Abstract—Metrics are important means to monitor the performance of an organization. Hence it is important to specify the metrics, because unclear specified metrics can lead to misinterpretation of the performance. This specification helps to apply the right metrics and also allows assessing the usefulness of these metrics. We developed a process for the specification of metrics to manage the metrics specification systematically and continuously. Modeling metrics entity conformant variability concept is the focus of this paper, with an introduction of the systematic metric specification process. Variability occurs as varying degree of metrics entity specification, the result of different inputs from different stage of specification process. Modeling variability towards a systematic metric specification aims to support the metric specification process, with providing flexibility on specifying metric from generic purpose to specific measurement. Variability model proposed in this paper was designed from a design pattern as one of variability mechanisms that are able to reflect our specification process.

Keywords—metrics, variability, software measurement, design patterns, Goal-Question-Metric (GQM).

I. INTRODUCTION

Metrics as quantitative standards of measurement being used by many organizations in order to control organization’s performance. In traditional way, the measurement process was a trivial task that did not get enough attention from management. As the growth of software engineering knowledge to control and improve the quality of process, measurement became one of the key process areas of Capability Maturity Model Integration (CMMI). Key process area of CMMI maturity level 2, Measurement and Analysis, covers the use of metrics to perform measurement in software organization [17]. Specify the right metrics is important, because unclear specified metrics can lead to misinterpretations of the performance. Unfortunately in many organizations process that address metric specification are often missing or too generic. Hence, we developed a process for the specification of metrics. The process of metric specification is designed based upon a generic requirement process and goal-question-metric approach (GQM) [5].

Within the systematic process of the specification of a metric, variability of a metric’s entity might occur. The variability term used in this paper is probably different from the general concept of common variability that concern about product family with the variation of product’s components. Therefore, the following definition will be used throughout the work to guide the understanding of this paper:

"Entity variability is the varying degree of entity specification, start from the initiation form until the complete form of entity that can be implemented". Modeling variability towards a systematic metric specification is a key element to manage the specification processes that need different input in different stages. The variability model proposed will be able to reflect flexibility in refining metric and support the metric specification that we developed.

The next section describes the metric specification process. Section III defines the variability model. The tool support and prototype to support the process is sketched in section IV. The last section provides the results of an evaluation and an outlook into future work.

II. A METRIC SPECIFICATION PROCESS

The design of the process was lead by two main goals. Firstly the process should support the organization-wide definition of new metrics as well as for project-specific metrics. Organization-wide defined metrics build a base of metric best practices. These guide the definition of project specific metrics that are used in the projects to answer certain management questions. Secondly the process should assign specific responsibilities to the people involved in the process. The metric specification process is an instance of the generic requirement process, as in fig 1. The requirements for the metrics need to be described based on the information needs of the user, and documented in an initial metric specification. Analysis in the second step aims on finding contradictions, redundancies and incomplete definitions inside this specification. In the third step the specification needs to be formalized so it is able to serve as documentation. The validation ensures that the metric is able to satisfy the needs of the metric. Validation step is a continuous activity that needs to be performed throughout the execution of the process and the outcome of the process is a complete metric specification.
We used goal-question-metric (GQM) approach to deduce the requirements from the information needs of the user. GQM is a top-down approach to establish a goal-driven measurement system for software development [5]. The GQM approach divides the process into three levels; conceptual, operational, and quantitative level. Goals and requirements for the process are specified in conceptual level; describing what general objective wants to be achieved. On operational level, questions that help to understand how to meet the goal are formulated. Metrics defined on the quantitative level identify the measurements that try to answer the question.

III. VARIABILITY MODELING

From the metric specification process introduced in the previous section, there are several main entities defined in the metric meta-model; Information Needs, Interpretation fragment, Indicator, Report, and Measurement. Information needs as the starting point for the specification become the focus to propose first variability modeling of metric entity. The next discussion will use Information Needs entity as an example to model the variability. Information needs describe all the requirements and goal of the metric. Metric user initiates the information needs as a textual description. Through several steps, the information needs will be refined to be more specify with grouping the information needs in specific category or formulating the information into one/more questions. The specification process of the information needs causing a variability, as in our definition of entity variability, that is need to be modeled to support the whole process of metric specification.

A. Variability Overview

Variability modeling is a domain specific modeling technique that helps managing complexity and facilitates reuse, with feature decomposition. Variability modeling consists of variation points, variants, and relationships between them. A variation point is a representation of a variable item of the real world or a variable property of such an item. A variant is a representation of a particular instance of a variation point. Therefore, a variant should have a relationship with at least one variation point [2]. Several variability mechanisms have been identified to introduce or implement variability, such as parameterization, information hiding, inheritance, variation points, and pattern. From our preliminary works attempted to model the entity variability, pattern is proposed in this paper as the best variability mechanism to reflect the flexibility of the entity.

B. Step of Variability Analysis

Variability analysis will be started with analysis of variability possibility of a metric entity. A potential entity of variability might occur from one or more possibility listed below:

- An entity is defined over several process steps, an entity that is started with textual description and later on become more specific with attributes attached to that entity for implementation need.
- An entity has variation evolution, possibility of an entity to be evolved into different type of entity.
- An entity that has variant attributes or cardinality in different project.

The entity with variability later on will be addressed as variation point. The next analysis step is to define all possible variants of the variation point with specific component that distinguish each variant. After defining variation point and its variants, variability mechanism will be applied to model the variability.

