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Logistics Procurement Planning of Medicine to Mitigate Flood Disaster Impact

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Abstract: Indonesia is one of country which vulnerable to disaster. It is due to several factors: geographical condition which is located in tropical area and imbalanced of both rainfall and capacity to handle it. The impact from flood is the existence of disease, e.g., infection, diarrhoea, URI (Upper Respiratory Tract Infection) and skin problem. The victims of flood need special medicine to avoid some dangerous substance to enter their body. However, when flood happens there is a problem about the stock out of medicine. On the other hand, there are some medicines which over stock and it will hide inventory problem, e.g., unreliable vendor, scrap and others. It indicates that procurement management of medicine is not effective. This research aims are to minimize stock out and over stock of medicine through simulation approach which is using system dynamics evolutionary search algorithms. The reduction for possibility on stock out and over stock of diarrhoea, URI and skin problems medicine from 0, 85, 100, 40, 100 and 40%. Therefore, it can be concluded that simulation of system dynamics and evolutionary search algorithms can minimize the amount of stock out and over stock from medicine when flood happens.

Key words: Disaster, stock out, overstock, medicine, system dynamics, evolutionary search algorithm

INTRODUCTION

Disaster is an incident that can endanger society life which is caused by nature or human factors and can engender victims of human, environmental damage and psychological impact (PRI, 2007). The history showed that Indonesia is one of the country which vulnerable to disaster and is caused by nature or non-nature factors. Statistics data from National Agency for Disaster Management (BNPB) showed that disaster in Indonesia in last decades reached 13,022 incidents (NBDM, 2014) and over 600,000 people in every year, suffer with this problem. Flood disaster is one type of disaster that has higher frequency than other disasters. Moreover, Oliver said that view of industry society about a disaster can be predicted also within flood disaster (Smith, 1996). It is because the cause of flood is the level of rainfall (Creutin *et al*., 2013).

Kudus Regency has geographical condition between Muria mountain and Pati hill that induce to become place that flooding. Several diseases that occur are diarrhoea, amebiasis, dermatitis, pneumonia and URI (Upper Respiratory Tract Infection). Public health care in Mejobo sub-district is one of the institutions which is crucial to distribute medicine when flood happened. However, to do procurement of medicine which usually happened stock out of certain medicine is difficult. This condition is because stakeholder cannot predict medicine need when to do procurement and has capacity limitation to predict effect of flood disaster. Simulation approach can be used to solve problem stock out and over stock because simulation approach has different perspective to view a system to be modelled. One type of simulation model is system dynamics simulation, this method suitable to analyze complex problem (Trilestari and Almamalik, 2008). System dynamics can be used to understand causes about something that not required and designing new regulation to repair/reduce those in other word system dynamics can accommodate problem that complex.

This study will look for logistics procurement regulation of medicine to mitigate diseases which was caused by flood to solve this problem, system dynamics will be used as a tool to help for modelling logistics procurement of medicine to reduce the impact of flood disaster.

Literature review: Disaster defined as serious disruption to community or society. Disaster involves a lot of people,

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material, impact of economics and environment which exceed capacity of community or society to handle it through using resources by society itself (United Nations, 2007).

Mechanism of disaster always started by hazard to cause event and if the disaster contacted with society and environment in impact will create damage. Hazard and disaster can be classified based on source of hazard and character of disaster itself.

Disaster management: The Red Cross and Red Crescent societies defined disaster management as an organization and management of resources and have responsibility to handle all aspects of humanity, especially for preparedness, responses and recovery to reduce effect of disaster.

The principal of mitigation can be done through elimination of disaster or known as preventive action, eliminate or reduce failure that inflicted by disaster to population and environment or combination both of preventive and therapy.

Humanitarian logistics: Humanitarian logistics is activity of planning, implementation and controlling that efficient, flow of cost effective and storage of goods, material and information from starting point to consumption point that has purpose to alleviate the suffering of victims (Thomas and Kopczak, 2005). Logistics more focused moving of something or someone from starting point to destination point.

