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Application of Soft Systems Methodology to Trigger Solar Energy in Iranian Buildings

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A B S T R A C T

Solar energy application as an important element of energy sustainability can be an important issue considering Iranian Resistance Economy policy. Compound Sustainable Energy launching Framework (CSEL) already has been developed in order to facilitate the deployment of sustainability initiatives and eliminate existing barriers in the industrial sector. This paper presents an application of Soft Systems Methodology (SSM) in applying this framework in Iranian Household Sector specially to facilitate solar energy application in this sector. The application of SSM and CSEL framework is discussed in this paper and it is proved that SSM method links CSEL framework to the solar energy application in the Iranian architect environment. The CSEL multi-methodology framework aims not only eliminating energy sustainability barriers but also an efficient assignment of capital investment on such initiatives.

1. Introduction

In the past 27 years, fossil fuels continue to meet more than 80% of total primary energy demand and over 90% of energy-related emissions are CO2 from fossil-fuel combustion [1].

The building sector contributes directly and indirectly (through consumed electricity) contributes up to 30% of global annual greenhouse gas emissions and consumes up to 40% of all energy [2]. Islamic Republic of Iran is an energy-rich country possessing 11 percent of global oil reserves and 15.3 percent of global natural gas reserves. Among the countries with significant amount of gas reserves the country is ranked 2nd in the Organization of the Petroleum Exporting Countries (OPEC) with a potential for exports to Europe and Asia. Iran also plays a significant role in the world energy market and the global economy. However, Iran's rapidly growing own energy consumption (about 6 percent per year for the past 30 years) has raised concerns about the country's ability to continue to export oil in the next decade [3]. The main driving forces behind the rising trend of energy consumption are economic growth (5 percent average for the past 40 years), population growth (about 2 percent), and heavily subsidized energy markets (12 percent of the GDP) [3]. Rapid economic development means industrialization, urbanization and motorization [4]. While all countries will need to work together to overcome the climate change challenge, according to the World

Resources Institute's Climate Analysis Indicators Tool (CAIT), in 2011, 10 countries alone contributed to 78 percent of global CO2 emissions (excluding land-use change and forestry emissions) [5]– [7]. South Korea, Iran, Canada and Saudi Arabia are among the 10 most intensive CO2 emitters [7].

Essentially, the three major environment affecting factors related to human activity are: population growth, material use, and energy use. Shifting human activity based environmental problems from local problems to global scale problems calls for a shift from "end-of-pipe" solutions to proactive means [8]. Changing the demand trend in the local dimension in favor of energy sustainability is the linking ring that connects the needs of developing word to the use of renewable clean energies, in which can be attributed solar energy. REEEP website of Sustainable Energy Regulation Network proposes the following definition for sustainable energy: "Effectively, the provision of energy such that it meets the needs of the present without compromising the ability of fut. generations to meet their own needs. Sustainable Energy has two key components; renewable energy and energy efficiency" [9]. The World Energy Council's definition of energy sustainability is based on three core dimensions: energy security, social equity, and environmental impact mitigation. The development of stable, affordable and environmentally-sensitive energy systems defies simple solutions. These three goals constitute a "trilemma", entailing complex interwoven links between public and private actors, governments and regulators, economic and social factors, national resources, environmental concerns, and individual behaviors [10].

The management systems approach towards energy sustainability offer different energy sectors continuous improvement models, and among them ISO 50001 is one of the best-practice management systems that is based on the plan, do, check, act (PDCA) cycle. However, every society will have specific, individual needs that are hard to be addressed with a general international standard. The availability of the facilities, cult. of the society, related organizations and constructional processes, applied natural energy resources, and economic conditions vary widely from country to country. Mostly available energy management systems like ISO 50001 provide a framework for adopting an effective energy management system but they still leave the determination of objectives and targets in different levels up to each organization or entity, sometimes making them avoid setting challenging goals for improving continuously [11]. The Compound Sustainable Energy Launching (CSEL) framework is already developed to be applied in the industrial sector to address two important questions relevant to industrial sectors, namely: where to start from and how to proceed to implement an efficient energy sustainability policy and embodies three major objectives: sustainable energy attractiveness analysis, gaps and barriers identification and mitigation, and effectively assigning the capital investment in priority sustainable energy initiatives.

