Alain Abran
E-mail: abran.alain@uqam.ca
Tel: (514) 987-3000 (8900)
Fax: (514) 987-8477

Jean-Philippe Jacquet
E-mail: c3401@er.uqam.ca
Tel: (514) 987-3000 (6667)
Fax: (514) 987-8477

Research Lab. in Software Engineering Management,
Department of Computer Science,
Université du Québec à Montréal,
P.O. Box 8888, Succ. Centre-Ville,
Montréal (Québec), Canada H3C 3P8

Abstract

The ISO (International Organization for Standardization) 14143-1 document is the first in a set of five documents constituting the international standard on Functional Size Measurement for software. This first document specifies a mandatory set of concepts required for functional size measurement and tackles it from a measurement method perspective. This is a unique perspective in contrast to other standardization work in progress on software. This article presents a structured analysis of this ISO 14143-1 to analyze its completeness and mapping to measurement principles and related concepts. This analysis is carried out following the structure of a process model for software engineering measurement methods identifying the distinct steps involved, from the design of a measurement method to the exploitation of the measurement results. For each step of this process model, the proposed analysis identifies the strengths and weaknesses of this ISO 14143-1 standard. A summary of key strengths and weaknesses is presented in the conclusion.

1. Introduction

Over the past 20 years, a number of so-called functional size metrics have been proposed in the software-engineering literature. Some, such as the DeMarco bang metrics [3], have been referred to extensively in the literature, but have not been widely used in industry; while a few, such as Function Point Analysis (FPA) [2], have been used a great deal in some segments of the industry and not in others.

FPA has received broad industry support through the setting up a US-based international users group, the International Function Point Users Group (IFPUG). This group has put in place a standardization committee in charge of both clarifying the rules for its application and documenting these rules in an official industry *de facto* standard, The Counting Practices Manual [5]. IFPUG has put in place a committee to certify individuals (through certification exams) and provides training programs. There are also software tools for supporting FPA counting practices [12].

However, the existence of IFPUG has not prevented the emergence of variants and extensions outside its influence, nor has it been seen to be responsive in taking into account, and integrating, the various concepts underlying proposals to address some of its weaknesses, as highlighted by researchers ([14], [9], [15], [1], [13]), with the exception of questions related to the reliability and consistency of the counting process across counters [10,11].

In 1994 IFPUG recognized the importance of the ISO (International Organization for Standardization) label for increasing its penetration into the industrial community and lobbied the ISO community to propose FPA as an international standard. A proposal for a new ISO project was put to national standardization bodies for a vote under the following initial title: "Function Point Analysis". The international standardization community recognized the need to address the issue and agreed to commit resources to staff a new work group referred to as ISO IEC/JTC1/SC7 WG12.

Soon after WG12 began activities, it became clear a choice had to be made between two alternatives. The first was to proceed quickly to standardize a measurement method, already a *de facto* standard in certain industry segments, even though it had some documented deficiencies, in the hope this would lead to an increase in investment to improve it. The other was to recognize that no known single functional size "technique" could then adequately meet all requirements for all types of software and some techniques might have strengths others did not have. It was also perceived that progress towards standardization would be slow and quite challenging, in effectively defining a single integrated Functional Size Measure (FSM) which would be unique in all-circumstances, and that for the foreseeable future, multiple functional size techniques might be required. This latter alternative was judged to be preferable, with the best chance of delivering an agreed-upon international standard for addressing this issue in the foreseeable future. The strategy evolved towards the identification of criteria any proposed FSM method would have to meet to be recognized as an international standard. This led to the renaming of the project (and document to be delivered by WG12) as the *Functional Size Measurement method*.

The purpose of WG12 is to identify and document criteria the design of FSM methods should meet to be recognized as an international standard.

In designing this international standard, the working group is using a five-document structure:

- The first was voted as an international ISO standard in 1998, "Definition of concepts"[1] [6], and contains a list of concepts related to the FSM method;
- The second, "Compliance Assessment of Software Size Measurement"[2], will provide a set of procedures to assess a functional sizing method in terms of its compliance with ISO/IEC 14143-1;
- The third, "Verification Guide"[3], will propose a structured set of characteristics which should be documented on the known quality of any FSM proposed as a measurement method;
- The fourth "Reference Models"[4], will provide a reference model against which FSM results can be compared for analyzing convertibility across proposals;
- The fifth, "Functional domains"[5], will provide characteristics of functional domains to characterize the domain(s) of application of each proposed FSM.

