

# Designing a Research Methodology for Solving a Social Problem: Explanations from May Brodbeck's Article Models, Meaning and Theories

Mohammed Shamsidin Ango Abdullahi\*, Yogesh Kumar Gupta

Department of Arts (Sociology), Faculty of Humanities, Mangalayatan University, India

Received December 8, 2023; Revised March 8, 2024; Accepted March 19, 2024

## Cite This Paper in the Following Citation Styles

(a): [1] Mohammed Shamsidin Ango Abdullahi, Yogesh Kumar Gupta, "Designing a Research Methodology for Solving a Social Problem: Explanations from May Brodbeck's Article Models, Meaning and Theories," *Sociology and Anthropology*, Vol. 12, No. 1, pp. 1 - 8, 2024. DOI: 10.13189/sa.2024.120101.

(b): Mohammed Shamsidin Ango Abdullahi, Yogesh Kumar Gupta (2024). *Designing a Research Methodology for Solving a Social Problem: Explanations from May Brodbeck's Article Models, Meaning and Theories*. *Sociology and Anthropology*, 12(1), 1 – 8. DOI: 10.13189/sa.2024.120101.

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**Abstract** Social research is incomplete without a philosophical worldview that guides a researcher in the research process for a study. From theory, literature, hypotheses, and research questions, to validating a research study, the element of measurement in scientific research plays an important role. While theory helps researchers formulate their sets of interrelated verbal abstractions for the construct of variables, measuring these variables helps authenticate their validity and reliability for study. More so, hypothetical statements made between the parameters of variables using applied statistical tools also help clarify the predictions of the relationship between these variables to verify the literature, hypotheses, and research questions thus validating the study. The models applied, therefore, are imitations that help researchers limit or narrow down how theories can be developed to provide new variables for future studies. So models especially in social research rely on isomorphism, arithmetic, mathematical, and physics models to solve social problems by emphasizing the mathematical model to provide scientific knowledge about an event, situation, or behavior in a society. This is mostly achieved by changing the content of the study to letters, and further converting letters to figures or numerical values as codes that will provide figures that can be calculated to provide the measure of central tendency and measure of dispersion and other statistical tools that will help arrive at a fundamental truth in the investigation of these events, situations, and behaviors under study in the society.

**Keywords** Concepts, Hypotheses, Literature, Measurement, Research Methods, Social Research, Theory

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## 1. Introduction

The work of Augustus Comte's Three Stages of the Law of Social Evolution can be argued to be considered historically classic because it has been at the center of social evolutionary changes in modern civilization. Before the work of Augustus Comte on the 3 stages of social evolution, societal differences and conflicts have contributed to the evolution of societies, and from Ibn Khaldun's work on Muqaddimah (Introduction with emphasis on Social Change), Asabiyat (Societal Cohesion), Badvi and Hazri (Rural and Urban social integration), and Cyclical Theory (Rise and Fall of Sovereign Powers) to the work of Thomas Hobbes's "Nature of the State" on the roles of the church, state, and people and Jean Jacques Rousseau's work on "Social Contract Theory" where people agree upon acceptable rules and values by the majority on what should guide them and how they are governed and Herbert Spenser's work on Social Evolution highlights the role of government in regulating society, sustaining nourishment from social institutions, distribution system in society to cater for all have proved that conflicts in society have remained constant. Comte's

theological stage, metaphysical stage, and scientific approach to social evolution are critical in contemporary societal cultures, norms, values, religiosity, and cultural homogeneity in heterogeneous interactions that occur in both Western and Eastern societies. Societies are governed by religious beliefs and religion influences political associations, for instance, in the US, the catholic and protestant churches play a decisive role in American politics, and the Christian churches in Germany play a vital role under the Christian Democratic Union in Germany's politics. In India, the Hindu religion plays a critical role in political hegemony, and in China and Nyamar the Buddhist leadership has control of politics and administration. Countries like Nigeria, Middle Eastern countries, Pakistan, and Bangladesh in Asia have a stronghold of Islamic hegemony in politics and administration. But even within these countries, does it mean the rights of minority groups towards religious and economic freedom should be denied? The denial of minority groups will always ignite conflict and to address such issues, research is critical to understand the problems and how to rectify them. The metaphysical stage of Comte tries to provide societies with the verbal abstraction of their environment based on their belief systems how they perceive them ontologically and how they relate to the environment epistemologically. All these are viewed differently as societies change on a global level with an increase in conflicts. It is important to note that in addressing such issues there is a need to define plans on how to solve such problems through research. The scientific approach provides the avenue to harmonize theology, and metaphysics in scientific methods to understand ontological understanding based on the epistemological fact of belief in culture and religion avoiding indispensability in the name of secularism in the environment to arrive at rationality that will provide a deeper understanding of society and collective societal cohesion where the rights of all are protected. Emmanuel Kant's five senses of feeling, taste, smell, sight, and hearing have been instrumental in how we view and interact with the metaphysical in deductive reasoning in the scientific world today. This has helped with the formulation of a theory in research and the operationalization of variable constructs through deductive reasoning. Bacon on the other hand has influenced the use of observation in qualitative research inquiry as the basis of anthropology for research through inductive reasoning.

