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SOFTWARE SUSTAINABILITY DEVELOPMENT: IMPACTIBILITY CHARACTERISTIC FOCUSES ON SOCIAL APPROACH

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ABSTRACT. Sustainable software is software which developed with minimal and positive impact on environment, economic and social over its entire lifecycle. The main purpose of sustainable software is to build a software process or product with highlighting the sustainability dimension's purposes i.e. (environment purpose, economic purpose and social purpose) instead of software development's benefit. Currently, software development is claimed as still immature due to lack of integration on these three dimension's purposes. Most of the studies are focuses on environment and economic dimension and less attention on social dimension in software development. Although, there are some studies emphasis on human matter in sustainable software, but the issues raised are not given serious attention and not clearly defined about the impact of software on social dimension. Therefore, this study needs to embed the social approach into software sustainability in extending the user satisfaction towards software performance provided by software. This paper presents a review on current state-of-the-art of social approach in sustainable software. The findings can support and recommend to the society in proposing the new criteria towards sustainable software with fully description on purposes, perspectives, point of views, and the context of the environment via adapting Goal Question Metric (GQM) method. The noteworthy of this study is to extend the concept of social approach in sustainable software and supporting the sustainability integration.

Keywords: sustainable software, sustainability dimension, social approach, sustainable criteria, Goal Question Metric (GQM)

INTRODUCTION

Sustainable software refers to the software that developed with the resources use aims to meet the needs of present generation until future with integrating the aspects of environment, economic and social towards long living software (Ahmad et al., 2015). The requirements of software sustainability is inherited from the sustainability requirement provided by Brundtland Commission Report (1987) that has been applied in the various domains such as manufacturing, construction, restoration of natural disasters, soil and erosion, ecosystems and biodiversity, and so forth. Sustainability concept is adapted into software engineering domain since ended 2009 and beneficially for software developers as references in developing software by integrating three pillars dimension of sustainability. The clearly definition of sustain-

ability dimension into software engineering are much helps developer to utilize the criteria that need to be attained in software development.

Nowadays, software is developed based on several dimensions in which they are highlighting sustainable dimension that meet the needs of organizational benefits, instead of the software development's purposes. For instance, the software products and processes are developed with either an environment, economic or social benefits and not intended to serve with an environment, economic and social purposes as integration (Ahmad et al. 2016). Although, there are some studies claimed that their software model is developed with combination of environment, economic and social dimension and aimed towards software sustainability. Unfortunately, they are focusing only two dimension which are environment and economic. While, social dimension is claimed has been embodied into environment and economic dimension indirectly. This is the main issue need to be addressed due to the social matter is extremely important to be highlighted as well. Therefore, this study is required to highlight the social approach for sustainable software in extending the user satisfaction towards software performance provided by software. This paper presents a review on current state-of-the-art of social approach in order to support and recommend to the society, a new criteria towards sustainable software with regards to extend the concept of social dimension via sustainability integration.

LITERATURE REVIEW

This section presents the state-of-the-art of sustainable software with discussing the best practices in developing software towards software sustainability. The outline is continued to the social approach for expressing the objective in this study.

Sustainable Software Practices

Software sustainability has been expressed by several researchers in different ways. Most of them are claimed had built their software model based on sustainable development by integrating environment, economic and social dimension as well. Beneficially, the researchers aimed to achieve software sustainability in their own ways based on their theories and practices, activities, opinions and experiences. The best known practices models and frameworks in the literatures such as software model proposed by Koziolek et al. (2011), Venters et al. (2013), Calero et al. (2013), Kocak et al. (2013) and several studies had produced a framework or guideline towards sustainable software such as Cabot et al. (2009), Jansen et al. (2011), and Penzenstadler et al. (2013).

Earliest study in sustainable software has been initiated by Koziolek et al. (2011) proposes several characteristics such as maintainability, modifiability, portability, evolvability and integrity. The researcher has proposed a set of characteristic in sustainability for long living software systems with highlighted the maintenance of cost efficiency and evolved over their entire life cycle. There are maintainability, extensibility, modifiability, portability, evolvability, and integrity. The proposed model is based on economic dimension in which maintainability and extensibility characteristic are the tightly coupled in determining the sustainability of software. According to the researcher, the sustainable development in software products and process can be achieved by preparing a guideline to conduct the stakeholders through the sustainable requirements such as documenting, prioritizing, analyzing, and tracing functional and non-functional requirements to an industrial software system is an important prerequisite for sustainability (Koziolek et al. 2011). They claimed that the sustainable requirements is helpful in tracing and noticing for long term development process or product as it preserves the knowledge about the decision making in every phase of development such as in architecture, design, implementation, testing and maintenance. However, the researchers had highlighted on environment and economic dimension without directly focused on social dimension.

