Designing Information Systems for Sustainability – The Role of Universal Design and Open Innovation

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Abstract. Although sustainability is a key concern in today's world, more efforts towards achieving sustainability are needed. User inclusion in the information system design process could enhance the outcome of a system's action towards sustainability. It is, however, important to understand the design procedure of a system to achieve such goals. A framework denominating as the inclusive innovation framework presented in this paper incorporated analyses from open innovation, universal design, and sustainability to motivate the initiation of internal and external driving factors towards sustainability goals. The derived framework could promote the information system's enabled sustainable goals by combining the use of universal design principles and the concept of open innovation. A requirement engineering model was also proposed that was interoperable within the three subjects of interest discussed in the paper and was necessary for understanding the application of an inclusive innovation framework. Two use cases were then presented as an illustration for arguing the validation of the proposed inclusive innovation framework. The findings from the use cases indicated that the use of universal design principles along with an open innovation concept could increase information systems' enabled sustainability goals. This could be done by enhancing a system's successfulness along with the increased user satisfaction.

Keywords: Sustainability, Open Innovation, Universal Design, Inclusive Innovation Framework.

1 Introduction

During the recent decades the impact of human activities on the Earth's eco-systems has become a growing concern. Research connected to sustainability issues in the information system field has increased due to larger awareness of environmental issues, climate change, and the risk of global warming [32], [45]. Information systems are ubiquitous in our society and they play an important role in confronting some of the adverse effects on the environment [46]. It is important to acknowledge that the increased use of the information system has constituted a growing environmental concern in itself, e.g. increased power consumption for running an IT system and the need of scarce resources to build IT artifacts [11]. The information system artifact is a tool that mediates activities and is different from a simple IT artifact. This is because

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the information system artifact is considered to be an intricate socio-technical system defined as an "integrated and cooperating set of people, processes, software, and information technologies to support individual, organizational, or societal goals" [45]. Also there seems to be a strong public belief in the information system as an enabler of sustainability [46]. All larger systems are influenced by a variety of stakeholders that determines its future [17] and this is also implied for the information system. While no definite definition of the open innovation concept exists and the newness of open innovation itself was argued [42], the concept has usually proclaimed that a single organization could not innovate in solitude (closed innovation) any longer [9]. Therefore open innovation is dependent on reaching and involving more stakeholders [6] which could be described as a paradigm shift for setting innovation strategy and managing the innovation process. The information system could make it easier for stakeholders to organize and share ideas to reach a common set of goals [12]. Although initiated as a focused design concept for accessibility issues, universal design has broadened its scopes and has become popular in interdisciplinary design research. One way of looking into universal design out of the accessibility domain is its ability to increase user involvements through design. Since the 1960s it has been generally acknowledged that user participation in the information system development process could increase the likelihood of project success [2], [16], [41]. User involvement is therefore likely to result in increased user satisfaction [18], [41] and the perceived usefulness of the application [16], [41].

It was argued in this paper that a universal design concept incorporated into information system development would increase user participation in the design process and thus could contribute in achieving a target goal. If a link could be created between system development and the external social world, we would see that the same concerned social world that could be affected by sustainability issues would be a cause of the system's development decisions. Taking this into account, information system design incorporating the concept of universal design presented in this paper has an increased chance to influence sustainability goals. The underlying research question considered in this research paper is: "How universal design concepts may be used for improving sustainability achievement goals through the information system design?" A theoretical framework titled as "Inclusive Innovation Framework" was proposed, which explained how to design an information system inclusively by additional interactive stakeholder involvement and also as an iterative development process in order to achieve user satisfaction, successfulness of the system, and eventually the desired sustainability goals.

This paper is divided into eight sections. After this introduction section, necessary understandings of sustainability, open innovation, and universal design were introduced in the background section. The inclusive innovation framework (Fig. 1) showed how to support and improve the information system development that enables sustainability achievements, presented in Section 3. A requirement engineering model (Fig. 2) was presented in Section 4, based on the activities from a cognitive decision-making model to clarify how the proposed inclusive innovation framework could practically be used. The method section was presented in Section 5 followed by the results in Section 6, where two use cases were presented to validate the proposed framework. Section 7 presented a thorough discussion and future research possibilities that were initiated from this research work followed by a conclusion given in Section 8.

