

Jurnal Made Kamisutara 1

by Made Kamisutara

Submission date: 29-Dec-2020 06:45PM (UTC+1000)

Submission ID: 1481841040

File name: 1._Jurnal.pdf (626.95K)

Word count: 5104

Character count: 29282



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International Journal of Innovation, Creativity and Change. www.ijicc.net

Volume 10, Issue 7, 2019

Monitoring Models of Expectant Mothers' and Babies' Health - A Web-Based and SMS Gateway

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This research was carried out against the background of the still high mortality rates of mothers and babies after giving birth. This is a special problem for Indonesia and other countries with the same experience. To overcome the high mortality rates for pregnant women and infants, a web-based application and SMS gateway solution is needed. This application monitors the health of pregnant women and infants in remote villages, far from adequate health services. Pregnant women can be helped through mobile services accessed easily via the web and SMS. Through information technology, the limitations of time and space can be overcome. The application was trialed at a health service centre in Kepanjen Malang, East Java. It can be integrated more widely using the internet. An experiment over five months turned out to be quite encouraging as a tool for collecting data on pregnant women, both those who did not experience health problems and those with certain health problems in their pregnancy. A web-based application and SMS gateway are quite capable of helping medical personnel, as they collect accurate data on the distribution of unhealthy pregnant women in the Kepanjen region. Given these encouraging results locally, this application can be applied elsewhere to improve health services for pregnant women and infants. The next task of researchers is to disseminate information at each health service centre in the East Java region.

Key words: *Warning, maternal health, SMS gateway, expectants mothers' health.*



Introduction

Smartphones are developing very fast in the community. Children and people generally do many activities on smartphones. By the end of 2015 there were approximately 55 million smartphone users in Indonesia. Total penetration reached 37.1 percent. The activities of people on smartphones varied, from games to business. Google Research with TNS Australia states that the 50 percent of smartphone owners in Indonesia make the device the main telecommunications equipment, including access to the internet. The development of digital technology has affected many fields. One is health. A number of health application appear. They can be accessed easily by smartphones or tablet devices. For instance, in developed countries, doctors examine and diagnose children's ears using smartphones. They provide the appropriate treatment for their patients through the device. The growing number of mobile applications in the health field will certainly facilitate treatment.

One aspect in e-Health is the emphasis on mobile device technology for health services. With mobile devices, such as smartphones, health services can better reach restricted areas, communities, and health practitioners. Expectant mothers and babies health comprise a complicated problem whose condition has not improved. Improving the quality of expectant mothers and babies' health services is believed to require conducive socio-political, legal and cultural conditions. Based on a 2007 Indonesia Demographic and Health Survey (IDHS), the expectant mother mortality rate in Indonesia was still 228 per 100,000 live births. Various improvements and handling have occurred, but it still requires a variety of supports. The expectant mothers and babies health program aims to improve health, especially that of expectant mothers and babies. One important element to support the availability of data and information that is very useful in planning, implementing, monitoring, and evaluating health service outcomes. Most expectant mothers' and babies' health programs in health institutions are not yet supported by adequate information systems, in terms of recording, processing, and analysis, as well as interpretation and reporting.

The main purpose in creating web-based application programs and SMS gateways is to help governments, health services and hospitals monitor pregnant mothers. They can know and detect health problems, especially for pregnant women living in the village still far from the reach of health services. This will facilitate the health of pregnant women. The deaths of pregnant women can be addressed and minimized, using an online SMS gateway easily operated by pregnant women wherever they are.

Research Questions: The research questions are as follows:

- Are expectant mothers and babies' health monitoring activities capable of generating valid data?



- Are expectant mothers and babies' health monitoring activities able to detect high risk pregnant women early on?
- Can data from expectant mothers' and babies' health monitoring be utilized for decision-making in determining the program?

