A preliminary investigation of information system using Ishikawa diagram and sectoral statistics

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Abstract. A preliminary investigation is a problem-solving procedure. The Ishikawa diagram illustrates the cause of the problem in a particular group of causes. Several studies have used Ishikawa diagrams in problem-solving procedures where the branches of the causes include some components of the information system. The purpose of this study is to conduct a preliminary investigation of information systems using Ishikawa diagram and sectoral statistics. This study uses the System Development Life Cycle method which is limited to preliminary investigation phase. This study has mapped all the components of the information system in the Ishikawa diagram as the branches of causes which grouped into 4M. Sectoral statistics determine the percentage of problems for each cause and category. Preliminary investigation produces several alternative solutions for clients/owners of sectoral statistics regarding categories and causes that have a percentage within the specified range. The percentages make determining the critical causes more measurable.

1. Introduction
The preliminary investigation was the first phase of SDLC (System Development Life Cycle) as a problem-solving procedure [1]. System analysts implement SDLC to solve problems on six components of the information system that include hardware, software, data, networks, procedures, and human [2, 3]. System analysts ensure that all components continue to support the provision of up-to-date information [1], and improve work efficiency and effectiveness [4, 5, 6, 7, 8, 9, 10].

The use of Ishikawa diagrams to build an understanding of the components problems and solutions is not a new idea. Ishikawa diagrams (known as a fishbone diagram or cause-and-effect diagram) used as a tool to map the cause of the problem [11, 12, 13]. Hardware, software, and human become a category of causes in the Ishikawa diagram for computer troubleshooting, which each category has branches [14]. The procedure of computer maintenance become a category of causes for computer services troubleshooting [15]. The solution for component problems mapped in Ishikawa Diagram such as awareness and training that can improve skills and benefits [16], and avoid misuse of data that cause financial loss and reputation [17].

These studies mapped out some of the information system components as a cause in the Ishikawa diagram. This research will make an Ishikawa diagram in which the branches of cause include all components of the information system. The purpose of this research is to carry out a preliminary investigation to find the problem in the components of information systems using Ishikawa diagram and sectoral statistics [18].
2. Methods

This study follows the preliminary investigation phase of the SDLC which include preliminary analysis, propose alternative solutions, describe the costs and benefits, and submit a preliminary plan [1]. The use of Ishikawa diagrams in the preliminary analysis phase through a series of activities: stating the problem, collecting the specific causes, and ensuring the importance of the identified causes /critical causes [19].

Problems to be solved with Ishikawa diagrams are within the scope of the information system components. The specific causes include human, hardware, software, network, procedures, and data that grouped into four categories / 4M (Man, Machine, Methods, and Materials). Several kinds of literature that discuss the components of information systems are used to determine the primary and secondary causes.

Component data presented in the table obtained from sectoral statistical documents. The table is used to ensure the importance of the identified causes. Documents used in this study captures the problem of information system in one of the local governments in Indonesia. Percentage units are used to express component issues and will appear as descriptions of the primary or secondary causes associated with the component.

If the primary cause contains several secondary causes, then the percentage of primary causes is the average percentage of secondary causes. The percentage of categories is the average percentage of primary causes, and the percentage of problems is the average percentage of categories.

![Ishikawa diagram](image)

**Figure 1.** Ishikawa diagram that contains the specific cause of information system problems.

Solutions are created only for causes or categories that have a percentage within the range specified by a government as a research client. All alternative solutions are presented in the report, complemented by an explanation of costs and benefits.

3. Results and discussion

The specific causes of information system problems included six components of the information system and grouped into four categories:

- Man: everyone involved in the process, which includes end users and specialist users / technical staff [20, 4];
- Machine: the PC (personal computer) software (system and applications) [21, 1], hardware (systems and peripherals) [22, 1], and network (system, device, and area) required to complete the work [23, 24];
- Materials: data used to generate information [20]; and
- Methods: includes problem-solving procedures [1] and information system activities [20] includes three procedures below:
a. Procurement, including purchasing or manufacturing activities in preliminary investigation phase up to system development which is only done by technical staff;
b. Utilization, Information system activities including collecting (input, storage), processing (processing, control), and deliver (output) in the phase of system implementation that can be done by technical staff or end users; and
c. Maintenance, including upgrades or repair in the maintenance phase that can be done by technical staff or end users.