2 Background

2.1 Sustainability

One key definition of sustainable development, i.e. sustainability, was given by the world commission on environment and development, "that it meets the needs of the present without compromising the ability of future generations to meet their own needs" [47], also known as the Brundtland definition. Subsequently, to work for sustainability is to enhance a process to minimize or reverse the negative impact of that process on sustainability, both currently and in the future. The majority of research in green IT has focused on how to improve sustainability through more power-efficient computers [10] and thereby reduce greenhouse gas emission. Sustainability should perhaps not only focus on a particular perspective like the environment. An improved and more holistic way could be to use Elkington's triple bottom line (TBL) which consists of three components, namely: economic performance, society, and the natural environment [40]. For instance, promoting sustainable design could be found from the previous work of the authors, in which the TBL perspective was used in designing sustainable IT systems [33]. To remedy sustainability, problems that are based solely on technological solutions are futile since information systems are embedded in a societal development, and the information system could have a crucial role as part of a comprehensive approach [21] by influencing organizational and individual behaviors towards sustainability in all three components of TBL.

Research in the information system could contribute by taking a holistic view of an entire system, its design, and its aim to reach sustainability [11]. From an organizational perspective, all organizations have a set of goals to create values and the organization implements strategies to achieve these goals [7]. Shareholder wealth is often the main goal but could be viewed as a form of narrow self-interest. This individual rationality does not, however, always lead to collective rationality [46], e.g. sustainability could be viewed as a collective rationality goal shared by all stakeholders. Reaching sustainability and minimizing environmental impact therefore could largely be derived from the capability to find new solutions to innovation and the probability to do so could be increased by acquiring more resources, e.g. getting more stakeholders involved.

2.2 Open Innovation

The number of approaches to innovation is numerous and some are similar or become similar depending on researchers and the lack of an agreed clear definition [15], [30], [42]. Open innovation increases the probability to capture innovation opportunities by including external stakeholders, e.g. customers, suppliers, and competitors etc. in the innovation process. Gassman and Enkel [19] found three archetypical processes in open innovation: "outside-in process", "inside-out process" and "coupled process." A distinction between open innovation and von Hippel's "User Innovation" is that the latter is solely centered on the user [3] and not as the prior that also includes suppliers, competitors, and others, e.g. inter-organizational innovation is very important [43].

For example, previous research has showed that external stakeholder involvement and expansion to academic research is important for the design of open innovation

[34]. Research has also shown that the collective intelligence of groups-many minds are often better than one—seemed to be good at idea generation [4] that is shared with crowdsourcing [29] whereas crowdsourcing seems to be mostly focused on solving a predefined task and could be seen as outsourcing to the crowd [15]. More users and active user participation should therefore leverage the "wisdom of crowds" [29] to harvest the collective intelligence.

In the context of this paper an interesting question related to open innovation that still remained was: What could be the different driving forces that would motivate an organization towards the use of the information system in having a higher impact towards sustainability goals? More stakeholders given by utilizing the power of open innovation should give a better chance to move towards sustainable goals [33]. Also an amended way could be to design a sustainable system with the help of different stakeholders, e.g. user involvement [18] that could promote a positive motivation to reach sustainable goals in the system design. To design a sustainable system could perhaps remedy the recognized needs of sustainable practices [12] that could fit multiple levels of practices and also consider multidimensionality, i.e. TBL.