Literature Review

Monitoring of the Level of Health of Pregnant Women. Eight Millennium Development Goals (MDGs) were set by the Millennium Summit of the United Nations (UN) in 2000. They were adopted from the UN Millennium Declaration. As many as 193 UN Member States and 23 international organizations agreed to achieve the MDGs by 2016. The eight goals are: eradicating extreme poverty and hunger; achieving primary education for all; encouraging gender equality and empowerment of women; lowering child mortality; improving maternal health; combating HIV/AIDS, malaria, and other infectious diseases; ensuring environmental sustainability; developing a global partnership for development. The progress of the MDG objectives needs to be assessed by a number of indicators formulated in conjunction with the MDG framework itself. The systematic nature of assessments by each country indicates that measurements are empirical, clear and highly accurate.

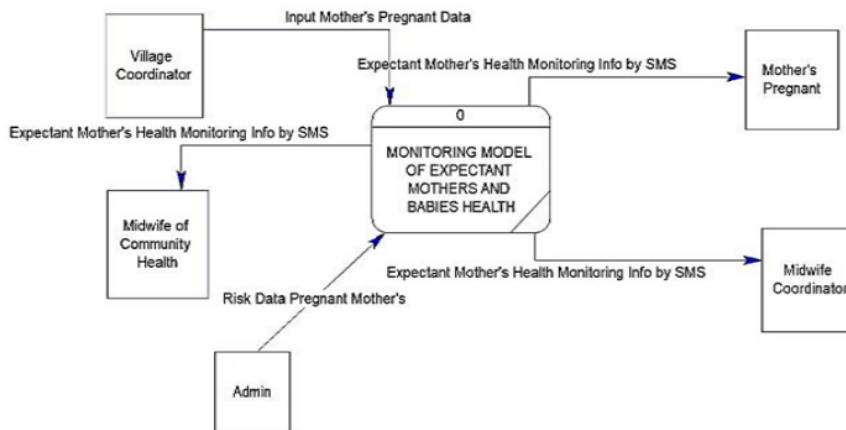
Data from the health services of the Republic of Indonesia showed a decrease in maternal mortality from 1991 up to 2015. The impact indicator measures whether the overall goal of the systems has been reached. It include changes in death rates from a specific epidemic disease, changes in patterns of morbidity, labour health behaviour changes in system implementations, and changes in health-related behaviours in a target population (Nugroho, 2015).

A public health surveillance system is evaluated to make sure that problems which relate to public health are effectively and efficiently monitored. Public health surveillance systems should be evaluated periodically, to determine how well the system meets the set goals and objectives. Evaluation findings should generate specific recommendations to improve quality, efficiency, and the usefulness of the surveillance itself. In addition to such periodic evaluation, public health must be monitored routinely to ensure that the system always achieves targets. Monitoring can be defined as routine data collection and measurements; a program or a process changing over time using a strategy and a plan agreed in advance. The difference between the planned implementations and also the identified facts as well is the actual improvement of conditions. Public health surveillance systems monitoring involves the regular collection and analysis of indicators, to measure how well surveillance systems reach their goals. Evaluation, on the other hand, involves specific study designs to regularly assess the relevance, effectiveness, and impact of the surveillance system. The evaluation is often in response to changes in the performance of a public health surveillance system. In monitoring

and evaluating the expected learning outcomes, recommendations improve surveillance activities. When the results of the monitoring routine track the impact of a public health surveillance system, that's when monitoring can be considered for ongoing evaluation (Lowery, 2010).

Monitoring Model of Expectant Mothers and Babies Health. The initial mechanism for this model and its application can be seen in detail in the image below, which explains it systematically and sequentially, step-by-step, from the beginning to completion. Its application is web-based, but based on an SMS gateway run on mobile phones using health care providers and pregnant women.

