

# A format to handle Sustainability problem in software design by engineering sustainability requirements

Razia Falak, Raheela Nasim

**Abstract**— One of the major challenges of our society is to achieve sustainability development. Sustainability contains three factor: social, environmental and economics sustainability. For individuals, sustainability is the ability to undergo and the probable for long lasting maintenance. So there is a need to develop a sustainable software with a liable feeding of resources. In software development process, a pattern is a written document that provides a general solution to a design problem that occurs repeatedly in many projects. Requirement engineering is considered one of the most important phases in the development life cycle. Requirement engineering is the crucial activity which can affect the entire life cycle of software development process. The main objective of the requirements elicitation phase is to collect requirements from different views such as requirements from the business, requirements from the customer side, requirements from the user side, and requirements from the security point of view. This research will explore to handle the sustainability problem in design, a new software pattern based on singleton and service locator design pattern is defined. This research also focuses on requirement engineering techniques that are affective to overcome these problems. These techniques are focus groups, interviews and ethnography for eliciting the requirements.

**Index Terms**— Sustainability, Sustainability problem, Software Design, Requirements Engineering, Sustainability Requirements

## 1 INTRODUCTION

The thought behind the sustainability was formally concocted for the world, and the significance of sustainability is to make things that are durable. Firstly the word Nachhaltigkeit (the German term for sustainability) was utilized by this importance. The uneasiness with defensive normal belonging that will utilized as a part of future is returning, coincidentally, unquestionably our Paleolithic lines are generally worried round their question complimenting. The idea of sustainability was initially authored in ranger service, where it implies never reaping more than what the woodland yields in new development. The word Nachhaltigkeit (the German expression for sustainability) was initially utilized with this importance. The worry with protecting regular possessions for what's to come is lasting, obviously: without a doubt our Paleolithic precursors stressed over their prey getting to be wiped out, and early ranchers more likely than not been uncertain about keeping up soil richness. Customary convictions charged thinking as far as stewardship and sympathy toward future eras, as communicated in the oft-cited expressions of a Nigerian tribal boss who saw the group as comprising of "some dead, few living and incalculable others unborn". Maybe there have dependably been two contradicting perspectives of the connection in the middle of mankind and nature: one which focuses on adjustment and concordance, and another which sees nature as something to be prevailed.

### 1.2 Sustainable Development

Since the Brundtland Commission initially characterized Sustainable improvement, handfuls, if not hundreds, of researchers and experts have enunciated and advanced their

own option definition; yet a reasonable, altered, and unchanging significance stays tricky. This has driven a few eyewitnesses to call development for sustainability a paradoxical expression: in a far-reaching way conflicting and beyond reconciliation.

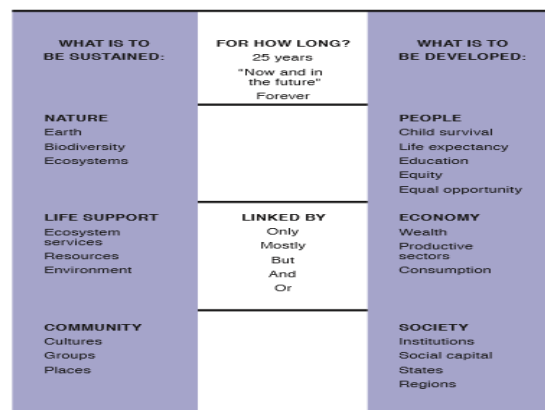


Figure: 1.1 Sustainable Development

Further, on the off chance that anybody can reclassify and reapply the term to fit their reasons, it gets to be unimportant practically speaking, or more regrettable, can be utilized to camouflage or greenwash socially or naturally damaging exercises. Yet, regardless of these scrutinizes, each definitional endeavor is a vital piece of a continuous dialog. Truth be told, development for sustainability draws quite a bit of its reverberation, force, and imagination from it's exceptionally

uncertainty.

