

Software Quality Model in the Presence of Culture Quality Factors

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Abstract: Researchers have often attempted to raise the success rate of software systems over the past century. Improve software quality models and other software elements to make it more customer satisfaction and achieve customer permanence. Several quality models and variables have been proposed to decrease software system failure and complexity. Also, several software quality models were proposed to assess the general and particular types of software products. These models have been proposed to determine the general or particular scopes of software products. The proposed models evaluate based on comparisons between the well-known models to customize the closed model. These comparisons are the leakage of criteria based on distinct views and knowledge of cultural and social requirements. A new factors proposed by the customize software quality models. The proposed cultural model has eight criterions namely: Language, Religion, social habits, publishing, custom, Ethics, and Law. We classified the new criterions factors into three main groups. The outcome of the proposed cultural model demonstrates that the eight criterions factors must be deemed to decrease the satisfactions of software failure and permanence variables. Finally we proposed a cultural language metric for measuring the satisfactions of software failure and permanence variables.

Key words: Software quality, quality model, culture quality factor, software metrics.

1. Introduction

Software quality plays a vital role in the overall software system's success; it considered an essential aspect for developers, users and managers of projects. Success is found relatively rare in the world of software projects. One potential reason might be the difference in the culture of the meaning of success in the minds of people evaluating the quality of the project. Therefore, the criteria for project success, as believed by various stakeholder groups, do not match. The highest determining factor of achievement is the functionality and quality of the project outcome, success in external goals such as customer satisfaction.

Cultural and social compatibility is essential to the acceptance of the software system. Spencer-Oatey and Franklin pointed out the culture associated with human

existence are provided in conjunction with the development of human life, according to individual creativity and production in various areas. It's a vital aspect of software systems, as discussed during previous studies [1].

Leidner and Kayworth define culture "is that complex whole which includes knowledge, belief, art, morals, law, language, custom, and any other capabilities and habits acquired by man as a member of

society" [2].

Several studies point to the success and persistence of software systems that have taken care of the cultural factor of communities such as WeChat and Microsoft Dynamics AX ERP. Blue Whale Challenge, users are reluctant to use it because they do not take into account their cultural factors.

2. Quality Models Background

In the literature of software engineering, there are many quality models; each model contains different quality characteristics or factors [3]. These models have been suggested to evaluate general and specific types of software products [4].

McCall proposed the first model in 1977, which defines the qualities of the software product as a hierarchy of factors, criteria, and metrics. The factors describe the system characteristics, a quality criterion is an attribute of software production and design-related quality factor, and metrics defining and using a measurement scale and method [5].

This model contains eleven factors and twenty-three criteria; these factors are divided into three groups of products: transition, revision, and operations. Because this model is ancient, there was no consideration for new features of systems such as security and social requirements; it has not taken into account unique characteristics of systems such as safety and social factors [5].

The second model called Boehm [6]. This model defined the primary quality characteristic as a general utility. The main purpose of this model is to address the contemporary weaknesses of models that evaluate software quality automatically and quantitatively. This model discussed the high-level characteristics and classified them into three groups: general utility as a utility, maintenance, and portability. Seven qualities collectively represent the qualities expected from a software system: portability, reliability, efficiency, usability, testability, comprehensibility, flexibility and human engineering [6].

The third model suggested by Dromey. He introduced a framework for assessing the requirements, designing, and implementation of the system. He indicates that the evaluation for each product is different, so we need a dynamic modelling idea. Therefore, the primary objective of the proposed model was to obtain a model that was broad enough for different systems to work [7].

The model aimed at enhancing understanding of the relationship between quality attributes (characteristics) and sub-attributes (sub-characteristics). Several attributes defined in this model, such as the layer, high-level attributes, and subordinate attributes. One of the main drawbacks of this model is that it suffers from a lack of software quality measurement criteria [7].

The fourth model, proposed by Robert and Hewlett-Packard called FURPS. In this model, the features are classified into two categories according to the functional and non-functional requirements of the user [8].

- The functional requirements are the input and expected output is defined.
- Non-functional requirements are usability, reliability, performance, sustainability, and usability which includes human factors, aesthetic, user documentation and material of training [8].