Research methodology is defined as the "plans and procedures for research that span the steps from broad assumptions to detailed methods of data collection, findings, and interpretations" [1]. To solve research problems there must be a systematic scientific process that must be followed to measure and validate a subject matter under study. The process includes identifying a subject to be studied and providing informed knowledge about "what" we know of the subject matter. In addition, we should provide source documents in published articles in journals and books to prove "how" we know what we know about

the subject matter. This will help develop hypothetical statements and research questions for investigation. A collection of data is necessary that will provide the findings or facts that will be analyzed and interpreted to validate the findings of the study. There are three major ways to solve a research problem using a quantitative method for generalization purposes which include; pure or basic research or theoretical research, applied research, and action research. Other research problems can be solved using the qualitative method of investigation which relies more on developing theories based on grounded theory. The questions faced by researchers in a research process are; How do you know what you know? What design is suitable for the study? How do you know when to apply a research method for a study?

### 1.1. Objectives

The objectives of this paper are to -

1. Analyze the philosophical worldview that provides insight into the systematic way of selecting a method for a study.
2. Examine the research designs that can be used in a study.
3. Compare statistical tools to provide validity and reliability within a research process study.

## 2. Materials and Methods

A secondary source of data collection was used for this paper with the review of 13 articles published in journals and books related to the subject matter. These articles provide analysis and evaluative insights into how the research process and the research method can be designed to solve a social problem using a scientific method to establish a fact. These articles were Google-searched and are English-based literature with some historical narratives of social evolution and scientific approach in contemporary society.

### 2.1. Philosophical Worldview

A philosophical worldview is critical for any scientific study because it helps the researcher evaluate the characteristics and dimensions of the subject matter and provides an option in a paradigm shift approach in terms of ontology, epistemology, methodology, and theory [2]. There are four types of philosophical world-view namely; Post-positivism which relies on Deductive Reasoning, Constructivism which relies on Inductive Reasoning, Transformative which relies on Abductive Reasoning on Dominance, and Pragmatism which relies on Abductive Reasoning on Structures and Processes. These worldviews provide a selection guide for a researcher to adopt a methodology for his or her study, and based on the three stages of social evolution, consideration for the researcher must reflect the theological, metaphysical, and scientific

processes, especially in anthropological studies to provide a law that serves as accepted occurrences in society and should not be a mere historical narrative in scientific research [3]. The ontological perspective of the researcher in post-positivism provides the basis for conceptualization or verbal abstractions of informed knowledge of “what” the problem is for the research study mostly related to the scientific approach applied in a quantitative method study. The researcher develops theories of his own and applies the epistemological perspective of “how” to prove how he or she knows “what” about the subject matter. This is achieved by a literature review with source codes provided by scholars published in books and journals that tell about the subject matter.

The positivist worldview in solving a research problem is divided into two; namely basic and applied research. Basic research or pure science applies a positivist approach and applied research applies a post-positivist approach to social research. The difference between pure science and social science is the ability of researchers to control variables in pure science and the researchers’ inability to control variables in social research investigation. Constructivism as a worldview is also important because inductive reasoning provides a role in understanding the characteristics and dimensions of a problem and giving meaning to it. While there is single and double hermeneutics in constructivism, they play a very important role in understanding qualitative social research based on the instruments of data collection which includes observation, participatory observation, in-depth interview, and focus group discussion to provide the law of an event or situation based on the observed patterns for coding and axial coding. In the case of a transformative worldview, abductive reasoning is critical in transforming the dimensions of society in terms of politics, religion, cultures, and economic hegemony that affects members of the society's deficient class citizens in terms of social mobility within the social system. Transformative worldview allows for abductive reasoning where two to three research methods can be applied in a study. Pragmatism as a worldview focuses on the practicability of structures and processes of institutions that overlook the norms and goals of social institutions meant to improve marginalized groups in society. Pragmatism allows for abductive reasoning and as such provides the researcher the ability to apply two or three methods in a study.