This paper aims at applying Soft Systems Methodology (SSM) of Peter Checkland in adapting the CSEL framework to the Iranian building sector. The structure of this paper is as following: In the first section an introduction is made on the sustainability challenges of Iran as an important owner of natural fossil energy resources and developing country with considerable CO2 emission rate. The following section presents a brief overview on the methodologies, namely CSEL framework and SSM; Section 3 will show the use of SSM to adapt CSEL framework for buildings solar energy and finally results and discussion section will be proceeded by conclusions in which fut. work will be discussed too.

2. Materials and Methods

As mentioned previously, this paper uses Soft Systems Methodology to adapt the use of CSEL framework to commercialize solar energy in Iranian building sector. The two mentioned methods are discussed as follows.

Soft Systems Methodology (SSM)

SSM is an action-oriented process of inquiry into problematical situations and deals with instructed, messy, changing, and poorly defined problems with a relevant social component. This methodology gives structure to these types of problematic situation, possibly to allow them to be dealt with in an organized manner [12].

The Four Main Activities Model of SSM, consist of [13]:

1. Finding out about the initial situation perceived as problematical.
2. Making some purposeful activity models considered relevant to the situation; each model being built on the basis of a particular worldview.
3. Using the models to question the real situation; thus structuring the discussion about the situation, aiming finding changes which are both desirable and culturally feasible.
4. Define/take the action to improve the situation. An overview of this approach can be seen in Fig. 1, where it is possible to see the cyclical nat. of the approach. As follows, the four main activities are detailed.

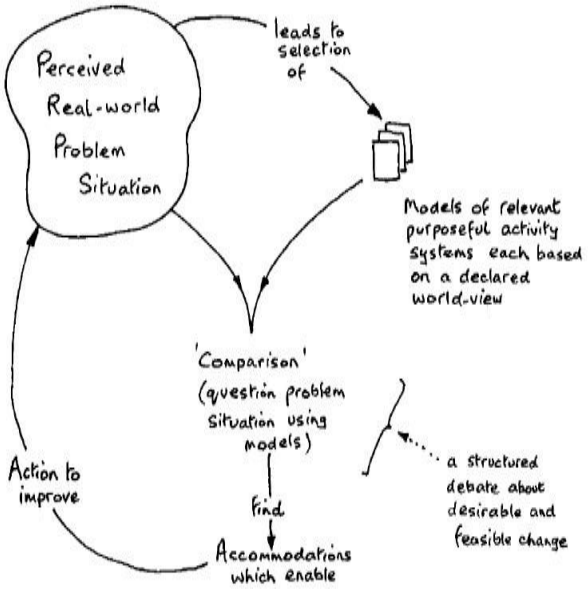

Figure 1. The inquiring/learning cycle of SSM [14]

In the first principle activity SSM uses rich pictures and carries out three kinds of inquiries, known as: Analysis One, Analysis Two and Analysis Three for addressing the continuously changing problem situation. The rich pictures in the first principal activity help familiarizing with the situation. Analysis One, or the analysis of intervention itself, consists of thinking about three key roles which are always present [14]: "Client", who causes the intervention to happen; "Practitioner", who conducts the investigation; and "Owner", regarded as being concerned about or affected by the situation and the outcome of its improvement.

Analysis Two, or analysis of the social reality, aims providing a clear idea of the social reality that is being intervened. It makes use of a particular model that illustrates the interaction between "Roles" as social positions that mark differences between members of a group or organization, "Norms" as the expected behaviours associated with and helping defining a role, and "Values" that are the standards by which behaviour in-role gets judged.

Finally, Analysis Three or political analysis covers one of the main determinants of the outcomes of a social process: the distribution of power in the social situation. This step concerns finding out via questioning two aspects of the social situation, namely, (1) How this particular cult. works? and (2) What change might be feasible and what difficulties would that change bring about? [15]. Politics is always a powerful element in determining what is "culturally feasible" (Reynolds & Holwell, 2010).

The purposeful activity models in the second principle activity are used to help structure an exploration of the addressed problem [15]. SSM uses Root Definition, CATWOE and Multi-level thinking tools in order to make purposeful activity models. The mnemonic CATWOE that is an abbreviation of the following words: Customers, Actors, Transformation process, Worldview, Owner, and Environmental constraints is applied.

