey, a structured questionnaire was designed for women who had been pregnant within the previous two years, and interviews were conducted with 102 women who lived near the paved road and 102 women who lived near the unpaved road.

Household survey:

Subjects: Women who had been pregnant within the previous two years (204)

Selection of subjects:

Both groups:	Women pregnant in or after 2001
Paved road (102):	Women living near a paved road
Unpaved road (102):	Women needing to travel an unpaved road to reach a paved road
Selection method:	Selected by health volunteers in charge of each village

In order to know the locations of the subjects for the sample, mapping was conducted by villagers prior to the survey. The locations of all the subjects were recorded on the map by the interviewees. Twelve graduates from the local nursing college (eight males and four females) were recruited to conduct face-to-face interviews in the homes of the subjects. The interviewers were introduced by the Serang Local Health Ministry.

The interviewers asked questions concerning the following items:

1) Household materials (3 questions)
2) Basic attributes (18 questions)
3) General health (11 questions)
4) Recent child delivery (22 questions)
5) Emergency obstetric care (4 questions)
   (Total of 58 questions)

The data collected were processed into statistical information and statistically analyzed using SPSS software.

3. Results

Table 1 identifies the socio-economic backgrounds of subjects. The average age was 28.3 (±7.3) for those using a paved road, and 26.8 (±6.9) for those using an unpaved road. Most of the subjects were unemployed housewives. Regarding education, the subjects' average years of schooling were 6.1 (±3.3) for the paved road, and 5.1 (±2.4) for the unpaved road.

Table 1   Socio-economic background of subjects

	Paved road (N=102)	Unpaved road (N=102)	p-value
Age	28.3 (±7.3)	26.8 (±6.9)	0.125
Years of schooling	6.1 (±3.3)	5.1 (±2.4)	0.017*
Work	Have work（12）	Have work（14）	0.567
Years of schooling (husband)	6.9 (±3.0)	5.8 (±2.4)	0.006*
Expenditure (1 month)	92925 (RP)	65972 (RP)	0.001*

*$p<0.05$.

t test for continuous data, χ^2 test for categorical data were conducted.

Table 2 refers to access to the health center by location. It indicates that women living near the paved road were more likely to walk to the health center, and women living near the unpaved road tended to use a bike taxi. In terms of the average time and cost to travel to the health center, it took less time and cost less for women living near the paved road than for women living near the unpaved road. The average travel time on the paved road was 8.9 min., and 17 min. on the unpaved road. The average cost was 847 Rp for the paved road and 2,216 Rp for the unpaved road. These time and cost differences were significant.

Table 2   Transportation to health center

		Paved road	Unpaved road	p-value
Walk	(N)	36	0	
	Average time	8.8±6.42	—	
	Average cost	0	—	
Bike taxi	(N)	49	76	
	Average time	8.8±4.01	16.8±5.96	
	Average cost	1,490±554	2,396±563	
Bus	(N)	2	0	
	Average time	10.5±6.36	—	
	Average cost	750±354	—	
Other	(N)	1	5	
	Average Time	10	19.0±7.42	
	Average cost	0	0	
Average time	N=88	8.86±5.09	16.95±5.96	0.001*
Average cost	N=81	847±842	2,216±709	0.001*

*p<0.05.

Unit of time is minutes, unit of cost is rupiah

In this study, the relationship between road conditions and three medical/health services ("antenatal care," "attendance of medically-trained personnel at the delivery," and "referral to emergency obstetric care") was analyzed. Firstly, we conducted a simple comparison between the two groups regarding the utilization of these three services. Table 3 shows the results of the utilization of antenatal care, in which 70% of the women who lived near the paved road indicated they had received antenatal care and 47% of the women who lived near the unpaved road had received antenatal care. There was a clear difference between the two groups in respect to the utilization of antenatal care. There were also significant differences in respect to antenatal care providers and where the care was provided. Sixty-four percent of the women who lived near the paved road received antenatal care by a medically-trained midwife, compared to 38% of women living near the non-paved road.

Table 3   Antenatal care

Antenatal care		Paved road		Unpaved road		p-value
Have you had antenatal care?	(N)	(102)		(102)		
	Yes	71	(69.6%)	47	(46.1%)	0.001*
	No	31	(30.4%)	55	(53.9%)	
Have you had antenatal care by midwives?	(N)	(102)		(102)		
	Yes	64	(62.7%)	39	(38.2%)	0.001*
	No	38	(37.3%)	63	(61.8%)	
Have you had antenatal care at the health center?	(N)	(102)		(102)		
	Yes	52	(51.0%)	29	(28.4%)	0.001*
	No	50	(49.0%)	73	(71.6%)	

*p<0.05.

χ^2 test was conducted.

Regarding the attendance of medically-trained personnel at the child delivery, most women in the region, whether they lived by a paved or unpaved road, had traditional births that involved the use of a traditional birth attendant. Hence, there was no significant difference between the two groups concerning the attendance of

medically-trained personnel at the delivery. Regarding the instances of emergency referrals between the two groups, only ten out of the 102 women living near the paved road and five out of the 102 women living near the unpaved road reported serious problems arising during the delivery. Consequently, this sample was too small to consider the differences.

