Social Sustainable Software Product- An Empirical Study on Main Measurements

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Summary
Today's modern and largely digitised world is concerned of the software engineering field and has considered sustainability in the development process as well as in the end product.To date, literature investigations reveal that numerous studies have focused on green hardware, however, limited efforts and assurances were made in the greenness of ICT software products.Green software and their products are important as they can possibly solve the problems associated with the long-term use of software; especially from the perspective of sustainability. Software's social sustainability and its measurements are important concern that need more and depth investigation. Currently, the literature study shows that there is still a lack of research which focuses on social sustainability of software products. So, the aim of this study is to presents basic measurements of the social sustainability requirements of software product. In addition, this research has made a fundamental contribution in solving the research problem and proposing a novel measurement based on empirical study to achieve software products.

Keywords:
Software product, Social sustainability, Social measurements, empirical study

1. Introduction

Software is a fundamental component in the modern technological world and vastly affects the environment's sustainability since the demand for energy and resource requirements are rising when producing hardware and software units. The sustainable product issue is fundamental according to the generation-based development of software and hardware manufacturing organisations (Dick et al., 2010). In recent years, creating Information Technology (IT) products and eco-friendly software have become the target of hardware and software industries. In both developed and developing countries, most software engineers are focusing on ecological products. The concepts of the eco-friendly target basically revolve around decreasing carbon utilisations, saving energy and minimising dangerous waste.

Social sustainability implies keeping up with social capital and saving the solidarity of societal groups. Social capital is speculations and administrations that make the fundamental structure of society (Goodland, 2002). For software engineering, this study suggests the explanation starter: 'What impacts do software systems have on society (such as correspondence, cooperation and government)?'. To create socially sustainable software, product engineers require a method for surveying, throughout the improvement procedure, the impacts that the developed software will have on the social sustainability of its planned clients.

Social sustainability is defined as maintaining social investments and assisting societal groups in their associations. Social investment is speculations and administrations that make the essential structure of society, and is trusted to reduce transaction expenditures (Penzenstadler, 2013). Additionally, Willis, McKenzie & Harris (2009) characterised social sustainability as "a positive and long-term condition inside groups and a procedure inside groups that can accomplish and keep up that condition".

Based on latest research and specially our review research (Raisian et al., 2018,2017; komeil et al 2016), so far not many studies have been led on the social sustainability within software product independently. However, it is important to investigate the significance of social sustainable software product.

The novelty of the study is what is the social sustainability and what is the measurements of social sustainability can be suitable to accomplish software product. The other sections of this research are organized as follows: Section two presents background of social sustainability. Section three describes the social sustainability of software product. The data collection is presented in section five and section six explains around relationship of factors for this study. Finally, this research is completed with section seven by conclusion.

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2. Background of Social Sustainability

Dick et al. (2010) presented that sustainable software was defined as "software that has an indirect and direct impact on society, human beings, environment and the economy either from the development, deployment or use of software whereby it has lower negative and/or potentially positive impact on sustainable development". To deliver a social sustainable software, software engineers require a method for evaluating, throughout the development procedure, the impacts which the built software would have upon social sustainability of its proposed clients.

Al Hinai & Chitchyan (2014) presented the social sustainability meaning, how it's measured and in what way social sustainability of a software framework is currently assessed. The researchers exhibited the primary outcomes of a systematic review on these inquiries as well as their findings. To conclude, there is a massive limitation in software sustainability assessment, its measurements and also its connection to software; as was emphasised in the primary outcomes of their work in the previous literature survey on social sustainability. Moreover, Al Hinai & Chitchyan (2014) only surveyed some common factors in social sustainability and not specific to software engineering. They also assumed some potential basic factors of social sustainability within the software engineering product such as employee, health, equity, education, security, social network, resilience, human right, technology acceptance, culture, potential and service facilities.

However, Chitchyan et al. (2015) had expressed deep concerns on social sustainability in the software product development perspective as compared to previous research by Al Hinai & Chitchyan (2014). Chitchyan et al. (2015) proposed the model related to personal and organisational prosperity as independent groups; thus, many concerns are present that these two should be a part of the bigger social sustainability group.

Researchers discovered a related limitation according to social subjects as well as a few references in their case study. For example, the idea identified as associational sustainability was coded as "simplicity of tool allocation", "Confirming the capacity for engineers to receive tools and methodology" or employee sustainability and tool support to use where devices facilitate the plan of complex multi-purpose systems. Chitchyan et al. (2015) mentioned that tool support and employee support are the main measurements in social sustainability in software engineering.

