

Research Methodology

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Abstract. This paper aims to provide an understanding of the basis for conducting a research with output in the form of scientific publications. A study, from proposal to scientific works, requires a research methodology. Many studies have been carried out on methodology, but few have returned according to the demands of the digitalization era. A methodology is in a fundamental position. The methodology familiarizes phenomena and paradigms with which objectives as interpretations of the problem formulation can be delivered to the target or outcome.

1. Introduction

In research, methodology is a decisive part of planning and carrying out research. It means that the methodology is a systematic analysis that tries to juxtapose the phenomenon and paradigm [1]. Although the methodology will not provide a solution, the methodology consists of theoretical analysis of methods and principles related to the knowledge development [2]. Therefore, the research methodology for mathematics is different than the research methodology for a computer science even though both of these knowledge are in one scientific path linearly [3]. Not only that, in mathematics itself, the research methodology for algebra will also be different for the research methodology for probability theory [4]. However, in addition to these differences, there are slices formed from the similarity between knowledge and other knowledge [5, 6, 7], and it allows there is a general form of methodology for all knowledge [8, 9].

Stating clearly what is being discussed will form an understanding that can connect problems with possible ways to solve them [10], and this requires the disclosure of methodology for research or the knowledge development, including methodologies for education, teaching, research, and research downstreaming [11]. This paper aims to describes the methodology and connects the related parts systematically. In order to the objectives in the introduction until the goal in conclusion of scientific works, there is a bridge by using the problem definition, as a tool for expressing it that is it determined by issues behind methodology, and the methodology behind a problem statement.

2. Problem definition

A term of *methodology* is interpreted as a body of methods, rules, and postulates employed by a discipline either as a special procedure or set of procedures, or an

analysis of the principles or procedures requested in a particular field [1, 2]. Thus, the methodology can be expressed as a systematic and theoretical analysis of the methods applied to field of study [12]. Whereas the research methodology is a methodology of developing knowledge [13], namely the theoretical analysis of the body of methods and principles related to the development of a knowledge [14].

Any research will use methods as a determined process for completing a task [15]. The task carried out and assigned by the paradigm. This literally presents knowledge. Each such method requires theoretical support to be applied to certain cases, and this is offered by the methodology [16]. Based on that, the term methodology also includes concepts such as paradigms, theoretical models, stages and quantitative or qualitative techniques [2].

In research, the approach taken is about the form of experiments and hypothesis testing so that provides a way to manipulate data and the situation [17]. Procedures are changed so that they are essentially the same as they are [18]. The variables are identified to manipulate and the relationship between variables is then measured by statistical techniques [19]. Qualitative methodology (based on quality) provides interpretation. Interpretation is built on an approach that allows the possibility of knowledge for growing, with knowledge based on reason that influences the results determined [20]. Whereas, based on quantitative techniques, reality can be dissected into variables that represent theoretical constructs based on observed phenomena [21]. All variables can then be manipulated through experiments and formulations that can be determined from the results of these manipulations [22, 23]. In this area of research, research relies on hypotheses that usually apply, which then empirically tests by involving verification based on structured experiments [24]. This test involves a complex statistical mechanism to determine the relationship between variables, and broader results in the form of plotting to the phenomenon under study [25]. Therefore, it is necessary to design a methodology to reveal the relationship between the titles of the research to the conclusion, where conclusions will reveal the possibility of the outcome of the research.

3. The issues behind methodology

The design of a research methodology is to reveal the systematic relationship between phenomena and paradigms about the development of a field of knowledge [26]. The title of the research or something researched is something that manifests itself to the researcher, through the five senses and in reason that can be considered for observation by researchers [27]. Thus, the title of the research stated in a sequence: problem statement, objectives, method, theoretical basis or study, road map, results and evaluation, which concludes with conclusions [24]. However, the sequence is not enough, because a research must have evidence that research has been carried out, namely outputs, from publications to products [11].

The phenomena to be observed are presented in a focus on the formulation of the problem, and it is not easy to express the problem in a systematic form which is supported not only by reasoning but also by research interests [28]. Based on the methodology, the formulation of the problem can be broken down into questions [1]. In other words, reason of the problem formulation are formed from questions, so that the formulation of the problem in the form of a statements is not a question [18]. Reasoning the formulation of the problem means that there is a statement that has value and this will prove to be true or false through the method disclosed. Depending

on the technique used - quantitative or qualitative, it may also be both quantitative and qualitative - the depth of the first research is shown by the research questions or expressed by the objectives expressed following the problem statement [29]. Always, each objective will have completion and be bait as a target at the conclusion in the research report [30].