Thinking in three levels can be expressed in another form of doing P by Q in order to contribute to achieving R that expands the view of the observer. This is called the PQR transformation.

SSM also recommends constructing purposeful activity models by combining two sets of activities: linked activities of operational system (an operational system to carry out the T of CATWOE); and activities which monitor the operational system and take control action if necessary.

The activity models in the third principle activity are used to question the real situation. Without these models lack of clarity and loss of focus of the discussions may occur; possibly diverting to address other (not so relevant) issues, levels, timescales, etc. In the fourth principle action according to previous SSM implementations when intending some kind of conclusion to the implementation, two common focuses arise. The first focus defines SSM as an action-oriented approach and tries to put the decisions of the previous step into an action by accommodation. Feasibility and desirability is considered, by specifying the substance of the intended change and what has to be done to enable change to occur. The second focus is a sense-making approach that clarifies the problem situation and makes it ready for actions to be taken. Sense-making approach itself can lead to action being taken [15].

3. Compound Sustainable Energy Launching Framework (CSEL)

The Compound Sustainable Energy Launching Framework (CSEL) is developed with the aim of stimulating and helping Iranian industrial companies in launching sustainable energy initiatives [16].

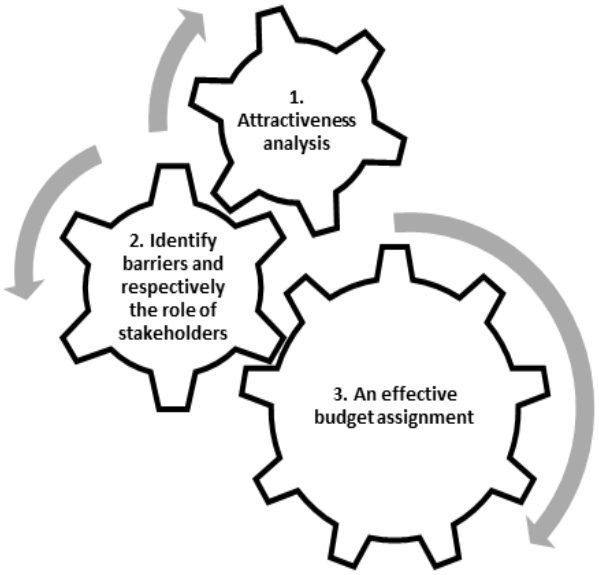

Figure2. Principle structure of CSEL framework [16]

This framework on its development process, as shown in Fig. 2, tries to fulfil three major principles as following:

1. Analysing the attractiveness of sustainable energy initiatives, among which is the use of solar energy as a

renewable energy source, in special society with its special culture

2. Identifying the barriers of energy sustainability issues, illustrating the energy sustainability gaps and respectively defining the roles and responsibilities of the respected organizations or entities in eliminating the barriers.

3. Efficient assignment of the budget.

For the attractiveness analysis CSEL framework engages the AHP model of Saaty [17] that gives an opportunity for converting qualitative data to the quantitative results of hierarchy in percentage. This framework adapts MCIR framework [18] to be used in different system levels and different energy sectors by applying SSM. And finally AHP model with some alteration helps for effective budget assignment of different industrial cost centres.

The rich picture shown in Fig. 3, illustrates some main entities and their relationships, which directly or indirectly affect the use of solar energy in the Iranian buildings. A brief introduction to the rich picture's entities is provided as follows.

Government & Legislation represents a group of entities in charge of Energy Demand Reduction (EDR) and deployment of sustainable energy measures under Resistance Economy strategies and other long-term or periodical energy strategies. Such entities are, among others, are the "Fuel Conservation Organization" of Ministry of Oil, Ministry of Energy, Energy Market Regulator, Energy Agency, Energy Commission of Parliament, Ministry of Roads and Urban Development and other public entities. These entities potentially foster sustainable energy measures through: their own initiatives; financing; taxation; legislative measures and, raising public awareness.

The Construction Engineering Organization is a nongovernmental organization that classifies the engineering and experts and train them to face construction challenges. This entity along with construction and urban development organization of the Ministry of Roads & Urban Development are in charge of granting permissions in different stages of construction to the utilization of the Iranian Buildings. So that they can play definitive role in utilization of solar energy in buildings.