2.3 Universal Design and its Principles

Although universal design, inclusive design, and design for all are alternative words for the similar basic concept [35]. The customary understanding of universal design is that it improves the user experience through design across a broad range of users. Thus by meeting different requirements of the excluded user group, universal design promises to improve product experience through a comprehensive range of users without any special need for adaption or specialized design by the users [5]. One of the present vulnerabilities in universal design is that sometimes it becomes more of a design concept than a design strategy by promising too much to the users. However, the universal design concept could offer more than just design for people with disabilities and it is thus important to explore those possibilities to be utilized in a broader perspective. Foster and Franz highlighted user involvement need in the early stages of system development [16] and universal design should thus be embedded within the design and development process for improved user involvement resulting in enhanced designed products, systems, and services.

One approach to seek user's involvement is framed in the concept of open innovation design space presented in this paper. In the context of this research interest we believe that universal design could help in introducing different driving factors for achieving sustainability. Use of the open innovation concept could therefore support practicing universal design, leading towards a successful system design for achieving the sustainability goals. The original set of universal design principles are copyrighted to the Center of Universal Design and developed by a group of U.S. designers and design educators from five organizations in 1997 [39]. These principles are Equitable Use, Flexibility in Use, Simple and Intuitive Use, Perceptible Information, Tolerance for Error, Low Physical Effort, and Size and Space for Approach and Use. In this research, three design principles (Equitable Use, Size and Space for Approach and Use, and Tolerance for Error) were ignored. Our interpretation was that they address the accessibility issue of a designed system where accessibility is solely meant for reflecting physical limitations or disabilities that were not the present scope of interest.

3 The Inclusive Innovation Framework

The core argument behind the idea of this proposed framework was that by improving a system development process by an open innovation concept and the universal design principles would enable the maximum possible users to be active in the requirement capturing process. The relationships between different chosen factors in the framework were explained in this section. Since our assumption was that increased user participation in information system development by using the concept of universal design could increase the possibility of achieving sustainability goals, the four universal design principles were considered. These could increase external driving factors such as standards, user demand, pressure from a dedicated group, disclosure requirement etc., as well as internal driving factors of the information system such as social equity, simplicity in use, and strong learning ability. These internal and external motivation factors could help to achieve sustainability goals.

Tait and Vessey [40] addressed the need to reduce the number of factors being studied. Investigating all factors affecting user involvement and its impact on system success could be tedious and the main constructs that are central to influencing user involvement for the system's success should be narrowed down and analyzed [40, 41]. Reducing the number of factors and finding relevancies between them is therefore an important issue while designing a framework. Keeping this in mind, two contingent variables have been selected from the universal design principles: Flexibility in Use and Perceptible Information, which are in a relation with the next two variables also selected from the universal design principles: Low Physical Effort, and Simple, Intuitive Use.

The framework presented in Figure 1 acquired four universal design principles for consideration that could work in a circular process in the inclusive innovation design space. When an information system design is simple and used intuitively it would be perceived as a "flexible to use system" by its users. Furthermore, when the information presented in the system would easily be perceptible it would lead towards the "simple use" of a system through its design. An information system that takes less physical effort during its use could thus be perceived as a "flexible system" to its users. Since poor design could initiate limited stakeholder involvement, the proposed framework could contribute towards benefiting the user participation (inclusive innovation design space in Figure 1). It was understood from our previous discussion that by enabling the information system's supported actions the possibility to realize sustainability goals could become higher. Therefore it is important to consider the user satisfaction parameter, which would be promoted through the design strategies of the system. Furthermore, a combinatorial approach of two dependent variables, flexibility in use and perceptible information along with two other variables (low physical effort and simple, intuitive use) could realize user satisfaction that could lead towards sustainability goals (Figure 1). Since a system that is simple and spontaneous to use, easy to understand, remember, and learn should be able to promote any sustainability actions or goals as desired by the system designers, it would lead to the system success phase. Nevertheless, there could be other different factors that could influence a system to be defined as successful from the point of achieving sustainability goals, which were beyond the scope of this research.

