جامعة الملك سعود
King Saud University
College of Computer & Information Sciences
Software Engineering Department

Software Sustainability

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Course Assignment

Topic:
Software Sustainability

Supervised By:
Dr.Manal Alahamad

#	Student Name	Student ID	Responsibilities
1	Renad Alsubaie	[redacted]	**What is software sustainability**
2	Jouri Alanazi	[redacted]	**How does software sustainability relate to software quality and why it is important**
3	Moneerah Alsubaie	[redacted]	**What are the implications of not addressing these quality factors of modern software**
4	Reem Alshareef	441200087	**What is our role as software engineers in addressing sustainability**
5	Fai Alotaibi	[redacted]	**What are the initiatives / solutions / techniques out there that aim to address software sustainability**

1-What is Software Sustainability?

Sustainable development has long been associated with ecology and the interconnectedness of people and the natural world. Software sustainability has just recently emerged as a field of research in the field of software engineering and has been identified as an important future due to the increasing dependence of new approaches to research on complex software systems that operate in evolving, distributed e-infrastructure eco-systems.

The concept must be understood in order for software sustainability to be developed as a field of research. However, there is no agreed-upon definition of sustainable software. The notion of software sustainability remains elusive and imprecise despite several attempts to define a definition; various individuals, groups, and organizations have expressed polar opposite perspectives. However, this is not a challenging issue for the of software engineering

The Latin word sustainer is where the word sustainability comes from Sustainability is described by the Oxford English Dictionary as "the property of being sustained," where "sustained" might mean "capable of being endured" or "capable of being " "kept." To endure is to "continue to be," and to maintain is to "be kept up." This implies that time, lifespan, and upkeep are crucial elements in comprehending sustainability. The definition of sustainability that is most widely used is that given by the Brundtland commission: "fulfilling the requirements of the present without compromising the ability of future generations to satisfy their needs." This term, however, is exceedingly general and challenging to comprehend and apply in any substantive sense.

Sustainability is defined as "the capacity to deliver improvements to a software system based on client demands which considers sustainability to comprise three components: environment, society, and economy." However, they claim that the phrases "software sustainment" are frequently used synonymously. This mean when the software's properties can be linked with the IEEE standards, it implies that sustainability is concerned with the traits of availability (available), extensibility (enhanced), and maintainability (supported).

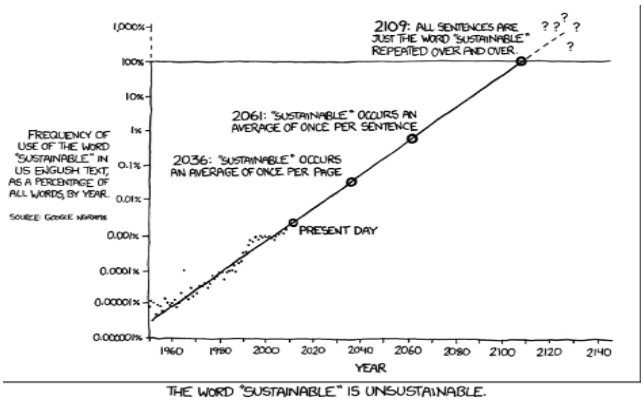

Figure 1.0: The word 'Sustainable' is Unstainable.

2-How does Software Sustainability relate to Software Quality and Why it is Important?

Quality is the capacity to fulfill requirements, whilst sustainability is the capacity to preserve to achieve this over time. Sustainability is ready for a long-time period for the organization.
It includes knowing how an organization will live on and thrive with inside the future, exceptional facilitates you gaining your desires now however, and sustainability guarantees that one's desires are met the following day as well. Sustainability may be considered as one of the greater vital exceptional characteristics in a row with the same old exceptional attributes of correctness, efficiency, and so forth.

Sustainability can be painted hand in hand with exceptional control instead of one by one as formerly believed. The usage of each ISO 9001 and ISO 14001 enhances the exceptional control management to guide the sustainability of the enterprise, each in dependable merchandise and improved revenue. Nowadays it seems that exceptional services or products must be sustainable in addition to economically viable, beneficial, available, and safe. Equally, an exceptional organization is one in which sustainability is sincerely important to its techniques, from moral delivery to environmental impact.