Figure 1. DFD Level 0 Monitoring Model of Expectant Mothers' and Babies' Health





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Figure 2. Expectant Mothers' Health Monitoring Info by SMS

Kecamatan	Puskesmas	Desa	Kode	Penduduk
DONOMULYO	PUSKESMAS DONOMULYO	DONOMULYO	0101	1.250
DONOMULYO	PUSKESMAS DONOMULYO	PURWOREJO	0102	1.350
DONOMULYO	PUSKESMAS DONOMULYO	SUMBEROTO	0103	1.350
DONOMULYO	PUSKESMAS DONOMULYO	TEMPURSARI	0104	0
DONOMULYO	PUSKESMAS DONOMULYO	TLOGOSARI	0105	0
DONOMULYO	PUSKESMAS DONOMULYO	KEDUNGSALAM	0106	0
DONOMULYO	PUSKESMAS DONOMULYO	BANJAREJO	0107	0
DONOMULYO	PUSKESMAS DONOMULYO	TULUNGREJO	0108	0
DONOMULYO	PUSKESMAS DONOMULYO	MENTARAMAN	0109	0
DONOMULYO	PUSKESMAS DONOMULYO	PURWODADI	0110	0

Research Methods

To carry out this research, we first create an application framework that links process inputs and outputs, as follows:

- *RAP (Rapid Assessment Procedure)*. This research was an evaluative observational research using cross-sectional design. Quantitative and qualitative methods were used. Quantitative data related to the implementation of expectant mothers' health monitoring systems, including inputs, processes and outputs. Inputs related to available resources and supporting facilities/infrastructure. The process related to how the expectant mother health surveillance system was implemented. Output related to the availability of valid data/information as a result of monitoring and utilization of data for decision-making. Qualitative data was also collected, to support and deepen the review related to program performance and other sectoral linkages.
- *Subject of the Study*. The population was the provider related to expectant mother health monitoring, i.e. a midwife in a village, a midwife of a community health clinic, and a



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midwife coordinator and staff in a health office. This research used cluster sampling. It was conducted at the community health clinic, in the Kepanjen Malang Regency.

Location of the Study. The research was conducted in the community health clinic at the Kepanjen Malang Regency and the Health Office of the Malang Regency. It was performed for two years. The sample was pregnant women starting from the beginning of their pregnancy, until the age of 59 weeks along with the puerperal condition for 40 days. Initially this application was tested in one community health clinic, at Kepanjen Malang.

Data Collection. Secondary data and primary data were included. The instruments were documentation, interview, and observation. Data collection was conducted by a research assistant and assisted by Health Department staff, to make it easier to coordinate and approach the research subject.

First, the researchers met the Head of the Health Office of Malang Regency. They obtained information about programs and policies related to the expectant mother health monitoring system, including capacity building and financing. The nature of programs and policies undertaken by the Malang District Health Office was ascertained, to strengthen the expectant mother health monitoring system, to accelerate the achievement of the objectives. Their questions included:

- Has the field staff been trained in the expectant mothers' and babies' health monitoring system, as strengthening and developing skills?
- Is there local government support for the implementation of an expectant mother health monitoring system?
- What are the constraints faced in implementing an expectant mother health monitoring system?

Researchers then met an expectant mother and babies' health officer. They obtained information on programs and policies related to the expectant mother health monitoring system, including capacity building and financing. They also enquired as to the programs and policies undertaken by the Health Office of Malang Regency, to strengthen the health monitoring system for expectant mothers, to accelerate the achievement of MDGs.

Data Analysis. Data collected from the field was entered into a computer. Data validation was then performed; i.e. checking the completeness of data, coding and data modification, in accordance with analytical needs. Data analysis was descriptive analysis for quantitative data, by looking at the mean and relative frequency distribution. Furthermore, the program evaluation was analyzed as follows:

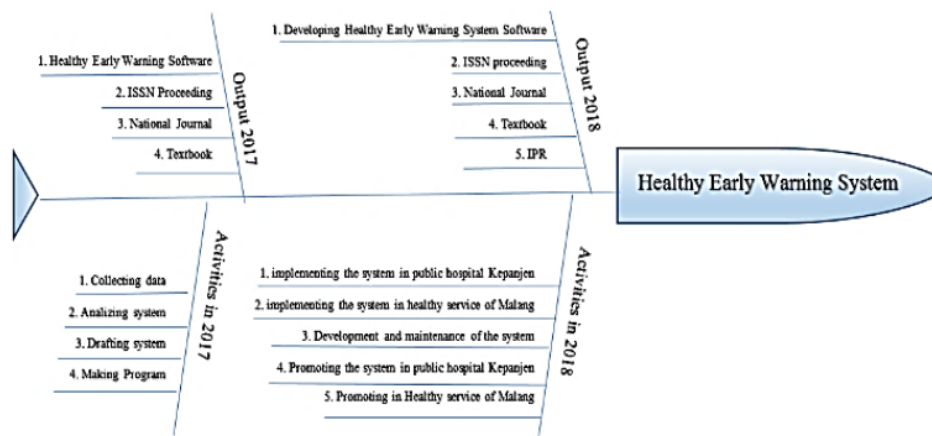
- Comparing the implementation of expectant mother health monitoring, with immunization guidelines.
- Comparing the implementation of expectant mother health monitoring program in Malang Regency.
- Assessing outputs, by looking at data accuracy as related to recording and reporting.
- Assessing the utilization of monitoring data for the policy. Qualitative data was assessed by descriptive textual analysis, to clarify the result of quantitative data. At the community health clinic, the researchers interviewed community health clinic midwives and village midwives. They were associated with the implementation of health expectant mother monitoring systems.

Conducting interviews individually, yet simultaneously, to avoid any response bias. Information was obtained from midwives, among others, about the system of recording and reporting, and personality issues. Monitoring officers used certain systems to monitor expectant mothers' health. They recorded the indicators. Interviews to obtain information about pregnant women involved newly detected high risk pregnancy signs, and recording and reporting expectant mother mortality and infant mortality. Conducting expectant mothers health monitoring training as well as reports submitted to the community health clinic resulted from monitoring or projection. Standards as to the provision of facilities and infrastructure to monitor expectant mother health should be met persistently, particularly if obstacles were encountered in the field during the monitoring of expectant mothers' health.

• Results and Analysis

Implementing Fishbone Diagram, This research can be described in a fishbone diagram:

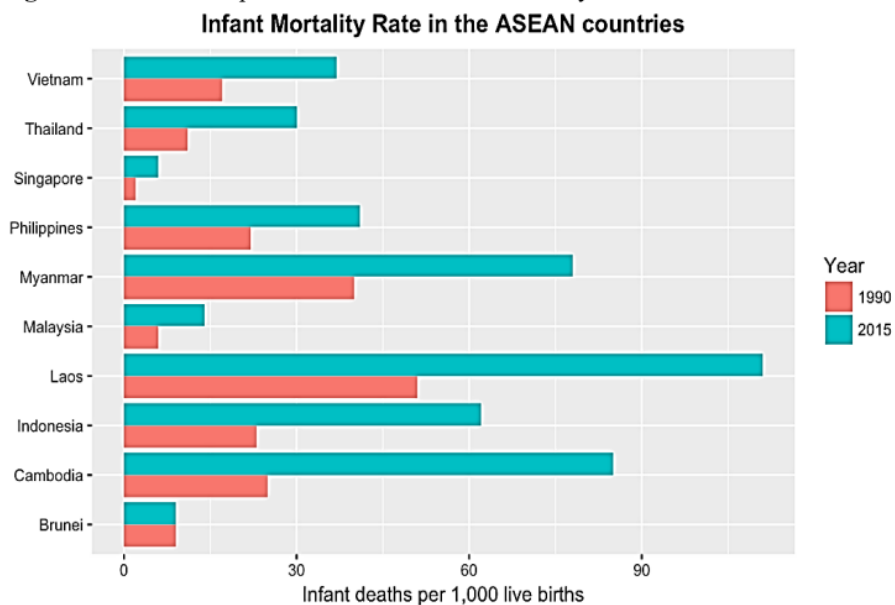
Figure 3. Fishbone Diagram of Healthy Early Warning System for Expectants Mothers and Babies