In context of disaster, effectiveness and efficiency in each event of humanitarian logistics must be designed well. The fundamental in humanitarian logistics should consider type of disaster that will happen in a region. Disaster which caused by natural and destructive action, flood for example, required effort to design logistics, higher in field of knowledge and cost (Cozzolino, 2012). Disaster management consist of mitigation, preparation/preparedness, response, reconstruction. Activity of planning in humanitarian logistics exist in preparation phase (Cozzolino, 2012) (Fig. 1).

Concept of system: System is part that interacts and depends in each element to preserve existence and function as whole to reach goal inside of complex environment. Basically, everything can be classified as a system (Haraldsson *et al*., 2006). The way that can do to describe a system as follows:

- To understand as entity that separate or has correlation with system bigger than place of system
- To look something more technical so can be easy to arrange it

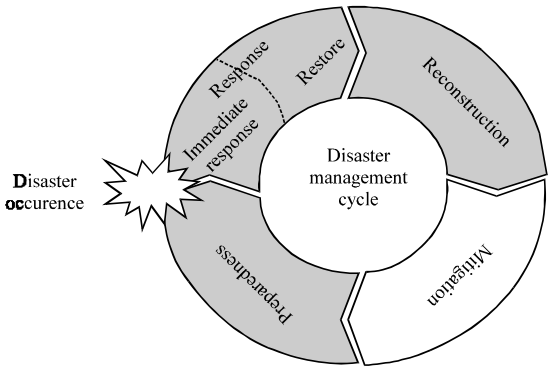

Fig. 1: Humanitarian logistics stream (Cozzolino, 2012)

System thinking: There are some important points that can be summarized from various definition of system thinking (Trilestari and Almamalik, 2008) such as:

- System thinking can be look as a new view that be used to help people for viewing and understanding complexity of reality in now a days
- System thinking is a discipline to look all of variable and linkages every variable in system
- System thinking is a framework to view relation and patterns
- System thinking is a group of principle, set and technique that bring through to understand system well

System dynamics: System dynamics is a method of modelling using computer simulation as a tool that used by manager to analyze complexity of problem. This method has strong relationship with questions about tendencies of system complex with pattern of behaviour (Trilestari and Almamalik, 2008).

There are three main characteristics in system dynamics as such close-loop, feedback-loop, variable state and rate.

Close-loop: System that as a model must be closed system, even though system not really closes because feedback loop cannot cross limitation of system. System can be considered as closed system.

Feedback-loops: There are two processes of feedback, positive feedback and negative feedback. All of system consists of two simple feedbacks (Sterman, 2000).

Variable state and rate: State means condition or accumulation from system at a certain time and rate is flow of quantity in state.

MATERIALS AND METHODS

Object in this study do in Mejobo sub district, Kudus Regency, Central Java. Kudus Regency is one of regions that categorized as a vulnerable area. The effects that were caused by flood that happen in Kudus, e.g., refuges, loss of wealth and other material. Efforts to minimize impact from flood started from mitigation preparedness, fast respond, rehabilitation and reconstruction.

System dynamics project do to study dynamics problem. Selecting and articulating feedback problem that dynamics and will determine success of project. The problem is not only dynamics but also there is natural feedback. Afterwards, it can be done by creating dynamics hypothesis and conceptual model. This step is used to develop hypothesis of theory that explain cause in dynamics problems. The hypothesis will be converted as simulation model and tested validity of hypothesis. Dynamics hypothesis can be called as a conceptual model. Verification is step to test consistency of internal model to dynamics hypothesis. In others word, effort to ensure model that built matching with hypothesis that was designed previously. Testing credibility of model is an effort to answering question whether model represent problem in real system that have relation in this study.

Method used in this study is system dynamics approach. Expectation from this method can be do procurement planning of medicine to reduce impact of flood with regard to behaviour from system that existed. System in this study can be in the form of system that having feedback, nonlinearity and delay.

RESULTS AND DISCUSSION

Model of flood: Model of flood that illustrated in form of Causal Loop Diagram (CLD) in Fig. 2 that has purpose to determine amount of flood victims. Therefore, procurement planning of medicine can be doing by public health service in Mejobo more effective.

