

MATERNAL DECISION SUPPORT SYSTEMS TO REDUCE MATERNAL MORTALITY IN INDONESIA: RESOLVING BARRIERS TO IMPLEMENTATION IN COMMUNITY HEALTH CENTERS

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ABSTRACT

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Aim: This paper aims to design a decision support system in Maternal and Child Health services or MCH that can monitor cases of pregnant women and prevent maternal deaths because maternal deaths are still found in Semarang. Indonesia. Method = Research and Development with system development using the System Development Life Cycle method, which includes studying user needs, analyzing the system used, determining the form of the system being developed, and designing the Maternal Decision Support System. The sample of this research is in the form of MCH service data in 2019 - 2021. Meanwhile, respondent data collection is carried out by interviewing MCH Program Holders and observing the system used, analyzing MCH data, and designing a region-based Decision Support System using PHP programming and MySQL database. Result: The development of an MCH decision support system application that can support the area-based MCH program is <https://spk-maternal.com/>. It is easy to use by officers at the community health centers and the Health Office to monitor pregnancy history to reduce maternal mortality. Conclusion = Results of our study indicate that a district-based decision support system

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is easy to use to reduce maternal mortality. The study's findings indicate a need for tremendous support from the government to make policies based on a decision support system for appropriate maternal and child health services.

KEYWORDS

Decision Support System, Maternal Mortality, Maternal and Child Health



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INTRODUCTION

Pregnancy is a necessary time to improve healthy behavior and parenting skills, as well as the need for Antenatal Care attention from the family (Poote & McKenzie-McHarg, 2019). The current finding is that 4.5 women die every day in Liberia from pregnancy, childbirth, and postpartum complications, equivalent to about 1,100 women per 100,000 live births (Bjegovic-Mikanovic, Broniatowski, Byepu, & Laaser, 2019). Risk factors encountered during pregnancy in poor nutrition and smoking cause premature birth in the Pleven region, Bulgaria (Kamburova, Hristova, Ludmilova, & Khan, 2015).

The reduction in deaths in North-West Russia is due to increased investment by the Russian government focusing on health care renovation (Burazeri, 2019), Maternal and infant mortality rates are very high in Ethiopia because they did not maximize the country's performance related to causes of death in 2015 (Misganaw et al., 2017). The study to investigate the differences between PHS identified more pregnancy-related outcomes than HDSS in this study. Inquiring about pregnancy and its outcomes may be a valuable way to improve the measurement of pregnancy outcomes (Kadobera et al., 2017).

Recent evidence from transitional Albania showing a higher multi-morbidity burden among female patients than men is cause for concern. Thus further raising awareness of health professionals and, in particular, policymakers and decision-makers to address gender issues and inequality gaps in health outcomes and disease burden of the Albanian population (Collaku, Resuli, Gjermeni, & Tase, 2018). Despite the remarkable progress in maternal survival in China with a 75% reduction in maternal mortality in 1990 and 2015, significant disparities remain, especially for poor, less educated, and ethnic minorities in remote areas of western China (Gao et al., 2017).

Research findings show the potential for Chamas, or group-based health and financial education programs for pregnant women, to achieve MCH benefits in Kenya (Maldonado et al., 2020).

Studies show that there are still cases of maternal death in Southeast Asia due to the lack of women receiving treatment to avoid neonatal complications (Kikuchi et al., 2018). Most deliveries in Ethiopia occur at home and are not assisted by skilled birth attendants. In contrast, birth attendants with midwifery skills during labour are critical interventions in reducing maternal morbidity and mortality (Roro, M. A., Hassen, E. M., Lemma, A. M., Gebreyesus, S. H., & Afework, 2014).

Based on research on decision support systems for chronic disease administration, a recommendation message is generated through a web service that supports management, including scheduling the implementation of chronic disease screening (J.-I., J.-G., Y.-H., & U.-G., 2014) (Dissanayake, Colicchio, & Cimino, 2020)

The challenge described by the World Health Organization is the widespread lack of data on adolescent fertility, including teenage pregnancy and childbirth. Access to reliable data is necessary to develop meaningful policies (Sentell et al., 2019).