An objective is always expressed with verbs, such as to describe, to explain, to express, and so on, but also this word is always related to questions, for example the word what is closely related to verbs for objective as for elaborating or to describe [27]. In this case, the depth of an objective can be increased even though the objective was originally based on the question of what, but obligation to the assignment of the methodology to achieve the technology readiness level (TRL) [31], objective description can be stated to be objective to prove the existence of something [32]. Therefore, of course basic level research can be developed and improved to be the applied research, and such research continues to the external stage of producing a product that is ready to be marketed, or a product that is ready to be used through the function of the delivering to the user community [33]. Indeed, the research always starts from the output of scientific publications whether it is in the form of papers at the conference level, articles in journals [34], to produce intellectual property rights (creations or patents) [35]. However, the cessation of research at some of stoppage stones is due to the need for other research support [36]. Thus, the depth of a research also depends on research collaboration [6, 38].

The depth of research to achieve the TRL is not only related to the objective of the research, but also how the review of the literature is carried out [39]. A review of literature or scientific work will eliminate some of the problems that need to be resolved, based on that it does not rule out the possibility of research collaboration if certain research turns out to have revealed some of the research that will be conducted [40]. This also proves the need to conduct a study: at least a review (descriptions) or to the latest development (it is a state of the art). Thus, research can focus on issues that have not been clearly proven, and this is meant by knowledge management by which there is no need to duplicate the development of knowledge done [41]. Optimization of the knowledge development.

4. The methodology behind a problem statement

Each research (-proposal) will always have completeness such as the title of the proposal/research, the problem statement supported by the interests of the research, the roadmap and the objective, and the output target. In addition, a research contains a roadmap that is supported by a review (also known as a literature review). Furthermore, in research proposals there are also research methods, implementation schedules and implementation budget [24].

As a theory, the research methodology deals with the most important issues in the field under a study, it is systematized in a problem statement. Each formulation of the problem is developed based on developing issues which are deemed necessary to produce something useful, contribute to the development of knowledge, and produce technology to improve human welfare [42, 43, 44]. For example, a chapter book entitled "The superficial method for extracting social networks for academics using web snippets" [45] has a problem statement, namely " researchers focus on extracting social network [46], but not overcoming problem of naming relationships or giving clues to the nature of relationships [47]. Therefore, an approach is developed not only

Table 1. A research design based on the methodology.

Techniques	Questions	Objective keys
Qualitative	What ...	Explanation
	Where	Origin and purpose
	Who/Whom ...	Actors and history
	Why ...	Reasons
	How ...	Way
Quantitative	How much ...	How much/many computation is based on formulation.
	How many ...	
	How long time	
Hybrid	To what extent	Combination

Table 2. Research design based on completeness.

Techniques	Necessary condition	Sufficient condition
Qualitative	Objective \Rightarrow Target	Objective \Leftarrow Target
Quantitative	Data process \Rightarrow Result	Result and Evaluation

to establish the strength of relations between social actors, but also to establish the underlying relation behind the link " [48]. While, in the application of mathematics [37], a formulation of a problem is stated for example such as "Knot theory is an analysis of closed curves that are not joint to each other in three dimensional space, namely from a set of ropes where the two ends are removed with the meaning of connecting them neatly without trace (say in everyday life as a circle). Thus a knot originating from a string can only be changed to another knot by opening the knot so that it becomes a string that is not knotted, then concludes it back to the second form. Facing with two interlocking straps where each one is circular in shape. If one can map the first to the second configuration without breaking the rope, one can say the other needs a proof" [49, 50]. However, the problem statement is not systematically arisen, it requires questions that accompany the presence of a problem, but it is not directly the questions formulated by the problem, such as questions about the relationship between the braid and cryptography, or it is not theory? For example, relating to the formulation of the problem above " without breaking the rope, how can one be determined?" is a question that leads to ", then one can say the other is to require proof" [49]. Therefore, the research question is a guide that makes it easy to construct a problem statement. Questions that can be built as research questions are options for building the problem statement that is appropriate and related to mutually supportive objectives. If there are quite a lot of research questions, of course there are arrangements for the formulation of problems that are better options. In addition, to determine which option is better among them, which is more real either narrative or reasoning is considered, Table 1.

Objectives are specifically presented from research questions involving verbs "infinitive to" such as "to describe" as an example. For example, in a variety of scientific works whether it is a paper or an article it is possible for the objective to be different or the same, namely "to map", "to introduce", "to rediscover", "to reveal", "to elaborate", "to analyse", "to recognize", "to increase", etc. so that the verb used does not present similarities, but it is realized differently in the content of the scientific works. For example, the object stated by the verb "to describe" is found in: "Basic