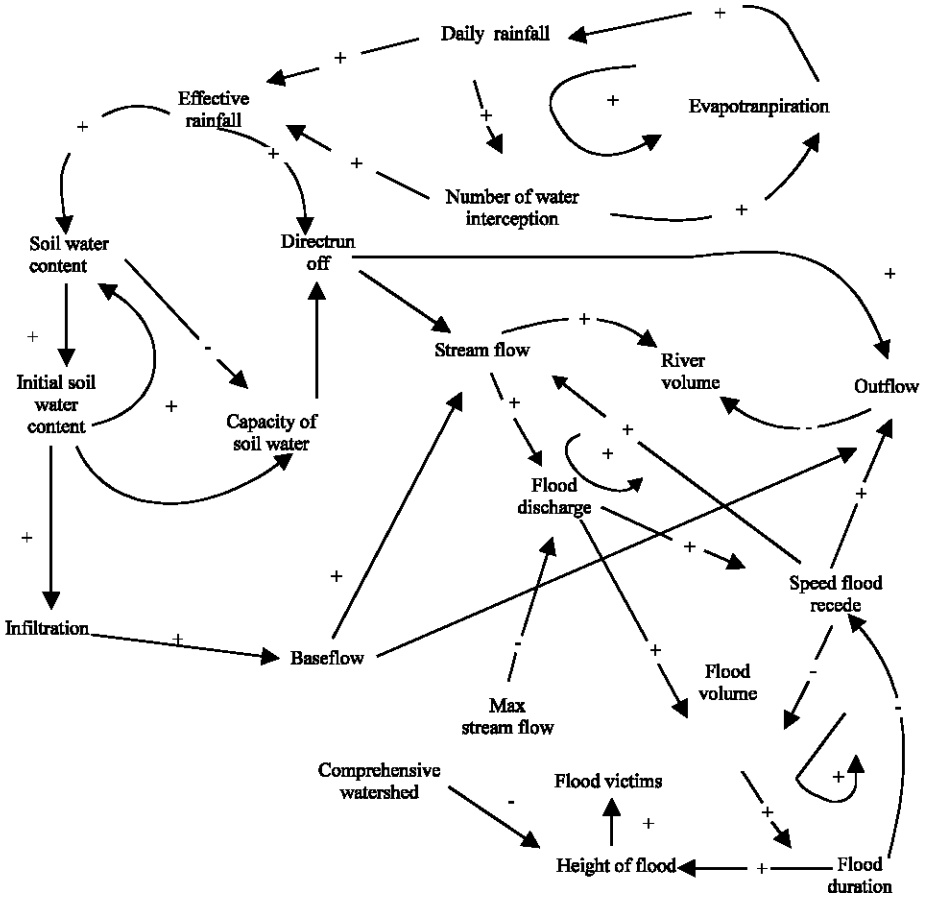

Fig. 2: Causal loop diagram of flood

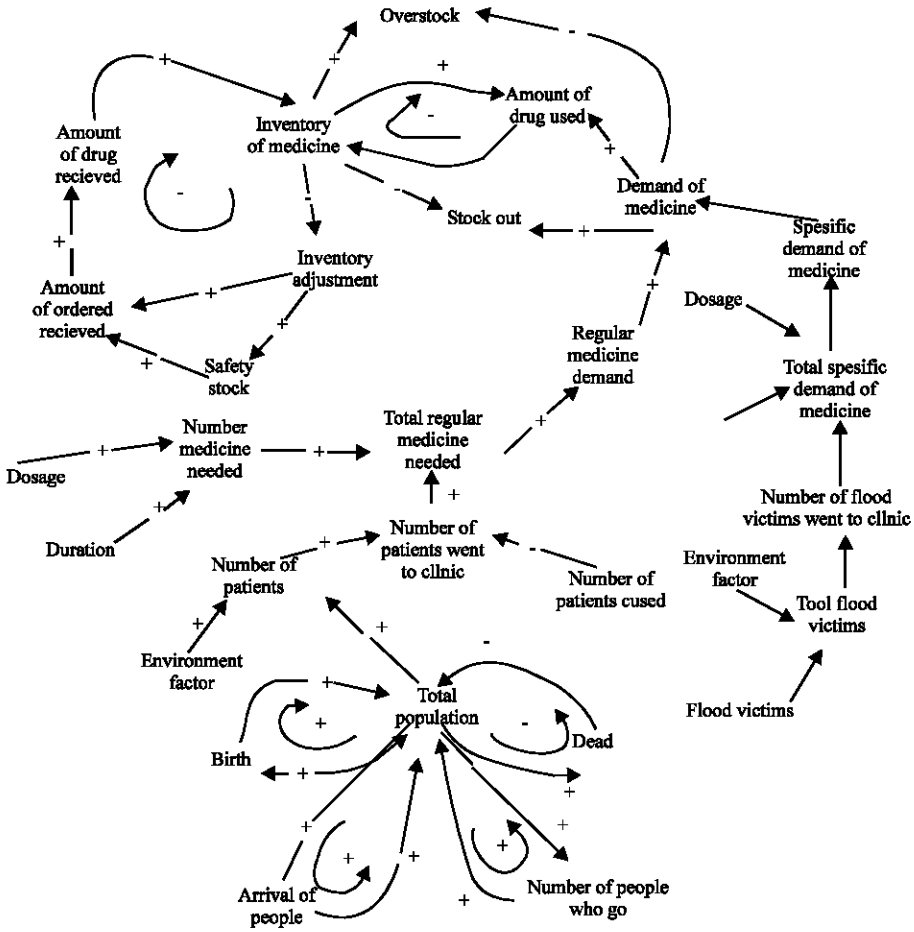

Fig. 3: Causal loop diagram of stock of medicine

Stock of medicine: Uncertainty of demand caused by several factors that consist of environment condition, population growth and extraordinary factor like flood disaster. The most important thing that should be considered is predicting demand in the next period.

To determine amount of medicine that should be reserved, procurement of medicine should consider stock of medicine for now, this has purpose to avoid over of stick in nest period. To deliver order of medicine from supplier to public health service in Mejobo need grace time that known as delay. It become consideration to determine amount of order of medicine that safety stock should be available in warehouse to anticipate if happen deviation of prediction of demand that was predicted previously. Hence, amount of demand of medicine must be exceeded as big as safety stock from prediction of demand. Hypothesis of dynamics system can be illustrated in form of causal loop diagram which shown in Fig. 3.

Model of flood events: Initial model of flood shown in Fig. 4 has been validated by using 2 types of validation test, i.e., test of behaviour model and test of extreme condition. Test of behaviour has been done through comparing behaviour of monthly debit from three rivers that pass Mejobo sub-district. While test of extreme condition is testing for flood event to find condition of behaviour model that happen.

Afterward, validation test in extreme condition performed on model through creating scenario if there something extreme event happen which there is no rain during year. It means, rainfall was equal with 0 mm in each month. Therefore, flood will never happen in three rivers that across Mejobo sub-district. Based on that scenario, model of flood event showed if during the year never occurs flood or debit of flood equal in 0 with real system or valid.

Inventory model of diarrhoea medicine: Inventory model of diarrhoea medicine validated using three type of test,