The emergence of the SDG's Program is a development of innovative programs introduced in response to the Millennium Development Goals demonstrating promise to reduce the global impact of maternal mortality, which was introduced by the country in 2015, designed to build on this progress (Callister & Edwards, 2017). The maternal mortality ratio has decreased rapidly and universally across China at the county level in the last two decades, which is possible even in economically less developed places with limited resources. This finding has important implications for improving the maternal mortality ratio in developing countries in the era of the *Sustainable Development Goals* (Liang et al., 2019). Another system development is a sexual health CDS system that is easy to use and can facilitate evidence-based care to reduce disparities in health outcomes (Miller et al., 2020).

A decision support system or policy is an integrated computer device that allows every decision-maker to interact directly with a computer that is useful in making decisions using data and models to solve semi-structured and unstructured problems (ŞAM, 2017) (Siemens Healthcare GmbH, 2018). Africa can achieve Universal Health Coverage with the adoption of digital health technology, which offers a new approach to providing quality health (Ohia, Ongolo-Zogo, & Fawole, 2021). Mobile health or m-Health is one of the potential solutions to maximize the impact and efficiency of health workers to achieve Sustainable Development Goals 3.1 and 3.2, especially in sub-Saharan African countries. Poor quality clinical decision-making is associated with poor pregnancy and birth outcomes (Amoakoh et al., 2017). The World Health Organization publishes some health reports each year, containing recommendations for addressing social challenges and system barriers to targeting unmet health needs, requiring the development of an implementation strategy for the recommendations of the WHO public health report (von Groote, Comanescu, Ungureanu, Bickenbach, & Lavis, 2018).

The 2016 Annual Report of the Directorate of Family Health shows that the Maternal Mortality Rate and Infant Mortality Rate are critical because they are indicators of Health development in the 2019 RPJMN and Sustainable Development Goals. And based on data from the Indonesian Basic Health Survey or IDHS, it shows a decrease in the Maternal Mortality Rate in 1994 – 2012, which was 390 per 100,000 live births in 1994 and 334 per 100,000. Still, there was an increase in the Maternal Mortality Rate in 2012 of 359 per 100,000 live births compared to 2007, which was 228 per 100,000 live births. Meanwhile, data from SUPAS in 2015 showed that both maternal mortality rate or AKI and IMR decreased, namely AKI by 305 per 100,000 live births and IMR by 22.23 per 100,000 live births. So in terms of indicators, there is a strategic plan that is part of efforts to reduce MMR, and IMR shows success in achieving the target. However, the achievement is still a gap when compared to the target of the entire population of Indonesia (Directorate of Family Health, 2016).

Semarang City is the Capital of Central Java Province. More and more people live, and there is mobility in the Semarang City area, so the government is increasing the health facilities provided so that they are easily accessible by the community. However, cases of maternal death are still found to be a health problem. Based on information from the Semarang City Health Profile in 2019, there were 18 cases of maternal death or AKI from 23,544 live births or around 75.8 per 100,000 live births; this remains a concern for MCH services by increasing the Maternal and Child Mortality Rate Reduction Program (Semarang City Health Office, 2020).

The problem is that there are still cases of maternal mortality in the Semarang City area, even though the MCH service program has implemented various information systems such as SIMPUS and Sigaspol, which are used for recording and reporting the MCH Program. Semarang so that this research has benefits to support the policy of the MCH Program. The area-based MCH Program produces reports in the form of online mapping so that the government can find out the distribution of cases of comorbidities in pregnant women and the incidence of maternal deaths quickly and precisely and based on region.

RESEARCH METHOD

This type of research is Research and Development using the System Development Life Cycle or SDLC method was carried out in 2021. We use maternal pregnancy history data from 2019 to 2021 as input for the maternal decision support system. Data in the form of the number of pregnant women, the number of high-risk pregnancies and the number of obstetric complications during pregnancy

Data collection methods by observation and interviews to observe and explore information about information systems in MCH health services. Interviews were conducted with the Head of the MCH Health Office of Semarang City as a critical informant to obtain information about policies and the role of MCH Information Systems in supporting decisions on the Maternal and Child Mortality Reduction Program at the Community health centers. As well as the method of observation carried out by direct observation of the MCH information system and MCH service data. We researched at Semarang, Indonesia, in 2021.