Each of these measurements directly identify with the subjects of tool support and employee support under social sustainability for software production, as demonstrated by (Chitchyan et al., 2015; Penzenstadler, 2015; Al Hinai, 2014; Al Hinai & Chitchyan et al., 2015, 2014; Vallance et al., 2011; Hutchins & Sutherland, 2008). For further information, refer to Table 1. More explanations of each main measurement and its sub-factors are presented in the following:

A. Tool Support

It is defined as providing tools that support the process of development work and meet user needs in order to become a useful software product (Chitchyan et al., 2015). Based on (Xanat & Toshimasa, 2017; Chitchyan et al. 2015; Pirkkalainen & Pawlowski, 2013; Penzenstadler & Bauer et al., 2012; Al-Ajlan, 2009; Sacco & Tavano Blessi, 2009), in perspective of tool support to social sustainability during software engineering, various concepts must be followed in order to provide tool support in a sustainable viewpoint. The following are the main sub-factors of tool support in social sustainability to produce software:

i. Eclipse plugins: A component of software in Eclipse introduced as a plug in. The platform of Eclipse permits the software developer to enhance applications such as the Eclipse IDE (Integrated Development Environment) with more functionalities via plug ins. In addition, applications of Eclipse provide a runtime according to a particularisation called Open Service Gateway Initiative (OSGi).
ii. Transformations: An outline of the Transformations and Projections toolset. The toolset consists of tools that change data of geography from the projection of one map to another. There are more tools to transform datasets; for example, rotate, shift and rescale.
iii. Lexical limitations: In the viewpoint of computer science, lexical analysis and tokenisation are the converting processes of a character's sequence (for example, in a computer web page or program) within a priority of tokens (strings with assigned determined meanings).
iv. Setting: Tool setting is defined as the procedure of identifying geometric information radius, length or diameter of a cutting tool. It utilises dedicated software and a device of tool setting, then connects the information in order to control the machine tool.

B. Employee Support

It means support for employees to learn the use of new appliances with advice provided so they can correctly use the software product (Al Hinai & Chitchyan, 2014). In viewpoint of employee support to social sustainability during software production, (Chitchyan et al., 2015; Al Hinai & Chitchyan, 2014; Vasileiadi et al., 2013; Bonanni et al., 2010; Blake-Beard, 2010; Sarkis, Helms & Hervani, 2010; McKenzie, 2009; Meul et al., 2008) presented various relevant concepts to be followed so as to provide employee support in a sustainable perspective through software production. The following are the main sub-

factors of employee support in social sustainability context to produce software:

v. Performance is considered the real time of advertising the item as "Green". This is similar in respect to a TCO Certified item and a few natural labels available.
vi. Human health is a collection that covers the health services quality provided for people. The health issues, health dangers and health activities are provided by experts within the community.
vii. Equity category incorporates elements that must reveal equity assessments for everyone, without considering their gender, ethnicity, age and social status; for instance, their income or wealth distribution, social inclusion, diversity of housing foundation, provisions to fundamental disabled needs, whether children or the elderly, with suitable access and fair competition.
viii. Education indicators are linked to facilities of education provided for the community. This can incorporate numbers of higher education individuals after secondary school or numbers of people between 20 to 64 years of age (Andersson et al., 2013), the level of employee's educational or literacy levels, offered employee training areas, student number based on per teacher and information on available educational institutions.
ix. Ease of advice provides access to new technology advices, which can be a typical battle between project managers and team members in terms of their usage.

Table 1 displays the main factors of a social sustainable software product based on current researchers(Raisian, K. and Yahaya, 2016).

Table 1 Social Sustainable measurements in software product according to various researchers

Authors	**Social Sustainability**	
	Employee Support	Tool Support
Chitchyan et al. (2015)	×	×
Calero (2015)	×	
Al Hinai & Chitchyan (2014)	×	×
Al Hinai (2014)	×	×
Al Hinai et al. (2014)	×	×
Lago (2013)	×	
Ricketts (2013)	×	
NBS (2012)	×	
Naumann (2011)		×
Liebowitz (2010)	×	
Dick et al. (2010)	×	×
Naumann et al. (2010)		×
McKenzie & Harris (2009)	×	×
Fleischer (2009)	×	
Beuche (2007)		×
Stutzke (2005)	×	
Robèrt et al. (2002)		×
Total	**13**	**10**

However, based on Table 2 and based on current researchers of sustainable software product, social sustainability and its measurements are defined as continue.