Early with inside the improvement of Total Quality Management, a few businesses made the funding to higher enhancing their techniques and stop merchandise – from which they benefited handsomely. Organizations together with Toyota and General Electric, took exceptional control past the meeting line and the product layout into the delivery chain, to higher increase the exceptional of substances used with inside the making of their merchandise. The notion that exceptional control also can be used about behaviors intended that relationships have been constructed more potent and greater lasting than formerly, growing sustainable good goods.

Figure 2.0: This shows a car's engine.

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Software Sustainability

Sustainability is ready to ensure that we do not ruin our planet. While Quality is essential for all components of life, if you need to be sustainable, then you definitely want to do matters properly. This consists of doing matters nicely and the usage of sources wisely
Sustainability is critical in a pleasant development as it allows to lessen waste and boom efficiency. If businesses need to achieve success in enterprise, they ought to discover ways to use sources efficiently. This method lowers the quantity of waste produced and grows the quantity of output according to the unit of input, there is a lot of importance of Sustainability in the Quality of Life we will provide some of them:

1. Sustainability is prime to retaining our planet
as the world's populace maintains to grow, it's essential to find methods to hold our herbal sources. By residing sustainably, we will assist lessen pollutants and preserve sources like water and energy, if you want to have a high-quality effect at the surroundings.
In addition, sustainability is essential for monetary motives. Sustainable practices can create jobs and stimulate the financial system as increasingly more corporations undertake inexperienced technology and sustainable enterprise practices. And with the aid of using enhancing public fitness, sustainability additionally saves money by lowering healthcare costs. Sustainable packaging may be a terrific step in assisting the efforts to hold our planet.

2. Sustainability allows the lessening of pollutants and preserves sources sustainability is prime to retaining our planet and one of the maximum essential methods we will gain is with the aid of using lowering pollutants and protecting sources.
The precise information provides us that sustainable practices assist lessen pollutants and preserve sources, which in flip allows holding our surroundings. There are many kinds of stuff every folk can do to assist make a difference, from protecting water to recycling.

3. Sustainability creates jobs and stimulate the financial system
Sustainability is essential for monetary motives. Sustainable practices can create jobs and stimulate the financial system as increasingly more corporation's technology and sustainable enterprise practices. Large company sustainability vision is about the company's intention to contribute to a changed sustainable future. However, their goals and management effort focused on incremental improvements in environmental performance and the minimization of social and Labor risks.

4. Sustainability improves public health Sustainability is essential for public health motives. Sustainable practices can assist enhance public health with the aid of reducing pollution, because pollution can motivate some of dangerous fitness problems which cause to die in some cases such as asthma, coronary, heart disease, and cancer. When we stay sustainable we will use fewer sources, this is right for the whole society and for our health. Also sustainability help us for lowering healthcare costs.

5. Sustainable improvement is viable with political will and Society support
Sustainable improvement is achievable if there's political will and Society support. When the authorities are together, they are able to make matters happen. For example, we will ensure that our sources are utilized in a manner that doesn't harm the planet or the next generation's future. We also can ensure that everyone in society has everything they need to life, like food, water, and shelter. Sustainable improvement is the assembly of the desires of the prevailing without compromising the cap potential of the future generations to fulfill their personal desires. This may be tough to gain, but it is possible if we put the right policies and measures in the right place.

3-What are the Implications of not addressing these quality factors of modern software?

Energy consumption is increasing with the growing number of devices, network traffic, computation power, and usage time therefore greenhouse gas effects and carbon are still growing .The quality of the software is often judged by its sustainability factors, which are often overlooked when considering modern software. This could cause harm to the public in the long run factors can have implications for software and its users. For example, by not dealing with the quality of the code, the software could be buggy and difficult to use. This could result in the user being frustrated and abandoning it. If technical support is necessary to maintain or fix issues with the software, an organization has more work on its plate due to lower-quality code from the lack of sustainability testing. The effects of this can manifest themselves in time wasted where employees are taking time away from their main responsibilities because they need to deal with these low-priority bugs that make simple tasks take much longer than they should take, Risky business can jeopardize both your brand reputation and your operations, and not Having specialized technology to help you manage your sustainability data also means that you difficult can quantify alternative costs.