From 1994 to 1998, WG12 focused its energy on the first document to be published as an International Standard [6]. Work is progressing on the other documents.

This article proposes a structured analysis of this FSM standard. This analysis is carried out following the format of the process model for software engineering measurement methods presented in [8]. This paper is organized as follows: section 2 presents and discusses the scope of ISO/IEC 14143-1; section 3 presents the method to be used to analyze the ISO document, that is, the process model for software measurement methods presented in [8]; sections 4 to 7 present the results of this analysis.

[1]ISO/IEC 14143-1
[2]ISO/IEC 14143-2
[3]ISO/IEC 14143-3
[4]ISO/IEC 14143-4
[5]ISO/IEC 14143-5

2. Discussion of the scope of ISO/IEC 14143-1

The scope of ISO/IEC 14143-1 [6] is to define the [6] "*... fundamental concepts of Functional Size Measurement (FSM)*" and to describe the "*... general principles for applying an FSM Method.*"

It is also specified in the scope section of the standard that it does NOT provide detailed rules on how to:

- *Measure Functional Size of software using a particular method;*
- *Use the results obtained from a particular method;*
- *Select a particular Method.*

This ISO document specifies it will not prevent the development of various methods, but rather provides only a basis for assessing if a particular method conforms to the ISO definition of an FSM.

According to the documented scope of this standard, it is restricted to defining fundamental concepts and describing general principles for applying a FSM method. This means the document aims to answer questions such as "What is a FSM?" or "What is a FSM made up of?". By contrast, it also means the standard is not aimed at addressing "quality" criteria of measurement methods. For example, it defines concepts to be required from a FSM method, but does not provide requirements for qualifying them as either "good" or "effective" FSM measurement methods. The WG12 is attempting to address these issues in subsequent documents (parts 2 to 5).

This ISO document aims to define the fundamental concepts of FSM and general principles for applying FSM methods means that, after reading the document, one should to be able to say, for example, what FSM is, what an FSM method is, what an FSM method must be made up of and what application steps are required to make it comply with the standard.

This article aims to analyze whether or not the ISO document meets the objectives of its scope completely. This means investigating issues such as does the document:

[6] [6], item 1

- Provide a complete list of measurement concepts about FSM; that is, does the proposed list of concepts cover the various parts of a measurement process?
- Provide a complete list of requirements and characteristics for these concepts?
- Give a general, but complete, list of principles for applying a FSM method?

To address these questions, the analysis presented in this paper has been carried out by verifying whether or not the standard tackles each step and substep of the process model for software measurement methods presented in [8]. Highlights of this model are discussed next.

3. A process model for software measurement methods

The analysis of this standard is based on a process model for software measurement methods and will be presented accordingly. This process model, presented in [8], highlights the key distinct steps of measurement methods, from their design as measurement methods to their utilization. This high-level model is made up of four steps (Figure 1):

1. Design of the measurement method: before measuring, it is necessary to design a measurement method.
2. Application of the measurement method rules: the rules of the measurement method are applied to software or to a piece of software.
3. Measurement result analysis: the application of the measurement method rules produces a result that can be analyzed.
4. Exploitation of the measurement result: the measurement result is exploited in a quantitative or qualitative model.

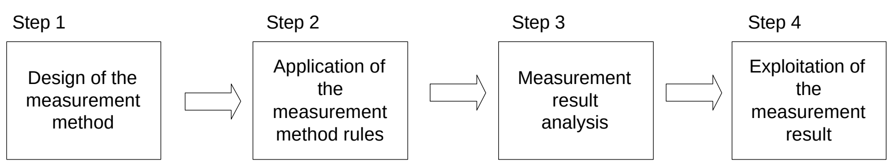

Figure 1: Measurement Process - High-level model [8]

An extensive literature review (from within and from outside the software engineering domain) made it possible to detail this high-level model and has permitted identification of the necessary substeps within each of the proposed steps. The set of substeps identified is illustrated in the detailed model of the measurement process described in Figure 2. [8] proposes the design of a measurement method should be based on the various steps and sub-steps presented in this process. The ISO/IEC 14143-1 analysis was built up accordingly.