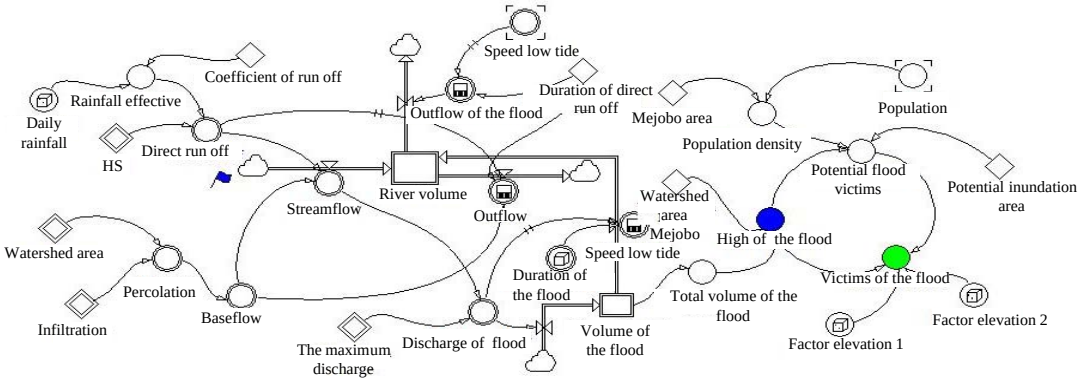

Fig. 4: Flow diagram initial model of flood

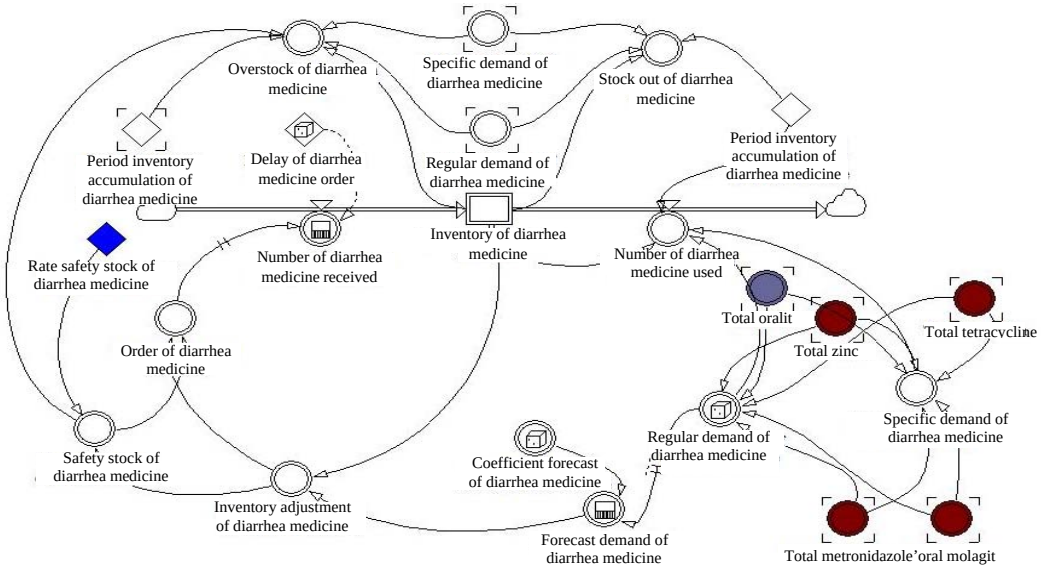

Fig. 5: Flow diagram inventory model of diarrhea medicine

test of behaviour supply of medicine in model versus actual, test of extreme condition and test of statistics. Based in test that has been done can be concluded if inventory model of diarrhoea medicine has similarity with real system that showed in Fig. 5.

In stage of statistics validation, selected variable as comparison with real system are supply of medicine such as: oralit, molagit and tetracycline. That medicine selected as a sample from inventory model of diarrhoea medicine. Diarrhoea medicine consists of three categories based on function to cure diarrhoea. The third category are antibiotic, fluid replacement and anti diarrhoea (Fig. 6a-e).

Based on the graphics supply diarrhoea medicine amount of supply is very fluctuating. It was caused by two factors consist of medicine that received from medical department and demand of medicine that always changed. Factor of medicine, that received from medical department, correlated with lead time of shipping that never constant, so, amount of demand that be expected exist in pharmacy warehouse in public health service not appropriate with plans.

Factor of demand correlated with environment condition that affect public health. The result from simulation of flood event that flood give an impact about victim of flood from December until February. Due to in that 3 months demand of medicine increase and caused medicine supply diminish.

Inventory model of URI (Upper Respiratory Tract Infection): Inventory model of URI has been validated using three types of test which same with inventory model of diarrhoea medicine. In statistics test, variable that has been chosen as a comparison with real system