Software systems had the sound effects on our environment and its sustainability that they need to talk. they estimated that there were two basic motives in the process of dominant software's development Firstly is that when we take sustainability in the process of software develop, there must be an intelligent blockade that was overwhelmed that was a difficult task. Secondly, this difficulty can increase the cost of the software development process, particularly when we want to hire experts for the measurement of sustainability. For inspiring software developers to measuring sustainability, we proposed a pattern for the requirements that were to be sustainable. These patterns offer direction to measure the requirements for achieving sustainability. These requirements consists material on the conditions in which we should use these patterns taking as a preliminary edge for the development of sustainable requirements and it also contains data that was required to development of these requirements.

[4]

The solid difficulties of sustainability development are at any rate as heterogeneous and unpredictable as the assorted qualities of human social orders and regular biological communities around the globe. As an idea, its pliability permits it to remain an open, element, and advancing thought that can be adjusted to fit these altogether different circumstances and settings crosswise over space and time. Regardless of this inventive equivocalness and openness to translation, development for sustainability has advanced a center arrangement of controlling standards and qualities, in light of the Brundtland Commission's standard definition to address the issues, now and later on, for human, financial, and social advancement inside of the life's restrictions emotionally supportive networks of the planet. Further, the intentions of both of the phrase's root words, "Sustainability" and "development" are for the most part very constructive for the vast majority, and their mix pervades this idea with inborn and close all-inclusive settlement that sustainability is a beneficial worth and objective—an effective element in assorted and clashed social settings [3].

### 1.3 Types of Sustainability

There are main four types of sustainability exist environmental, social, human and economic. These four types are considered to preserve the entireness of life on earth. While intersected, it is most significant to consider the modifications of every in wording of its nature and necessities.

#### 1.3.1 Human Sustainability

The exceptionally essential need of human sustainability is great conceptive wellbeing and safe childbearing. Those that repeat have the obligation of administering to their kids, giving them access to fitting training, and advancing their wellbeing and health. Sooner or later, the youngsters ought to have enough aptitudes and learning such that they can maintain their own specific manner of life. It is by then that they get to be considered as gainful human capital and people that can experience the procedure of proliferation and raising. The length of this procedure is kept up at a rate that every single human framework can bolster, human sustainability ought to be no reason for concern.

#### 1.3.2 Economic Sustainability

In basic terms, economic sustainability is having a set measure of capital for a sure period. The individuals who expend that capital must additionally ration it with the goal that they will keep on appreciating it towards the end of the predefined period. This implies that we must protect every one of our resources as we expend them so that individuals later on can appreciate them too. To accomplish this, we must recover our assets at a rate that is equivalent to or quicker than our utilization.

#### 1.3.3 Social Sustainability

Social capital is a critical part of sustainability in light of the fact that it is through groups and common social orders that mankind can without much of a stretch and economically cooperate. Without fitting levels of social capital, it can undoubtedly drain and roughness and also doubt can assume control. At the point when that happens, social orders and everything else that relies on upon them will be annihilated. Through legitimate upkeep of and adherence to laws, principles, and qualities that social orders have produced for the benefit of everyone, social sustainability can be accomplished.

#### 1.3.4 Environmental Sustainability

Environmental sustainability is critical in light of the fact that it includes characteristic possessions that individual's requirement for monetary or fabricated capital. Materials taken from nature are utilized for arrangements that address human needs. On the off chance that nature is exhausted quicker than it can recover, people will be left without crude materials. Moreover, environmental sustainability likewise includes guaranteeing that waste emanations are at volumes that nature can deal with. If not, all people and other living things on Earth can be hurt to the point of termination.

## 2 DESIGN PATTERNS

Design patterns speak to the best practices of experienced object-oriented programming engineers. Design patterns are repeating answers for basic programming issues. These arrangements were found through experimentation by various programming engineers over a significant duration of time. Gamma, Erich, Helm, Johnson, and Vlissides (1995) inventory those best practices with 23 examples. The creators depict every Design patterns with a name and an aim, which characterizes what the pattern does and what design issues or issues it addresses. Pretty much as item arranged programming empowers code reuse, Design patterns support design reuse. Design patterns assist software engineers with catching the components of good programming arrangement and make more reusable and viable projects.

