Building Social Sustainability into Software: Case of Equality

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***Abstract*—Equality is an important aspect in todays diverse communities, which plays a significant role in communities social sus-tainability. This paper looks into modeling equality as a social sustainability dimension using a generic model of sustainability. Patterns of equality requirements are identified in this generic model. This model and respective patterns are then used in software requirements elicitation of a case study.**

I. Introduction

As software increasingly becomes the central mediator in more and more spheres of our lives - from business, communication, innovation, healthcare to education, and even art - we must consider the impact it has on the wellbeing of humans and human society, i.e., on social sustainability.

Social sustainability is defined as [1, 2] "a positive and long-term condition within communities and a process within communities that can achieve and maintain that condition".

In recent social sustainability literature review, [3] Landorf concluded that "basic needs and equity are consistently evident as fundamental themes of social sustainability. Both concepts are necessary for the physical and psychological survival of individuals." In addition, social sustainability is related to access to services and opportunities that promotes "longer life expectancies, less crime, stronger civic engagement and more robust economic vitality" [3].

There is strong evidence that software does foster and maintain this "positive condition" by, to name a few avenues, fuelling economic growth, easing education, enabling contact between like-minded individuals and geographically distant family members and friends. Yet, there also is a substantial evidence of the negative effects that software brings along, such as cyber bulling [4], theft of intellectual property [5] and financial assets, spread of online child abuse [6], loss of privacy [7] to name a few. There are also indirect losses resulting from cyber crimes, such as lost business opportunities due to banks inability to communicate with customers by email [8].

Thus, in order to support social sustainability in the long run, we must ensure that software is engineered in a way that its negative effects are countered, or, at least minimized. This however is an open challenge.

This paper is an attempt to demonstrate how social sustainability can be engineered into software systems. In this work we address equality as a social sustainability aspect and study how it can be engineered through software systems. The paper aims at aiding software engineers in the process of social sustainability requirements elicitation. The initial requirements patterns for equality engineering are also identified.

II. Equality and Social Sustainability

In a previously conducted literature review [9], we have looked into the different categories and indicators of social sustainability. The general systematic literature review on social sustainability produced over 600 relevant indicators. Through application of a light-weight grounded theory analysis, these indicators were aggregated into 12 groups of: employment, health, education, security, services and facilities, equality, human rights, social networks, social acceptance, resilience, cultural and political. Below we focus on discussing equality and its indicators reported in literature.

Equality is defined as the right for all members in a society to enjoy living and getting access to services and facilities without being discriminated because of their origin, believes, position, or (dis-)abilities [10].

A comparative study on assessment of the social impact of building materials and identification of the most socially sustainable ones is presented in [11]. This study also aimed at identifying trade-offs and potential improvements in stages of the building process. The indicators of social impact considered here include fair salary, equal opportunities and discrimination in different building phases (pre-building, building and post-building phase). In addition, fair competition between value chain actors was used as an indicator for social impacts on value chain members [11].

In [12], the long-term social performance of irrigation was assessed using a compound social viability indicator. This viability indicator was subcategorized to social impact and social capacity. According to [12], "social impact refers to the effects of irrigation on people, their well-being, social organization, and livelihoods." The paper notes that equal water distribution between users can be an indicator to equality [12]. Yet, in some cases equality is differentiated from fairness and fair distribution (not equality) is used as social sustainability indicator [12].

In [13], Chitb and Komathi suggest a model for evaluating vulnerabilities of the development of ICT programs in rural areas. Socio-cultural vulnerabilities are linked to the relationships among community members [13]. The human relationships "affect access to resources and assets, and decision-making power of people, established by gender, age, race, religion, caste, and class egalitarianism within communities" [13]. The paper suggests that ICT interventions help in reconciling the vulnerabilities by reducing the gender, social and economic power [13]. This is a way of achieving equality by reducing gender power indicator.