The fifth model proposed by ISO 9000 model, which considered the most basic standard for quality assurance. Total quality attributes of software products have been classified as characteristics and sub-characteristics in a hierarchical tree structure. The highest level of this structure's consists of quality characteristics and the lowest level consists of software quality criteria. Six characteristics, including Functionality, Reliability, Usability, Efficiency, Maintainability, and Portability, further divided into twenty-one sub-characteristics. The defined characteristics in this model can apply to all software types, including firmware computer programs and data, and it can provide consistent software product quality terminology. They also offer a framework for trade-offs between the capabilities of software products [9].

3. Software System Failures and Success

Completion software is often far from meeting user expectations and business performance objectives. The software project success or failure is internal process measure of the project team's performance, including criteria such as scheduling, budgeting, meeting the project's technical objectives and maintaining smooth working relationships within the team and parent organization.

Based on an examination of the literature and interviews with experienced project managers, three distinct aspects of project performance were identified as benchmarks against which to assess the success or failure of a project. These aspects are:

- The implementation process itself.
- The perceived value of the project.
- Client satisfaction with the delivered project.
- The Culture and social requirement.

The first of these aspects is primarily concerned with the internal efficiency of the project implementation process. The second aspect of project success or failure assessment is the perceived project quality; it includes the perception by the project team of the value and usefulness of the outcomes of the project. This evaluation emphasizes the potential impact of the project on users. This is the judgment of the project team as to how good a job they have done for the client. The evaluation of the project by the project team may or may not agree with the evaluation of the client. The third aspect of project performance, customer satisfaction, is an external measure of customer effectiveness [10]. The fourth aspect is the culture requirement contains organization culture and national culture. Software projects failure if they fail to achieve organization and national cultures, such as Language, Religion, and the Ethic [11].

Several software projects achieved great success because they met cultural and social factors. Microsoft Dynamics AX is one of Microsoft's software products. It's part of the family of Microsoft Dynamics that used for enterprise resource planning. It is designed to help organizations doing the business activity across locations and countries through the standardization of processes, and the simplification of compliance. Dynamics AX is used throughout the world in more than 20,000 organizations of all sizes; it is available in more than 30 countries and in 25 languages.

This software has success as a globally because this software obtain a cultural sub-factor (language versions) from the web store and customized it to suit any language requirement for different tax laws, accounting rules, and currencies [12].

WeChat is a multi-purpose Chinese messaging, social networking and mobile payment application, that developed by Tencent. During the 2014 Chinese Lunar New Year festival, WeChat application was launched during the celebration. Social media supports the traditional values of China through virtually linking a vast collectivist society. A red Bag or a red packet in Chinese and other East Asian and Southeast Asian cultures is a monetary gift given during special occasions. People can exchange ideas, money, and demonstrate traditional Chinese values. The Red Bags digitally further built by Tencent's WeChat platform from a business point of view. At its peak, the Red Bag application was used by 20 million people during the Lunar New Year festival of 15 days in 2014 [13].

Blue Whale Challenge game is considered as a failure software system. This game does not take into account the social and cultural quality factor. This game involves a set of tasks to be performed over 50 days that with each passing day, the tasks become increasingly dangerous and life-threatening. The main challenge in the game that took the world by storm is dangerous." Blue Whale Challenge" that often involves teenagers. This game is probably the only game the participant has to finish his / her life to finish the game. In our present society, the Blue Whale Challenge could be seen as an illegal, unethical and inhumane endeavor [14].