## 2.2. What is the Definition of Law in Social Science?

To understand the philosophical worldview in designing a methodology to solve a social problem better, it is important to understand what a law is both in pure and social research. A law can be defined as “the instance of one fact leading to an instance of another” [4]. In pure research like physics, Newton’s third law states that “For every action, there is an equal and opposite reaction”. This means that in an interaction of two objects the action and

response share equal force. So the law of natural science is different from the law of sociology as a social science and as such the observed rational and logical input of action theories on the behavior or phenomena of an event cannot produce an output that is equal to the action theories in response. The law plays a great role in understanding the two attractions of a model namely the attraction to study nature and the attraction to compete with each other. A model is defined by the biologist as “the reconstruction of nature for study” (Levins). But “how” do we accept a “law” in the reconstruction of nature? In sociology, society is seen from three major theories, symbolic interactionism as argued by Max Weber, structural functionalism as argued by structuralists like Herbert Spencer, Augustus Comte, Emile Durkheim, Talcott Parsons, Robert Merton, Anthony Giddens, and conflict theory as argued by Karl Marx. All these theories provide dimensions to which society can be studied. The model provides the extrinsic use of understanding the real world on the one hand based on dimensions researchers may choose to select based on the subject matter and the other hand can be manipulated and transformed to tell us more about the subject matter under study. “How” do we get to know about how to manipulate and transform society on a general scale? [5, p. 174]. This is where deductive reasoning based on theories comes in to provide a shortened way to improve on the model by taking into cognizance the characteristics of the object, thing, or institution. A Theory’s definition is a “set of interrelated concepts, definitions, and propositions that explains or predicts events or situations by specifying relations amongst variables” [6]. Theories are dependent on concepts which are verbal abstractions extracted from observations of identified occurrences in events, situations, or behaviors that are useful in the construct of variables.

## 2.3. Research Design

Research designs help a researcher plan “how” to conduct a fieldwork investigation through an effective and efficient scientific process that can explain or predict the problems and consequences of a subject matter based on the objectives, hypotheses, and research questions or observations. Research designs are different and depending on the philosophical worldview, a researcher can apply a descriptive design, quasi or causal design, correlational design, the transformative sequential mixed method design, or the transformative taxonomy development design which enables a researcher to conduct a study either through a theoretical lens or allows for developing a theory.

## 2.4. Research Method

The three major research methods approach used in any scientific study are the quantitative method, qualitative method, and the mixed method or triangulation. The instrument for the collection of data is crucial for any study, the questionnaire is important when a researcher applies the

quantitative method approach. Its use of variables constructed from the existing theories tries to present the relationship between variables with some variables explaining the outcome as dependent variables and other variables as explanatory variables as independent variables in verifying theories. Instruments of data collection in the case of a qualitative method include observation, participatory observation, in-depth interviews, and focus group discussion. This method focuses more on developing new theories, the findings in this case cannot be generalized. The mixed method approach or the triangulation mixes both instruments of quantitative and qualitative approach in a research study bearing in mind the weighting advantage of which comes first and why based on the researcher's worldview on the subject matter [7, p.10].

## 2.5. The Relationship between Models and Theories: Conceptual Review

This paper tries to explain the role of models and theories in selecting a scientific method for solving a social research problem. The main difference between model and theory can be understood from the logic and fact that theories that share the same verbal abstractions in process or structure produce isomorphic theory models or physical models related to physical things of natural science. Nonverbal abstractions produce other types of models that can also carry new sets of theories both factual and logical which can lead to arithmetic and mathematical models. While the model of physics even though related to pure science relies on mathematical models. The idea of modeling is to categorize design models that will help in the systematic selection of methods for a study based on the theorization of the model [8, p. 381 ref. 27].