4-What is our role as software engineers in addressing Sustainability?

Software engineers are part of a massive global movement of people who are caring and taking place in sustainability, Sustainability works in every discipline across engineering, from designing smallest and deeper part to designing user experiences and release the system, software engineers who are interested in sustainability are calls as green software engineers, the main reason to practicing Green Software Engineering is for sustainability, anything else is a supplementary advantage.

Green Software Engineers recognize there are many advantages to building sustainable applications which are almost in low price with more performance, Web-Queue-Worker, N tier, Micro-services are some Examples of Common applications architecture which apply the principles of green software engineering.

Software engineers Looking to software from different levels in, Developing , Using , Serving, Also includes e-waste , as known about software engineers they are the main part in SDLS, so they have the full responsibilities to try to make as much as possible every phase sustainable to be using in other software or improve, and also it should be aim to long-living systems, in development phase for example, engineers need to make the software portable as possible to be using in many operating system, putting a clear documentation to allow other software able to modify it as need and integrate it with their system, it also should be so powerful with high level of security and quality to reduce the amount of needed effort and budget to maintain or developed if the system has been hacked or fail.

it's not always easy to draw a line between the code we write and sustainability, Sustainable Engineering helps by breaking the responsibility of software engineering into three distinct areas : first area is Technical Sustainability Which include the direct decisions making by software engineers for the system to produce its desired results , It includes hardware decisions (CPUs, Memory, Networks) , software decisions (language, architecture, complexity) , as things like slow performance in the system, testing requirements, or efficiency of software and hardware , Developing software to devise like smartphone, smart wearable , IOT devices and many other devices which run on strictly limited power resources require energy-efficiency for testing and improvement.

Second area is Operational Sustainability it interest about any area of the system which required hard effort to maintain it like the deployment process, the inner developer loop, this usually referred to human sustainability so it's an important factor in engineers fail and reduce system quality if it's being ignored.

Third area is Environmental Sustainability, which focuses on the impact a system has on the effect of the planet it is based mainly on carbon emissions but exemplified through proportions like Power Usage Effectiveness (PUE) and Compute Utilization Factor (CUF) within data centers. The primary goals are to optimize a data center's power, waste, and water usage.

Figure 3.0: the principles of sustainable software engineering

5-What are the initiatives / solutions / techniques out there that aims to address Software Sustainability?

There is a lot of initiatives/solutions/techniques that aims to address software sustainability. First, we need to make plans about ensuring software sustainability and also we need to educate our development teams at this plans in earlier stages of our projects. Also, we need to follow the eight principles of sustainable software engineering that produced by Microsoft. This principles will help us to provide sustainability in our software.

These principles of sustainable software engineering are:

Second, for sustainable programming use green coding approach. Green code is a code written with main goal which is reduce the relative power consumption of the algorithm. Green code have a main benefit which is minimizing the energy load on physical systems and servers. To make green code, we need to:

- Improve features with high energy consumption.
- Remove unused loops and features.
- Improve data usage through a more effective cache policy, reduce data exchange and so on.

Third, you have to keep watching the energy consumption of the developed software by measure the impact of your product to identify the units you can improve. For example at the deployment phase, monitor real-time power consumption by dynamic code analysis technique. Fourth, set forth a strategy that guides trade-offs between environmental and business goals and also allows for flexibility to make the engineers learn well. For example Facebook released its Net Zero Commitment paper in 2020, which ensuring the willingness for sustainable software engineering and careful resource usage management. Finally, make the cloud green. Because we want the data center to be green which results improving hardware (by reducing the incidence of overheated servers) and minimize carbon emissions (by increasing the mix of renewable energy that powers them). Also we want to make the server green because this will save more energy consumption by using virtual servers.

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