Table 1. Factor Definition

Culture factors	Definition	Related factors in the previous study
knowledge	is a familiarity, awareness, or understanding of someone or something, such as facts, information, descriptions, or skills, which is acquired through experience or education by perceiving, discovering, or learning.	understandability
language	a body of words and the systems for their use common to a people who are of the same community or nation, the same geographical area, or the same cultural tradition	X
religion	set of beliefs concerning the cause, nature, and purpose of the universe, especially when considered as the creation of a superhuman agency or agencies, usually involving devotional and ritual observances, and often containing a moral code governing the conduct of human affairs.	X
experience	is knowledge or skill in a particular job or activity, which you have gained because you have done that job or activity for a long time.	usability
custom	is a common way of doing things. It is something that many people do, and have done for a long time. Usually, the people come from the same country, culture, or religion. Many customs are things that people do that are handed down from the past.	X
Ethics	is the body of principles used to decide what behaviors are right, good and proper.	X
music	Music is a collection of coordinated sound or sounds. Making music is the process of putting sounds and tones in an order, often combining them to create a unified composition.	X
Cuisine	Cuisine is a characteristic style of cooking practices and traditions, often associated with a specific culture.	X
Behavior	It is the response of the system or organism to various stimuli or inputs, whether internal or external, conscious or subconscious, overt or covert, and voluntary or involuntary.	X
values	is the body of principles used to decide what behaviors are right, good and proper.	X
Media	The term media, which is the plural of medium, refers to the communication channels through which we disseminate news, music, movies, education, promotional messages and other data. It includes physical and online newspapers and magazines, television, radio, billboards, telephone, the Internet, fax and billboards.	X
Film	is a medium used to simulate experiences that communicate ideas, stories, perceptions, feelings, beauty or atmosphere by the means of recorded or programmed moving images along with other sensory stimulations.[1]	X
Dressing	is dressed according to the function, culture or beliefs (non-revealing dress).	X
style	how something is done or how it happens	X
Dance	is a performing art form consisting of purposefully selected sequences of human movement. This movement has aesthetic and symbolic value, and is acknowledged as dance by performers and observers within a particular culture	X
game	is a structured form of play, usually undertaken for enjoyment and sometimes used as an educational tool.[1]	X
architecture	is both the process and the product of planning, designing, and constructing buildings or any other structures.[3] Architectural works, in the material form of buildings, are often perceived as cultural symbols and as works of art. Historical civilizations are often identified with their surviving architectural achievements.	X
Sports	Activities or games, usually involving physical effort or skill. Reasons for engagement in sports include pleasure, competition, and/or financial reward.	X
Design	A design is a plan or specification for the construction of an object or system or for the implementation of an activity or process, and/or the result of that plan or specification in the form of a prototype, product or process.	X
Publishing	the business or profession of the commercial production and issuance of literature, information, musical scores or sometimes recordings, or art	X
Law	is a system of rules that are created and enforced through social or governmental institutions to regulate behavior	X
social habits	is behavior among two or more organisms within the same species, and encompasses any behavior in which one member affects the other. This is due to an interaction among those members	X
attitude	In psychology, attitude is a psychological construct, a mental and emotional entity that inheres in, or characterizes a person.[1]	X
A hierarchy	is an organizational structure in which items are ranked according to levels of importance. Most governments, corporations and organized religions are hierarchical.	X
A role	is the set of norms, values, behaviors, and personality characteristics attached to a status	X
A spatial relation	[1][2] specifies how some object is located in space in relation to some reference object.	X
material objects	The definition of material refers to a physical object, as opposed to something spiritual or mental, or something that is essential and relevant	X

4. Proposed Software Quality Model

This paper proposed a software quality model in the presence of culture and social quality factors. The social and cultural quality factor is essential in the quality software system. It plays the main rules in the success and failure of the software systems. In this study, we specify the main factor affecting the success and failure of software by analyzing the definition of culture. According to [15] culture means "Culture is a way of life for different races/ ethnicity encompasses many facts like religions, languages, dressing attires, hairstyles of cuisines food eaten/ certain games/ sports/ martial arts practiced / certain musical entertainments played, certain songs/ music's dances, values systems etc." which have their own unique identity. Another definition of culture is the characteristics and knowledge of a particular group of people, encompassing language, religion, cuisine, social habits, music, and arts. Culture refers to the cumulative deposit of knowledge, experience, beliefs, values, attitudes, meanings, hierarchies, religion, notions of time,

roles, spatial relations, concepts of the universe, and material objects and possessions acquired by a group of people in the course of generations through individual and group striving. These definitions then includes what have been called the 'classical' cultural industries – broadcast media, film, publishing, recorded music, design, architecture, new media – and the 'traditional arts' – visual art, crafts, theatre, music theatre, concerts and performance, literature, museums and galleries – all those activities which have been eligible for public funding as 'art'. Analyzing the definition above cultural contains twenty-seven factors.

Based on a comparison of all previous elements and a repeated cancellation or that gives the same meaning, we have got a set of cultural factors that appear in Table 1.

According to analysis results, we classified a cultural factor from software engineering quality into two categories

- Related to software engineering quality factors (SQF)
- None related to software engineering quality factors (NSQF).

