

Step by Step for Social Innovation with Neuro-Fuzzy Modelling¹

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Abstract

Innovation as the key element of economic development is a crucial factor in social processes. Technical innovations can be identified as prerequisites and causes of social change and cannot be created without the renewal of society. Technological and economic innovations cannot respond to all social challenges. Natural and material resources are becoming more and more scarce, so it is necessary to use investment assets as efficiently as possible, maximizing social and economic efficiency. It is a major task to address the backwardness of social disparities and to create opportunities for catching up in peripheral regions. The aim of our study is to identify the local level of catching-up opportunities that arise from social innovation efforts, and model values for other disadvantaged areas. The investigated solution is presented as a case study after a structured analysis of the local initiatives of the settlement. In addition to examining the prominent role of local actors and networks, we present the process of social innovation, the framework conditions that determine systemic functioning, as well as the social needs, potentials and barriers that determine social innovation efforts. The study identifies the social, economic and political challenges associated with social needs in peripheral regions, as well as proposals for solutions based on neuro-fuzzy modelling that can be adapted to other disadvantaged areas. Exploring solutions and innovative structures and collaborations provides an opportunity to demonstrate the role of the social innovation process in local-level catching-up initiatives.

Keywords: social innovation, disadvantaged settlements, catching up, neuro-fuzzy modelling, process orientation

Introduction

A number of fundamental problems of the economy and society - such as the decrease in population, unemployment, migration, or lagging regions - require long-term solutions that need new forms of cooperation between social actors, the direct voluntary participation of citizens in decision-making processes, and the pursuit of social innovation efforts (Veresné Somosi-Varga, 2018). Social innovation and so-called technical innovations reinforce each other and as a result they can respond to local, community-level challenges, find solutions to everyday problems and thus enhance the well-being of the community. Innovations resulting from the expansion of innovative areas can be characterized as complementary processes.

Social innovation efforts can be interpreted at several levels.

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Micro-level social innovation is based on the involvement of companies, social enterprises and civil society organizations implementing social innovations at the organizational level together with the novel co-operation of citizens and local governments.

The analysis of social innovations at the meso level focuses on investigating novel regional co-operations. The exploration of contexts makes it possible to define the framework conditions that will be involved in generating regional social innovation. Defining and studying relationships between settlements, network analyses and micro-regional cooperations make it possible for us to measure the regional social innovation process.

When examining macro-level social innovation, network and systematic analysis of regional contexts is required. Examining a representative sample, a structured interview and a classical network theory approach make it possible to identify national-level social innovation efforts. Identifying global social initiatives requires the implementation of an international analysis by examining the adaptability of expert interviews and international practices.

In the first part of the study we examine the relationship between social and technical innovations, with special emphasis on the role of social efforts in the catching-up process of disadvantaged settlements. In the literature review, we also identify the factors that can be used to determine the process-oriented examination of social innovation.

In addition to determining the process-oriented framework, we examine the micro level of social innovation and the framework conditions that can be interpreted at the organizational level, which enables the identification of social innovations at organizational level and also their generating potential. Among micro-level social initiatives, we focus on exploring good practice within a structured interview. Social innovation as a new means and model to help the process of catching up is a kind of good practice in the toolbox of local governments, especially in disadvantaged regions.

We are exploring a new and innovative solution that we present in the form of a case study. Case analysis enables us to present good practice in a complex way, creating opportunities for adaptation, sustainable operation and effective implementation.

The relationship between social and technical innovation

In 1970, Dénes Gábor examined several types of innovations, and attributed the backlog of efforts to increase social welfare to the predominance of technical innovations. In his opinion, social initiatives can be identified as reforms controlling innovation (Gábor, 1970). Drucker (1985) emphasized the importance of novelty in innovation. His starting point was the fact based on empirical observations that there was a shift in the focus in the US economy. Drucker stated that the economy typically being controlled until then had shifted towards the working principle of so-called entrepreneurial economy. As a result of the entrepreneurial economy there was not a stagnant period in the American economy, which was due to the descent of the Kondratyev cycle. According to his reasoning, the development of the entrepreneurial economy was primarily due to social innovations, therefore Drucker had already emphasized the importance of social innovations in the 1980s. He argues that innovation is needed in all areas of life, innovation must not be limited to technical or economic areas, but it is also a social category. Expressing this theory he made the concept of social innovation more important.