The mapping of this ISO standard to the high-level model is discussed in section 4 through an analysis of the definitions and to the detail-level modeled in sections 5 to 7 through an analysis of how this ISO standard tackles each step and its corresponding sub-steps.

4. High-level model mapping

In the software engineering literature, the words (nouns) “measure” and “measurement” are often used indiscriminately to refer to many distinct concepts at the same time:

1. A measurement method,
2. The application of a measurement method,
3. The result of this application,
4. The process from the design of a measurement method to its exploitation.

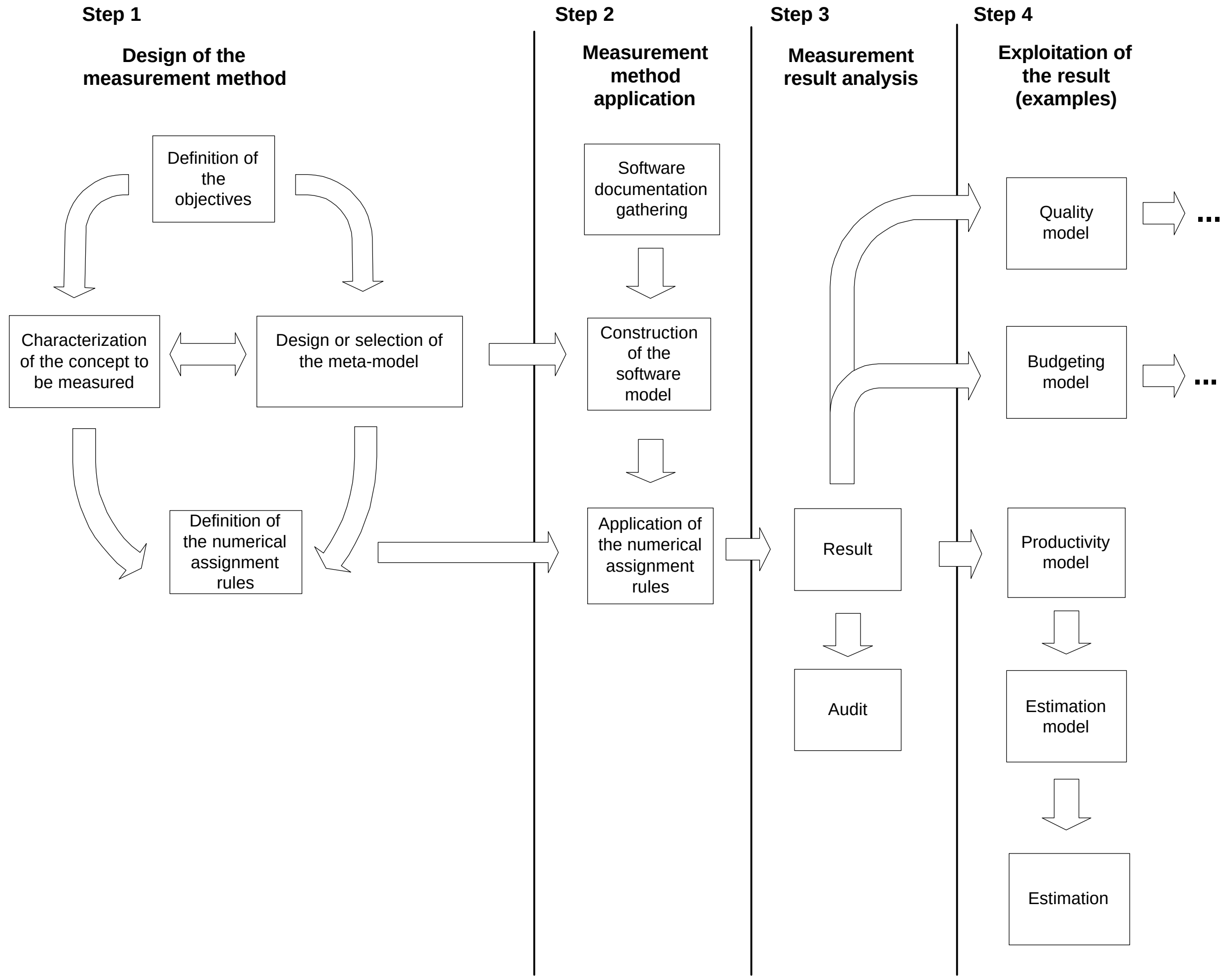

Figure 2: Measurement Process - Detailed model [8]