The stages in system development include:

1. User needs study or feasibility study which aims to determine user needs for regional-based MCH decision support system development, conducted by interviewing key informants
2. Analyzing the information system currently running on the MCH program service, which aims to assess the features of the MCH information system
3. Determine the form of a new decision support system based on the results of the current MCH information system analysis
4. Design of area-based MCH Decision Support System using PHP programming and MySQL database.

The data analysis method used is descriptive, which describes the research results in the form of an MCH decision support system design.

The study was conducted under the supervision of the Chair of the IRB (Institutional Review Board). The right of privacy of the studied subjects was guaranteed. Only the leading investigator had access to the identifying information.

RESULT AND DISCUSSION

The MCH program implemented in the Semarang City area is the responsibility of the Semarang City Health Office by carrying out various health efforts, namely public health efforts and individual health efforts. For community efforts, including essential health efforts, one of which is MCH services.

The implementation of MCH services in routine activities is inseparable from the use of information systems in recording and reporting, which aims to improve maternal and child health. For this reason, a decision support system was developed using the SDLC method. The stages of this research are a study of system feasibility, conducted by

interviewing the person in charge of the MCH Program Health Office who has used the SIMPUS application for recording and reporting at the Community health centers in MCH services. Stakeholders of the MCH program, according to data needs at the Community Health Centers, then report to the Semarang City Health Office. Sigaspol for recording and reporting of pregnant women's health carried out by Gasurkes or health workers recorded directly according to findings in the field and reported to the Semarang City Health Office. However, there is still a gap between Sigaspol and SIMPUS because data duplication can occur.

The MCH program stakeholder by the needs of the data in the Community health centers then reported to the Semarang City Health Office, Indonesia. The Sigaspol for recording and reporting on the health of pregnant women was carried out by Gasurkes or health workers who recorded directly according to the findings in the field and reported to the Health Office Semarang City. However, there is still a gap between Sigaspol and SIMPUS because there can be a duplication of data. The Community health center can record repeated visits by pregnant women from the exact identity of pregnant women.

Data Population

The city of Semarang has 37 Community health centers, which are spread out in each sub-district. Based on data on the health status of pregnant women from 2019 to 2021, it is shown in the following table:

Table.1. Number of Pregnancies in Semarang City, Indonesia in 2019-2021

		number of pregnancies in 2019	number of pregnancies in 2020	number of pregnancies in 2021
N	Valid	37	37	37
	Missing	0	0	0
Mean		645.5405	702.19	461.9189
Median		565.0000	603.00	402.0000
Std. Deviation		395.94981	474.172	319.59978
Variance		156776.255	224839.158	102144.021

Table 1 shows the number of pregnancies in Semarang City, Indonesia, from 2019 to 2021, with the highest average in 2020. The lowest number of pregnancies is in 2021 because it was collected data cut down September 2021.

Table.2. Number of High-risk Pregnancies in Semarang City, Indonesia in 2019-2021

		number of high-risk pregnancies in 019	number of high-risk pregnancies in 2020	number of high-risk pregnancies in 2021
N	Valid	37	37	37
	Missing	0	0	0
Mean		269.6486	248.84	173.7838
Median		202.0000	215.00	122.0000
Std. Deviation		195.56644	200.720	156.62413
Variance		38246.234	40288.473	24531.119

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Table 2 shows the number of high-risk pregnancies in Semarang City, Indonesia, from 2019 to 2021, with the highest average in 2019. The lowest number of high-risk pregnancies is in 2021 because it was collected data cut down September 2021.

Table.3. Number of Pregnancies with obstetric complications in Semarang City, Indonesia in 2019-2021

		Number of pregnancies with obstetric complications in 2019	Number of pregnancies with obstetric complications in 2020	Number of pregnancies with obstetric complications in 2021
N	Valid	37	37	37
	Missing	0	0	0
Mean		36.9189	47.05	23.7027
Median		25.0000	30.00	9.0000
Std. Deviation		34.58595	72.231	29.30004
Variance		1196.188	5217.275	858.492

Table 3 shows the number of pregnancies with obstetric complications in Semarang City, Indonesia, from 2019 to 2021, with the highest average in 2020. The lowest number of pregnancies with obstetric complications in 2021 because it was collected data cut down September 2021

Decision Support System Development

The stages of information system analysis include: 1) Studying the system that has been used in MCH services so far, according to the information from the MCH Program holder that SIMPUS and Sigaspol are computer-based applications. Various types of applications that have been used in MCH services are still found to have no menus that support to help monitor the distribution of cases of comorbidities in pregnant women and the incidence of maternal deaths by region. 2) Analyzing the decision support system designed by making a regional-based MCH decision support system using PHP programming and MySQL database. 3) Analyzing the hardware used in the form of a computer from the MCH Program holder who already uses a laptop and has a device or mobile phone. Analysis of system requirements to find the information required by the Head of the MCH Service, Staff of the MCH Program, and the MCH Program Holder at the Community health centers.