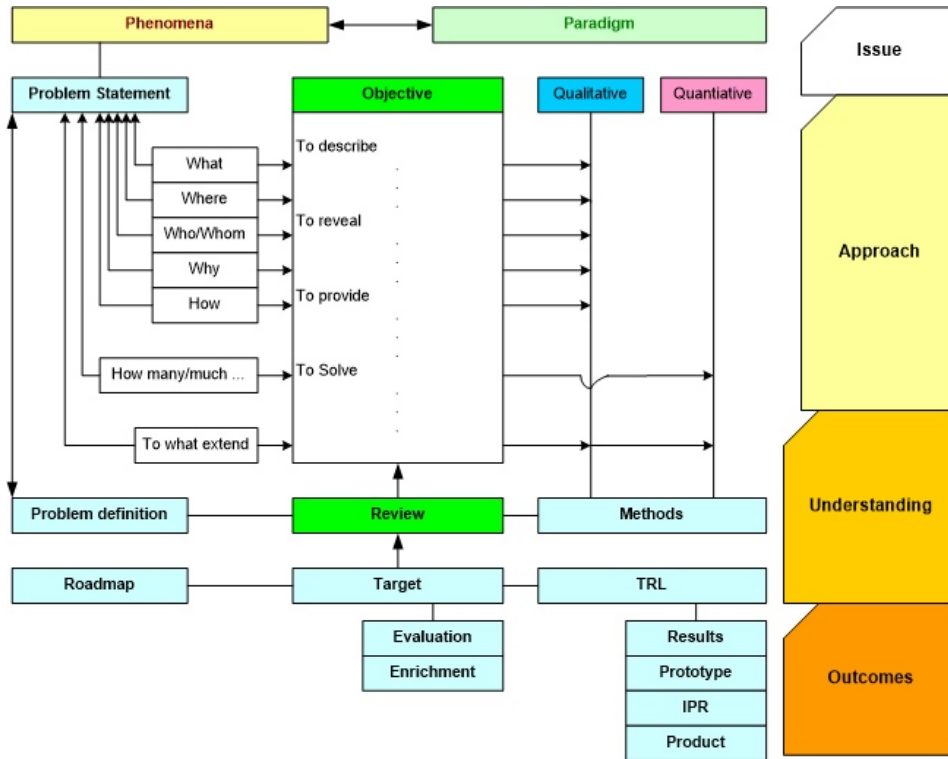


Figure 1. Relation between phenomena and paradigm

framework of urban design based on natural resources" [51]; "Calligraphy design for coconut garbage use" [52]; "Semantic interpretation of the search engine resultant" [53], "Triangle number of Laurent polynomials for the closed braids" [37]; "Social network extraction based on Web: 3. The integrated superficial method" [54]; "No research without publication: Early mining" [55]; and "Information retrieval based on the extracted social network" [56]. Thus, the objective "to describe" used functions for various purposes: outlines the conceptual design framework of urbanization based on natural resources; describes the design concept of a letter painting involving unused natural waster; semantic interpretation of resultant from a search engine; describes in mathematics a form of numerical arrangement; conceptually describes the possibility of several methods being integrated; describes in a portrait of research publications; or formally describe mathematical evidence and experimental evidence (results) about information retrieval. In this case, although it involves the same objective verb, content does not only contain concepts, interpretations, formal proofs of mathematics and/or evidence involving data in an experiment. Therefore, the depth of an objective research depends on how to interpret the objective, and that interpretation will also depend on how the study is conducted [57].

In a qualitative design, the methodology assigns a problem statement to be proven by interpreting the objective in content that meets its needs, while the depth of objective interpretation into content requires sufficiency as a condition. This is based on the fact that a statement can be an implication or bi-implication [58]. In a quantitative design, the methodology assigns a problem statement to be proven

by interpreting the data through an eligible process that needs to be objective, while the depth of objective interpretation is expressed through the assessment of the results of the process or making comparisons with other results analysis [59]. Based on this, the research design can involve both techniques (qualitative and quantitative), with the methodology assigning a problem statement obtaining evidence of objective interpretation into the content containing necessary requirement and sufficient requirements [60], Table 2.

The depth of content and the TRL is not only related to the objectives presented to interpret the problem statement, but objective interpretation as far as possible is done depends on the study based on the bibliography. The study is thus functioned by a methodology to increase the depth of objective interpretation in addition to providing research focus or direction, Figure 1. However, the study from the point of view about researchers or research organizations always starts from the traces of scientific records that have been developed. This track record is controlled as a roadmap. A researcher must have a roadmap as well as a research organization. Based on the consideration of knowledge management where there is no overlap in the knowledge development, each research conducts research based on a roadmap with which roadmaps are used to form the basis of developing a review of the bibliography. Some researches not only produce product output or appropriate technology, but also reveals methods that are suitable for each problem studied. Through the appropriate method, it can be ascertained that the objective can be transformed by the methodology to be the target expressed in the research conclusions.

5. Conclusion

Every knowledge development or research requires a methodology to deliver phenomena to paradigms, which is generally supported by objectives, reviews, and discussions. In various instances, it has been revealed that although there are differences in the formulation of the problem, objectives, and methods used, the study has shown that the methodology provides a general solution through research questions and targets as outcomes.

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