Gender equality was also an indicator of social sustainability in the study where a framework for sustainable development policy was suggested [14]. The paper argued that reducing the gap between genders satisfies love and belonging needs of the members of a community [14]. Economic participation and opportunity, educational attainment, political empowerment and health and survival were sub-indicators of gender gap (attained from Gender Gap Index GGI) [14]. "The GGI provides a measure of societal/jurisdictional views toward gender equality." [14].

The study in [15] was conducted with a goal of achieving sustainable development that balances the economic, environmental and social aspects of sustainability. One of selected social sustainability indicators was equity in income level between rural and urban areas/residents [15].

Social equity was selected as a dimension of social sustainability evaluation suggested in [3]. Social equity "measures the level of equality in the way resources and opportunities are distributed in a community" [3]. The resources and opportunities included housing, community (e.g. child care) and social (e.g. cultural events) infrastructure [3].

The indicators of income equality, gender equality, equal resources and services distribution, collected from the papers included in the literature review of [9] are promoted as social sustainability characteristics. However, not all of these indicators are directly quantifiable or measureable: e.g., it is not clear how to undertake the measurement of monopoly and anticompetitive behaviours to evaluate fair competition indicator be-tween value chain actors. Similarly, discrimination based on gender, age, race etc. is not directly and clearly measurable. Yet, all these indicators are, without a doubt, relevant and important concerns that must be taken into consideration during software engineering if the intended systems are to promote equality. We observe that these indicators often correspond to more detailed breakdown of equality-related values held in given communities.

Barn [22] have mentioned that "ownership and property; privacy, freedom from bias, universal usability, trust, autonomy, informed consent, identity and others" are the most applicable values to Information systems. We can see that they are similar to equality/social sustainability indicators.

The following section discusses the topic of values in software engineering.

III. Values in Software Engineering

According to Locke, "values are what people want or consider beneficial to their welfare" [20]. Goguen states: "Since values are the essence of what holds communities together, if we can design systems that embody the values of a community, we will have gone a long way towards being able to reliably design systems that will be embraced by that community." [21] Despite the impacts of human values on software success, values are generally under-used in the software engineering processes [22], except for in few pieces of work discussed below.

Value sensitive design is known as "a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process." [23]. The application of value sensitive design in user interface and systems design has been discussed in [23]. The paper discussed three projects that focused on several human values such as privacy, physical and psychological well-being, walkable neighbourhoods, space for business expansion, affordable housing, freight mobility, minimal government intervention, minimal commute time, open space preservation, property rights, and environmental justice [23].

In [22] Barn and colleagues presented a framework to help translate human values into software engineering practices. The paper itself is focussed on privacy value. The framework assisted in identifying design requirements from stockholders.

In addition, values are researched for and used in modelling the business goals of decision makers in software development projects as well as users goals [16]. In [16] value functions (BFC=better, faster, cheaper and "XPOS" = Risk Exposure) were used to evaluate alternative software engineering technologies.

In [17], a generic model of sustainability was developed. The model divided sustainability into five dimensions each of which represents an aspect (i.e., economic, technical, environmental, individual and social) of sustainability [17]. Each dimension has a set of values. Values refer to moral or natural good, such as human health and long-term use of products, that express a dimension of sustainability [17]. Values are decomposed and scored. Actions that support achieving the given values (termed activities) are then defined. Regulations - optional elements in the model - can also affect values. The presented sustainability model [17] supports the analysis and implementation of a sustainable products (such as software) or processes (such as company operation).

While other work (e.g., [19]) focuses on financial value, we follow the view of [17] in considering moral values, which are much closer related to social sustainability domain, as discussed below.

IV. Equality Value Pattern

To analyse the equality concern from social sustainability domain, we utilize the generic sustainability model proposed in [17] (as discussed in the two preceding paragraphs). We used the data on structure and content of equality values obtained

from our literature review (see section 2 above) to create an initial equality value pattern (depicted in Fig.1) that can be further adapted and re-used for specific software systems. Values, indicators and activities for this pattern were also extracted from our survey.

Achieving equality is the main compound value in this pattern, with socio-cultural equality, fairness and social equality listed as sub-values. Indicators and activities that contribute to these values are also modelled (shown in Fig. 1).