Information Needs is one of the metrics entities that are defined over several steps in the specification process. The specification process is started with initiation for proposing metric as textual description of all general information that are required. The next step of specification is either categorization or question formulation, both of the steps have to be accomplished to get the completed entity of information needs. Categorization is a step to group similar information needs with the existing category in the system, such as cost, time, quality, content and risk; with several subcategories for each main category. Categorization aims to realize the reusable functionality, based on the same category to reuse existing metric. On the other hand, question formulation is a step to break down the rough description of information needs into several detail questions. This step is carried out with formulating a question that will be answered by a metric that is proposed on the end of process. The question for each information needs description can be formulated more than one, in one time or in different step.

The variation point of information needs is the entity itself, while the variant is the variability point of the variation point. The commonalities of all related variants are reflected in variation point itself. In the metric information system, the main commonality of an entity is the initiation phase of entity specification; where an entity is initiated by textual description. From the specification process of information needs explained, the variants are determined as different states of the entity; *initiated*, *categorized*, *formulated*, or completed entity. Initiated as the starting state, while completed is the final state of the entity after the categorization and formulation process committed. Categorization and formulation process can be performed one after another based upon the user, and each process can be iterative.

C. Design Variability Model for Information Needs

Variability solution pattern proposed to model the entity variability is decorator pattern, one of design patterns that are
referred to variability mechanism. Decorator pattern allow an object to add many features and function dynamically, especially when the combination of feature could not be predicted in design time. Fig. 2 presents the mapping result of decorator pattern to our information needs entity. 'InfoNeedComponent’ represents the interface of the entity and 'DescriptionComponent’ represents the concrete component. All of the information needs entity object created will include 'DescriptionComponent' as the first component for the entity, to describe initiation of information needs in textual description. All classes that are derived from 'InfoNeedDecorator' are the decorators. Those decorators will wrap the initiate entity object with new component and refined the entity. There are two decorator classes for information needs entity; Decorator_Category and Decorator_Question. Decorator_Category is a class to reflect categorization of information needs, while Decorator_Question is a class to describe the formulation of information needs’ question.

The structure of decorator pattern provides flexibility to add more property that can reflect the variability of the entity. Varying degree of entity specification is presented by different properties and functions in different state of entity specification. Every decorator attached to entity will change the specification dynamically to reflect the variability.

**D. General Variability Model**

The general solution pattern based on decorator pattern will be presented in this section. Another metric’s entity with potential variability can be model from this general pattern. Fig. 3 shows the general solution pattern for entity variability.

Entity defines the interface for each entity. DescriptionComponent is the concrete component for each entity in abstract textual description form; the object that will be initiated first and extends the Entity. New property/component will be added dynamically to the Description-Component to specify the entity. All decorators present component to specify the entity, with new state, new component that will wrap the entity, or new behaviour. The decorators are derived from EntityDecorator class that implements the same interface with Entity.

![Fig. 2 Information Needs model with decorator pattern applied](image)

![Fig. 3 Solution pattern proposed for entity variability](image)

The decorators allow adding new method or extending the state of the entity, and each decorator has an instance variable for the entity it decorates. Those decorators that are used to wrap the entity will change the specification degree of the entity and cause the variability between entities. The structure can be nested to model a decorator component that can be decorated more with another decorator.

**IV. TOOL SUPPORT**

A dedicated tool is needed that supports the newly designed process and reflects the different states of the metric specification. A support tool to manage, communicate, and develop metrics will help to avoid errors, misinterpretations, or sporadic use of metrics, and help to share the knowledge from the metric experts. Therefore, a support tool named MeDIC (Measurement, Documentation, Integration, and Calculation) was developed.

MeDIC is a web-based software tool developed using Enterprise JavaBeans 3.0 as the base technology. MeDIC V.2.0 is the current version of the MeDIC that is still being developed as this paper was written. Unfortunately, the current version of the MeDIC has not implemented the variability model that is proposed in this paper. However, GUI prototypes are sketched to provide a first look at the actual implementation of this variability modeling in the MeDIC system.

**V. EVALUATION AND FUTURE WORK**

We introduced the design of metric specification process including a dedicated tool support developed to implement the process. Entity as part of the metrics needs to be specified as well. Metric entities are defined from rough description to concrete model that can be implemented. Variability occurs from the process to specify the entity of the metric, as a result of different inputs from different stage. To support the metric specification process, modeling the variability of the metric entity is a necessary. The variability model will enhance the
current metric specification process and support a process of entity refinement. Entity will change eventually as a result of user input and the general pattern proposed in this paper is able to model every entity variant in different state of the specification.

The general solution pattern is adopted from decorator design pattern. Compare with another variability mechanisms mentioned in [19] and [20], decorator pattern selected to model entity variability in our work. Decorator offers two main features that support variability. First, decorator pattern allow an object to add many properties and function dynamically. Therefore, decorator pattern able to handle various components attached to the entity and causing the variability. Second, decorator pattern enable to model the combination of the feature that could not be predicted in design time. Hence user inputs that cannot be predicted can be cover with this model.

Information needs chose as an example to model entity variability in this paper with consideration of the potential variability of this entity and as an initiate entity in metric specification process. The proposed model will be applied to other metric entities, such as measurement and report entity. Overall evaluation of the proposed model will be collected after all variability in metrics is modeled and implemented.

REFERENCES