A careful review of this ISO standard reveals this mistake has been avoided. The words "measure" and "measurement" are never used alone, but always within expressions such as (and defined as):

1. FSM***:*** *The process of measuring Functional Size.*
2. FSM method***:*** *A specific implementation of FSM defined by a set of rules, which conforms to the mandatory features of this part of ISO/IEC 14143.*
3. Application of a FSM method.

These definitions are themselves based on the following two definitions:

- ***Functional Size:*** *A size of the software derived by quantifying the Functional User Requirements.*
- ***Functional User Requirements:*** *A sub-set of the user requirements. The Functional User Requirements represent the user practices and procedures that the software must perform to fulfill the users' needs. They exclude Quality Requirements and any Technical Requirements.*

It can be seen that the first three ISO definitions can be mapped to the three distinct steps in the measurement method process presented in Figure 1. This mapping is illustrated in Figure 3.

This means this ISO/IEC document, like the measurement process modeled in Figures 1 and 2, differentiates the various steps from the design of a measurement method to its utilization.

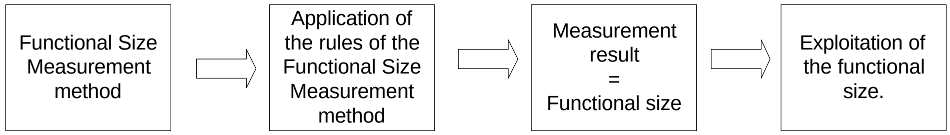

Figure 3: Functional size measurement - High-level model

It must be pointed out that exploitation of the results of FSM (e.g. Step 4 of the Measurement Process model) is discussed only in the Informative Annex of this ISO document. In ISO terminology, this means annexes of this type are not part of the prescriptive content of ISO standards and, therefore, does not lead to an ISO certification label. Informative annexes are sometimes added to ISO documents to provide additional contexts for the topics being covered, without any attempt at being exhaustive and without implying the information contains binding elements.

The analysis presented here addresses the three steps contained in the prescriptive sections of the ISO standard, that is, "Design of the measurement method", "Measurement method application" and "Measurement result analysis". This analysis is based on the detailed model of [8]: issues relating to all substeps and steps in the detailed model are identified and an analysis of the way this ISO document deals with them, or not, is carried out.

5. Analysis of the design requirements

In this section, questions that should be answered at each substep in the design level of a measurement method are highlighted, followed by a verification on whether or not they are addressed in this ISO standard.

5.1 Substep 1.1: Definition of the objectives

The first step in the design of a measurement method should be the definition of its goal and objectives. Indeed, before designing a measurement method, it is important to clearly state, through definition of the measurement method objectives, the set of issues to be addressed by the design of the measurement method. Examples of such issues in terms of measurement method objectives are:

- What is going to be measured (which attribute, what kind of software, etc.)?
- Will the measurement method point-of-view be (e.g. software user, software designer, etc.)?
- Must the specific desired properties or characteristics of the measurement method be?
- Are the intended uses of the measurement method?

All these objectives have a strong influence on the design of a measurement method. Are they all specified in this ISO standard? Explicit answers to some of these design issues with respect to the objectives of the FSM methods are provided, but not to all of them:

What is going to be measured? The measured attribute is, of course, functional size and is specified within the definitions of "functional size" and "FSM Methods" themselves. This ISO document specifies proposed designs must also address the issue of what kind of software will be measured when it states that an *FSM Method shall describe the Functional Domain(s) to which the FSM Method can be applied.*[7] Thus, FSM proposals are not expected to address the functional size issue for all kinds of software simultaneously and there could be distinct design answers to this question. However, this ISO document indicates it will provide guidelines on this issue later by specifying the concept of "Functional Domain"[8] [9]:

- From which point of view? This ISO document clearly states the point of view of every FSM method must be that of the user (see definition of functional size). This is also stressed by the following design requirement:

> *An FSM method shall have the following characteristic: it is based on a representation of the user requirement from the perceptive of the users*[10].