Smeds (1994) identifies technological innovations as prerequisites and causes of social change. According to Introna et al. (1999), technological innovation cannot occur without the renewal of the society. Innovation is an "expanded" interpretation of a new or significantly improved product, process, marketing method, or organizational method in business practice, organizations or in relationships motivating cooperation (EC, 2006). The definition primarily means guidelines for technical and economic innovation, however, the European Union's research and development and innovation policy (Horizon 2020) already pays particular attention to defining social innovations. Murray and his co-workers (2010) investigated novel social co-operation and, in their opinion, new structures are developing new social solutions to address social problems through technological development. Franz et al. (2012) examine technical and social innovations separately, and emphasize the importance of the question whether innovations with new technological achievements are needed (desirable) for the society in every case. In their view, the new is not necessarily a good and desirable category, and social innovation efforts mean a wide range of practices that are widespread and accepted in the society.

The different types of innovation interact and lead to the transformation of economic and social relations.

Technological and economic innovations cannot respond to all social challenges. Natural and material resources are becoming more and more scarce, so it is necessary to use investment assets, maximizing social and economic efficiency. It is a major task to address the backwardness originating from regional disparities and to create opportunities for catching up in peripheral regions.

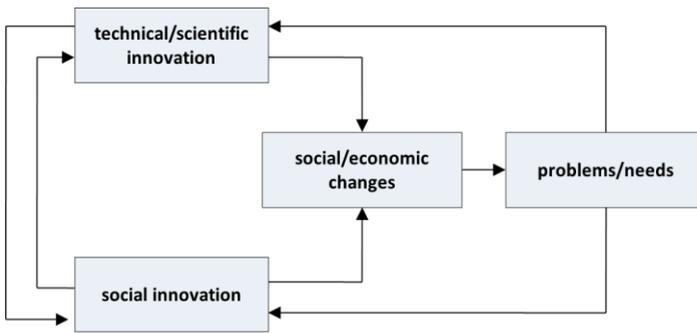


Figure 1 Embeddedness of social innovation. Source: Kocziszky-Veresné Somosi, 2016

Social innovation can be interpreted as a concept that results in meeting the needs of society, along with new or novel cooperations and structures. Social innovation efforts lead to the renewal of society while encouraging members of society to act.

After a structured review of the literature, it can be stated that the theoretical field of social innovation is divided into six basic approaches.

Approach, emphasis	Author	Main results
meeting community needs	Fairweather, G. W. (1967), Bagnasco, A. – Sabel, C. F. (1995), Hazel, C. – Onaga, E. (2003), Mulgan, G. et al. (2007), Murray, R. et al. (2012), Neumeier, S. (2012), Bulut, C. et al. (2013)	social and behavioural changes
creative problem solving, innovative cooperation	Whyte, W. F. (1982), Zapf, W. (1989), Bagnasco, A. és Sabel, C. F. (1995), Mumford, D. M. et al. (2002), Phills, J. et al. (2008), Jégou, F. – Manzini, E. (2008), Moolaert, F. et al. (2013), Balaton, K. – Varga, K. (2017)	new social relationships, renewed social organisations
addressing social challenges	Kemp, R. et al. (1998), Rotmans, J. et al. (2001), Phills, J. et al. (2008), Voss, J.-P. et al. (2009), Witkamp, M. J. et al. (2011), Weerawardena, J. – Mort G. S. (2012)	special solutions, social and technological changes
improving the quality of life and well being	Hazel, C. – Onaga, E. (2003), Mulgan, G. et al. (2007), Pol, E. – Ville, S. (2009), Peyton Young, (2011), CRISES (2012), Cajaiba-Santana, G. (2013), Kocziszky, Gy. et al. (2017)	social and technological innovations, community-related innovations
local (community-related) development	Bagnasco, A. – Sabel C. F. (1995), Moolaert, F. et al. (2005), Swyngedouw, E. (2005), Gerometta, J. (2005), Membretti, A. (2007), Jégou, F. – Manzini, E. (2008), MacCallum, D. (2009), Moolaert, F. et al. (2010), Bouchard, M. J. et al. (2013)	strengthening social cohesion, social change
link with further innovations	Gábor, D. (1970), Drucker, P. (1980), Zapf, W. (1989), Pot, F. – Vaas, F. (2008), Franz,H.-W. et al. (2012), García, M. et al. (2015)	solutions generating further innovations