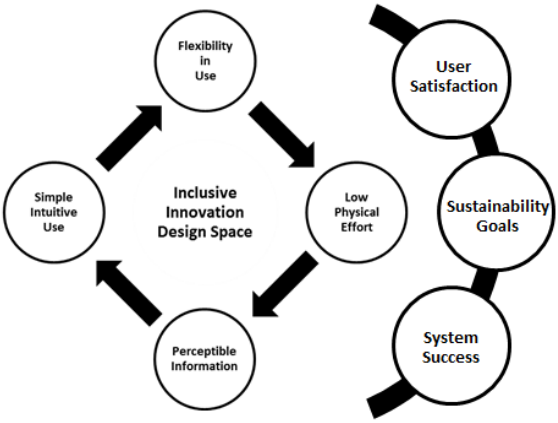

Fig. 1. Inclusive innovation framework for sustainability

4 Requirement Engineering Model

Designing a future information system requires a thorough understanding of organizations, user behavior, technology, and how all these are interrelated. The management of knowledge and intellectual assets is crucial for companies that desire to survive in the turbulent, ever more global and competitive environment [1]. Nuseibeh and Easterbrooks [36] defined requirement engineering as a series of decisions that lead from recognition of a customer problem to be solved (or a need to be satisfied) to a detailed specification of that problem. Typically requirement engineering is modeled as a process including a variety of sequential or iterative activities [26], [31]. Decision-making appears typically as embedded into one of the activities in the requirement engineering process. In the previous example [26], such an activity is "requirements analysis and negotiation." In another requirement, the engineering process described by Macaulay [31] is an activity of "feasibility and choice of options." This means that a requirement engineering model is important in several contexts. These different contexts could be considered as individual parameters for a requirement engineering model.

With the proposed inclusive innovation framework in hand it is thus important to realize how the activities in this framework could be practiced. A requirement engineering model could consequently help us understand what was proposed and described in this section. In order to raise the understanding of sustainability goals we call for an interactive approach in which distinguishing between the organizational and individual level of decision-making would be needed. Individual experts' work is full of choices, which may not be visible for upper organizational level actors, e.g. boards, management groups etc. In their cognitive process model Corner et al. [8] stressed these decision-making levels as four activities: attention, encoding, storage/retrieval, and choice, which were taking place iteratively at the organizational and individual levels. These four activities were considered and mapped in our requirement engineering model as four parameters that have relational connectivity within themselves. These parameters and the proposed model based on them were shown in Figure 2 and described below.

- Attention could determine the usefulness of a system, which means that the stakeholders would be aware of the usefulness of the system.
- Encoding could give information that would be determined as usability of the system in this research.
- Storage/Retrieval in our model would be mapped as sustainability awareness. Whether or not the stakeholders would be aware of sustainability, it could be used as an information bank that could be used to put impact on the other three parameters of our choice.
- Choice is an iterative process. It was mapped with the user participation and it would be the choice of the designers, whether or not they would be designing by considering any certain design principles for universal design.

Houdek and Pohl [22] noticed that requirement engineering activities were heavily intertwined and not seen as separate tasks by the participants of the process. We supported their argument and argued that decision-making could appear in intertwined requirement engineering activities for both individual levels, e.g. requirement engineering engineers' focus of attention and choices made, and collective levels, e.g. stakeholder communication, expert boards' work, and project management. The principle question behind this requirement engineering model's activities was: How could the information system's users successfully be driven to a decision towards sustainable awareness by the system's usefulness, usability, and inclusiveness of user participation? This model considered sustainability awareness to be its centralized objective since we previously discussed that an inclusive innovation framework could make stakeholders more involved and committed to a common sustainable goal. Active user participation would be helpful for discovering the usability of the system. Thus the user satisfaction parameter could be used to measure and derive usefulness of the system, which in turn would motivate increased user participation. On the other hand, positive feedback from the users of a useful system could motivate the designers to enhance the "design for all" concept for triggering user inclusion. Besides, an information system which could be perceived to be useful by its users should increase user satisfaction level. Furthermore, a higher user satisfaction acts as an external motivation factor to improve the system design. Therefore an improved usability outcome from a system would possibly result in useful system development by involving more user participations and this could make the whole process an iterative one. The combination of the usefulness of a system, a system's usability, and increased user participation could be an interoperable process to enhance sustainability awareness amongst the users of the system.