Next, we analyzed more closely the points where we observed the most significant differences in our simple data analysis, namely, "whether the woman had received antenatal care" and "whether that care was provided by a midwife." Our method of analysis involved investigating the relationships between these aspects of care and variables where significant differences were observed within the following items on the questionnaire: the subject's basic attributes, economic situation, experience of the pregnancy and delivery, and access to the market and the health center. From this, it was found that "the level of education of the pregnant woman," "the education level of her husband," and "cooking fuel used" had a high level of correlation with "whether the woman had antenatal care" and "whether that care was provided by a midwife." Adjusting these variables by a logistic regression analysis, we then investigated the correlation with the road condition. Table 4 shows the results of the correlation between road condition and "whether the woman had received antenatal care." There was also a significant correlation with "whether that care was provided by a midwife."

Table 4
Factors related to antenatal care and antenatal care by midwives after adjustment
（Results of multiple logistic regression analysis）

	Antenatal care		Antenatal care by midwives	
	Odds ratio after adjustment	95% confidence interval	Odds ratio after adjustment	95% confidence interval
Paved road vs. unpaved road	**1.88**	**1.00 - 3.55**	**1.91**	**1.03 - 3.54***
Educational level of pregnant women	1.22	0.80 - 1.84	1.20	0.80 - 1.79
Educational level of husband	1.71	1.10 - 2.66*	1.54	1.02 - 2.33*
Fuel for cooking	1.95	1.28 - 2.97*	1.84	1.25 - 2.69*

*p<0.05.

4. Discussions

In Figure 2, the grey portion of the logic model indicates the areas where we tried to analyze the relationship in the study. The bold squares are the factors wherein we could identify a relationship.
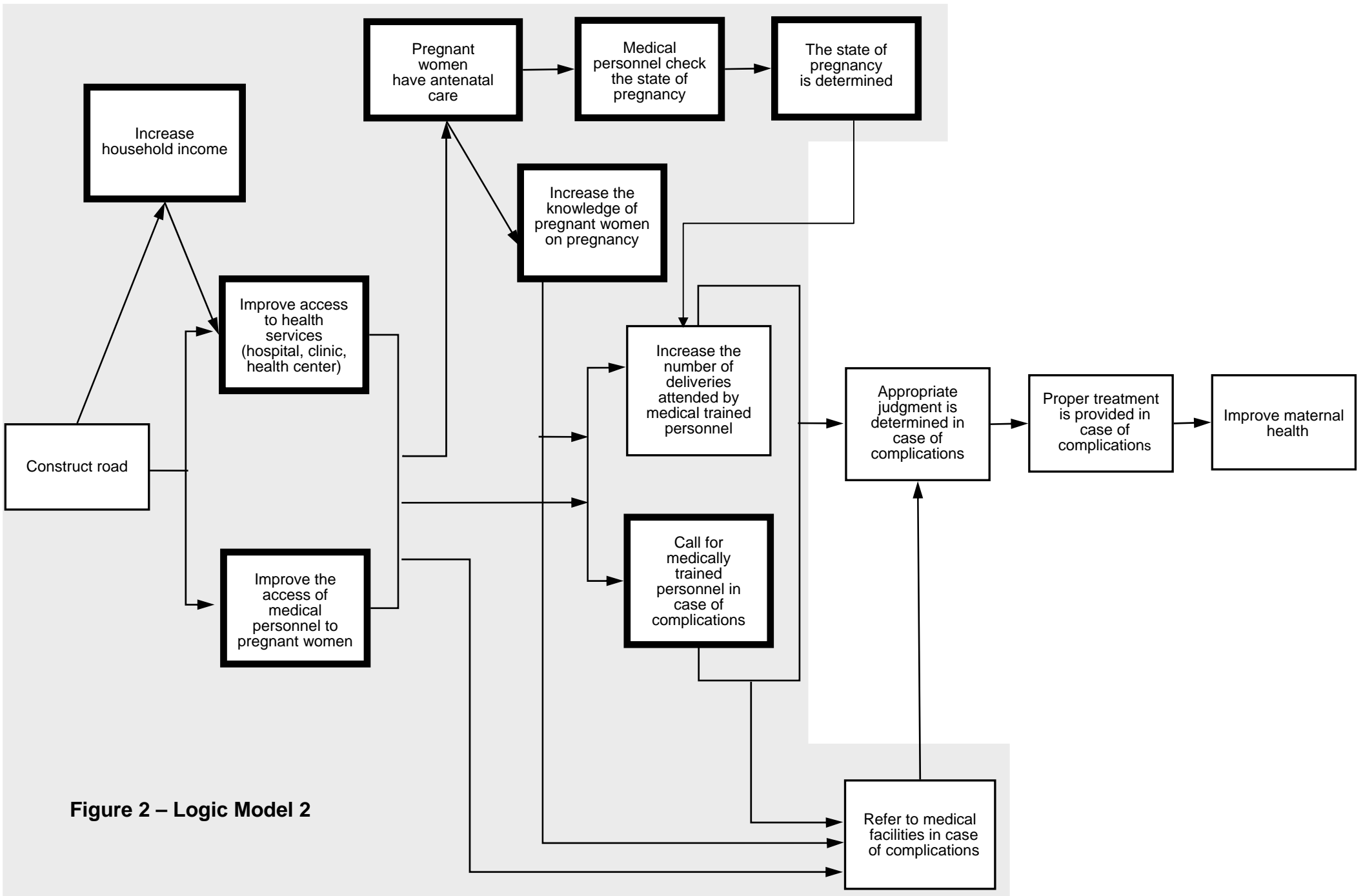
Figure 2 – Logic Model 2