The contractors work closely with Construction Engineering Organization and Supervising Engineers. Apart with the construction supervisors, the energy managers and engineers also supervise the energy management considerations in the buildings.

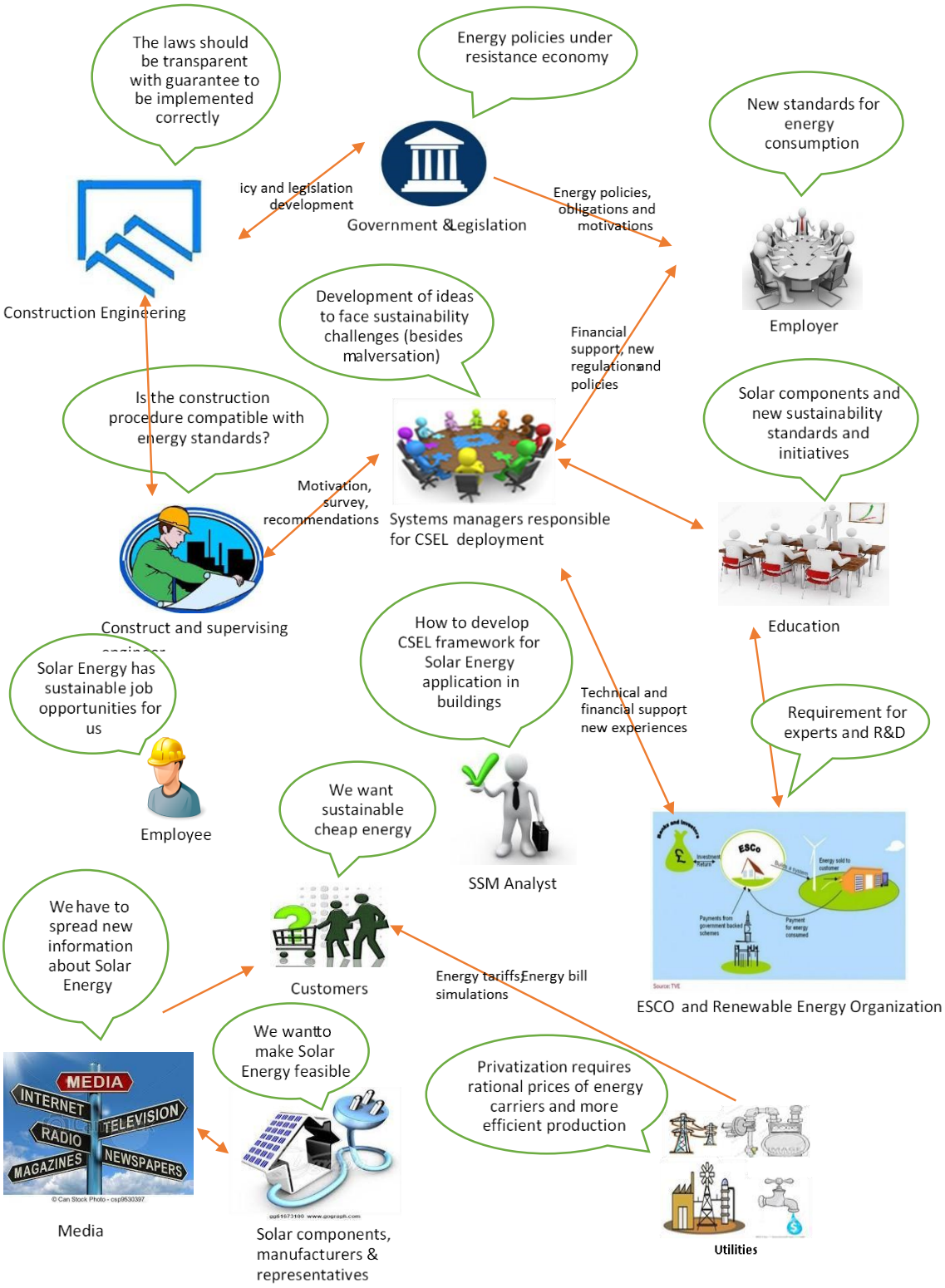

Figure3. Rich picture of the Iranian entities intervening in the solar energy development *[1]*

In Iran 97.4% of electricity generation capacity belongs to the Ministry of Energy [19]. Iran has a significant potential to catch the energy from sun and wind. Additionally, hydropower is being produced in some government-owned locations. Note that the Ministry of Energy is in charge of water and electric supplies and the Oil Ministry is in charge of fossil fuel supplies. The policies in this area, according to Sabetghadam (2006), are directed at expanding electricity capacity, natural gas production and consumption, renewable energies (REs), and also price reform policies/programs.