Many organizations faced problems for achieving sustainability in their business. Although, these companies need extra energy to incorporate sustainability factor in their industry. Because in the process of old business and also in the old software development processes finding sustainability factor was a difficult task. In the traditional business processes, there was a no clear definition of sustainability. Because it was not considered sustainability an important factor in all the phases of software life cycle. So, if we want to

consider sustainability a most important factor we had to understand sustainability in the software development process. [2]

Design patterns will advantage creating programming and make it adaptable, measured, and reusable. In any case, knowing Design patterns does not generally imply that they will be usable. As a result of the way of Object-Oriented development, the design has a tendency to be changed and refined time to time. It is not uncommon that the programmer thinks that it's helpful to apply some Design patterns a while after the advancement begins. Yet contrasted and early advancement stage, it is regularly harder to apply designs in middle of the programming. Design patterns don't fit immediately. Project codes oblige some sort of tidying up or changing for the designs' utilization. Refactoring then becomes possibly the most important factor. Refactoring tidies up codes and assist a with targeting Design patterns fit in the system better. Refactoring is an effective instrument to expand the shots of utilizing examples and enhancing the nature of programming.

### 2.1 Singleton Design Pattern

Singleton design pattern gives the guarantee that a class has only one instance and it deliver a global point of access to it.

Singleton design pattern summarized initialization in time or on first time initialization.

Make the single's class instance in charge of access and "initialization on first utilize".

The single instance is a private static attribute. The accessor capacity is an open static strategy.

For designing object oriented systems, use of design patters is best practice. Many experienced developers used design patters for their design problem and consider it as a solution of the problem. Many developers focuses on the identification and documentation of patterns instead of their experiences about using the patterns because design patters were generated from the experiences of the software developers. Design patterns provide a good tool to develop design for specific problem, so it is essential for design pattern to be used by unexperienced developers. [7]

### 2.2 Service Locator Design pattern

It also offer a global point of access to a service deprived of linking users to the existing class that implements it.

### 2.3 Requirements

If at any time frameworks advancement tasks required a "reasonable wind", they unquestionably do as such today. Quick changing innovation and expanded rivalry are setting always expanding weight on the improvement process. Successful requirements engineering lies at the heart of an association's capacity to manage the boat and to keep pace with the rising tide of many-sided quality. Programming is at present the prevailing power of progress of new items.

### 2.4 Requirements Elicitation

Requirements elicitation is about learning and comprehension the needs of clients and undertaking backers with a definitive point of imparting these needs to the software engineers. It is considered as the most tedious and effortful movement. Requirement Elicitation was the process of gathering, analyzing, trimming, documenting, and authenticating the needs, and requirements of the stakeholders for the desired

system. They also stated that improper RE can lead to system failure, by using appropriate RE approach, software quality can be improved. There were some features of ES that were same as in the requirements of basic projects that were application domain, types of requirements engineers, resources of information, involvement of users and requirements possessions. In this research, their main goal was to enhance the quality of ES by offering appropriate RE approaches that were used in the development process of ES. The use of these appropriate approaches can reduce the cost, time and scope and avoid the effort to rework in the development process of ES. [1] Elicitation of Requirements is about social affair data from the clients with reference to how the framework ought to be, what capacities it ought to perform including its non-practical Requirements like execution, throughput, dependability, effectiveness, and so on. There are numerous methods for getting however much data as could reasonably be expected from the clients and different partners. Indeed, even the gathered data which go about as Requirements in the system can be contrasted and Requirements of different clients for arrangement and strife determination.

## 3 CHARACTERISTICS OF GOOD REQUIREMENTS ELICITATION TECHNIQUES

The most appropriate method is the particular case that lets you to perform the objective in your present circumstance. A few strategies are productive in discovering applicable requirements and some are less demanding to execute than others. A few strategies are more pertinent to specific circumstances and task sorts others are material to all. Every elicitation strategy has its own criteria for selecting requirements i.e. what kind of requirements it will reveal, what setting it will work legitimately in, what will be the method's result, and so forth. Every procedure obliges endeavors before actualizing and after usage for requirements gathering. Requirements social occasion procedure is frequently tedious procedure in light of the fact that as it is the procedure of gathering point by point information on the operation of a framework. Concentrating on elicitation system choice, there is no best procedure yet as not sufficient information is accessible for settling on the choices with respect to viability of methods.