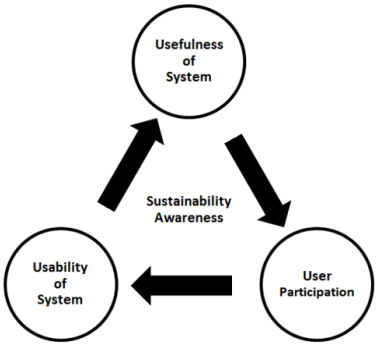

Fig. 2. A requirement engineering model for inclusive innovation framework

5 Method

The framework presented in Figure 1 was validated using use case methodology, which was important to clarify and organize system requirements. The use case is a popular and powerful method that gives a decent foundation for the verification of higher-level models. This usually is done by role-playing for the validation of different functional requirements. The sequences of interactions between a system and its users related to a specific goal are represented typically through the use cases.

For the validation of proposed inclusive innovation framework, two previous research articles were selected as our cases that could reflect similar research interests of sustainability and information system design. Two use cases were then derived on the basis of models presented in those two articles. These use cases showed how those models would behave within the context of our proposed inclusive innovation framework. In the first article by Kasarda, Termenny et al. [25], Design For Adaption (DFAD) methodology was discussed for achieving sustainable design goals. The first use case showed how inclusive innovation framework could contribute to DFAD methods to achieve sustainability goals. In the second article by Jabareen [24], the author presented a conceptual framework for sustainable development. The second use case thus showed how inclusive innovation framework could be applied in this conceptual framework for achieving sustainability.

The rationales behind choosing these two articles were that they were highly related to the similar aims of inclusive innovation framework in terms of goal, size, and complexity. The phenomenon presented in two selected articles was considered as two case studies. The proposed framework introduced a new way of achieving sustainability in information system design in which the organization level focuses were prioritized by using the concept of universal design and open innovation. Case studies should investigate contemporary phenomena in real life and the focus should be on organizational or managerial level [48] cited in [23] which was the instance here too. Thus the two selected models from the articles were considered to be our theoretical sampling as two cases. They were critical and extreme cases concerning the sustainability achievement. Through the help of use cases it was then shown how our proposed framework could act on these samples. Since it is often appropriate to choose multiple cases for theory testing and descriptions [23], two cases were chosen.

Since use case also focuses on the interaction of users in a particular situation of system by showing all possible system activities, it could thus make it easy to understand the difficulty of a large system by breaking the problems in to major functions and by stipulating applications from the user's perspective. Therefore different artifacts were identified from the two selected models from the two selected articles and were analyzed in the context of inclusive innovation framework before coming up with the use-case design. This was done by means of a group of elements to describe the behavioral views of two different cases presented in two articles. The presentation of two use cases to show how the proposed inclusive innovation framework could fit into the two selected cases conforms to the purpose of using case studies in qualitative research by Walsham [44] cited in [23], Eisenhardt [13] cited in [23], Lee [27] cited in [23], and Lee and Baskerville [28] cited in [23] where it was argued that case studies could be used to test theory within the positivist paradigm. Therefore the reasoning behind the choice of these two particular cases and thereby coming up with two use cases for the initial validation of the proposed theoretical framework was evidently unbiased.

6 Results

6.1 Use Case 1

Kasarda, Termenny et al. [25] presented two simple models for demonstrating the DFAD concept that explained how a control system analysis and design could be applied for adaptable product design. Our first use case therefore dealt with how an inclusive innovation framework could be used in the closed-loop feedback system.

The use-case diagram was shown in Figure 3. The suggested process of building this use case was then described. A closed-loop dynamic feedback system was re-designed by Kasarda, Termenny et al. [25] to a multivariable control system in which authors showed mathematically how multiple inputs and outputs could work as a nested loop. The components of the basic control system were mapped with the elements of inclusive innovation framework to show how the control system process could be sustainable by adding additional parameters from our proposed framework.