### 2.5.1. Types of Models in Solving Social Research Problems

There are 4 types of models namely; the Isomorphic theory model, the Arithmetic model, the Formalization model or Mathematical model, and the models in Physics.

### 2.5.2. The Model of Isomorphism Theory

This model helps researchers to identify institutions as study models thereby minimizing the dimensions to be identified to help develop a good theory that will help in a research study. Isomorphism provides a way to understand the similarities and differences of organizational structures and processes by focusing on the imitation of organizations or the development of independent organizations.

There are three main types of Isomorphism namely; normative isomorphism, coercive isomorphism, and mimetic isomorphism [9, p. 107]

#### a. Normative Isomorphism

The normative isomorphism relies on professionalism. Institutions are generally subjected to other institutions that are more professionally experienced in their operations of

networking and their adaptation to norms and values related to society. This type of isomorphism largely focuses on institutions that have excelled to ensure adaptation, achieved goals, are fully integrated, and are latent consciousness as Talcott Parsons argued—for instance, Kentucky Fried Chicken or Islamic Development Bank (IsDB).

#### b. Coercive Isomorphism

Coercive isomorphism refers to the external forces to which organizations comply with the rules and norms of other institutions or for the cultural expectations of the society in the institutions' operation. This type of isomorphism relates to the monopoly and hegemony of institutions to dominate weaker societies as argued by Emmanuel Wallerstein's world system theory. It exposes institutions to the postulates argued by Robert K. Merton which limits functional unity, universal functionalism, and indispensability. For instance the role of the World Bank (WB) or International Monetary Fund (IMF) in developing countries.

#### c. Mimetic Isomorphism

The mimetic isomorphism in organization theory refers to the imitation of one institution's process and structures in another institution because the process and structures are beneficial to the imitating institution. This type of isomorphism relates to the imitation or duplication of structures and processes that have been able to contribute to the overall social system. For instance, Grameen Bank of Bangladesh.

### 2.5.3. The Model of Arithmetic Representation

The logic of axioms and theorems involves numbers or numerical values for any empirical study whether quantitative or qualitative. However, it is important to note that the process of translating word content into letters and letters into figures is critical in providing an understanding of a fundamental truth in social research. How can this be achieved? This can be achieved through scaling, scaling is an important means of measurement in the operationalization of theories. The four scales of measurement ratio scale, interval scale, ordinal scale, and nominal scale are necessary for measuring variables that test for validity and reliability.

There are 4 types of arithmetic representation models namely; Analytic geometry, probability theory, measurement, and the theory of games. This model being the foundation of mathematics deals with additions, subtraction, multiplication, and division and is applied to the study of integers. Integers are whole numbers and are grouped into 0 as neutral to 1, 2, 21, 2065, etc. as positive numbers while numbers below 0 -1,-2 -3 are referred to as  $\mathbb{Z}$  integers. The rational real numbers include 1,2,3,4,5,6,7,8 etc. while irrational numbers are those expressed in square root,  $1/2$  fractions. The arithmetic model of the theory is based on the logic of axiom

statements that are termed true and accepted but have no proof. This model in solving social research forms the basis for the calculation of central tendency which both quantitative and qualitative methods rely on. In essence, dealing with metaphysics entails measuring a thing, object, or institution to provide laws that can help arrive at facts [10, p. 427].

The 4 types of arithmetic models are -

#### a. Analytical Geometry

**“Analytical Geometry studies the measurement of shapes, size, the relative position of figures and properties of space” (Euclid).** It deals with the measurement of length, area, and volume. Euclid took an abstract geometry in his 13- Elements Book and introduced axioms or postulates propositions of theorem and construction based on logic to help in measuring variables as a basis for understanding facts in social science. In calculating using analytical geometry, for instance, the area of a rectangle and its length multiplied by breadth ( $L \times B = \text{Area}$ ) which applies to squares of the same length. Area of Circle  $\pi r^2$ , Area of a parallelogram is also ( $L \times B = \text{Area}$ ), for (Kite its  $\frac{1}{2} ab = \text{Area}$ ), Area of parallelogram is ( $L \times B = \text{Area}$ ). This type of arithmetic model is applied mostly in pure science and can be constructed in theoretical terms to find facts about social events in social science by using the measurement scale of ratios and intervals.