3. SOCIAL SUSTAINABILITY IN SOFTWARE PRODUCT

Social capital is speculations and administrations that make the essential structure of society: trust brings down transaction costs. According to Penzenstadler (2013), "Social sustainability implies keeping up social capital and protecting the societal groups in their completeness". Willis et al. (2009) characterised social sustainability as "a positive and long-haul condition inside groups and a procedure inside groups that can accomplish and keep up that condition". The Life Cycle Assessment (LCA) has been applied to include social concerns such as labour force, community living standards, cultural freedom, poverty prevention, equity, health and safety and heritage (Menikpura, 2013; Egilmez, Kucukvar & Tatari, 2013). In terms of theoretical study and clustering sorts of measurements, as shown in Table 1, the main measurements of social sustainability in green software products are as follows:

A. *Tool Suppor*

Chitchyan et al. (2015) defined tool support as providing tools that support the software work product. Organisations of software development use tools to support important activities, converting a package of client needs into useful products. Automating the analysis, design, implementation and maintenance of compressed software products are supported by CASE (Multitude of Computer-Aided Software Engineering) tools; the challenge, however, is how to reasonably use and take in tools to help organisation business goals and the technical requirements of product developers (Beuche, 2007).

Carlsson and Fullér (1996) mentioned that establishing tool support for a product line involves activities such as identification of needs, selection, evaluation, insertion, measurement and maintenance. In fact, tool support for a software product plays a main role, more than the total of individual tools capabilities that support particular software engineering activities. Therefore, the corporate ability of a chosen collection of tools is fundamental in order to automate production in a software product line (Leung & Fan, 2002).

Fischer & Naumann (2010) recommended tool support partners with various skills for embedding sustainable and green techniques in developing, administrating or using software products. Recommendations can be checklists, guidelines, implementation reports, best practice examples, etc. Tools might be those of software, although other tools such as data collection sheets can be based on paper. There are few

available recommendations on the Internet, but they can be difficult to find. Therefore, a specific internet knowledge base or search engine would make it easier to find them.

As Robèrt et al. (2002) noted, today, fast growing options related to the number of approaches and tools to develop sustainability are almost conflicting or competing. Thus, a systematic approach containing sustainable fundamental principles is needed so as to show that these tools are supplements and can be used in parallel with critical software sustainable development. Actually, it is only when using these approaches outside of their integral sustainable context that conflicts are caused.

B. *Employee Support*

Employee support means helping and aiding employees to use new software tools for great software development (Chitchyan et al., 2015). It might be a strong and powerful matter in sustainability since every employee can become a hidden green champion. Ricketts (2013), in his Employee Engagement Model, stated that employees are one of the main and secret factors to successful social sustainability that can be effective for an organisation. Enhancing employee engagement in greening your business has various social and monetary advantages; it can prompt a more persuaded, productive and elemental workforce that comprehends the significance of good business morals and corporate obligations (NBS, 2012).

In some conditions, trainees or fresh employees that come from academic backgrounds are the most capable and experienced people for a project, even though having brief or less experience in an industrial environment. There are less conditions, if any, for corporations within the academic industry to aid educated and experienced industrial engineers and chemists in the processes for green software and new technologies (Lago, 2013).

Fleischer (2009) assumed that keeping employees involved, cheerful and productive has regularly been the greatest approach for advancing organisations and companies. Green members are self-organised, popular and interoperable with other groups of employees who voluntarily gather to train and educate; they are active and strong employees through sustainability. They distinguish and implement particular answers to support their organisation and operate in a more environmentally sustainable way. Currently, since 'green' has become more mainstream, a growing number of employees want to work for a company committed to sustainability and seek a work setting where green practices valued at home are being implemented at offices.

Employee functions of an organisation can be instrumental for encouraging a thorough approach of providing a culture of environmental supervision and sustainability. In this way, it is recommended that a Sustainability Administrator of an organisation work closely with the Human Resource executive of the organisation. The importance of this view in sustainable software development can develop a significant role in organisation systems.

This idea might be considered a new area of focus for the practical implementation of sustainable development in a company. The strategy involves making significant changes to the organisation's system such as: new employee selection, enrolling candidates, leading execution assessments, directing new employee introduction, making a progression arranging process, deciding employee pay, preparing employees with education and improvement and coaching them as well as their chiefs. It should additionally include making a win-win-win cooperation among numerous partners who are struggling with each other (Liebowitz, 2010). As Liebowitz (2010) mentioned, various cases are present which exhibit how emphasising on each employee system has supported organisations to create a sustainable culture; successfully leading to financial sustainability.