The results demonstrated that in the region studied, pregnant women who lived near a paved road were more likely to receive antenatal care by a midwife in the health center, thus highlighting the value of a discussion on the relationship between the utilization of health services and road construction. In addition, what is important about the results is that the relationship is maintained even when variables such as education level and economic conditions are adjusted.

In terms of improving maternal health, however, although antenatal care is very important, the quality of services must also be considered. To improve women's health, antenatal care is part of a vital process that correctly identifies any problems a woman may be experiencing in her pregnancy, and then deals with that problem effectively through the provision of iron supplements and other nutrients. Simply having antenatal care may not necessarily lead directly to improved health if this process is not complete. From the results of our research, we can see that a paved road has a positive relationship with increasing the number of women who seek antenatal care, but the influence of improved infrastructure on the quality of service was not analyzed here. This can be identified as a limitation in terms of investigating the effect of road quality on improved maternal health.

From the results of the household survey, we were unable to show that "attendance of medically-trained personnel at the delivery" or "referral to emergency obstetric care" was related to the road condition. In other words, our hypothesis "that women who live near a paved road will be more likely to have medically-trained personnel attending the delivery and will more likely be referred to emergency medical treatment if needed" could not be supported. Though the sample of "women who experienced some sort of emergency during the delivery" was very small, the results suggest that calling medical personnel to attend the delivery or judging whether to make a referral for an emergency procedure could depend on factors other than road access.

In addition, we could not find any correlation regarding emergency referrals through quantitative analysis. In-depth interviews with those who had experienced problems during delivery, however, were conducted and these indicated a pattern when an

emergency arose: "calling a midwife," "receiving advice from the midwife regarding referral for emergency care," "hiring a public vehicle," and then "taking the woman to hospital by car." In particular, there is a case where a woman was actually taken to a hospital when a problem arose. As a public vehicle was hired and driven along the paved road to the hospital, it appears at least possible for the paved road to be an advantage.

5. Conclusion and recommendations

5.1. Development of methods for evaluating infrastructure

The above analysis indicates that the methodology developed in this research project for evaluating the relationship between maternal health and infrastructure has the potential for its application in terms of the following points:

1) A framework for cross-sectional comparative research on two sample groups "living near a paved road" and "living near an unpaved road," using village "mapping" as a base
2) Methods of selecting a medical/health service access point
3) The use of "service utilization" as an evaluation indicator
4) The recruitment of students from a nursing college as data collectors

One of this research project's limitations was that cause and effect relationships, namely the changes caused by a road's construction, could not be considered. To achieve this, a new project could be to conduct detailed interviews that take into account the negative impacts before and after the completion of a road, and to analyze and consider such results.

5.2. Proposal regarding infrastructure projects that consider the MDG's health sector targets

5.2.1. Proposal on road construction projects
Based on the results of this study, we would like to propose that the importance of

improving road infrastructure leading to access points in the community as well as access to top referral hospitals should be taken into consideration in future road projects. Such access is necessary from the perspective of community health, and should be planned alongside other heath sector projects.

This study was to demonstrate the relationship between a paved road and the utilization of health/medical services. In order to improve access to a health facility, road paving is one choice while easing traffic congestion could be another. It could also be suggested that from the point of view of "cost" and "time" to acquire medical/health services, running a public bus or providing low cost transport of some kind is also necessary.

5.2.2. Proposal on general infrastructure projects

To set the initial conditions for infrastructure projects, it is necessary to collect the following data in a preliminary stage survey:

1) The type of medical/health services the local people use
2) The access point to medical/health services in that region
3) The direction of access to provide services

Through an analysis of these data, it might be possible to identify areas in which other infrastructure can contribute to improving access to health facilities. For example, in this study, there was a pattern whereby a midwife goes to the house of a pregnant woman after receiving a telephone call. This is a case of improving access through communication, and suggests that the provision of mobile phones may contribute to improved health sector communication.

In the process of data collection related to the above, it is important to hear the voices of local residents as much as possible. Therefore, participatory methods in conducting surveys and the involvement of local NGOs should be promoted. Taking these points into consideration, the significance of collaboration between experts in both the health and infrastructure sectors at the planning stage of a project should be emphasized.

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