Monitoring Levels of Expectant Mothers' Health. In 2000, the UN Millennium Summit established eight general development goals, adopted from the United Nations Millennium Declaration. In total 193 UN member states and 23 international organizations agreed to achieve the MDGs goal by 2016. These eight goals were eradicating extreme poverty and hunger; basic education for all; promoting gender equality and women's empowerment; reducing child mortality; improving maternal health; combating HIV/AIDS, malaria, and other infectious diseases; ensuring environmental sustainability; and developing a global partnership for development. The progress towards achieving this MDGs objective needs to be assessed against a number of technical indicators formulated in conjunction with the MDGs framework itself. Systematic assessments by each country provide an empirical picture that clarifies and targets measurements.

Data from the Health Service of the Republic of Indonesia showing the decline in expectant mothers' infant mortality rates from 1991 to 2015:

Figure 4. Trend of Expectant Mothers Infant Mortality Rate



Impact indicators measure the achievement of overall objectives, including changes in cases of death from epidemic diseases, changes in morbidity patterns, changes in health workforce behaviour in the implementation system, and changes in health-related behaviours within a target population.

Evaluation stages of the surveillance system are as follows:



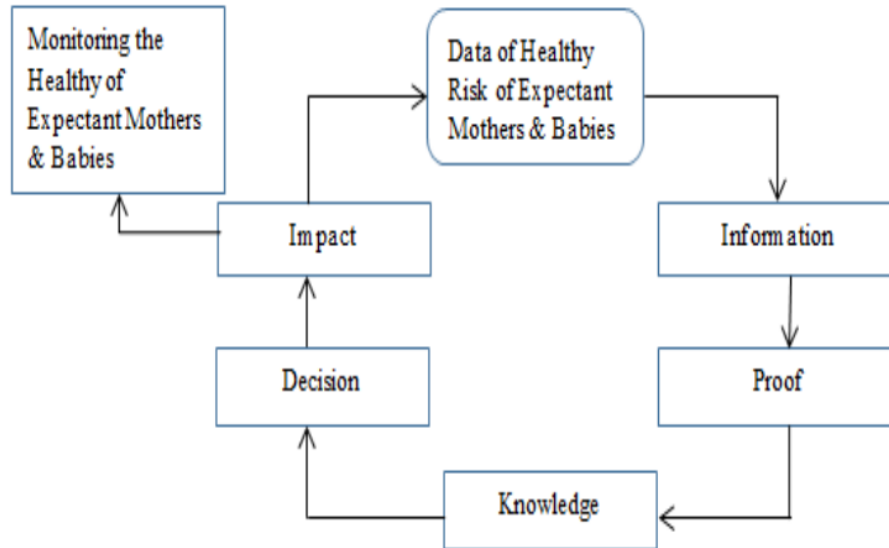
- What are the goals and objectives of the surveillance system? Are they already achieved?
- What is the importance of public health to disease or health events in the implementation of surveillance?
- How does the system work?
- What resources are needed?
- What does the system contain? Does the system match the data source?
- Is there communication and feedback between different administrative levels?
- Does the system provide useful data? Does it lead to public health action?
- Are each of the findings described and used by every policy maker?

Evaluating public health surveillance systems ensures that public health-focused issues are effectively and efficiently monitored. They should be evaluated periodically to determine how well the system is meeting established goals and objectives. The evaluation findings should result in specific recommendations for improving the quality, efficiency, and usefulness of the surveillance itself. In addition, the systems should be monitored regularly to ensure that they always reach their targets.

Monitoring is the process of collecting data regularly and measuring changes to a process. In a public health surveillance system, it involves the routine collection and analysis of indicators, to measure how well the surveillance system achieves its objectives. Evaluation, on the other hand, involves the use of specific study designs to regularly assess the relevance, effectiveness, and influence of surveillance systems. Evaluations are often conducted in response to changes in the performance of public health surveillance systems. Monitoring and evaluation of outcomes is expected to increase surveillance. When the results of routine monitoring track the impact of public health surveillance systems, monitoring can be considered an ongoing evaluation.