Analysis of system decisions by determining the form of the system based on several alternative solutions from the new system that can meet the needs of system users, according to the feasibility and recommendations of the candidate systems being developed, namely: policy of the MCH Program Holder. The approach process is carried out to determine the input, output, database, operating procedures, models; Determining the selection of decision support system development software in the form of applications that suit the needs of system users, Selection of the operating system from the decision

support system, which uses Windows and can be used using Android or Mac applications. Selection of new system users, namely the new decision support system that is multi-user in nature, with a communication network that allows interaction from the community health center with the MCH sub Program. Selection of tools for a new decision support system using PHP programming and database using MySQL and Google Maps for mapping.

System feasibility analysis includes: 1) Technology Feasibility Analysis where computer hardware and software development is very dynamic and in line with the improvement of data communication networks or the internet that are easily accessible in all areas. 2) Legal Feasibility Analysis that application development software is open source can be developed for all parties. 3) Operational Feasibility Analysis, namely currently the use of android and internet data usage is necessary so that its use does not make it difficult for officers and the public. 4) Economic Feasibility Analysis: This DSS-maternal application is easy to access and does not require a fee to access it.

The design of the new decision system includes the design of a Maternal Health Decision Support System or SPK-maternal using the UML Design or Unified Modeling Language, which is shown in the following figure:

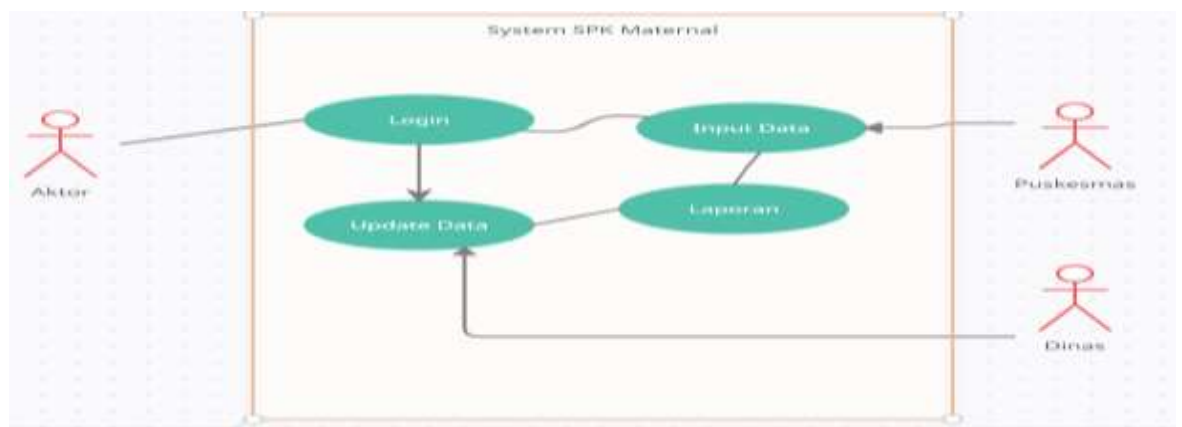


FIGURE 1. UML Design with Use-case Diagrams

Figure 1 shows that the UML design describes the maternal decision support system entities in the form of users, namely admins, community health centers, and government offices. The activities carried out include inputting data from the community health center in pregnant women's health data, which will automatically be reported to the Health Office with the system. The service can access reports from the community health center by updating data based on the reports sent. At the same time, the admin is the facilitator and updating of the information system that has been created.