Table 1 Main focus of the concept of social innovation. Source: own compilation

Social innovation as a means of catching up

Social challenges requiring long-term solutions (e.g. unemployment, migration, disadvantaged areas) require new social cooperation. Social innovation is a necessary step towards improving development and competitiveness, where the role of innovators is emphasized. Innovators are members of the local community or, more broadly, of the society, who meet the needs of new or novel solutions in response to their needs. In our research, we pay special attention to the most disadvantaged areas and explore the opportunities for catching up. In the case of lagging settlements, it is absolutely necessary to introduce novel co-operation, to identify and accurately meet local needs, to involve inhabitants in local decisions, and to analyze the impact of social innovation efforts on raising the standard of living.

The research emphasizes the importance of exploring new social innovation efforts in the process of recording good practices in the database, as novel cooperations in certain settlements and between settlements serve as examples for other disadvantaged settlements. Presenting and learning about local, regional, and international experience and practices

is useful both to the example-giving and later to the example-taking parties. The former can expand their knowledge of sustainability, while the latter can examine the challenges of adaptation and the opportunities offered by new structures.

It is a major task to address the backwardness originating from regional disparities and to create opportunities for catching up in peripheral regions. Until the 1980s, innovations that were primarily aimed at increasing the well-being of a society and a particular community, appeared alongside with technical and natural science innovations. The peripheral settlements and their need for catching-up have come to the fore. One of the reasons for this lagging behind is the failure of the international product cycle concept for Vernon. According to Vernon's (1966) theory, the production of innovation-based products is constantly shifting to less developed and later developing countries (depending on resources, expertise and cost differences).

Nowadays, the majority of the production does not work that way. R&D costs and increased computer integration do not allow for cost savings in wages as much as in the 1950s and 1960s (at the time of the conception), so there is no relocation of production while it is moving along the product life cycle. This process determines the fixation of the development disparities, the reduction in (or, in some cases, the total absence of) the chances to catch up due to social disparities. The social disparities, the reduction in the chances to catch up, the lower level of the competitiveness of the peripheries, together and also separately, require a solution that should support the chances to catch up and the reduction in the disparities (Varga, 2017).

In this catching-up process, local innovative community-level ideas and social innovations played an important role. It should be emphasized that besides the process of social innovation, it is natural sciences, engineering and economic innovation that are also of great importance, because they are able to increase the welfare of the given community together. The relationship between technical and economic innovation as well as social innovation is described by Farkas as "the latter process means the boundary condition, the working space and the medium of the previous one" (Farkas, 1984, p. 11).

There is a correlation between the economic capacity of the given region and its ability of innovation (Kocziszky-Veresné Somosi, 2016). However, innovation (the search for new and innovative solutions) needs to be interpreted more broadly than before. In line with social changes, the European Union pays more attention to the context of social innovation than before.

There is a need for a paradigm shift; besides the R&D activities in technical and natural sciences, which require more and more investment, there is a need for new, innovative solutions to address the social and economic problems of a given community (settlement, region).

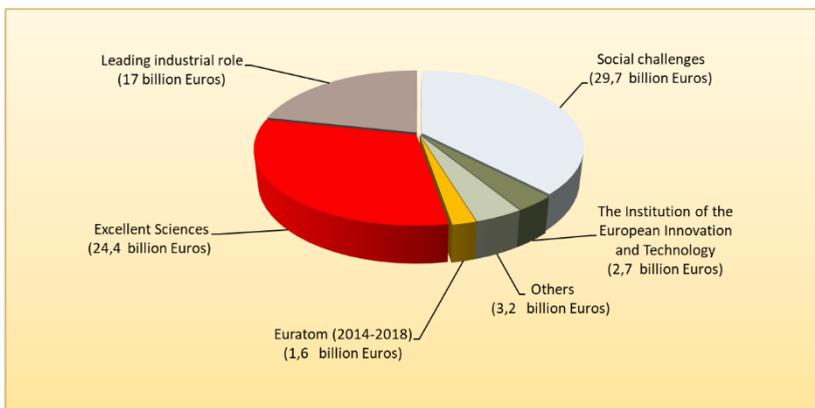


Figure 2 H2020 budget (2014-2020). Source: EU

Process-oriented analysis of social innovation

García et al. (2015) identify social innovation as a broad-spectrum process the results of which are as follows:

- resources, services are provided to meet social needs,
- confidence builds up and activity supporting marginalized groups increases,

- social relations are changing, and transformation creates new governance measures.
- Bacon et al. (2008) identified three determining factors that explain the dynamics of the social innovation process:
 - willingness to change (based on fear of threat or opportunity for innovation),
 - efficient activation of (internal) resources available for change,
 - effective achievement of available (external) resources for the implementation of the transformation process.

Resources (people, money, skills, and networks) in this interpretation represent the resources that provide positive feedback from the community for renewal.

The main areas of the social innovation process (CRISES, 2012) are as follows:

- a product and/or manufacturing-based social innovation process (employee involvement and participation in organizational processes, matching of workers and workplace regulations),
- social innovation process related to consumers / users (involving consumers, introducing new services, encouraging responsible consumption),
- an enterprise-based social innovation process (cooperation, social responsibility),
- an area-based social innovation process (new forms of governance, community development).

Bund and authors (2015) emphasize that there are the following aspects in the focus of social innovation efforts:

- identification of unsatisfied social needs,
- understanding these needs,
- the responsibility of society,
- and combinations of these factors.

The basic criterion of the social innovation process is that it should be a novel initiative. This does not necessarily mean a completely new solution, but a novel combination of previously well-functioning routines that meet the occurring social needs, thus creating new skills. In the case of social needs, it is an extremely important criterion how urgent the need is and how sustainable the proposed solution is. Social innovation is not a linear but a spiral process due to feedback. The level of occurrence, the sector where the initiative can be observed, and the examination of further developing (generating) opportunities are basic questions to be answered.

Social innovation is a dynamic process. Feedback and temporal relevance are of key importance in certain activities of social innovation.

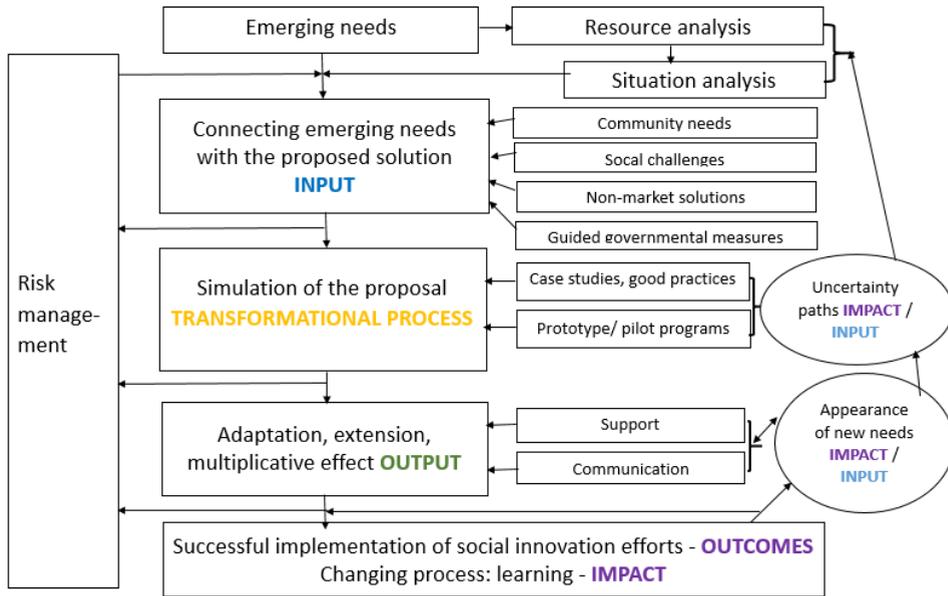


Figure 3 The dynamic process of social innovation. Source: own compilation. (Varga, based on 2018)