In Venters et al. (2013) suggests the concept of sustainable software with the elements of a composite requirements and non-functional requirements. The researchers agreed to the Koziolek et al. (2011) in stressing on environment and economic dimension in proposing the criteria for sustainable software. They had declared their proposed model was achieving the sustainability even though the element of social dimension is embodied into environment dimension. Although, the proposed characteristics and sub-characteristics are defined into three sustainability dimension, but the social dimension is keep soundless. Venters et al. (2013) inherits the standard quality by McCall model into their proposed model. They are used the criteria proposed by McCall model in software quality standard as their benchmark towards sustainable software such as extensibility, interoperability, dependability, portability, reusability, scalability and efficiency. Next, Calero et al. (2013) had agreed to the theory of Venters et al. (2013) by relating software quality criteria into theory of sustainable software. The researcher includes the element of quality such as non-functional requirement in order to create a set of criteria in software sustainability. They agreed that the software sustainability is the improvement of a software product that is a part of quality development and recounted to non-functional requirements. In Calero et al. (2013) focuses on environment and economic dimension in which the concept used is to reduce the impacts on energy consumption and resource optimization. They agreed that the impact of these two elements are needed to be reduced in order to decrease the use of resources for sustainability aimed and energy use that can affected to the economic impacts. Unfortunately, the issue of social impacts did not clearly define in their proposed model towards sustainable software.

Several studies proposes framework or guideline towards sustainable software such as Cabot et al. (2009) had focused on natural environmental in which they are proposed a framework as a sustainability taxonomy for modeling the software system where the decisions have a potential impacts on sustainability. They are covered all dimension in sustainability, however the guidelines to develop the taxonomy is unclear, limited and too generalized. In Jansen et al. (2011) is focused on sustainability of software from an economic perspective which is the way of software product and process are created to remain the economically viable over its entire lifecycle. In addition, this model framework defines the sustainable software as sustainability on risk which is an estimated on value based that related to business economy of risk. The latest framework produced by Penzenstadler et al. (2013) as a reference model towards sustainable software which basically focused on three dimension of sustainability. The environmental dimension has been broken into another dimension namely individual dimension that focused on the maintenance of the private good of individual human capital. The economic dimension is focused in maintaining the assets and social dimension focuses in maintaining social capital and preserving the societal communities. According to the researcher, the software sustainability is required to fulfill the requirement engineering in these three variables in order to achieve sustainable software. However, the researchers did not to propose any characteristic towards software sustainability.

As explained from the previous studies, most of them are proposing the variety of concept towards sustainable software. The most important element is the integration of environment, economic and social dimensions towards software sustainability are highlighted in the previous works. Though, most of them did not to observe the sustainability paradigm with clearly define the goal to be achieved and the dimension which required to be emphasized such as social dimension. However, there are only one model is observed the issue of social such as Penzenstadler et al. (2013) through their generic sustainability model framework. The issue of social is debated in their framework that software is developed to support the human work on good communication, helps companies to set up rules for positive, open and efficient communication and the elements pointed can support the company culture builds on the above named values. The values are created to focus on business social that are central to values of tolerance, trust, fairness and culture. Even so, this framework did not to define the goal, purposes,

perspectives, and highlights the context of criteria that need to be achieved. As conclusion, the concept used in the previous models are only based on the theoretical works in which the concept used is still nebulous to be applied in the real software project. The social dimension is focused on human relationship to the software, but the ideas does not achieved since the criteria of human approach is not clearly defined. Therefore, the needs to propose the concept of social approach will be addressed in this study in order to highlight the social sustainability dimension directly with introducing the *impactibility* characteristic. The adaptation of goal oriented measurement contributes to define the precisely goals by determining the purposes, perspectives, point of views in the following context of environment with respect to achieve software sustainability (Ahmad et al. 2016).

Social Approach

Social approach is referred to the development that preserves the community especially in maintaining the close social relationships in communities (Brundtland Comission, 1987). The social sustainability is related to the development in maintaining the social capital and societal communities in the harmony situation without compromising to the government and any other party. This element is related to the social capital as an investments and services that can create to the basic framework for society (Ciegis et al. 2009). In the context of software engineering, the social sustainability dimension is referred to the technique on how the software development is built to enhance the social capital value (Amri et al. 2014). There are two aspects that are needed to be highlighted in the social sustainability dimension such as the technical community and the user community. For instance, the social dimension in software sustainability is assessed the values for technical community such as enabling the participation, communication, and interaction. Besides, the value for user community is related to the accessibility of the software system that had been developed (Amri et al., 2014; Razavian, Procaccianti, & Tamburri, 2012).