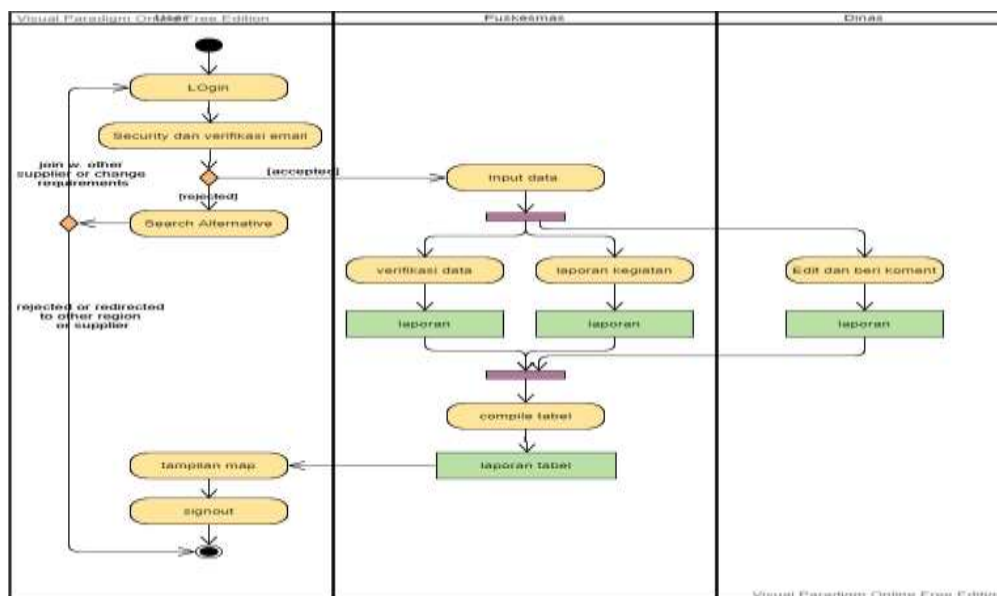


Figure 2. UML Design with Activity Diagram

Figure 2 describes the maternal decision support system; that when you first log in to this system, verification from the user's email will be carried out. A form of system security allows users interested in MCH program services to access this decision support system. Furthermore, after verification on the email, the user at the community health center level inputs the health data of pregnant women. If the data entered is correct, verification is carried out from the community health center by adding information to the DSS menu, namely MCH Program Achievements. Furthermore, the agency will access this decision support system by viewing reports in the form of mapping of the distribution of cases of comorbid illnesses in pregnant women and the incidence of maternal deaths and follow up on the results of the MCH program achievements by providing decisions in the form of narratives in this system.

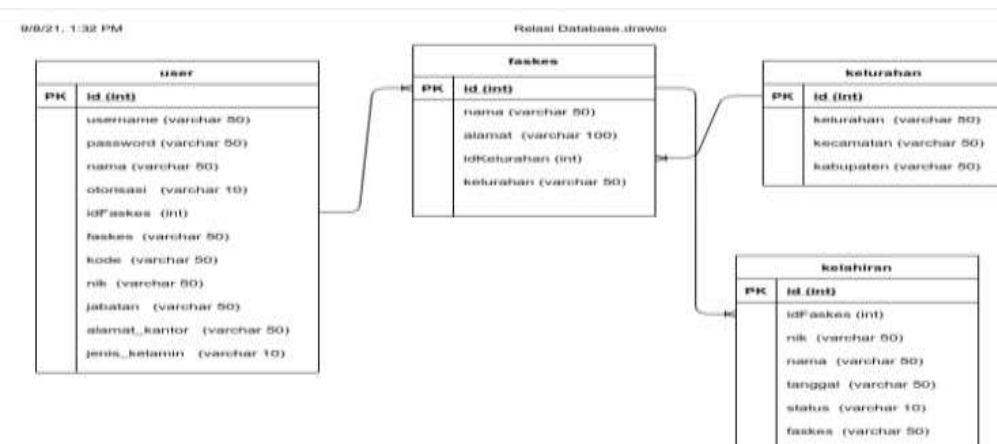


Figure 3. DSS-maternal Database Relations

Figure 3 shows the database structure design made to explain the fields in the data file accompanied by the data type and width or the number of characters. We can access the maternal decision support system via the link <http://spk-maternal.com/>. The menu display for logging in to the maternal decision support system can be seen in the following figure:

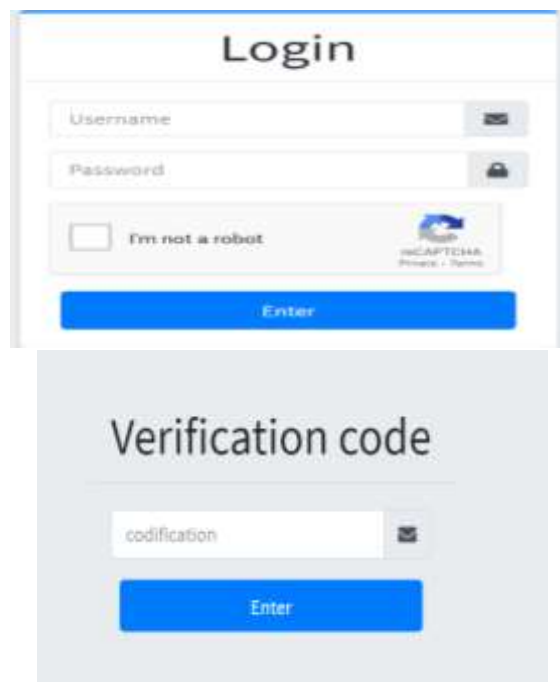


Figure 4.a. Menu for System login **Figure 4.b.** Menu for Login verification

Figure 4.a. shows the initial login to the maternal decision support system that uses the email and password of each user so that it can distinguish it for access from the community health center, the service, and the admin. While **Figure 4.b.** shows the verification of this system login, this is made to maintain the security of the maternal decision support system for users who are interested in MCH services

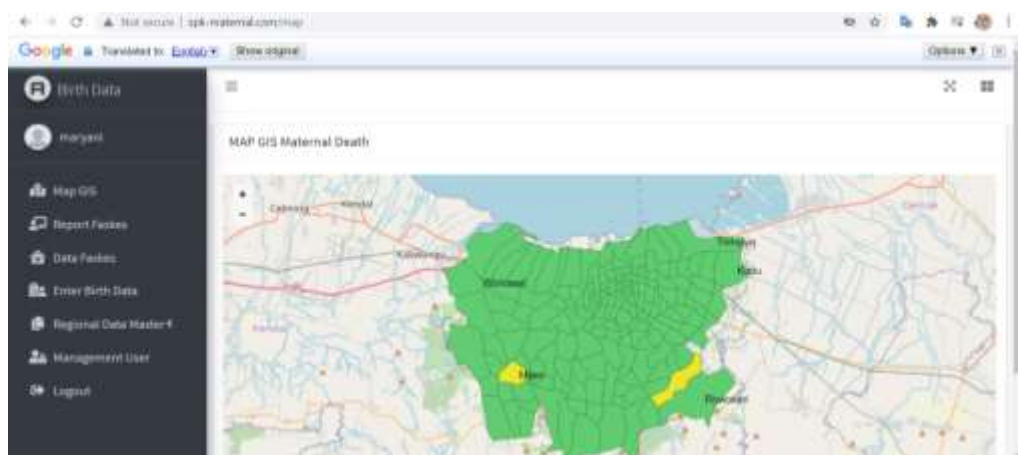


Figure 5. Map Menu on SPK-maternal

Figure 5 shows the appearance of the Semarang City area in the form of a map and can bring up the distribution of the incidence of disease and maternal mortality if the health data for pregnant women has been inputted from the community health centers.