The value of socio-cultural equity (see pattern in Fig. 2) suggests that community members, regardless of their differences, are to be allowed to equally utilize community services. The member differences can stem from age, gender, race, religion, etc. In terms of software applications, this can be related to different stakeholders accessing the system through different technologies and with different abilities.

The sub-values and indicators related to the fairness value pattern (Fig. 3) show that organisations should facilitate fairness among their employees as well as their value chain suppliers. In addition, equality between urban and rural citizens also relates to fairness among community members. All these indicate that fairness value must be satisfied for all the stakeholders.

Through modelling of the social equality value pattern (sown in Fig.IV), we observe that social equality is achieved by allowing the community members to benefit from the available services, facilities and opportunities. The services and facilities vary between health care services, education opportunities, housing services and agriculture related services. In terms of software system, this can be associated to allowing stakeholders to utilize the services provided by the software. Another possibility is to use the software and its functionalities to help people to benefit from available services. For example,use email to enquire or register in flower design course provided by local flower shop.

We observe that activities can influence one or more value. For example, citizens empowerment activities influence fairness and socio-cultural equality values (Fig.1.).

Avenue of ICT contribution to equality values: Through analysis and modelling, we have come to conclude that ICT can support the equality values in several ways:

- It is possible to utilize ICT to provide access to services and opportunities. This can be thought of as al-lowing citizens to vote through e-voting, electronic utilities payments, e-banking, reading free publications and news on internet, etc.;
- ICT can also support fair competition, e.g., through e-Tender applications;
- Fairness between citizens can be supported by having systems that assure income compliance with specific wage regulation;
- Some values, such as gender equality, can be indirectly supported through ICT by ensuring that gender is not revealed, or is actively hidden when participation or remuneration is concerned;
- In [13], a proposed Extended Technology-Community-Management Model suggested that ICT training can help in reducing knowledge and skills gap among women and old people.

Value Pattern Use: Having developed the equality value pattern (Fig.1), we then used it in anticipating and identification of relevant equality-related software requirements. To do so, we followed two main steps, which are to:

1) Identify systems stakeholders. We focused on direct stakeholders.
2) Determine an appropriate way of satisfying the equality values of the stakeholders.

Some sample requirements obtained through this approach are detailed in the section below.

V. Case Study: Health Watcher

We have used the Health Watcher system to instantiate the above discussed equality value pattern (Fig. 1). The Health Watcher system [18] is a web-based application that allows public users to file complaints against institutions such as restaurants. The system also provides health information to users. The case study is available to public and its original requirements are illustrated by use-cases.

Following the steps described in section 4, we first identified the main stakeholders for this system (from the case study requirements documents) which are:

- the public users (citizens),
- the health officers (Employees) and
- the organization involved in a complaint.

We then need to to determine how to achieve socio-cultural equality, fairness and social equality for the above three types of stakeholders.

The socio-cultural equality value pattern (in Fig. 2) guided us to consider different system users not only with human factors differences but also with technology differences. In the case of health watchers, this includes all citizens with different ages, gender, physical abilities as well as different platforms and devices used.

The achieve fairness value indicates that all stakeholders are to be equally served by the software. This is related to people who file complaints and people who the complaint is against in the Health Watcher system. In fact, this value pattern helped in verifying the correctness of the identified stakeholders in step 1. The value of achieving social equality by allowing access to services and opportunities implies that software should provide stakeholders with services they need. This value lead to a detailed description of the requirements derived from the fairness value. The services include record complaints, pro-vide health advices and receive and respond to citizens en-quires. Table 1 provides the summary of collected requirements.