Use Case: Designing a control system for sustainability
Level: System
Scope: Changing the performances in different phases of control system to make the overall procedure more sustainable
Primary Actors: Designer of the control system (giving input or desired output response)
Supporting Actors: Users, System engineers (not shown on use-case diagram)
Preconditions: None
Success Guarantees: The team has good communication ability with its stakeholders and they are aware of the meaning of the sustainability goal in the context of their project.

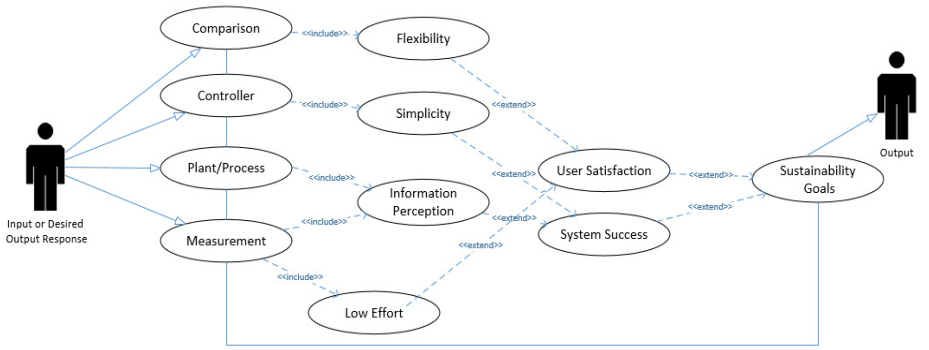

Fig. 3. Use cases for closed-loop control feedback system from [25] with inclusive innovation framework

Stakeholders and concerns:

- **Designers:** want to understand how to use inclusive innovation framework for increasing user satisfaction and achieving the system's success leading towards sustainability goals.
- **Users:** want to feel the system is simple, flexible, easy to perceive, and takes low effort to learn.
- **System Engineers:** want to understand the requirements of users and pass the information to designers accordingly.

Trigger: The designer decides to design the control system to be sustainable for enhancement of the user satisfaction.

Success scenario:

A. Initialization of the Control Process

1. The designers initiate the process by an input signal or desired output response signal. The input and out signals are compared.
2. Different components use algorithms to modulate actuator. The actuator is used to measure the changes.
3. The performance of the process or the system is to be controlled.
4. How the signals are detected and measured should be considered.

B. Inclusive Innovation Design Space Process

5. The comparison should be flexible with the context of the process or system. This increases user satisfaction.
6. The controller that is going to measure the changes should be simple enough so that the successfulness of a system can be increased based on this.
7. Users should be able to perceive the process information system easily so that it can lead towards system's success.
8. Low effort (physical or cognitive) should be given for the measurement and designers need to keep this in mind. This will improve user satisfaction. Measurement should also be given to consideration to be easily perceivable, which will trigger the system to be successful.

C. Other Steps

9. User satisfaction will initiate the process towards the phase of achieving sustainability goals.
10. A successfully designed system will initiate the process towards the phase of achieving sustainability goals.
11. The actors see the result of the designed system (achieving sustainability goals).
12. The process has dependency with basic elements of the control system and thus input actors can gain knowledge from the resulting output.

D. Conclusion

13. Project manager decides when the process needs to be terminated or when new sustainability goals can be initiated so that the elements of control process initiation can be changed with respect to inclusive innovation design space.

Variations:

1. The process is iterative so several iterations might be required before determining the true meaning of system success and user satisfaction based on the context of process or system of the designed system (achieving sustainability goals).

2. Steps 5 and 6 should be performed parallel to steps 7 and 8.
3. It may be needed to refine the understanding of sustainability goal with the context of selected system or plant after the first iteration for achieving system success and user satisfaction accordingly.