Design of SMS Gateway Based Application. Short Message Service or SMS is a service used in the system of sending and receiving text between mobile phones. This technology was introduced in 1991 in Europe [3] and later became the standard for GSM-based mobile communications. SMS is widely applied to mobile communications systems. It allows users to deliver alphanumeric messages between customer terminals or between customer terminals with external systems such as e-mail, paging and voice mail. SMS Gateway is a tool that can link or bridge applications or systems with mobile phones. There are two kinds of Gateway SMS; namely SMS Gateway in the form of hardware and software. In the SMS system, the main mechanism is to send short message from one customer terminal to another terminal. It is facilitated by an entity called Short Message Service Center (SMSC), also called the Message Center (MC). The SMSC stores and forwards short message traffic. Ordinarily SMSC always uses Signal Transfer Point (STP). This design aimed to monitor the health of expectant mothers and babies, as follows:

Figure 5. Cycle of Monitoring the Healthy of Expectant Mothers & Babies



Mechanism of Early Detection for Expectants Mothers and Babies Health Disorders.

The main output of this application was as follows:

- Expectant mothers and babies health monitoring activities generated valid data;
- Expectant mothers and babies health monitoring detected high-risk pregnant women early; and
- Their monitoring data could be used for decision making.
- The success of this application requires that the community health clinic Kepanjen Malang must perform the following in a focused and periodical form as follows:
 - Implement an Early Warning Health System for expectant mothers and babies at the clinic,
 - Develop and maintain the System, and
 - Socialize the System at the clinic.

Data was collected by this application at the clinic, because the health office of the Malang Regency had authority. The object of data collection was the health condition of pregnant women aged 0-59 weeks with health problems as to their pregnancy. The people executing data entry, about everything related to the health of pregnant women, are nurses and midwives at the local clinic. The data set was the number of pregnant women, the illnesses they suffered and the number of babies born. The data collection process started at the neighbourhood level, then ascended from the hamlet to the urban village level in the sub-



district of Kepanjen Malang. By filling in the data, the type of pregnant women's health disorder could be monitored early, and she could get proper treatment. Charging data through an SMS gateway would save people's time, and be faster and more efficient generally. Outputs from data filling could provide advice to the community health clinic at Kepanjen, especially when prioritising the handling of health problems of pregnant women. *It prevented the death of pregnant women from health problems.* The flow of data filled in by health community health clinic officers can be seen in Figure 4 above. All the data of the main server could be important information for the clinic, to monitor and improve services to pregnant women patients suffering diseases. Early detection, using early warning systems, could be a breakthrough for community health clinics in doing early actions, to address health trouble suffered by pregnant mothers. With this technological application, local government, and the health service of Malang Regency could more intensively monitor and trace pregnant women who had health problems regarding their pregnancy.

Conclusion

The role of the government in reducing the incidence of maternal mortality since 1991 requires a reliable program, for the early detection of diseases that interfere with the health of pregnant women. The emergence of early warning applications will greatly assist government programs run through community health clinics and integrated service stations, in reducing maternal and infant mortality rates. This application is expected to help the government's performance in reducing maternal and infant mortality rates.

The level of readiness of application implementation is quite high, because it is very familiar in the environment of community health clinics and integrated service stations. Medical personnel can monitor and collect authentic data, to minimize maternal and infant death rates due to health problems that often threaten the safety of pregnant women and infants. Through this program, the government will be able to accelerate its service, its role and its responsibilities in the future, to help handle the health of pregnant women and their babies. With the help of SMS gateways and a web base, it can be applied easily. Currently, electronic devices and information technologies are growing rapidly. They support the application of this application program that can cover a wide area because it runs web-based and mobile-based devices.

The researchers have the following suggestions: Expand socialization activities by community health clinic and integrated service station in the sub-district, down to the urban village, and the smallest area of hamlet and neighbourhood. The objective is to improve the distribution of resources to expectant mothers and babies with pregnancy health problems, by accelerating and better targeting the monitoring of pregnant women and their infants. Policies are needed to develop the program, so that it is more flexible and easily accessible to users.