VI. Discussion

By using the generic sustainability model [17] we were able to model social sustainability and focus on equality as

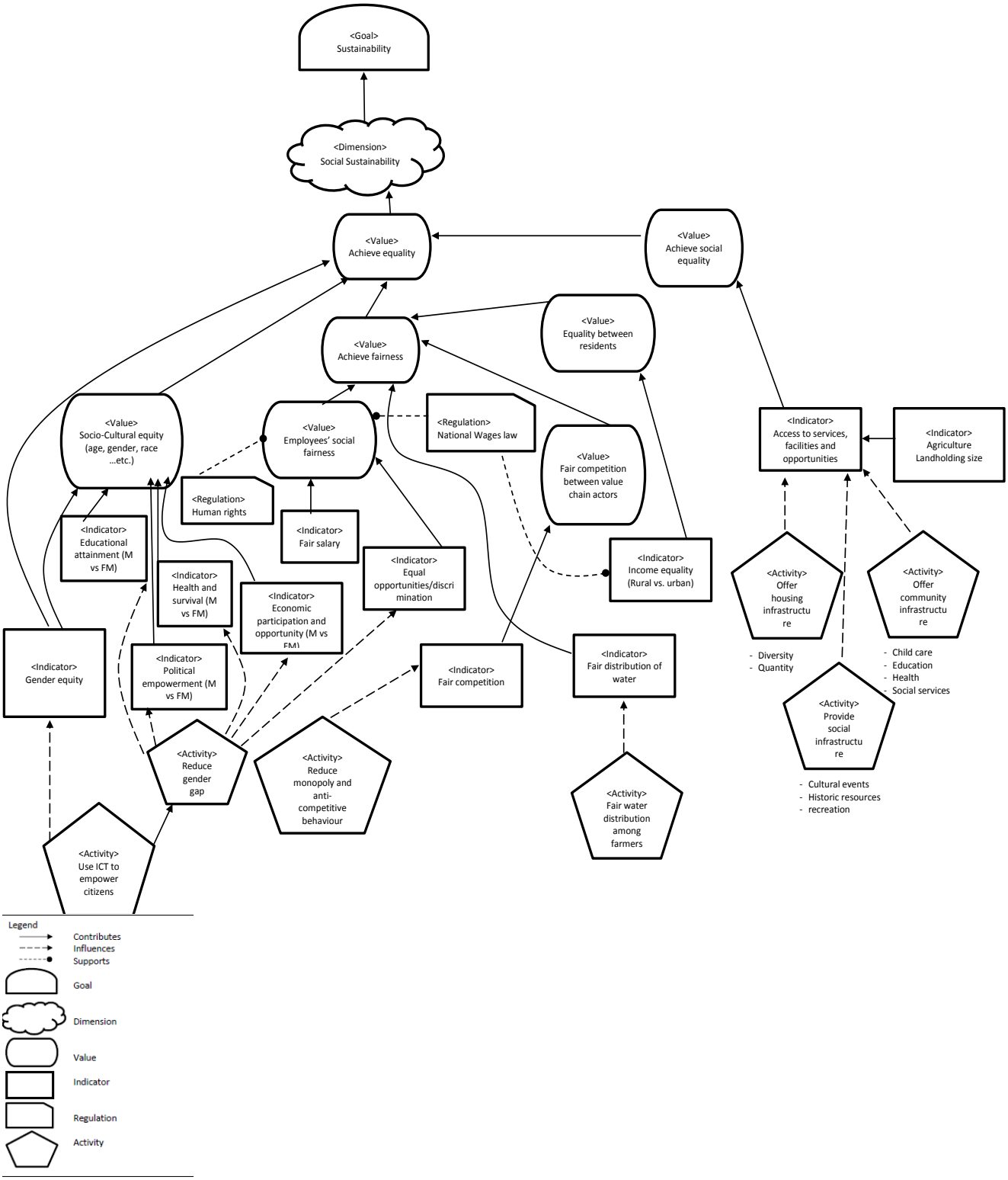

Fig. 1. Equality value pattern

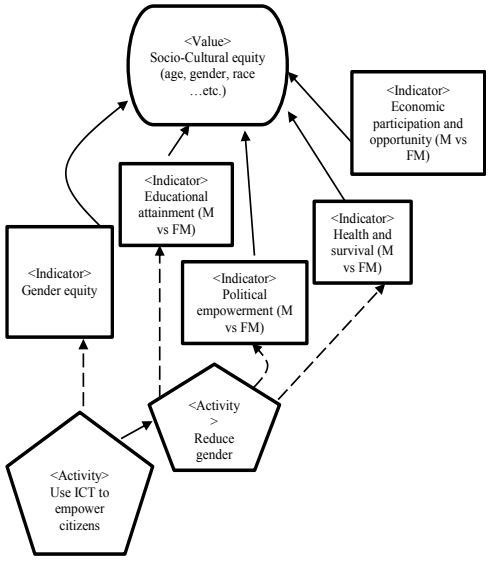

Fig. 2. Socio-cultural equity value pattern

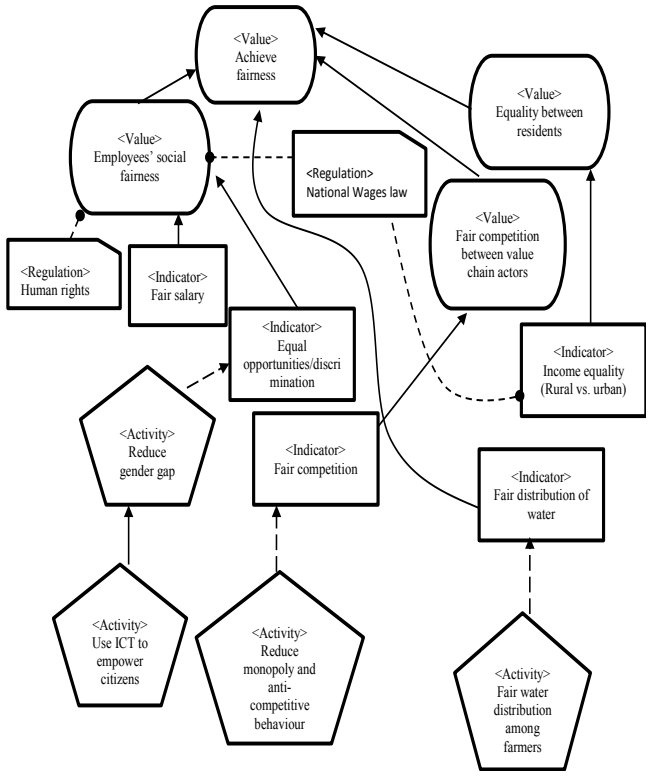

Fig. 3. Fairness value pattern

the main category/value. We then used the structural and contextual knowledge of equality obtained from literature to derive a value pattern for equality concern. The value pattern in Fig. 1 sup-ported elicitation of equality-related software requirements: by questioning how the