Table 2 shows the classification.

Table 2. Cultural Factor

Elements not related to software	Elements related to software
Behaviours	Knowledge
Values	social habits
attitudes	experience
design	Language
Music	custom
arts	Ethics
Media	Religion
Dressing	publishing
Styles	Law
Sports	--
Games	--
Film	--
Dance	--
cuisine	--
hierarchies	--
architecture	--
notions of time	--
roles	--
spatial relations	--
material objects	--

In this section, the factors that are not related to software engineering quality were excluded, and the factors that are related to software engineering quality were focused on as shown in the following Table 3.

We divided the previous items shows in Table 1 and 2 based on their definition into two groups:

- 1) The first group was considered as an application for the software product. We compared the proposed culture element quality factors by the ISO quality model. This comparison determines which elements of culture have been associated and taken into account the quality factors for the software product.
- 2) The second group was considered as non-applicable to the software product, We divide this group into two subgroups, As shown in Table 3.
 - Elements of culture that applies to software engineering quality factors (SQF) which can be excluded.

- Elements of culture that are non-applicable to software engineering quality factors (SQF), and we have grouped those elements based on relationship and similarity. This classification aid to easily understand and measure them to subsequent integrations.

Table 4 shows the proposed cultural quality factor model comparing with the five models proposed in the literature.

2.1. Software Quality Factors and Quality Criteria

In this section, the quality criteria and their relationship to quality factors will be explained. Criteria represent the main part to evaluate and define any quality factor. These criteria may be attributes of the product or attributes of the production process [21].

Table 3. Applicable and None-applicable Factor

Elements of culture applicable for (SQF)	Elements of culture non-applicable for (SQF)
knowledge	Language
experience	Religion
	custom
	social habits
	publishing
	Ethics
	Law

Studying and analyzing the relationship between culture definition and software quality, we proposed software quality factors (SQF) related to cultural elements and its criterion. Table 5 shows the relationships between quality factors and criteria. In the study, two elements are considered as none-applicable factors namely, knowledge and experience.

Table 4. Comparison of Quality Model

Factors/Attributes/Characteristics	McCall	Boehm	Dromey	FURPS	ISO 9126	Culture model
Maintainability	X		X		X	X
Flexibility	X					X
Testability	X	X				X
Correctness	X					X
Efficiency	X	X	X		X	X
Reliability	X	X	X	X	X	X
Integrity	X					X
Usability	X		X	X	X	X
Portability	X	X	X		X	X
Reusability	X		X			X
Interoperability	X					X
Human Engineering		X				X
Understandability		X				X
Modifiability		X				X
Functionality			X	X	X	X
Performance				X		X
Supportability				X		X
Cultural						X
18	11	7	7	5	6	18

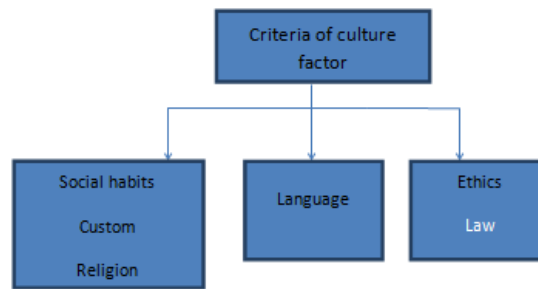


Fig. 1. Culture factor criteria.

2.2. Quality Criteria and Related Factors

Most organizations are concerned with the quality of the software systems used within their organizations. Therefore, the measurement and evaluation of the quality of software systems are very important. Table 5 shows the relationship between criteria definitions and related software quality factors while table 6 shows the criterion for the quality factors.

In this section, we focus on the software product, which is particularly interested in measuring customer satisfaction with the quality software system from the cultural aspect. The culture factor was defined as a set of criteria (language, religion, customs, Social habits, Law, Ethics). Figure 1 classified the criteria into three main groups based on their definition.