The initial step in the process of social innovation is the examination of emerging needs, the satisfaction of which requires prior resource analysis and related situation analysis. Connecting community needs, social challenges, non-market solutions and guided governmental measures, as well as novel responses to them, means the input factors in the social innovation process. Efforts are basically not market based solutions, but they are initiatives that also result in the renewal of the society that form the community in the long run. Risk management can also be seen as an input factor at this stage. The following step is to examine the possible and proposed solution with the help of the Falcon model, which involves the introduction of prototypes and/or pilot programs after examining case studies and good practices. This is the most uncertain phase of the social innovation process, which is constantly challenging those concerned. After practical compliance, social efforts become adaptable, then extension takes place and multiplicative effect appears. At this point in the process, the supportive atmosphere (resources, institutions, political and social framework conditions) and proper communication are important factors. At this stage of the process, either new needs can emerge or new efforts can be proposed to the community with the help of well-functioning communication channels. Successful implementation of the social initiative leads to a changing process (learning) as a result. During the process, it is necessary to consider and evaluate the risks, to develop strategies for their reduction or elimination. Following the successful implementation, new needs emerge that can be met by the socially innovative community along the above process. Therefore, social innovation is a dynamic process that results in social learning through feedback loops and constant risk assessment.

Social innovation efforts can be a proposed solution for meeting social needs and handling the challenges of peripheral regions. Social needs and challenges facing the community can be grouped in three ways:

Social Needs involving citizens, social services (healthcare, education, etc.), mobility, community	Challenge emigration, ageing, disadvantaged groups, inequality between levels of education	Economic Needs security, stability, employment, sustainability, trust	Challenge housing conditions, unemployment, financial resources, expertise	Political Needs awareness, mobilizing power, political participation	Challenge government transparency, independence of decisions, commitment
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Table 2 Social needs and challenges of peripheral regions. Source: own compilation

The lack of financial resources is a critical point in the feasibility of the social innovation process. If individual or community ideas provide new, innovative solutions for disadvantaged areas, more organizational and financial support is needed to implement the project. At the local level, the various programs of the European Union (LEADER, GINOP) provide support for economic development and innovation for municipalities with catching-up needs.

Characteristics of the system supporting the development of social innovation

In our research, we have come to the conclusion that the phase involving the development of social innovation should be supported due to the huge amount of data to be processed, i.e. the introduction of a supporting system is needed. To set up the model, we first determined the aspects and conditions that can be applied to the input data and what we would like to achieve. In order to select the right system, we reviewed the needs hierarchy of social innovation, selected the proper aspects (e.g. inhibiting factors, organizations to be involved, potential implementers, etc.) and developed the settlement statistics database.

Our aim was to create a framework where huge amounts of data can be managed on the basis of different aspects. The data that are available for us include statistics, i.e. objective data, as well as the results of interviews, which can be considered subjective data, therefore we chose to use fuzzy logic.

The fuzzy system is able to manage several data types at a time and can be perfectly combined with decision trees, which is the basis of our model. Fuzzy applications have already appeared in medical biology, insurance risk assessment, and many other areas of life. In this regard, our approach to use them in generating social innovations is a novelty. Following fuzzy logic, other sub-symbolic artificial intelligent methods have emerged: primarily neural networks, evolutionary programs, genetic programs etc., which are often combined and are commonly known as soft computing. The advantage of the fuzzy control system is that the model can be set up directly by observing input-output pairs and can be installed by tuning the quasi-optimal control algorithm. The disadvantage is that such a model can only be approximate. After studying several neuro-fuzzy models, we chose the Falcon method, which is capable of learning both parameter and system rules. In the construction of Falcon's pre-loaded network, the fuzzy weights characterizing the input and output member functions are embedded in neurons, therefore it has three hidden layers instead one.

In our study, the neuro-fuzzy model, i.e. the fuzzy logic controller based on neural network has a:

1st layer: (the input functions of the model) the area of the settlement; the number of inhabitants and their distribution by age; marital status; economic activity (workers, number of unemployed people); level of flat equipment, being the part of the sewerage or water supply system

2nd layer: whether the settlement has facilities for medical care and entertainment, such as cinema, library, museum etc.