given pattern can be instantiated for stake-holder in the given case study (Health Watchers system).

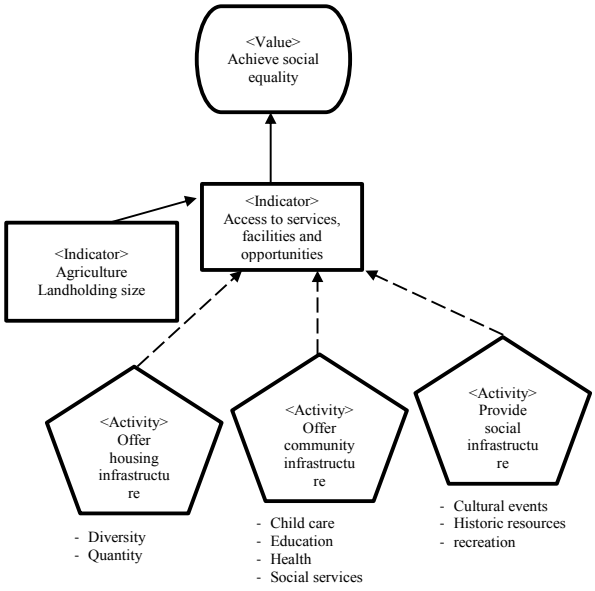

Fig. 4. Social equality value pattern

The resultant requirements include both functional and non-functional types. Examples of derived functional requirements are recording complaints, responding to health enquires and tracking complaints. Non-functional requirements are related to the system availability on different operating systems (Android, Mac, etc.) and different information display formats (audio, video, text). Those requirements were not identified in the original requirements document [18].