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[7] *[26, item 5.2.1.1 d)].*

[8]***Functional Domain:*** *A class of software based on the characteristics of Functional User Requirem*ents *that are pertinent to FSM.*

[9] ISO/IEC 14143-5 will provide a list of functional domains. This document is a work in progress.

[10]*[26], item 5.1.1.1 a).*

- With which properties and characteristics? This ISO document provides information on characteristics that shall be met, that could be met and that should not be met. For example:
  - *An FSM method shall have the following characteristics: it can be applied as soon as any Functional User Requirements have been defined whilst they are available,* [11].
  - *An FSM method should be as independent as possible of particular software development methods or technologies*[12].
- Intended uses? This ISO document does not impose any constraint on intended uses, but requires they be addressed in every FSM method proposed. This is expressed by the following ISO requirement:
  - *An FSM Method should describe the purposes for which the FSM Method can best be used such that the users of the FSM Method can judge its suitability for their purpose*[13].

This ISO document clearly addresses the design substep of the specification of objectives for the proposal of FSM methods. On one hand, it insists all design issues related to this substep be addressed for recognition as complying with this ISO standard; but, on the other hand, it imposes only a few constraints on the answers to be provided. This means it does not provide explicit answers to all aim and objective-related questions, even though it requires they all be addressed.

5.2 Substep 1.2: Design or selection of the metamodel

Software is not a tangible product. However, it can be made visible through multiple representations (e.g. for a user, a set of reports, screens etc.; for a programmer, a set of lines of code, etc.). The set of characteristics selected to represent software or a piece of software and the set of their relationships, constitute the metamodel proposed for the description of the software to which the proposed measurement method will be applied. The metamodel must therefore describe the entity types to be used to describe the software and the rules allowing the identification of the entity types.

[11] *[26, item 5.1.1.1 b).*
[12] *[26], item 5.1.1.2 d).*
[13] *[26], item 5.2.1.2 c).*

In the Function Point Measurement Method (FPMM), for example, an Internal Logical File (ILF) is a piece of software of the entity type. This entity type is defined according to the FPMM's metamodel. The IFPUG manual presents a definition of this ILF entity type, as well as identification rules to ensure each and every ILF can be clearly recognized within a piece of software.

In short, when considering metamodels, three main elements have to be examined:

1. The entity types of the metamodels (i.e., the different types of components taking part in the modeling of the software).
2. The relationships among entity types.
3. The entity (types) identification rules.

For the sake of generality, this ISO document does not impose a specific metamodel. However, this document clearly addresses the design substep of the metamodel for proposals of FSM methods. Again, it imposes a few constraints on the answers to be provided; but, by contrast, it insists all design issues related to this substep be addressed for recognition as complying with this ISO standard. To do so, it specifies the requirements relating to the three main elements given above. This is by:

1. **Entities of the metamodel:** This ISO document defines three basic entity types, called components, for describing the metamodel of a measurement method. These are:
   - ***Base Functional Component (BFC):*** *An elementary unit of Functional User Requirements defined by and used by an FSM Method for measurement purposes.*

     NOTE *- Example, a Functional User Requirement could be "Maintain Customers" which may consist of the following BFCs: "Add a new customer", "Report Customer Purchases", and "Change Customer Details". Another example might include a collection of logically related business data maintained by the software under study such as "Customer Details". There are many other examples.*

     This definition is strengthened by the following requirement: *It expresses only Functional User Requirements; it does not express Technical Requirements; it does not express Quality Requirements*[14].

[14] *[26], item 5.2.2.*

- ***BFC Type:*** *A defined category of BFCs.*

  NOTE *- Examples of BFC Types are 'External Inputs', 'External Outputs' and 'Logical Transactions', and data stores such as 'Internal Logical Files'.*

- ***Boundary:*** *A conceptual interface between the software under study and its users.*

2. **Relationships among entity types:** The requirement about relational entity types is: *An FSM method shall: define the relationships, if any, between the BFC Type and the boundary. Note 3: An example of a relationship of a BFC Type with the boundary is: "an Internal Logical File must reside on the software side of the boundary"*[15].