The first step was the creation of a knowledge base, a database of existing good practices. It contains objects with their structures, fields, and attributes that are connected by fuzzy functions.

Certainly this database should constantly be updated with new good practices and statistical data. The good practices shown in the knowledge base need to be categorized, which in our case took place in line with:

- the form: technology, product, service
- the aim: enhancing the quality of life (according to a needs hierarchy)
- the level: mezo
- the way of financing: state, private, funded
- the innovator: civil organisation

The input functions of the model are the area of the settlement, the number and age distribution of the population, marital status, economic activity (workers, unemployed people, dependents), the level of equipment of the flats, agricultural area, forest. In the second round, we examined whether there are facilities for medical care and entertainment.

Case study – Social and economic challenges and solution in Mezőszemere

Hereinafter we present a social innovation initiative in a structured way, which, in response to local challenges, enhances the well-being of the population, helps disadvantaged groups, and identifies the stages of the innovation process outlined above. This case as "good practice" is the part of our knowledge base. The establishment and operation of the oil plant in Mezőszemere can be identified as a social innovation effort.

Mezőszemere is a beneficiary settlement in terms of social, economic and infrastructural issues [Gov. Decree No.105/2015. (IV. 23.)]. It is located in Füzesabony district, which is also a region to be developed (i.e. it is in a beneficiary situation). A settlement that is considered to be a beneficiary area in terms of social, economic and infrastructural aspects, or is considered to have major unemployment, and is located in the district to be developed as defined by the Governmental Decree on the classification of beneficiary districts, will receive the same treatment as areas to be developed and will have an access to grants for development.

In the course of the analysis, the establishment of the oil plant in Szeged was classified as good practice. The basic purpose of presenting good practices is to identify the tools and methods that are more effective in achieving the set goals than previously known methods. Novel and constructive approaches, techniques that can contribute to the quality standards of a given organization, can also serve as an example for other organizations (Szabó-Nagy, 2014). Among the evaluation criteria for good practices were the following:

- innovativeness,
- possibility of success,
- sustainability,
- possibility of development,
- adaptability,
- possibility of documentation
- multiplicative effect
- the process of change.

Taking the above aspects into account, we have documented good practices on three main issues. The questions focused on general information, a descriptive presentation of the practice and the reasons for good practices. This documentation principle has made it possible to fully analyze and judge the success of the exemplary practice.

The main activity of Saldo Sys Social Cooperative is to educate a healthy lifestyle among the disadvantaged young generation. The primary manifestation of their activities covers the organization of sports programs and leisure activities, their main area of activity is the settlements of the Northern Hungary region, Miskolc and its agglomeration. In order to provide the necessary resources, the Cooperative has decided to launch a business activity involving the production of cold pressed seed oil - in line with its original mission, involving disadvantaged people in employment, promoting a healthy lifestyle through the production and sales of healthy raw materials. The activity was launched with the support of the GINOP-5.1.3-16-2017-00017 "Promotion of Social Enterprises" program in a settlement called Mezőszemere in the district of Füzesabony, Hungary, in cooperation with the local government and institutions.

The municipality gave the co-operative a property in the form of a rental property, which, after renovation, became the venue of implementation. The program started with the involvement of 10 people, 6 out of which were recruited as new employees. In order to help disadvantaged workers to integrate into the economy, the Cooperative provided various training sessions for those concerned – in IT training, sales promotion and marketing communication.

The preparatory activities included the purchase and installation of the necessary equipment and machinery, training, and arranging the cooperation with business partners. The aim of forming a network was to involve organizations operating in the Northern Hungary region, this way improving the local economic activity, but due to the limited availability of special machinery, equipment and raw materials, the scope of stakeholders was extended nationwide.

The sales of the finished product take place through several channels. In the direct supply chain, the supplier of raw seeds is a company in Szarvas, whose main activities include the cultivation of oil seeds. Seed processing and oil production are carried out by the Saldo Sys Social Cooperative while the primary buyers of the finished products are a food wholesaler and an agricultural and food cooperative, so the products made by the Cooperative are used both for further sales and for the production of other products.