RE was the key factor that measures the importance of product. A well-defined requirement elicitation reduces the time and cost of development and increases the quality of the software system. Therefore, to degree and additionally identify the current methods and difficulties that were challenged by the software developers, it was most significant to design well-defined RE methods. So it was considered a positive thing for software developers to define good requirements engineering. [5]

## 4 QUALITIES OF GOOD ELICITATION TECHNIQUE

It has the ability to find out most and great esteemed requirements

It has the ability to find out implicit requirements

Accomplishes its goal with least use of resources i.e. time and budget.

Carry out its objectives with minimum resources used  
 Non-excess [6].

## 5 INTERVIEW

Interviewing comprises of getting some information about the space of interest and how they perform their assignments. Interview can be unstructured, semi-organized, or organized. The achievement of an interview session is subject to the inquiries asked (it is hard to know which inquiries ought to be asked, especially if the questioner is not acquainted with the area) and the master's capacity to express their insight. The master may not recall precisely how they perform an assignment, particularly in the event that it is one that they perform consequently. Some Interview routines are utilized to construct a specific kind of model of the assignment. The model is assembled by the learning specialist taking into account data got amid the Interview and after that looked into with the space master. Now and again, the models can be manufactured intelligently with the master, particularly if there are programming devices accessible for model creation.

## 6 FOCUS GROUP

A focus group is a gathering interview of pretty nearly six to twelve individuals who offer comparable qualities or normal hobbies. A facilitator directs the gathering in light of a foreordained arrangement of points. The facilitator makes a situation that urges members to share their observations and perspectives. Focus groups are a subjective information accumulation strategy, implying that the information is distinct and can't be measured numerically.

## 7 ETHNOGRAPHY AND ITS KEY CHARACTERISTICS

Ethnography is the craftsmanship and science used to portray a gathering or society. Ethnographers hunt down unsurprising examples in the lived human encounters via precisely watching and taking an interest in the lives of those under study. Ethnography might likewise include a full inundation of the specialist in the normal lives or society of those under study. Ethnography as a system has certain particular attributes to start with, it is led on location or in a naturalistic setting in which genuine individuals live. Second, it is customized since you as the analyst are both onlooker and member in the lives of those individuals. Ethnography likewise gathers information in different courses for triangulation over a broadened span of time. The procedure is inductive, all-encompassing and obliges a long haul duty from you. At long last, ethnography is dialogic since conclusions and elucidations framed through it can be given remarks or input from the individuals who are under study.

## 8 PROPOSED DESIGN PATTERN

In proposed design pattern, it syndicates the properties of both the singleton design pattern and service locator design

pattern. The singleton design pattern confirms that there occurs only a single instance of a class. It also offers an over-all point of access to it. In contrast, the purpose of the new design pattern is to guarantee that for the specified set of fixed parameter values, a class has only one instance. Same as in the singleton design pattern.

By using different requirement elicitation techniques like as interview, focus group and ethnography, it makes sure that the proposed design pattern has a factor of sustainability.

## 9 MOTIVATION

Any structure of the system cannot accept numerous instances of some classes with indistinguishable parameters. For example, at the same time, by using the same serial port, there cannot have two instances. There are no two instances that can be used to listen to the one socket connection. And at the same time there are no two instances that are used for writing the same file construction.

## 11 USAGE OF NEW DESIGN PATTERN

We can use the new design pattern:

With the given parameter, there exists only one instance of a single class.

From a well-recognized point of access, these instances must be available to clients.

