ICT-Enabled Social Innovation in support to the Implementation of the Social Investment Package - IESI

Proposed methodological framework to assess the social and economic impact of ICT-enabled social innovation initiatives promoting social investment in the EU - i-FRAME V1.5 (D2.2)

Editors:
Gianluca Misuraca and Csaba Kucsera

2016
This publication is a Technical report by the Joint Research Centre, the European Commission’s in-house science service. It aims to provide evidence-based scientific support to the European policy-making process. The scientific output expressed does not imply a policy position of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of this publication.

Contact information
Name: Gianluca Misuraca
Address: JRC-IPTS, Edificio Expo, C/ Inca Garciás, 3 – 41092 Seville, Spain
E-mail: gianluca.misuraca@ec.europa.eu
Tel.: (+34) 95 4488718

JRC Science Hub
https://ec.europa.eu/jrc

JRCxxxxx

EUR xxxx xx

ISBN xxx-xx-xx-yyyy-x (PDF)
ISBN xxx-xx-xx-yyyy-x (print)

ISSN xxxx-yyyy (online)
ISSN xxxx-yyyy (print)

doi:xx.xxxx/yyyy (online)
doi:xx.xxxx/yyyy (print)

© European Union, 2016

Reproduction is authorised provided the source is acknowledged.
## History of the document

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Authors</th>
<th>Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>26.02.2016</td>
<td>JRC-IPTS</td>
<td>Draft Report</td>
</tr>
</tbody>
</table>
Acknowledgments

This report has been elaborated by the IESI Team of the Information Society Unit of the European Commission's Joint Research Centre, Institute for Prospective Technological Studies (JRC-IPTS) as part of the research on 'ICT-Enabled Social Innovation in support to the Implementation of the Social Investment Package' conducted with DG Employment, Social Affairs and Inclusion (DG EMPL). However, it is the result of a collaborative work as it integrates the findings of the 'Study to support the development of an operational framework to assess the impacts generated by ICT-enabled social innovation initiatives promoting social investment in the EU' conducted under the supervision of JRC-IPTS by Fair Dynamics Srl (Contract Number: 198568-2015 A08-IT).

Therefore, we are particularly grateful to Prof. Luigi Geppert who led the research team of Fair Dynamics Srl in implementing the support study, and who coordinated external contributions of experts, including in particular Prof. Pal Davidsen of the University of Bergen, and Douglas McKelvie from Symmetric Partnership, UK, who acted as internal peer-reviewers of the study.

This report builds on the preliminary proposal of i-FRAME (V1.0) advanced by JRC-IPTS in 2015 (see IESI D2.1) and thus we are thankful to all researchers who supported the IESI Team in the inception phase of the design of the research for their valuable insights. In particular, special thanks go to Gwendolyn Carpenter of the Danish Technological Institute (DTI), and Simona Milio of the London School of Economics (LSE), who reviewed a first draft of the i-FRAME (V1.0).

Furthermore, the development and validation of the i-FRAME benefited of inputs from participants in various events where it has been presented and discussed. More specifically, we would like to thank all the experts and representatives of stakeholders who attended the 3rd IESI workshop in Seville on 7-8 July 2015 and the participants in the workshop organised by JRC-IPTS and Fair Dynamics alongside the European Social Network’s Seminar on Integrated Services, held in Manchester on 4th November 2015, for their precious comments and suggestions.

Finally, we are indebted to our colleagues of DG EMPL, and in particular Mr Aurelio Fernandez-Lopez for his continuous guidance throughout the challenging journey towards setting up the foundations of the i-FRAME as a meta-framework for social impact assessment.

Note

This report is based on the analysis conducted as part of the 'ICT enabled Social Innovation in support to the Implementation of the Social Investment Package' Administrative arrangement (AA) for a research between JRC-IPTS and DG EMPL (No 33268-2014-01).

For more information about IESI see http://is.jrc.ec.europa.eu/pages/EAP/eInclusion.IESI.html

This report may be referenced as Misuraca, G., and Kucsera, C., (Eds.) (2016) 'Proposed methodological framework to assess the social and economic impact of ICT-enabled social innovation initiatives promoting social investment in the EU- i-FRAME V1.5 (D2.2)', European Commission's Joint Research Centre, Institute for Prospective Technological Studies, JRC Technical Reports Series.

Disclaimer: The information and views set out in this publication are those of the authors and do not necessarily reflect the official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this study. Neither the Commission nor any person acting on the Commission’s behalf may be held responsible for the use which may be made of the information contained therein.

© European Union, JRC-IPTS, 2016
Table of Contents

Executive Summary ............................................................................................................. 8
Rationale and scope of the report ...................................................................................... 8
Key results .......................................................................................................................... 8
Conclusions: the way towards i-FRAME 2.0 ................................................................. 10

1 Introduction ...................................................................................................................... 11
  1.1 Policy background and research scope ................................................................. 11
  1.2 Objectives and structure of the report ................................................................. 16
  1.3 Methodological approach ...................................................................................... 18

2 i-FRAME as a 'meta-framework' for social impact assessment ...................................... 22
  2.1 Rationale, key concepts and outline of the i-FRAME ........................................... 22
  2.2 Relevance and potential of dynamic simulation modelling: key findings from literature review comparing complex systems methods ........................................... 36
  2.3 State of the art of dynamic simulation applied to ICT-enabled social innovation and personal social services of general interest .............................................. 49

3 i-FRAME methodology and operational components ...................................................... 57
  3.1 i-FRAME methodological approach ..................................................................... 57
  3.2 Operationalising the i-FRAME methodology ...................................................... 69
  3.3 Defining relevant domain related sub-models for modelling the impacts of ICT-enabled social innovation initiatives ......................................................... 74