4. Data Collection

The list of acquired possible software organisations from private and government companies that have related software backgrounds in Malaysia was taken from the internet. Additional sources of possible organisations and companies were taken from friends who work in the software industry. The third way to obtain possible samples of respondents was through members of research centres working and studying in the software area.

The researcher contacted the most potential respondents by phone, WhatsApp application and email and requested their participation in the questionnaire; from December 2016 until February 2017 (220 respondents total). Out of the contacted respondents, only 148 (67%) had participated, while the remaining 72 refused to participate.

A total of 102 questionnaires or 69% of respondents were deemed valid for this research, which is adequate and acceptable based on Saunders et al. (2011) and Fisher (2007). Distinctive methods were utilised to collect the data; particularly, manual or face-to-face gatherings, mail postages and online overviews. Face-to-face meetings were utilised to guarantee that respondents understand each question and answer them appropriately. If they had any doubts regarding the questions, they were able to quickly ask for clarification. However, most respondents preferred to answer the questionnaires by mail postage or online rather than face-to-face. In this manner, an online questionnaire was made by utilising Google documents and was messaged to respondents who consented to complete the questionnaire.

The questionnaire was posted by Google documents for three months; within December 2016 until February

2017. The response rate was higher compared to face-to-face meetings; this progressively popular method of data collection reduced costs and time wastage.

More than one month was apportioned for respondents to return the questionnaires. Updates were sent to the ones who failed to return as well. There was 19% of unreturned questionnaires, while 12% were rejected because of incomplete answers; 69% were deemed valid and useful for this research. Table 2 shows the outline of the respondent rates for this study.

Table 1. outline of the respondents

Details	Number	Percentage
Number of respondents seeking to participate	148	100
Online respondents	75	75
Unreturned Surveys	28	19
Manual or Face-to-face respondents	17	17
Mail postage respondents	10	8
Incomplete survey	18	12
Total usable	102	69

Based on 102 valid questionnaires, 73% of completed questionnaires were from online respondents, while 17% were filled out manually or face-to-face. Around 10% of questionnaires were answered through mail postage. Table 3 shows the respondents' methods of completing the questionnaire for this study.

Table 3. Method of respondent answers

Details	Number	Percentage
Online respondents	75	73
Manual or face-to-face respondents	17	17
Mail postage respondents	10	10
Total valid	102	100

Employee support, as the main measurement of social sustainability in software product for achieving green software, had obtained the 'Most Important' rating from respondents. Employee support can be a strong and powerful matter in sustainability as every employee can become a hidden green champion. In addition, employee engagement is one secret to success in social sustainability that's effective in an organisation. Enhancing employee engagement in greening your business has various social and monetary advantages; it can prompt a more persuaded, productive and efficient workforce that comprehends the significance of good business morals and corporate obligations.

Tool support for a software product plays a crucial function in social sustainability, particularly supporting software engineering activities. Therefore, the corporate ability of a chosen collection of tools is fundamental to automated product production in a software product line. As Fischer & Naumann (2010) recommended, tools support partners with various skill degrees in embedding sustainable and green techniques in developing, administrating or using software products is highly beneficial. Recommendations include checklists, guidelines, implementation reports, best practice examples, etc. Tools may include tools of software, although other tools such as data collection sheets based on paper are also present; unfortunately, there are only a few available recommendations on the internet, but these are difficult to find. Therefore, a particular internet knowledge base or search engine would make it easier to find them. These practices regarding tool support as a social sustainability measurement in sustainable software product was justified as a significant consideration in previous studies. The respondents were further questioned regarding software product practices that must be performed in order to produce high green software. The mean value for each practice was obtained from the analysis, as it represents the most selected answers on average. The 5-point numerical scale was used for these questions, which ranges from Not Important to Most Important. The scale was then mapped to equal intervals by using SPSS Analysis. The interval ranges were calculated using the following formula (Ismail, Abedlazeez & Hussin, 2011):

$$\text{Interval ranges} = (n-1) / n \quad (1)$$

Where n is the maximum number in the used scale, which is equal to 5. Thus, the interval size of the consideration level between one through seven is 0.8, as the interval values are depicted in Table 4.

Table 오류! 지정한 스타일은 사용되지 않습니다.
Interval Values

Degree of Importance (DI)	Interval Values
Not Important (NI)	1.00 – 1.80
Less Important (LI)	1.81 – 2.60
Neutral (N)	2.61 – 3.40
Important (I)	3.41 – 4.20
Most Important (MI)	4.21– 5.00

This study also found that respondents had mostly chosen the 'Most Important' rating, as presented in Table 5.