The socio-cultural equality value pattern allowed acknowledging potential users of the system and planning the system adaptability to their differences (e.g. blind and visually impaired users).

Achieving fairness value suggests providing the software services to all users. The main users are members of the public with complaints. On the other hand and to achieve fairness, we should allow the other party involved in the complaint to de-fend, justify or at least apologize to the complaining user.

Use-cases were used for deriving functional requirements for the health watchers system [18]. Citizen and employee were decided as the actors in the system. By using the equality value pattern we were able to identify a third actor which is the institution that the complaint is filed against. In addition, a functional requirement on providing alerts on complaints with no decisions/actions was derived from the value of achieving fairness.

The presented equality value pattern, however, is not helpful in identification of detailed operational/functional requirements (with priority, input/output conditions, main and alternative flow etc.). In the present case study these were derived (prior to the present work) through use-cases.

Moreover, the above noted value patterns lead to a few observations on the types on the requirements for equality

TABLE I
VALUES AND REQUIREMENTS

Socio-cultural equality	All stakeholders should be allowed to use the system regardless of gender, race, age... Note: the requirement is to be modified based on the content. Restrictions must be justifiable.	RQ1. The system should be available for users with different devices (desktop, tablets, mobile, kiosks), different operating systems (Android, iOS, Mac, Windows) RQ2. Information should be displayed in different format (audio, video, text..) to support blind and visually impaired users. Note: users include citizens, health officers and complainee.
Achieve fairness	The system should provide services equally to all stakeholders. This is more obvious requirement in cases where we have stakeholder against another stakeholder.	RQ3. The system must allow citizens to use the system. RQ4. The system must allow health officers to use the system. RQ5. The system must allow organizations (complainee) to use the system.
Achieve social equality (access to services, opportunities)	The system should provide stakeholders with their desired services.	RQ6. The system must accept and record all citizens complaints. RQ7. The system must track all complaints and make sure an action is taken. RQ8. The system must allow citizens to view their recorded complaints and the status/action taken. RQ9. The system must allow citizens to enquire health information. RQ10. The system must provide response to all health enquires. RQ11. The system should allow citizens to view health information. RQ12. The system must allow health officers to view complaints. RQ13. The system must allow health officers to refer and comment on complaints. RQ14. The system must provide alerts to health care officers in case of no decisions/actions are associated to a complaint. RQ15. The system must allow health care officers to view citizens health enquires. RQ16. The system must allow health care officers to reply on citizens enquires. RQ17. All complaints must be reviewed by an officer. RQ18. Organizations who are blamed in a complaint should be allowed to view the complaint and comment/respond to it.

engineering, which are that in the present case study:

1) Socio-cultural equality value pattern led to non-functional requirements. The non-functional requirements are mainly accessibility and compatibility requirements e.g. use of different media for information delivery to accommodate different users (see R1 and R2 in Table 1).
2) Fairness value pattern entirely led to abstract functional requirements, primarily focused on access to services and resources (see R3, R4 and R5 in Table 1);
3) Social equality value pattern led to detailed functional requirements (see R6 to R18).

Thus, we observe that the value patterns could potentially lead to requirements patterns as well.

Similar value patterns can be developed for other social sustainability aspects such as education, health, employment as all aspects can be related to values. These value patterns can serve as the backbone for softwares social sustainability requirements development and can be used alongside other requirements engineering techniques to add to and enhance the requirements elicited.

VII. CONCLUSION

As discussed above, social sustainability aspects are closely associated with the values and normal held by the community members. In terms of softwares social sustainability i.e. equality, the values are associated to the equality benefits gained by the users community. By identifying the value patterns, software engineers are able to notice and document social sustainability requirements of the software under development.

In the immediate future work, we will undertake more case studies to validate the value patterns and their utility in eliciting social sustainability requirements for software. The patterns of requirements elicited through value patterns will also be closely reviewed. In addition, models on other social sustainability aspects can also be developed and applied to different case studies.

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