6.2 Use Case 2

Jabareen [24] developed a conceptual framework for sustainable development that was built on seven concepts. The central concept was the ethical paradox where sustainability (related to environment) and development (related to monetary variables) could have different practices based on the differences in ideological points of view. Natural capital stock represented all natural resources for the idea of maintaining it constant through time. Integrative management was the holistic view to integrate economic, environmental, and social matters in the management process. Utopia represented a vision for humans in which concepts of solidarity and justice are incorporated. Eco-Form was the design with ecological desired goals; in reality sustainable design. Global Agenda was a new political discourse based on sustainability. Equity was the social aspects of sustainable development and included economic, environmental, and social considerations and social values such as democracy, empowerment, freedom etc. The use-case diagram of inclusive innovation framework mapped into the framework of Jabareen [24] was shown in Figure 4. The purpose of Jabareen [24] was to understand the definition of sustainable development and the framework initiated this understanding from a multidisciplinary perspective. This framework was therefore considered important in order to understand what sustainable development could be in the context of the information system, its present and future development. The actors in the use case were the information system users who strive to reach any predefined sustainable goals. Eco format deals with design in a sustainable context and could be seen as sustainable design. Sustainable design should strive towards simple intuitive use since the information systems would then be characterized and seen as understandable and intuitive by the user.

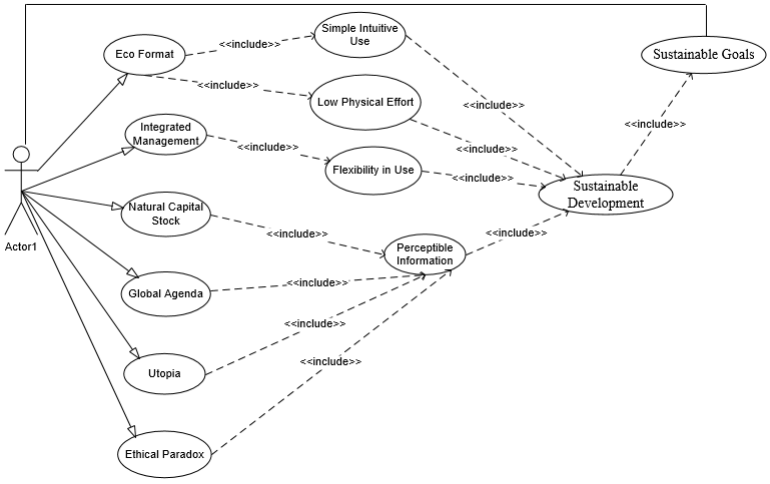

Fig. 4. Use cases of sustainable design with inclusive innovation framework

Also eco format could be seen as a parameter impacting the information system in a way in which the user should be given the possibility to use the information system without compromising any extra efforts (cognitive or physical). Ethical paradox could trigger perceptible information since it would have impact on the perceived legibility on information given by the system to the user. Natural capital stock belonged to the improved perceptible information parameter because the rule of keeping resources at a constant level is straightforward and also contributes to the legibility of the information system. Integrative management triggers flexibility in use, since the integration of economic, environmental, and social aspects could be done in many ways by the system. Utopia could activate perceptible information because the vision given by an information system could be said to identify universal goals (democracy, justice, empowerment etc.) that probably all users could agree with, were worth striving for, and could be internalized by users to give legibility to the information system. Global agenda also could trigger perceptible information because the new political discourse that was based on sustainability must provide legibility. As mentioned in Section 2.3, "Equitable Use" universal design principle was not considered in this research; the effect of equity into inclusive innovation framework was not discussed here.