. **TABLE** 오류! 지정한 스타일은 사용되지 않습니다.
INTERVAL VALUES OF SOFTWARE MEASUREMENTS

Measurements	Description	Mean	Degree of Importance
Tool Support	Provide tools that support the work process and tools to convert customer requirements into a useful product.	4.37	Most Important

Employee Support	Help employees learn to use new tools for software.	4.38	Most Important

II. The Relationship of Factors

The Pearson correlation test was done to assess the magnitude and direction of the variables. Table 6 indicates the correlation thresholds as suggested by Cohen (1988).

Table 6 Cohen's guideline for correlation strength

Source: Cohen, 1988

Value of "r"	Strength
Weak	0.10 – 0.29
Medium	0.30 – 0.49
Strong	0.50 – 1.00

It has been previously noted that the research hypotheses tests are conducted when a precondition test for correlation and regression are fulfilled. Generally, the Pearson correlation is used to test the relationship between the variables. However, multiple regression analysis is used to determine the strength of the variables. In addition, hierarchical multiple regression analysis test is used for mediating the effect between variables (Raisian et al., 2016).

Based on previous articles, 0.685 is a strong and significant relationship. Employee Support is important to increase Social Sustainability in the software industry sector. The final results of the research indicate that Social Sustainability within the software product sector is positively connected to Employee Support (Relationship = 0.685), see Figure 1. The correlation matrix demonstrates that all hypothesised relationships are recognised at p <.01 degree. The relationship is considered statistically significant with a significance level of less than 0.01 (p = 0.000). Thus, the hypothesised relationship of the research was accepted.

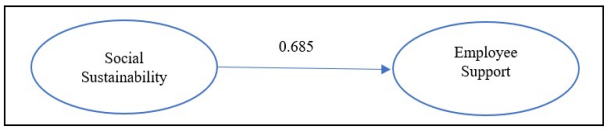

Fig 1 Relationship between Social Sustainability and Employee Support

Surprisingly, many respondents strongly agreed (62%). The relationship between Social Sustainability and Tool Support is also high (0.622), see Figure 2. The final results of the research indicate that Social Sustainability within the software product sector is positively connected to Tool Support (r = 0.622). The correlation matrix demonstrates that all hypothesised relationships can be recognised at p <.01 degree. The relationship is considered statistically significant with a significance level of less than 0.01 (p = 0.000). Thus, the hypothesised relationship of the research was accepted.

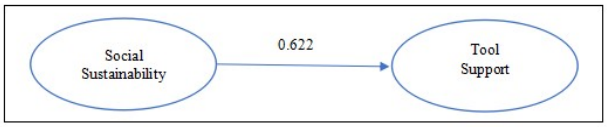

Fig 2 Relationship between Social Sustainability and Tool Support

To sum up, Figure 3 demonstrates the relationships of social sustainability and its measurements based on the practices through the outcomes of the empirical study in software product.

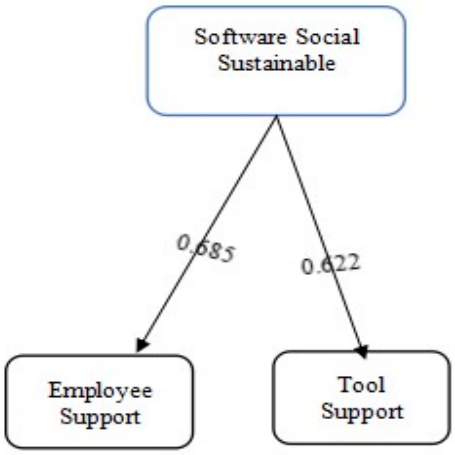

Fig 3 Measurements of Social Sustainable in Software Product

5. Conclusion

This study successfully explained the literature review that it is necessary for this study, mentioning the current activities found in the literature with respect to social sustainability and its measurements in software product and relevant issues. The goal was to investigate the current practices of social measurements which relates to software products. The proposed factors fulfilled the research problems by including the social sustainable measurements and its related components that are expected to create software product in advanced business conditions as the reference standard. Next, the research is used survey sample population is selected equal with 102 responders that is Non-probability or not randomly obtained from

international software organizations in Malaysia to identify main measurements of social sustainability through software product and finally is investigated based on that. In future research directions regarding to software product, we need to concern and integrate other critical sustainable dimensions and its measurements to achieve green software product.

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