The specific causes and categories are further mapped into the Ishikawa diagram as shown in figure 1. Thus the research succeeded in mapping six components of the information system as a cause in the Ishikawa diagram, refining other research that only mapped hardware, software, human, and procedures [14, 15]. Each primary cause has branches (secondary causes) as in previous studies [14].

The client limits the preliminary investigation to the machine category with the percentage range from 50% to 100% or above 50%. Data on machine problems derived from sectoral statistics as shown in table 1.

**Table 1. Machine data from sectoral statistics.**

| Primary Cause | Secondary Cause | Components | No Problematic | Problematic |
|---------------|-----------------|------------|----------------|-------------|
| PC            | System          | Operating System | 152            | 388         |
|               | Driver          | 118        | 442            |
|               | Utility         | 169        | 994            |
|               | Model           | -          | 103            |
|               | Source Code     | -          | 103            |
|               | Manual          | 1          | 102            |
|               | Installer       | 7          | 96             |
| PC            | Application     | Desktop    | 744            | 38          |
| Hardware      |                | Portable   | 419            | 23          |
|               | Scanner         | 5          | 1              |
|               | Faximile        | 4          | -              |
|               | Printer         | 62         | 27             |
|               | All in one Printer | 57        | 8              |
|               | Speaker         | 5          | -              |
|               | Headset         | -          | -              |
|               | Webcam          | -          | -              |
|               | UPS             | 4          | 2              |
|               | External Hard Disk Drive | - | - |
|               | External Optical Disk Drive | - | - |
|               | Proyektor       | 52         | 1              |
| System        | Building Entrance | 14        | 61             |
|               | Equipment Room  | 3          | 72             |
|               | Teleco. Enclosure | 10        | 65             |
|               | Work Area       | 49         | 26             |
|               | Backbone Cabling | 59         | 16             |
|               | Horizontal Cabling | 21        | 54             |
| Network       | Bridge          | 15         | -              |
| Device        | Router          | 110        | 1              |
|               | Switch          | 51         | -              |
|               | Hub             | 60         | 9              |
|               | Access Point    | 69         | 3              |
|               | Modem           | 41         | -              |
| Area          | Local Area Network | 47        | 28             |
|               | Campus / Metro Area Network | - | 75 |
|               | Wide Area Network / Internet | 10 | 65 |
Percentage of system software problems is the number of problematic devices (operating systems, drivers, and utilities) divided by the total number of devices (problematic and not problematic). Percentage of software problems is the averages percentage of system and application problems. The same way is used to determine the percentage of problems for other causes and categories, so the results as shown in figure 2.

![Machine category percentage](image)

**Figure 2.** Machine category percentage.

Based on the specified percentage range (above 50%), the primary cause that needs to be solved is software (89%) which includes secondary cause system (81%) and application (98%). These percentages make determining importance of the critical causes more measurable.

Based on sectoral statistics, system software is problematic because there are no operating system and driver backups, and no utilities installed. The problem is due to the gap of knowledge and skills in the end user. Therefore the first alternative solution is the capacity building program for end users [16]. The gap can also cause system software untreated, so the second alternative solution is device maintenance and support program implemented by information technology department's [4].

The application software is problematic because of incomplete development documentation. The first alternative is to create a documentation standard as a reference in the preparation of contract documents. According to the capability maturity model, organizations with software engineering capabilities at level 3 (defined) have software process standards that include management and engineering activities, as well as documenting the process [25].

Moreover, the second alternative is to create a policy that defines the operation associated with the software process by the performance of the organization. Performance describes the time, cost, quality and flexibility desired by the organization. With the policy, the operations manager can make efforts to increase if the desired level of performance has not been achieved [26].

4. Conclusion
This study has succeeded in making Ishikawa diagram based on the literature, where the primary and secondary causes include the six components of information systems and divided into 4M categories. This study has made alternative solutions for each secondary cause that has a percentage of the problem within the range specified by the client. Percentage describes component problems according to sectoral statistics. The component problem data taken from sectoral statistics is limited to machine category, so this study does not present the percentage of overall information system problem.

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