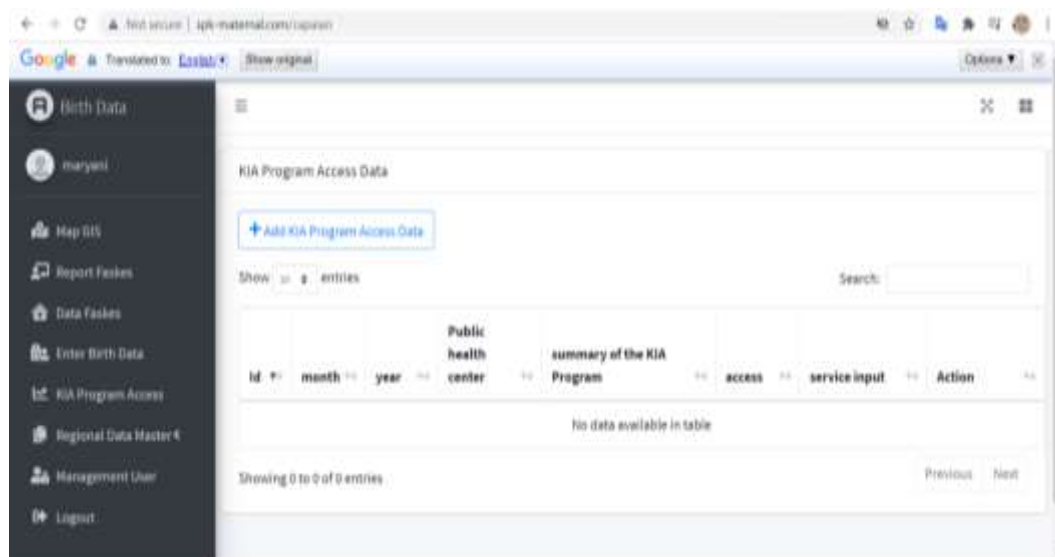


Figure 6. MCH Program Achievement Menu

Figure 6 shows the display of decision support activities in the form of an MCH Program Achievement menu, which displays a summary of MCH programs that have been carried out from the community health center, which will follow up from input from the service. An advantage of the MCH Program decision support system, especially for maternal and maternal health monitoring.

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		Number of pregnancies with obstetric complications in 2019	Number of pregnancies with obstetric complications in 2020	Number of pregnancies with obstetric complications in 2021
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Median		25.0000	30.00	9.0000
Std. Deviation		34.58595	72.231	29.30004
Variance		1196.188	5217.275	858.492

CONCLUSION

The results showed that pregnancy in Semarang City, Indonesia, mainly occurred at the beginning of the Covid-19 pandemic. Pregnant women and babies are among the high-risk groups during the Covid-19 pandemic. Research shows that pregnant women with COVID-19 in the third trimester are more likely to need intensive care when compared to pregnant women without COVID-19. When pregnant women with COVID-19 symptoms requiring hospital admission have worse maternal outcomes, including death, although the absolute risk remains very low (Elsaddig & Khalil, 2021). Meeting the very ambitious 2030 SDG targets to eliminate maternal mortality, high mortality countries can do based on the efforts that have been made to reduce maternal mortality between 2000 and 2010 (Alkema et al., 2016). Malnutrition of children and mothers is still a significant risk factor for disease burden in India from 1990 to 2017, and this can affect nutritional intake for pregnant women (Swaminathan et al., 2019).

Results from an assessment of the influence of clinical decision-making support systems or CDMSS directed at frontline healthcare providers on neonatal and maternal health outcomes suggest that evidence-based recommendations exist for the use of mobile CDMSS in Ghana and other West African countries (Amoakoh et al., 2017).

A knowledge discovery-based interactive decision support system has been developed on a web platform that will help health care policymakers to design evidence-based decisions aimed at reducing inequality of maternal and child health service indicators against regional socioeconomic differences; strategic location-specific policies should be designed and based on increasing the scope of this intervention will help reduce inequality and improve local health care indicators (Saha, 2019).

The role of information in every organization is significant because the value of information depends on its application and use. The success of an organization's activities is highly dependent on the quality of the information it produces. So that information can

be used as raw material for decision making. A computer-based information system or CBIS aims to make the process very effective and efficient when it involves significant data. Although there are several types of information systems that support decision making, decision support systems are one of them (Tripathi, 2011).

Based on the results of the design of a maternal decision support system, according to developing an application to monitor the delivery process using a Support Vector Machine or SVM. It is hoped that it can provide a tool for midwives to automatically monitor the progress of the delivery process so that if there is an emergency in the delivery process, it can be overcome (Sulistiyanti, Farida, & Widodo, 2018).

The results of a study involving pregnant women with SCD showed a decrease in maternal mortality. The need for a multidisciplinary obstetric and hematology team approach that can reduce maternal and perinatal mortality (Asare et al., 2020).

Decision Support System application to monitor the labour process using the Support Vector Machine method, the first stage is developing a maternity medical record data management application. The second application development stage is to monitor the labour process using the Support Vector Machine or SVM. The hope is that it can provide aids for midwives in monitoring the progress of the labour process automatically so that they can overcome emergencies in the delivery process (Sulistiyanti et al., 2018).

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