Table 5. The relationships between Quality Factors and Criteria

Quality Factors	Criteria
Correctness	Completeness, consistency, operability
Efficiency	Concision, execution, efficiency, operability
Flexibility	Complexity, concision, consistency, expandability, generality, modularity, self-documentation, simplicity
Integrity	Audit ability, instrumentation, security
Interoperability	Communications commonality, data commonality
Maintainability	Concision, consistency, modularity, instrumentation, self-documentation, software independence
Portability	Generality, hardware independence, modularity, self-documentation, software independence
Reliability	Accuracy, complexity, consistency, error tolerance, modularity, simplicity
Reusability	Generality, hardware independence, modularity, self-documentation, software independence
Testability	Audit ability, complexity, instrumentation, modularity, self documentation, simplicity
Usability	Operability, training
Modifiability	Structure, augment ability
Understandability	Consistency, Structure, conciseness. legibility
Documentation	Completeness
Functionality	Capability, security
Performance	Flexibility, efficiency, Reusability
Supportability	Testability, extensibility, maintainability, compatibility
Culture	Language , Religion , social habits , publishing, custom, Ethics, Law, knowledge, experience

To measure the criteria of the cultural factor and provide quantitative values to the stakeholder, which enable him to assess the quality of the product in the cultural aspect in the decision-making process. We will study the language as a case study for measuring the new factors.

Abufardeh [20] defines language as “a system that consists of the development, acquisition, maintenance and use of complex systems of communication, particularly the human ability to do so; a language is any specific example of such a system”.

Table 6. Criteria for Quality

Criterion	Definition	Related factors
Traceability	Those attributes of the software that provide a thread from the requirements to the implementation with respect to the specific development and operational environment	Correctness
Completeness	Those attributes of the software that provide full implementation of the function required	Correctness
Consistency	Those attributes of the software that provide uniform design and implementation techniques and notation	Reliability Correctness Maintainability
Accuracy	Those attributes of the software that provide the required precision in calculation and outputs.	Reliability
Error Tolerance	Those attributes of the software that provide continuity of operation under monomial conditions.	Reliability
Simplicity	Those attributes of the software that provide implementation of functions in the most understandable manner. (usually avoidance of practices which increase complexity)	Reliability Maintainability Testability
Modularity	Those attributes of the software that provide a structure of highly independent modules	Maintainability Flexibility Testability Portability Reusability Interoperability
Generality	Those attributes of the software that provide breadth to the functions performed	Reusability Flexibility
Expandability	Those attributes of the software that provide for expansion of data storage requirements or computational functions	Flexibility
Instrumentation	Those attributes of the software that provide for the measurement of usage identification of errors.	Testability
Self-Descriptiveness	Those attributes of the software that provide explanation of the implementation of function	Flexibility Testability Portability Reusability
Execution Efficiency	Those attributes of the software that provide for minimum processing time.	Efficiency
Storage Efficiency	Those attributes of the software that provide for minimum storage requirements during operation.	Efficiency
Access Control	Those attributes of the software that provide for control of the access of software and data	Integrity
Access Audit	Those attributes of the software that provide for audit of the access of software and data	Integrity
Operability	Those attributes of the software that determine operation and procedure concerned with the operation of the software	Usability
Training	Those attributes of the software that provide transition from current operation or initial familiarization	Usability
Communicativeness	Those attributes of the software that provide useful inputs and outputs which can be assimilated	Usability
Software System Independence	Those attributes of the software that determine its dependency on the software environment (operating systems, utilities, input/output routines, etc.)	Portability Reusability
Machine independence	Those attributes of the software that determine its dependency on the hardware system.	Portability Reusability
Communications Commonality	Those attributes of the software that provide the use of standard protocols and interface routines	Interoperability
Data Commonality	Those attributes of the software that provide the use of standard data representations.	Interoperability
Conciseness	Those attributes of the software that provide for implementation of a function with minimum amount of code.	Maintainability
Language	a body of words and the systems for their use common to a people who are of the same community or nation, the same geographical area, or the same cultural tradition	Culture
Religion	set of beliefs concerning the cause, nature, and purpose of the universe, especially when considered as the creation of a superhuman agency or agencies, usually involving devotional and ritual observance, and often containing a moral code governing the conduct of human affairs	Culture
social habits	Is behaviour among two or more organisms within the same species, and encompasses any behaviour in which one member affects the other. This is due to an interaction among those members	Culture
publishing	the business or profession of the commercial production and issuance of literature, information, musical scores or sometimes recordings, or art	Culture
custom	is a common way of doing things. It is something that many people do, and have done for a long time. Usually, the people come from the same country, culture, or religion. Many customs are things that people do that are handed down from the past.	Culture
Ethics	is the body of principles used to decide what behaviours are right, good and proper.	Culture
Law	is a system of rules that are created and enforced through social or governmental institutions to regulate behaviour	Culture
knowledge	is knowledge or skill in a particular job or activity, which you have gained because you have done that job or activity for a long time	Culture
experience	is a familiarity, awareness, or understanding of someone or something, such as facts, information, descriptions, or skills, which is acquired through experience or education by perceiving, discovering, or learning	Culture