#### b. Arithmetic Representation

Arithmetic representation of probability theory is a branch of mathematics that deals with probability which measures the likelihood that an event will occur. The weight of empirical evidence arrived at inductive reasoning is called Probability. This arithmetic model helps convert the proposition of content into letters and letters into figures to be able to find a factual claim about an event or situation.

#### c. Arithmetic Representation of Measurement

Arithmetic representation of measurement in empirical science also requires the application of arithmetic. In this case, measurement can be grouped into two parts namely the measurement of axioms statements about the hypothesis, here it is important for the conversion of measurement to get the exact outcome from the construct of axioms or statements. An example includes converting distance and time into measured rational numbers into feet and time into seconds, the formula for measuring distance and time. This explains the use of the metric system as a scale to measure and quantify objects or attributes like attitudes, values, interests, and personalities. On the other hand data analysis is measured by the weighted frequency of hypothesis in which the measurement can be based on central tendency mean, mode, and median or measure of dispersion which includes range, variation, and standard deviation. The frequency could also be summarized as cumulative frequency. A pie chart or bar chart can summarize the findings of each arithmetic representative

measurement of frequencies to illustrate the percentages or the actual number of respondents.

#### d. Arithmetic Representation of Games Theory

Arithmetic representation of the Theory of games is also termed a branch of mathematical model since the game's player is faced with uncertainty of the opponent or the cards to be distributed to each player. The connection between the theory of games and the theory of behavior creates an arithmetic representation based on these uncertainties to make a player decide what options he has to win a game or set of games. This creates probable chances, and it creates rational options where a player keeps his utility in the game. Logic plays a vital role in solving problems as the theory of games also applies the arithmetic of the probabilities of uncertainties to construct empirical laws of human behavior.

#### 2.5.4. The Model of Formalization or Mathematics.

The mathematical model is a description of a system using mathematical concepts and language known as the formalization model because the mathematical model is used in both the natural and social sciences to explain a system study and the effect of different components that make predictions about situations, events, and behavior. It takes into account the isomorphic, arithmetic, and physics models in a natural or social science study. It creates laws that facilitate deductions or check deductions already made. It may also apply to isomorphism where two sets of structures have the same law about different phenomena. It also applies to the illustrative flow system in empirical evidence. Formalization of the mathematical model must include any quantified empirical theory with numbers attached to its description. It must also refer to all arithmetic representations of an empirical theory where analysis of the truth about numbers is made and finally refers to a system of empirical, tautological, and indeterminate expressions or statements. These 3 expressions provide a source of hypotheses and these hypotheses rely solely on an arithmetic model. For instance  $X = Y$  as a deterministic approach  $X = Y$  with a probability (P) or  $X_1, X_2, X_3 = Y$  as a causal approach. The mathematical model however transforms the letters into numerical which will provide an outcome for fundamental truth [11].

#### 2.5.5. The Model in Physics

Models in physics share with mathematical models but differ in non-physical and non-atomic sciences in the sense that it has invisible entities, the unique nature of the connection between the models and the theory which is devised to explain or predict events or situations based on hypothesis. Its complex nature of dealing with invisible particles of atoms makes the physics model different in terms of observation to provide empirical evidence of study as explained in the physics classroom. For instance, pressure or gas in a container is an example of the model in

physics. The laws of matter differ from the law of the atom, likewise, the wave theory applies to moving light and differs from the thermo-dynamic theory which applies to pressure. The mechanic theory applies to real objects and differs from quantum physics which applies to astronomy. However, these theories can be used simultaneously in physics but the laws in physics must rely solely on the mathematical model to provide measured facts.

## 2.6. Research Design

Research design helps organize a research study on how to achieve the study's outcome considering the ethical values in research. Depending on the philosophical worldview a selection of experimental, quasi or casual, descriptive or correlational designs can be used in a quantitative study, and narrative, historical, or comparative designs can be selected in a qualitative study. In contrast, convergent, exploratory, or explanatory designs can be used in a mixed-method study.