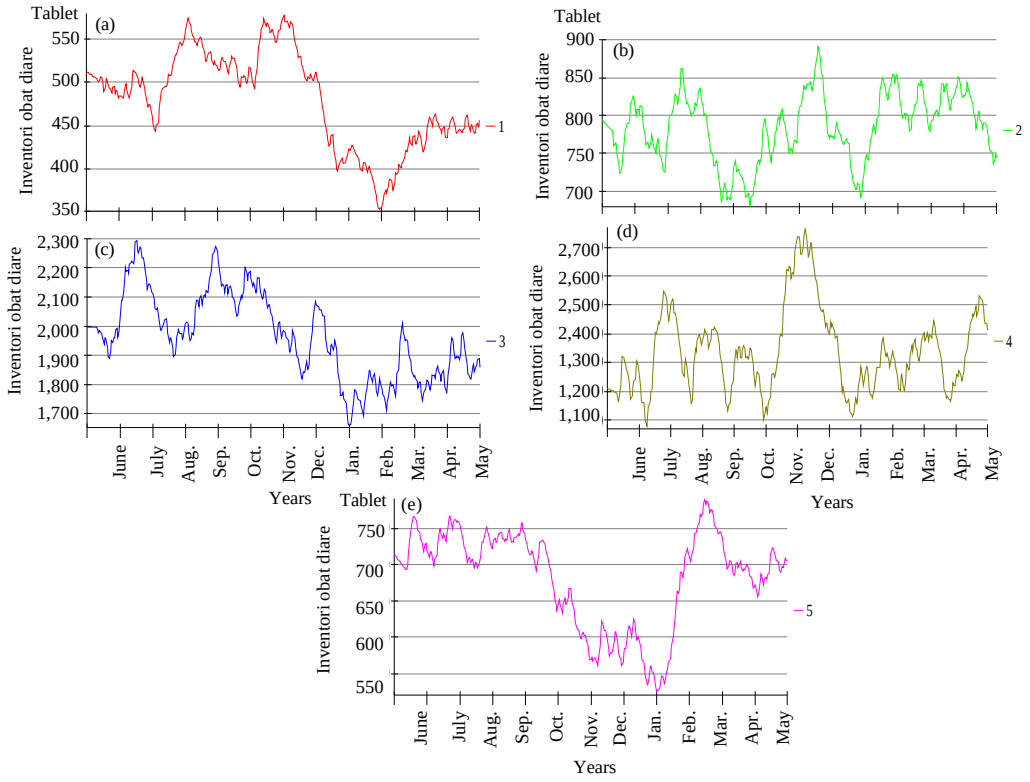

Fig. 6: Graphic of inventory diarrhea medicine; Inventori obat diare; a) -1; b) -2; c) -3; d) -4 and e) -5 (Non-commerical use only)

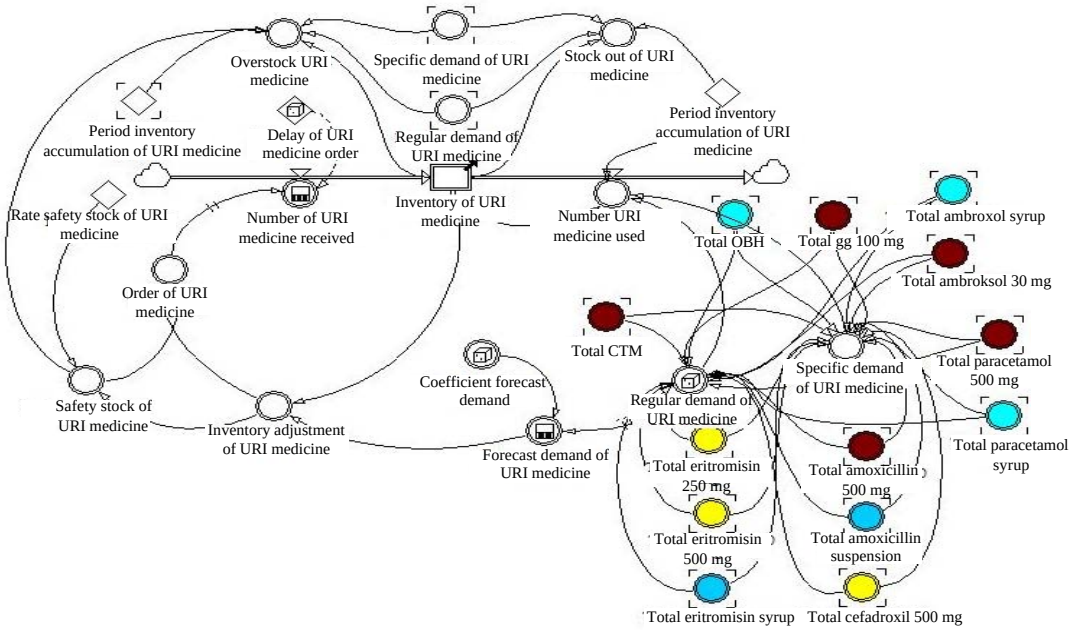

Fig. 7: Flow Diagram inventory model of URI (Upper Respiratory Tract Infection)

consist of amoxicillin 500 mg, OBH and paracetamol 500 mg. Based on testing that has been done using that type of test, inventory model of URI medicine has similarity with real system or valid that shown in Fig. 7.