The use of language is well firm in human culture. The number of languages that have emerged in the world is close to 5000 to 7000, a large proportion of these languages have become extinct and the extinction of languages will continue to happen by 2100 to approximately 50% to 90%, according to the estimates of the relevant studies in this area. The six approved within the United Nations and the most widely spoken languages in the world are English, Chinese, Arabic, Spanish, Russian and French.

After studying the concept of culture and analyzing a set of elements that were considered as a criteria related to culture factor which was proposed as one of the software quality factor(SQF), we found that one of these criteria is the language of the software product, which is a key pillar in the development of the global software product, as indicated by a previous study, by Abufardeh on Global Software Development

(GSD), which is mainly based on multilingualism and cultures. He also called for the need to focus on studying this aspect and researching it. Through the study conducted by the researcher, that the translation of the software product commensurate with the language of a particular country, does not rely solely on the language translation of the program, but includes the representation of data and text and the way of presentation and coordination so as to suit the culture prevalent in that country [20]-[24].

In this study, we used function point as a method for measuring the size and productivity of software systems. It is also used to calculate the size and complexity of applications based on outputs, inputs, queries, internal files and interfaces.

To calculation the language complexity of the software system for satisfactions of software failure and permanence variables, we set up the following definition for a cultural language metric:

- Number of Basic Language Activities in a system (NOBLA): NOBLA metric counts the number of basic language activities in a system. NOBLA is a simple one-dimensional metric based on a function point activities, unlike other complexity metrics which manipulate two or more dimensions of a process.
- Number of Language Structured Activities (NOLSA): NOSLA calculate how deeply we used the language (length). NOSLA metric is another simple one-dimensional length metric similar to NOBLA. However, instead of counting basic activities, it counts the number of language structured activities in a system. It should be noted that NOLSA simply counts the number of language structured activities and attach weights to United Nation Languages.

Information Flow complexity for a Language (IF4L): IF4L metric is an adaptation of a language on a system. It is a fan-in is represented by input activities while fan-out is represented by output activities. The IF4L is defined as the square of the product of the Number of Input Language Activities (NOILA) and the Number of Output Language Activities (NOLA) contained in it. This is shown in Eq. 1:

$$IF4L_l = (NOIL * NOLA)^2 \quad (1)$$

$$WIF4L_l = (NOIL * NOLA * Weight)^2 \quad (2)$$

where l is a language used weight = 2 for United Nation Language, 1 for other languages.

For large systems with several languages are used, a summation of the complexities of all language contained in the system is obtained as shown in Eq. 2:

$$IF4L = \sum_{l=1}^n IF4L_l \quad (3)$$

$$WIF4L_l = \sum_{l=1}^n WIF4L_l \quad (4)$$

where n is the number of languages used in the system.

5. Conclusion

In this paper, we study the failure and success software and emerging the software quality models to reduce the failure software. Hence, we discussed the software quality models for the presence of cultural and social requirements. This paper compares the quality model factors from cultural and social aspects. Furthermore goes behind the definitions of the cultural requirements form the software quality factors, sub-factors and criteria that affect the software failure and success.

Furthermore, new factors were proposed to get clear and accurate differences between software quality models. This method requires assign values for the sub-factors moreover the main factors, which is giving a

clear picture of the differences between the models.

The values in this study were given equivalently between the factors and between the sub-factors that is because this comparison was generally. In a specific domain, the costs for each factor and sub-factors have to be defined according to the selected domain. Eight cultural criterion factors proposed for satisfactions of software failure and permanence variables. To measuring the complexity of cultural factor we proposed a cultural language metrics.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

The research idea suggested by Hamed Fawareh to cover the effective culture for software failures, and suggest metrics to measure the effectiveness. Ayat Mohammad conducted the research. All authors had approved the final version.

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