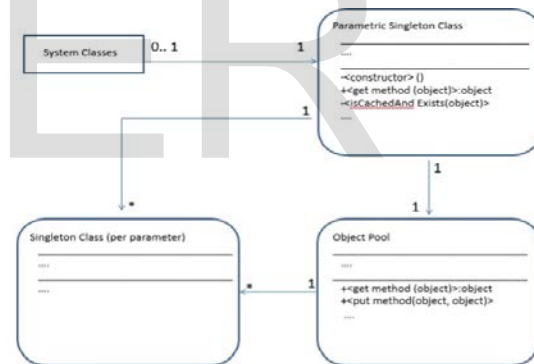


Figure 2: Class Diagram for the new design pattern

## 12 CONCLUSION

The creation of a new design pattern is more multifaceted job and there is a need to analyze many excellent properties of design patterns. Though by using the sustainability requirements engineering this questionnaire could be helping factor in the development of design pattern and it can also help developers to improve recognize the requirements and satisfaction level of the proposed design pattern.

This tool is helpful in recognizing some difficulties in detailed manner before the development of new design pattern. It can also reduce the dangers in the implementation of new design pattern. It is also important to notice that opinion of customer is most important rather than the thinking of the developers. It survey uncover some unforeseen dissatisfaction problem that is not easily detected. To check the validity and reliability, this

questionnaire is sent and tested by different organizations. This tool can be used by different organization's developers for the evaluation of the existing system and it can be used for the improvement of developing systems. It could be made functional to many organizations by making some changes.

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Software Design Patterns are reusable designs providing common solutions to the similar kind of problems in software development. Software Design Patterns are proven design methods which when used carefully in the implementation of software development will lead to several advantages.

Requirements engineering in order to help engineers to produce workable, complete, and consistent requirements. Requirements engineering is often viewed as a euphemism along the lines of "sanitation engineering" – something to be done by non-engineers who want to feel like they're doing real engineering work. While this view may be accurate for the vast majority of requirements, it is possible to apply engineering rigor to the process of creating requirements, and in so doing, to greatly improve their quality (and the lives of the engineers who have to implement them!). RE is a multi-disciplinary, human-centred process. The tools and techniques used in RE draw upon a variety of disciplines, and the requirements engineer may be expected to master skills from a number of different disciplines.

This research proposes a new design pattern based on the two design patterns i.e singleton and service locator design patterns. It is a combination of old design patterns and also uses the requirements elicitation techniques to overcome the sustainability problem in software design.

## REFERENCES

- [1] Ang, J.K., Leong, S. B., Lee, C. F and Yusof, U.K. 2011. Requirement Engineering Techniques in Developing Expert Systems. IEEE sunoisium on Computers & Informatics (ISCI),1(1):640-645.
- [2] Betz, S and T. Caporale. 2014 Sustainable Software System Engineering. IEEE Fourth International Conference on Big Data and Cloud Computing,1(1):612-619.
- [3] Kates,W., T. Parris and A. Leiserowitz. 2005.What is Sustainable Development? Goals, Indicators, Values, and Practice. Environment: Science and Policy for Sustainable Development,47(3): 8-21.
- [4] Roher, K and D. Richardson. 2013. Sustainability Requirement Patterns. IEEE third International Workshop on Requirement Patterns (RePa),1(1):8-11
- [5] Tahir, A and R. Ahmad. 2010. Requirement Engineering Practices - an Empirical Study. IEEE International Conference on Computational Intelligence and Software Engineering (CISE),1(1):1-5.
- [6] Yousuf, M, M. Asger and M.U. Bokhari. 2015. A Systematic Approach for Requirements Elicitation Techniques Selection: A Review. International Journal of Advanced Research in Computer Science and Software Engineering,5(4):1399-1403
- [7] Zhang, C and D. Budgen. 2012. What Do You Know about the Efectiveness of Software Design Patterns?. IEEE Transactions on Software Engineering,38(5):1213-1231.

---

• Author is Razia Falak currently pursuing MS (CS) program in University of Agriculture, Faisalabad, Pakistan, PH-0092-3317738140 . E-mail: raziafalik@hotmail.com

• Co-Author is Ms. Raheela Nasim currently is Lecturer in MS(CS) degree program in University of Agriculture, Faisalabad, Pakistan, PH-0092-03217806896. E-mail: raheela\_uaf@yahoo.com  
(This information is optional; change it according to your need.)