Inventory model of skin medicine: Inventory model of skin medicine has been behaved like real system. It has been evidenced using three validation tests, e.g., test of behaviour inventory model skin medicine versus real

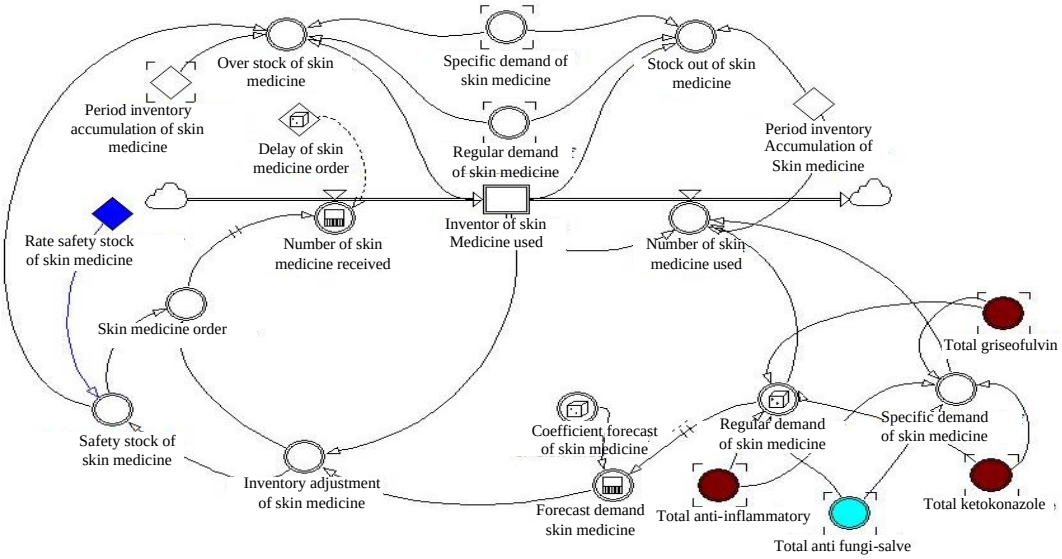

Fig. 8: Flow diagram inventory model of skin medicine

system, test of extreme condition and test of statistics. Based in Fig. 8 can be known that skin medicine can be divided in three categories, anti inflammation, anti fungi ointment and anti fungi tablet. The medicine that included in anti inflammation is such as CTM, dexamethasone, leratadin, prednisone and metil prednisolone. While medicine that include in category of anti fungi are function DOEN, ointment 24, mikonazol and ketokonazol cream. Medicine of anti fungi form of tablet is consisted of ketokonazol and grisefulvi.

Experimental design: Based on cause effect diagram, there are several factors that become causative factor stock out and over stock, failure to predict demand of consumer, failure to predict amount of safety stock, inaccurate data that be usd because there human error when do process of input data. In this study, causative factor stock out and over stock that will be eliminated.

Weight of demand forecast that be used to predict demand of medicine for next period with amount of stock out and over stock decrease significantly. Amount of medicine that stock out fall until 100%. Meanwhile, the amount of medicine over stock is reaching 85%.

Simulation model in this study are using as a tool to make a decision to determine amount of medicine that should be available to mitigate flood disaster. Model in this simulation is used as a reference to help decision maker determine supply of medicine. Demands for medicine in certain period are influencing the supply of medicine.

CONCLUSION

Model that was created and has been verified and validated showed that this model represents condition in real case. It can be seen from fluctuating demand of medicine and simulation flood disaster that has been done. This model can help decision maker to determine how many medicine should be available in warehouse and when to order medicine based on demand of medicine.

RECOMMENDATIONS

Recommendation for study that has been done to add another variable that more detail like rainfall intensity which is suitable with condition. Moreover, creating experimental design can be elaborated more. The area of study can be expanded with doing research for other disaster type likes volcanic eruptions and drought.

Furthermore, for next research can be doing sensitivity analysis to weight of forecast demand that has been obtained using evolutionary algorithms and analyzes supply of medicine in each supply chain when disaster was happened.

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