3. **Entity identification rules:** Requirements about entity identification rules are: *An FSM method shall:*

- *Describe how to identify BFCs within the Functional User Requirements*[16].
- *Define how to classify BFCs into BFC types, if there is more than one BFC type*[17].

This ISO document does not, however, specify any requirement to address subjectivity in the identification of entities. Unfortunately, a common weakness of many measurement methods is subjectivity. This can arise when numerical assignment rules are ambiguous or more frequently when rules to identify the components of the metamodels are ambiguous. For example, many software 'metrics' do not formally specify their metamodel nor their components, using instead expressions such as "process" and "data flows", without providing precise definitions of these. This makes them context-dependent; i.e. dependent on the way the users of the measures understand these expressions. Rules for the identification of valid components should be defined in a manner that prevents them from being interpreted in different ways.

Additional requirements relating to metamodels could have been included in this ISO document, such as: "The BFCs and BFC Types of the metamodels are defined without ambiguity" and/or "The identification rules for the BFCs and BFCs Types are not ambiguous". Therefore, such requirements will have to be included later in the verification guide (ISO/IEC 14143-3).

[15] *[26], item 5.2.2. f).*
[16] *[26], item 5.2.2.c).*
[17] *[26], item 5.2.2.d).*

5.3 Substep 1.3: Characterization of the concept to be measured

Once the attribute (or concept) has been chosen in the design of a measurement method, an (empirical) operational definition of this attribute must be given, that is, the concept must be characterized. This can be done easily for physical attributes (such as height and weight for a person), but will be more complicated for abstract attributes such as, for example, quality; Zuse refers to this difficulty as the "*intelligence barrier*" [17]. For these attributes, stating explicitly how the concept is decomposed into subconcepts can make this characterization. This decomposition describes which role each subconcept plays in the constitution of the concept measured and how these subconcepts are themselves defined.

This ISO document does not specify any requirement, nor does it provide any direction or specifications as to the subconcepts comprising the concept of functionality. It does not provide any property characterizing this concept (for example, additivity, etc.). It specifies only criteria that "shall not" take part in the characterization of the concept of functional size[18]:

a) It is not derived from the effort required to develop the software being measured;
b) It is not derived from the effort required to support the software being measured;
c) It is independent of the methods used to develop the software being measured;
d) It is independent of the methods used to support the software being measured;
e) It is independent of the physical components of the software being measured;
f) It is independent of the technological components of the software being measured.

The fact this ISO document does not specify requirements about the characterization of the concept can be explained by the lack of consensus about what the concept of functionality is made up of or about the properties of this concept.

Nevertheless, the role of this ISO document could have been to build ("create") such a consensus on what the characteristics of functionality are. Such a strategy has been carried out at the ISO level for the definition and characterization of the concept for software product quality [7]. In this other ISO

[18] [26], item 5.1.3.

document, a generic definition of software product quality is given, together with a set of characteristics decomposing software quality with minimal overlap. These characteristics are Functionality, Reliability, Usability, Efficiency, Maintainability and Portability. These characteristics are themselves decomposed into subcharacteristics; for example, the Usability characteristic is decomposed into Understandability, Learnability and Operability.

ISO 14143-1 is therefore fairly weak in providing characterization requirements for the measurement concept to be addressed for a FSM method. It does not provide a consensual foundation to judge whether or not a proposed measurement method indeed measures functionality. As this ISO document is currently written, such judgment will be carried out according to the properties the measured attribute does not own (for example, *not derived from the effort required to develop the software being measured, independent of the methods used to develop the software being measured, etc.*) and not according to its internal characteristics, i.e., what it is made up of.

5.4 Substep 1.4: Definition of the numerical assignment rules

From a mathematical viewpoint, to characterize a concept is to define an empirical relational set [16]. To complete the design of a measurement method, a numerical relational set and a homomorphism between these two relational sets must be defined. This is achieved by defining numerical assignment rules.