Energy Service Companies (ESCOs) are commercial or non-profit businesses that develop, design, implement and fund energy-saving and retrofitting projects (which reduce energy, operations and maintenance costs) [16]. ESCOs are often the project developers for energy conservation measures assuming its technical and performance risks. There is currently a need for such companies in Iran; even existing ones should be as efficient as possible, with adequate information, experience and skilled human resources. The employers have an important role in launching sustainable energy measures When an employer intends deploying EE and solar energy components, especially in Iranian construction environment, lots of barriers are eliminated and budget assignment takes place easily and effectively.

Systems Management entity on the other hand is responsible for energy management systems deployment in the construction environment, whether can be retrofit or new deployment. This entity normally is a part of ESCOs and can be defined to be the responsible agent for deployment of CSEL framework too. Yet it is important to consider that the success of deployment of any system depends on the aim and contribution inside the society (i.e. the corporate social responsibility, CSR).

Social responsibility in Iranian society can cause Customers to be more sensitive about sustainability issues and energy sustainability in construction. The solar component manufact.rs and representatives of that manufact.rs are working closely with universities and media. The R&D part of the solar component companies need to use the latest findings of the universities. The media also can protect these entities by informing customers and also by socializing the resistance economy initiatives among producers and representatives. Also the activity of media can yield to CSR in the society.

Analysis one, two and three of SSM will help the SSM analyst to have a broad vision on the Iranian building sector in order to adapt CSEL in that sector for the use of solar energy. Three key roles are as following:

- Client – Iranian government, ESCOs, or Construction Engineering Organization.
- Practitioner – a systems analyser or project developer possibly from ESCOs or a university
- Owner – Government, ESCO, or a university.

In order to build purposeful activity model, this study can have PQR transformation as following:

- P – Adapting the CSEL framework in the Iranian building sector.
- Q – Using SSM to decide on the most suitable model and respective methods.
- R – Facilitate launching Solar Energy components in the Iranian Building Sector.

The Client, Practitioner (or that of Actor) and Owner of the CATWOE the are already presented in this section.