The Cooperative is trying to reach final consumers for direct sale by enhancing its marketing communication activities, so they are also represented at fairs and exhibitions, and they also organize product tasting events. Online presence also plays an important role – they promote the products by online advertising on their own website, as well as through offline channels, like brochures.

General information	Name / Title	Oil plant in Mezőszemere
	Contacts	Saldo Sys Social Cooperative
	Objective	Educating young people to lead a healthy life, employing disadvantaged workers
	Target group	The inhabitants of Mezőszemere (especially disadvantaged groups)
	Target region	Mezőszemere
	Necessary human resources	10 people
	Financing	Project funds, municipal support
	Necessary infrastructure	IT training, courses supporting sales promotion and marketing communication

Description of practice	Short description/needs recognition	Employing disadvantaged workers from the region, helping them integrate into social and economic life
	Realization	The finished product is sold through several channels, in the direct supply chain, the supplier of raw seeds is a company in Szarvas. Saldo Sys Social Cooperative carries out seed processing and oil production; while the primary buyer of the finished products is a food wholesaler and an agricultural and food cooperative, so the products made by the Cooperative are used both for further sales and for the production of other products.
	Results, outcomes, future prospects	10 employees (6 people are disadvantaged), IT training, sales promotion, marketing communication course, purchase and installation of machines and equipment necessary for implementation, carrying out the necessary trainings, and arranging cooperation with business partners.
	Problems and lessons learned	The aim of the network was to involve organizations operating in the Northern Hungary region, improving local economic activity, but due to the limited availability of special machinery, equipment, and raw materials, the scope of stakeholders was extended nationwide.

Why is it good practice?

Area-based approach	Similar businesses in Northern Hungary are often engaged in creating jobs and helping disadvantaged people, while the economic and social integration of workers is slow. Social cooperatives need to generate the amount of revenue that allows the business to be maintained, so it is logical to put business activities at the forefront.
A bottom-up approach	The practice clearly focuses on local needs, involving the local population in the implementation.
Partnership approach	Self-government, Hatvani-Projekt Ltd.
Innovation	Socially innovative solutions based on real social dialogue and partnership have emerged, in which the partnership goes beyond the usual forms and engages in active brainstorming.
Integrated approach	The individual measures and development programs are closely related.
Publicity / Networking	Publication, website, thesis, fairs.
Sustainability	The project responds to real needs, adjusts to needs, and cooperates with the municipality.
Transferability	Local factors, barriers and priorities can be identified as important factors. Framework conditions for improving living conditions at the local level will result in catching-up. The identification of stakeholders in the process, the role of communication (informing), the planning of financial resources, attempts to change attitudes and institutional background are all of particular importance.

Table 3 Mezőszemere – Oil plant as good practice in social innovation. Source: own compilation. (based on Szabó-Nagy, 2014 and Varga, 2018)

Comparing the results of testing with the help of the developed model, we can conclude that the social innovations implemented in the examined settlements in the recent period are compatible, i.e. our system is capable of generating new social innovations based on its knowledge base.

Conclusions

Social innovation factors are key factors in the the catching-up process of peripheral regions. While emphasizing the role of local and regional innovators the concept of social innovation deals with the novel initiatives based on the involvement of inhabitants.

In order to improve the well-being of the community, social innovation gives new answers to the everyday problems of the certain community, and as a means to respond to challenges results in a novel approach to handling regional disparities.

In seed areas technical innovations mean solution for developing life quality, however, in disadvantaged peripheral regions it is necessary to take novel initiatives such as social innovations into account. Reducing regional disparities and enhancing regional competitiveness are important factors in the innovation efforts of settlements. In our opinion the starting point for examining social innovation is the precise formulation and answering of the questions that analyse the definition, its connection with technical innovation and the territorial characteristics. One of the possible ways of the conceptual clarification of social innovation is examining the implementation of good practices.

Modelling on the basis of neuro-fuzzy logic also determines further development opportunities. With the help of good practices and expertise, proposals can be made that lead to professional advisory activity following a cost/benefit analysis.

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