The concept of human is vital in software development due to all works in software development is performed by people who are called knowledge workers and will be reflected to human towards the end (Drucker, 1999). The knowledge workers are defined as the people who are involved and responsible in the software development such as manager, developer team, maintainer team, and users. The acknowledgment of the social approach in sustainable software can ensure the success of interaction between human and application. The reason to gain the satisfaction of human towards software performance provided by software process or product is potentially a significant role in gaining the success-ability of the software development. Consequently, neglecting the importance of human factors in developing software process and product can leave a huge impact on the integration concept of sustainability dimension in software sustainability.

RESULTS & DISCUSSION

The characteristic and sub-characteristic for sustainable software is proposed in Ahmad et al. (2015) via Systematic Literature Review (SLR). The features are adopted from ISO/IEC 25010 (2011) – Product quality namely *functional suitability*, *performance efficiency*, *compatibility*, *operability*, *reliability*, *security*, *maintainability*, and *transferability*. Towards more sustainable software with highlighting the social approach, there are new added characteristic in this research namely *impactibility*. The word of impact is defined as an action of one object coming forcibly into contact with another (Concise Oxford English Dictionary, 2011). Therefore, *impactibility* in sustainable software is defined as a degree or ability of the software to interact on human either in positive or negative impact in providing the user satisfaction on software process or product performance, safety and standards. This section presents the definition of goals for the concept of human through *impactibility* characteristic into sustainable

software that is focused on social dimension directly with using the adapted GQM templates illustrated in Table 1.

Table 1. Definition of Goal for Impactibility Characteristic in Social Dimension

Characteristic	**Impactibility**
Goal	*Purposes*: To evaluate the process impact in order to improve it. *Perspectives*: Examine the impact of software performance on human from user and developer's point of view. *Environment*: In the following context of social sustainability impact.
Sub-Char.	**1. Social Acceptance**
Sub- Goal	*Purposes*: To predict the relationship of software social networks technology and knowledge sharing between human in order to learn it. *Perspectives*: Examine the degree of network congestion, the load on servers and the complexity of the query from the user and developer's point of view. *Environment*: In the following context of the ability of the software to interact on human in providing the user satisfaction.
Sub-Char.	**2. User Connectedness**
Sub-Goal	*Purposes*: To evaluate the services of software in order to stimulate human individual and group' behavior in order to improve it. *Perspectives*: Examine the software functions with equipped the function of perception, mobility, learning, communication and coordination from user and developer's point of view. *Environment*: In the following context of software effects for individual social sustainability with software connectivity to human.

Dealing to sustainable software, the relationship between software and social approach are much required to be optimized in order to achieve the integration of sustainable software. The relation between software and human is developed through the quality of software performance towards user satisfaction. Therefore, the *impactibility* characteristic is introduced to gain the level of software effect on human through the sub-*characteristic of social acceptance* and *user connectedness*. *Social acceptance* is the ability of software to provide the relations of social networks and knowledge sharing between human virtual team. This feature is to support data availability and stability in different contexts. In order to address the impact of software performance on human from the axes of social acceptance, the degree of network congestion, the load on servers and the complexity of the query are evaluated from the perspective of user and developer's point of view. This sub-characteristic will support to achieve *impactibility* in the context of the ability of the software to interact on human in providing the user satisfaction. While, *user connectedness* is ability of software to provide the services that relates to the connection of human social individual and group' behavior related to knowledge generation, knowledge communication and knowledge use. In order to address the impact of software performance on human from the axes of connectivity impact, software functions with equipped the function of perception, mobility, learning, communication and coordination are evaluated from the user and developer point of view. This sub-characteristic will support to achieve *impactibility* in the context of software effects for individual and group social sustainability with software connectivity to human.

CONCLUSION

Due to software development today is very economic activity which needs to ensure the profitability with quality of software product and process, the needs to highlight the criteria of social approach extremely important to ensure the software product and process are satisfied by user requirements. The quality of software development must involve the socail approach as the significant stakeholders with reason the users demand a sustainable software that gives positive impact directly on environment, economic and social that are performed from devel-

opment and deployment of the software. Consequently, the adaptation of GQM has much assists in defining the accurate goal and sub-goal for characteristic and sub-characteristic respectively with fully descriptions on the purposes, perspectives, the point of views, and the context of the environment that are needed to be highlighted. The future work is moved to develop the questions and metrics for this characteristic and sub-characteristic towards sustainable software.

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