## 2.7. Statistical Tools in Social Research

The statistical tools used depend on the researchers' set goals in a study. However, important tools like the central tendency and measure of dispersion are necessary in quantitative studies. The mode measures the frequency or outcome that is more frequent for univariate, while the median score measures the variable or variables that are in between the highest and lowest scores. The mean score measures the average score of the specified variables based on categories or themes that can predict if they have a good confidence level with a .05 error margin in a social research study. Correlation Coefficient as a statistical tool is used mostly to measure the correlation between variables while chi-square measures variables that are nominally measured to find the relationship between them. Other statistical tools that can be used by researchers in a study are Simple Linear Regression, Ordinary Least Square (OLS) regression analysis, or Multiple regression. Simple linear regression helps provide factors that are more frequent within the variables of a parameter. In this regression model, the total mean score of the parameter forms the basis for the independent variable while each variable is a dependent variable. Simple linear regression tries to explain the relationship between variables of a single parameter and calculate this relationship, the correlation coefficient, standard error, mean score, variance, and standard deviation help to identify the factors responsible for an increase in the X- axis there should be an increase on the Y axis for hypothetical variables. In the case of OLS, the relationship is between the variables of two sets of parameters that help explain causal or correlational relationships among variables. In addition, the qualitative research method is critical in studying society's cultures, religions, and beliefs through ethnography, grounded research, and case studies. Data collection instruments in

qualitative research that are critical for researchers include in-depth interviews, focus group discussions, observation, and participatory observation that can critically evaluate and analyze the behavior of members of the society and how future research can be done to improve understanding of society through acceptable cohesion based on qualitative developed theories [12].

## 3. Results and Discussion

While models and theories help shape social research investigation through a systematic scientific approach, the models and theories used in solving a social problem are critical for a study based on the philosophical worldview of a researcher. According to May Brodbeck [13, p. 217], "models are good things" and if models are good "mathematical models" needless to say, are even better. Emphasis on a mathematical model in solving social research is paramount in research because it summarizes the whole picture of the relationship between variables while the theories emphasize the establishment of a law that justifies the frequency of what we know about social problems that can lead to further studies. In addition, a qualitative investigation provides a frequency mode to establish a law around observed patterns in the themes under study.

According to May Brodbeck's summarized characteristics of a model

1. There must be a notion of empirical evidence derived from the construct of interrelated variables drawn from the hypothesis. Based on theories, the law establishes a fact of reoccurrence in empirical evidence. So the theoretical framework in the literature review of the subject matter tries to provide unambiguous doubt about the problem in social research.
2. There must be an abstraction of a real thing for models. The better the theory, the more knowledge we have about neglected variables' performance. Understanding objects, things, and institutions under study provides concepts for verbal abstractions of behavior, imitations, and structures and processes under investigation.
3. There must be an abstraction for things that cannot be behaviorally measured in finding ideal situations. Social science problems provide a double hermeneutic understanding in investigating a social problem by applying both deductive and inductive approaches in a study. In this case, a researcher verifies his study and at the same time develops new theories.
4. Models must be able to apply quantifiable law in its interrelated variables even if such variables are qualifiable. Transforming social science content into letters must be identified first and understood in theory. To verify the theory the letters must be

converted to numerical values as codes for them to be validated and translated into new existing facts as laws based on mathematical models using statistical tools.

The concepts to draw abstraction guides the philosophical worldview of the researcher which relies on the model for which the research process will be designed based on a theory. For the sociological study, the model of agency in the theory of symbolic interactionism, the model of isomorphic institutions in the theory of structural functionalism, and the model of objects in the theory of conflict help limit observations about the subject matter for further investigation and study.

## 4. Conclusions

May Brodbeck's work may have explained why models are good and mathematical models are even better in her work. However, one may argue for or against her work on models meaning, and theories, but the fact remains that mathematical models are better at solving natural and social problems. The isomorphic model breaks dimensions and characteristics of objects, things, and institutions, the arithmetic model breaks the measurement of variables for validity and reliability and the coding of the whole content to numerical values to help predict claims and outcome of the investigation using the central tendency and the measure of dispersion The mathematical model breaks down dimensions using statistical tools that can validate the null hypothesis of the subject matter under study, while the model in physics provides abstraction for the measurement of variables applicable in social sciences. It is recommended that students and social scientists should always apply the best alternative theory that guides research studies with the consideration of the internal, and external validity and reliability of the measurement in the dimensions and characteristics of the situations, events, and behaviors within the society under study and without any indispensability, considering the different norms and values of societies in a global world, thus, making social justice inevitably well informed and practiced to promote social cohesion that is accepted by all in society.

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