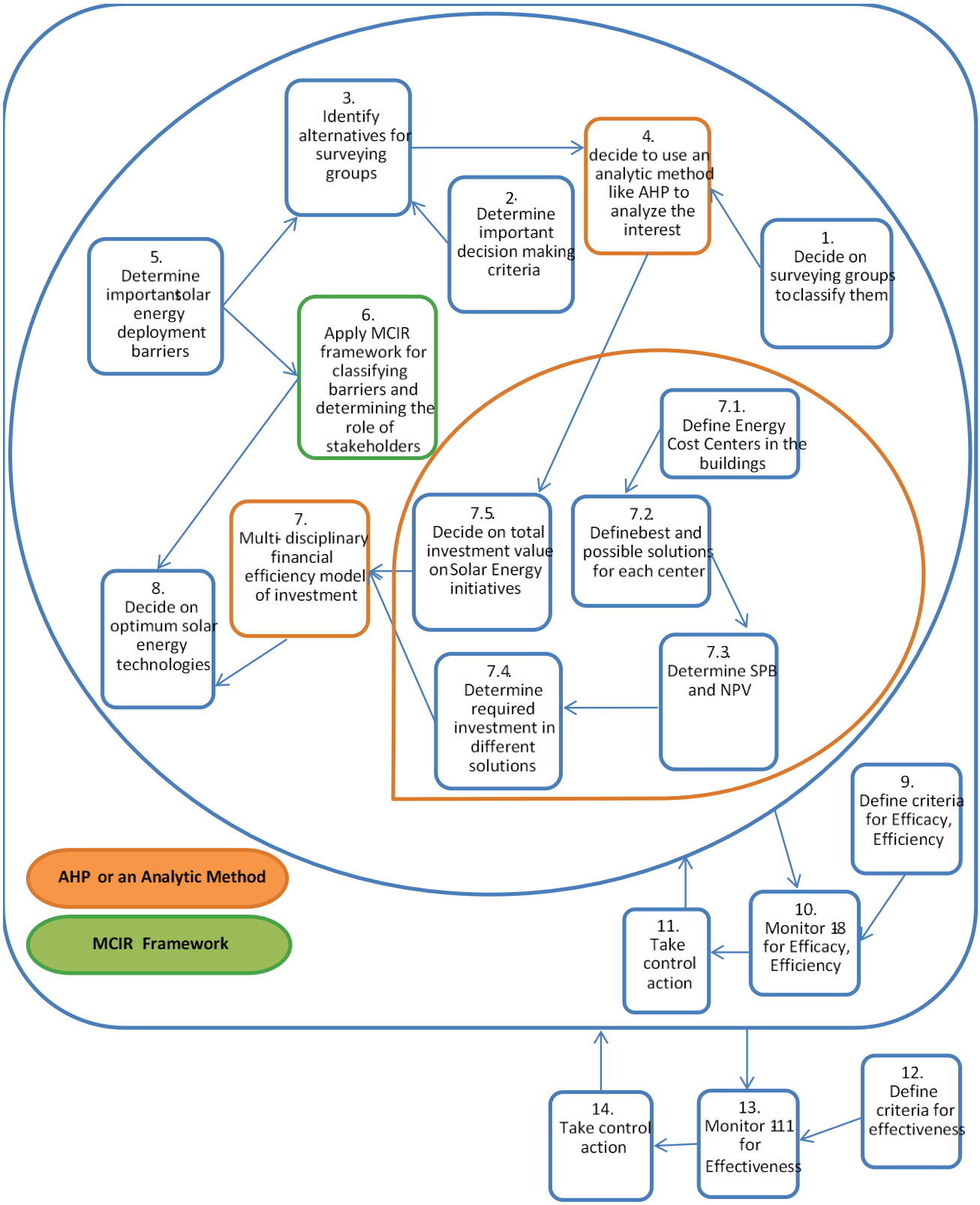

Figure4. The purposeful activity model

In order to use for Model Building the remaining parts are as follows:

- Transformation – CSEL framework for deployment of solar energy in Iranian Buildings.
- Worldview – SSM can help to adapt CSEL framework to facilitate energy sustainability and deployment of solar energy in Iranian Building Sector.
- Environment – Iran is experiencing rapid growth while there is an urgent requirement for economic evolution under resistance economy policy.

Considering this CATWOE, the root definition for the system level can be: to apply SSM in order to facilitate launching solar energy systems in Iranian building sector through systems analysts and project developers, considering rapid growth and urgent requirement for evolution in the Iranian economy.

4. Result and Discussions

The Purposeful Activity Model of this study is presented in the Appendix 2 by Fig. 4. In this model Activity 4 will be analysed for the best analytic methodology to compile data from activities 1, 2, and 3. In contrast with primary CSEL framework the MCIR framework in this work needs redefined barriers and stockholders. MCIR framework surveys the system in four stages of Motivation, Capabilities, Implementation and Results. An application of MCIR framework is presented in the Appendix 3 by Table 1. This table shows how a company dedicates the responsibilities of stakeholders to overcome energy sustainability barriers after determining them in a similar table format.

Activity 7 of the multi-disciplinary model intends to assign capital investment efficiently. The sub-activities that are shown by 7.X. format prepare required data for a rational analysis. The outcome of activity 7 should help the decision maker to efficiently assign the budget in solar energy solutions of his/her building.

5. CONCLUSION

This paper shows how SSM can help a management system framework like CSEL to be adapted in different energy sectors. Although it may be thought that this is not a typical use of SSM but by assigning more time and applying this procedure in several implementation cycles SSM can show its facilitating role in applying such a framework in solar energy deployment in the buildings.

Yet the CSEL model is already developed to be used in the industrial sector but it has to be mentioned that this framework has to develop towards maturity in different steps of application and rethinking and by expanding it in different energy sustainability initiatives, not only solar energy. Also this model has to be considered to see if it has capability to adapt with other energy sectors like transportation, commercial and agriculture. These activities along with application of different methodologies in development of CSEL framework can be considered as fut. work of this study.

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