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After this application was successfully applied at the level of community health clinics and integrated service stations, the researchers hope it can be developed again especially in the health field. Another program that can be developed from this application is an early warning application program, to monitor the health of infants up to the age of 36 days, as calculated from the baby's birth. Infants are prone to health problems. In addition to controlling the safety of pregnant women, the health and disruptions to infancy until the age of 36 days can also be carefully controlled.



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Biographies

Made Kamisutara, completed his education in the field of informatics and completed his undergraduate degree in 1999 at the Adhi Tama Institute in Surabaya. Continuing studies in the Postgraduate Program in Informatics Engineering graduated in 2007 at the November 10 Institute (ITS) Surabaya. He has been a lecturer at Narotama University in Surabaya since 2011. Besides actively teaching, he also actively researches and writes books. The book that was written was *Micro Controller: Wireless Smart Switching* (2016) published by Narotama University Press. Another book that was successfully completed was *The Application of Information Technology in Early Warning conditions in minimizing the Death Rate of Pregnant Women and Babies* (2017). Has a concern in the field of developing MSMEs, especially in the field of Web-based application design, in an effort to support the progress of online-based small business actors.

Agus Sukoco, Lecturer of Narotama University, Department of Management, Jalan AR Hakim 51, Surabaya, Indonesia. Routine activities other than teaching are as researchers, textbook authors, and also active in community service activities.

I Putu Artaya, born in Jakarta on June 29, 1966, obtained a master's degree in human resource management from Narotama University, Surabaya, in 2002. An economics degree in marketing management from the same campus, graduated in 1991. Besides teaching, he was also active in activities research, as a researcher and as a principal researcher. Other activities carried out are routine writing books, and the most phenomenal is the book entitled *Salesmanship - Building a Sales Network, Optimizing small business centers in the field of food security and much more*.

R. Agus Baktiono is a Lecturer in management study program at the faculty of economics and business at Narotama University Surabaya, the last education is a master of management in the field of management science, The courses that have been taken care of so far are marketing research and business feasibility study of SMEs. In addition to being busy in the teaching field, he is also active in conducting research, especially in the field of management, one of the phenomenal studies that have been carried out with the team is the optimization of the role of MSMEs in supporting food security in East Java (2016). Another activity that is often carried out is providing training to small business groups of cooperative members in the environment of East Java Province where the main aspects of the training focus on the marketing of superior SME products, and an online marketing model for increasing sales of MSME products.



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Wahyudiono, born in one of the villages that entered the city of Magetan, completed his undergraduate accounting program in 1986, attended a master's program in management with marketing specialists in 1996, continued his doctoral education program in management economics graduated in 2006 at the same institution at Airlangga University, Surabaya. His career as a lecturer began in 1983 as a teaching assistant until he finally won an academic position as a head lecturer and certified lecturer. Since 2008 began to pursue the field of research with the interest of studies in the field of MSME strategic and management. Obtain Dikti research grants from 2012 to 2017 and gain the trust involved in the research team as many as five research titles that have been funded by Kemenristekdikti (competitive research grant schemes & superior research universities).

2

Abdul Talib Bon is a professor of Production and Operations Management in the Faculty of Technology Management and Business at the Universiti Tun Hussein Onn Malaysia since 1999. He has a PhD in Computer Science, which he obtained from the Universite de La Rochelle, France in the year 2008. His doctoral thesis was on topic Process Quality Improvement on Beltline Moulding Manufacturing. He studied Business Administration in the Universiti Kebangsaan Malaysia for which he was awarded the MBA in the year 1998. He's bachelor degree and diploma in Mechanical Engineering which his obtained from the Universiti Teknologi Malaysia. He received his postgraduate certificate in Mechatronics and Robotics from Carlisle, United Kingdom in 1997. He had published more 150 International Proceedings and International Journals and 8 books. He is a member of MSORSM, IIF, IEOM, IIE, INFORMS, TAM and MIM.

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