The basis for these numerical assignment rules is the proposed metamodel and the characterization of the concept. A numerical assignment rule can be described through a descriptive text (a practitioner's description) or through mathematical expressions (a formal theoretical viewpoint). The first type of description is used when the measurement method is applied in practice. The second is required to allow a mathematical analysis of the mathematical properties of the measurement method. This analysis (carried out by establishing the relationships between the characterization of the concept and the mathematical description of the measurement method) will, among other things, enable determination as to whether or not the measurement method is consistently built (internal consistency) and which mathematical operations can be used on the results. Using mathematical expressions, this mathematical analysis will be carried out by proving a homomorphism exists between the empirical relational set designed in the "definition of the concept to be measured" substep and the numerical relational set implied by the mathematical description of the numerical assignment rules.

ISO/IEC 14143-1 lists some requirements concerning the way the numerical assignment must be achieved. The requirements specified deal with:

1. Assessment of BFCs: As discussed in the second substep, this ISO document prescribes metamodels for FSM methods are based on BFCs. It also specifies calculation of FSM must be based on the evaluation of each base functional component. The document requires, therefore, FSM methods shall:

   - *define the rules used to assess the BFCs*[19]*;*
   - *define how to assign a numeric value to a BFC according to its BFC Type*[20]*;*
   - *Derive the functional size through the assessment of BFCs* [21].

   However, this ISO document does not require a statement of the full rationale for the selection of the rules for assigning a numerical value to the software according to the assessment of BFCs. Therefore, the list of requirements provided for this step does not seem complete without this last requirement.

2. Units of the measurement method: This ISO document contains only one requirement for the units of a measurement method: *An FSM method shall define the units in which Functional Size is expressed*[22].

The definition of units is related, among other things, to the way an attribute is measured. This means, of course, some relationships exist between the unit, measurement method and measured attribute. The justification for the decision of what unit to use in a measurement method should be provided (for example, by reference to a standard, to a theory, etc.). If this is not done, then the rationale for the interpretation of the unit is not provided. This ISO document does not explicitly state relationships between units and functional user requirements (or BFCs) be stated either.

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[19] *[26], item 5.2.1.1 b).*
[20] *[26], item 5.2.2 e).*
[21] [26], item 5.1.1.1 c).
[22] *[26], item 5.2.1.1. c).*

Furthermore, the utilization of units implies some properties of the concept to be measured have been verified and suggests the use of some kind of measurement scale and precludes the use of others (such as, ordinal scales). If any FSM method has a unit, then the document should explain what these properties are and why some scales cannot be used to measure functional size. Otherwise, the former requirement ([6], paragraph 5.2.1.1 c) should be replaced by "An FSM method shall state the rationale for the assignment rules and units in which functional size is expressed".

6. Step 2: Measurement Method Application

Once the measurement method has been designed and all its design deliverables are available, it can be applied. The application of a measurement method is carried out through the following substeps (Figure 2):

- ***Substep 2.1***: Software documentation gathering: The documentation required for the application of the measurement method is collected from the software to be measured. This documentation gathering process allows the second substep to be carried out, the modeling of the software, if the appropriate model of this software is not readily available.
- ***Substep 2.2:*** Construction of the software model. Once this documentation has been gathered, the model of the software to be measured is built. This model describes how the software to be measured is represented by the measurement method. The basis for the construction of the model is; of course, the proposed metamodel, and the rules for modeling it are the rules identifying the valid components taking part in the measurement. If the appropriate model has already been built and is available from the previous substeps, this second substep is bypassed.
- ***Substep 2.3:*** The numerical assignment rules are next applied to the software model derived from the previous substeps. This ISO document discusses the application of proposed measurement methods in section 6 of the document, Process for applying an FSM method:

> *An FSM Method shall include the following activities to derive functional size:*
>
> *a) Determine the Scope of the FSM;*
> *b) Identify the Functional User Requirements within the Scope of the FSM;*
> *c) Identify the BFCs within the Functional User Requirements;*
> *d) Classify BFCs into BFC Types, if applicable*
> *e) Assign the appropriate numeric value to each BFC;*
> *f) Calculate Functional Size.*

In this list of activities, points a) b) c) and d) are related to the construction of the software model according to the metamodel in substep 2.2, e.g. according to the BFCs and types of BFCs defined for the measurement method. Points e) and f) refer to substep 2.3 "application of the numerical assignment rules": once the software has been modeled, the BFCs can be evaluated and the functional size of the measurement method can be calculated.