7 Discussions and Future Work

The assumption stated in Section 3 was that increased user participation in information system development by using the concept of universal design could increase the possibility of achieving sustainability goals. The two use cases presented in the result section gave support to this. From the first case it was shown how a closed-loop feedback system can act more sustainably with the help of inclusive innovation framework. The DFAD concept for achieving sustainable system design was heightened by the help of inclusive innovation framework. Harmon et al. [20] found that an information system aiming for achieving sustainability should be able to redefine the process and this should be a character of an IT system. The findings from Use Case 1 supported this argument, since inclusive innovation framework was able to redefine the whole process in an iterative manner, which also supported the argument of Gassman and Enkel's archetypical open innovation processes (in this case the coupled process) [19], where the inside-out and outside-in processes were working at the same time and the organization worked in an alliance with partners and together could gain mutual benefits and value creation. The use of the inclusive innovation framework showed initiation of this coupled process. In Use Case 2 it was shown how the multidisciplinary concept of sustainable development in an existing framework could be practiced with inclusive innovation framework aimed at achieving sustainable goals. This finding supported the argument from Porter and Millar [37] where the authors wrote that the information system could have a huge impact on the organizations and their competitive achievement by transforming the value chain. One way to achieve a competitive advantage could be through the use of the inclusive innovation framework aimed at achieving sustainability goals. The transformation of the value chain initiated in human-computer interaction (HCI) research was taken into consideration by the proposed framework together with the impacts an organization could experience through the information system use by achieving sustainable goals.

Two important transfers were initiated from the findings of this research. Looking into universal design concept beyond physical disability was one major shift. The way universal design principles were used in the framework had nothing to do with design for people with disabilities. This supported the argument raised in the work of Mustaquim and Nyström [33] in which the authors used universal design principles to derive design principles for sustainability and argued that it was important to consider the universal design idea while aiming for sustainable design. Secondly, the concept of sustainable HCI was represented out of its traditional thoughts. Usually sustainable HCI referred design for changing human behavior towards ecological actions. This is often done by using cognitive dissonance to persuade and change users' behavior towards a predefined more sustainable behavior. The framework in this paper showed that this must not always be the case, to use HCI in a sustainable context. Instead HCI could represent its experience of sustainability in many different manners (universal design perspective, for example) and this could help building knowledge in the research of information system design and design science.

Smith and Reinertsen [38] argued that sharpening the front-end of the design and making the decisions earlier may have a better chance of attaining a direct effect on the goal of creating the product, such as by a successful marketing launch, higher user satisfaction, and increased usability of the product. Based on their argument and considering sustainability achievement as a goal to be affected, the proposed requirement engineering model could help identify the needs that could be essential to address in the earlier stages of system development. Because each decision might embody a commitment or abandonment to stakeholders' concerns, we stressed an active and reflective collaboration in the early phases using this requirement engineering model. Improved visibility into the requirement engineering process through the adoption of the open innovation concept should therefore enable better communication between different stakeholders.

A number of motivating research possibilities were initiated from the result of this research work. For instance, how to measure and perhaps benchmark an organization's information system in terms of achieving sustainability goals or sustainability measurement could be a highly interesting topic. What the appropriate methods to introduce would be when doing research on the requirement engineering model with organization could be another interesting research question for further study. Also it would be interesting to study how we could utilize collaborations in a stakeholder network to reach sustainability, together with a system's success and user satisfaction. Another research topic could be to investigate how different incentive systems could work in the inclusive innovation framework with the stakeholders involved in the process. Initiating information collection process for finding requirements from different user groups to measure sustainability goals through the inclusive information framework could be another issue that might commence from this paper. Empirical data collection from organizations using different information systems aiming for sustainable goals would be needed for this purpose. A combination of the inclusive innovation framework and the requirement engineering model in one unified model form could then be suggested, based on the findings from the empirical data analysis. Finally, it would also be interesting to see the possibilities to improve the usability of a system through measuring sustainability goals using the inclusive innovation framework.

8 Conclusions

In this paper the inclusive innovation framework was proposed, which showed how to achieve sustainability goals through the design of the information system. The framework included universal design principles and used the concept of open innovation in terms of creating a design space which was supported by a requirement engineering model. The findings from this research suggested that it would be worthwhile to practice inclusive innovation framework for achieving sustainability goals through the design of an information system. While research driven innovation is pulled by organizations and technology based innovation is pushed towards the organizations, design could play an important role for adding additional values towards improved usability of a system that could contribute in promoting design driven innovation for organizations. It was shown in this paper that it could be possible to use concepts from HCI to build new knowledge in information system study that would permit the collection of empirical data for further research.

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