It can be observed that the ISO list does not talk directly about the software documentation gathering process of substep 2.1: it is referred too only implicitly in another section. **WHAT SECTION?**

> *An FSM Method should describe the kind of information necessary to enable the FSM Method to be applied*[23].

It is necessary to have information to be able to apply a measurement method. Of course, without this information the measurement method cannot be applied and it is well known this gathering of information can sometimes be a very long and costly process. Consequently, this gathering activities is an important step in the process for applying an FSM method. It should not, then, be neglected and could be added to the list of activities that must be carried out to derive functional size.

7. Step 3: Result of the measurement application

The application of the numerical assignment rules enables a measurement result to be obtained. This measurement result must then be documented and should be auditable. Audit of the measurement result was not considered within the scope of this ISO document, and was not included. Consequently, only the first substep, Presentation of the measurement result, will be discussed here.

- ***Substep 3.1:*** Presentation of the measurement result. Applying measurement rules makes it possible to obtain a result. To be evaluated, this result should generally be documented (unit, description of the intermediate results, description of the measurement process and team, etc.).

[23] *[26], item 5.2.1.2 a).*

ISO 14143-1 explicitly sets out the prescriptive requirements for the presentation of results: *Designation of Functional Size: The FSM Method shall state the conventions to be adopted when reporting Functional Size such that it is qualified with:*

a) The units of the FSM Method

b) The name of the FSM Method.

NOTE 1 - Example: Functional Size = 300 Function Points (XYZ v2.0).

c) An indicator that a local customization of a particular FSM Method has been used, where applicable.

NOTE 2 - Example: Local customization of version 2.0 of XYZ Method = XYZ v2.0c.

These requirements are precise and complete. Reporting of measurement results in such a way should allow efficient utilization of results.

8. Summary

ISO 14143 (Parts 1 to 5) aims to define a standard on FSM methods. Only Part 1 has been published as an ISO standard. This first ISO document addresses the definition of concepts for FSM. A structured analysis of the content of this ISO standard was carried out using the measurement process model described in [8]. This has allowed discussion of the coverage of this ISO document with respect to its stated scope of specifying the requirements for FSM methods. This ISO document was therefore analyzed from the following perspectives: the required steps for the design of measurement methods, the application of measurement methods and the presentation of measurement results.

This analysis confirms that, with few exceptions, most measurement method concepts have been addressed in this ISO document. The missing components, as well as some weaknesses, have also been identified; these findings are presented in summary fashion in Table 1.

Acknowledgments

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Table 1. Summary table

Measurement process	**ISO/IEC 14143 document**	
	Strengths	**Weaknesses**
Step 1: Design of the measurement method.		
Definition of the objectives.	Prescribes all required substeps be addressed (what is going to be measured, what the measurement viewpoint is, etc.).	Prescribes specific requirements only on the viewpoint to be stated, that is, the user viewpoint.
Design or selection of the meta-model.	Prescribes the three main elements of metamodels: the entity types (BFCs, BFC types and the boundary), the relationships among entity types and the entity type identification rules.	No specific requirements specified. Distinct measurement methods could therefore even measure distinct objects, thereby rendering convertibility across methods quite challenging.
Characterization of the concepts.	Describes what MUST NOT be included in the characterization of the concept of functionality	Does not provide requirements on characteristics that should be included in this characterization, i.e., measuring the same objects differently, therefore leading to different sizes according to each method proposed, and recognized, as compliant to this standard.
Definition of the numerical assignment rules.	Addresses the numerical assignment rules and the definition of the measurement units in which the functional size is to be expressed.	Does not require the rationale for the assignment rules and that the units be stated.
Step 2: Measurement method application.		
Software documentation gathering.	The document acknowledges the "Software documentation gathering" and the "Application of the numerical. Assignment rules" substeps and describes a list of activities for carrying them out.	Not addressed explicitly.
Construction of the software model.		Not addressed explicitly.
Application of the numerical assignment rules		
Step 3: Measurement result analysis.		
Result.	The document provides specifications	

Measurement process	ISO/IEC 14143 document	
	Strengths	**Weaknesses**
	on how a result must be documented.	
Audit		Outside the scope of the document.
Step 4: Exploitation of the result.		Outside the scope of the document.