4 Qualitative validation of the i-FRAME methodology ...................................................... 83
  4.1 Criteria for case study selection and type of validation ......................................... 83
  4.2 Selected case studies for scenario building ........................................................... 85
  4.3 Qualitative validation of the i-FRAME through scenarios of use ........................... 88

5 Examples of quantitative application of the i-FRAME approach ...................................... 100
  5.1 TANF as example of quantitative application of the i-FRAME ............................. 100
  5.2 Social housing homeless provision in Dublin region (PASS/DRHE) ....................... 105
  5.3 Cross-case comparison and stakeholders' validation ............................................. 112

6 Conclusions and recommendations ................................................................................. 117
  6.1 Validation of the proposed i-FRAME methodology ............................................. 117
  6.2 Recommendations for further development of the i-FRAME ............................... 118
  6.3 Next steps: towards i-FRAME 2.0 ........................................................................ 123

Annex I – Review of technical and organisational options ............................................. 125
Annex II – Data gathering template .................................................................................. 135
References ......................................................................................................................... 141
List of Figures

Figure 1 – IESI Research Design ................................................................. 14
Figure 2 – Methodological approach for developing and validating the i-FRAME .............................................. 18
Figure 3 – i-FRAME Outline – meta-framework to assess social and economic impacts of ICT-enabled social innovation initiatives promoting social investment ................................................................. 28
Figure 4 – Conceptual model underpinning the i-FRAME methodological approach ...................... 33
Figure 5 – Example of application of the conceptual model underpinning the i-FRAME .................. 34
Figure 6 – Level of abstraction in the conceptualisation of hybrid simulation modelling .................. 35
Figure 7 – Features and Properties of Complex Systems .................................................................. 38
Figure 8 – Shanthikumar and Sargent’s four classes of HM ............................................................. 48
Figure 9 – Three classes of HM ......................................................................................... 48
Figure 10 – Logical impact of ICT-enabled innovation of BOP population ........................................ 54
Figure 11 – Example of a System Dynamics model of 'relevant population' .................................. 61
Figure 12 – Classification of 'variables' and 'structural indicators' of a System Dynamic model ... 62
Figure 13 – Example of 'domain-related sub-models of a System Dynamic model ...................... 62
Figure 14 – Stages of stakeholders' involvement .............................................................................. 65
Figure 15 – Stages of domain experts’ involvement ......................................................................... 65
Figure 16 – Example of a dynamic simulation model (in CLD) assessing the impact of ICT investments on Silver Age ................................................................. 67
Figure 17 – Domain–related sub-models of the Example of a dynamic simulation model (in CLD) assessing the impact of ICT investments on Silver Age ................................................................. 68
Figure 18 – Example of causal loop diagram .................................................................................... 70
Figure 19 – Example of state charts ................................................................................................ 70
Figure 20 – Popular multi-methods model architectures ................................................................... 73
Figure 21 – Dynamic simulation model of ICT diffusion (example A) ............................................ 77
Figure 22 – Dynamic simulation model of ICT diffusion (example B) ............................................ 78
Figure 23 – Dynamic simulation model of broadband adoption ....................................................... 79
Figure 24 – Dynamic simulation model of Wi-Fi diffusion .............................................................. 80
Figure 25 – Dynamic simulation model of web 2.0 diffusion ......................................................... 81
Figure 26 – CLD of Societal Ageing Impact Simulation ................................................................... 89
Figure 27 – CLD of TDP and EKSOTE ......................................................................................... 93
Figure 28 – CLD of Express Train to Employment .......................................................................... 95
Figure 29 – CLD of Strategy for Digital Welfare ............................................................................. 97
Figure 30 – CLD of Telematization of Services ............................................................................. 99
Figure 31 – Causal Loop Diagram representing the Dynamic simulation model of TANF ............... 102
Figure 32 – Hybrid Model of TANF ............................................................................................ 103
Figure 33 – The results of Hybrid Model of TANF ....................................................................... 104
Figure 34 – CLD of Dublin Region Homeless Executive with PASS (simplified) ........................................ 108
Figure 35 – Stock and Flow diagram of PASS-like model ........................................................................... 109
Figure 36 – Output of simulation modelling ................................................................................................. 111
Figure 37 – Experience in simulation modelling ............................................................................................ 114
Figure 38 – Application of simulation modelling ............................................................................................ 114
Figure 39 – Perceived usefulness of simulation modelling ................................................................................ 114
Figure 40 – Sector of activity of who consider simulation modelling useful/very useful ............................... 115
Figure 41 – Perceived degree of applicability of the i-FRAME approach ....................................................... 115
Figure 42 – Sector of activity of who considers applicable the i-FRAME approach ......................................... 116
Figure 43 – Degree of feasibility of the i-FRAME approach proposed ........................................................... 116
Figure 44 – Possible approach for i-FRAME methodology large scale application ....................................... 122
Figure 45 – A possible architectural scheme of the i-FRAME based modelling and simulation deployment ............................................................................................................. 133

List of Tables

Table 1 – Comparison of Macroeconomic General equilibrium models with Dynamic Simulation models for modelling and simulation of complex systems ......................................................... 44
Table 2 – Attributes for domain 'relevant population' and their representation with SD and ABMS (source: Fair Dynamics elaboration) .................................................................................. 60
Table 3 – Methods for domain 'relevant population' ....................................................................................... 60
Table 4 – Modelling and Simulation methods comparison .............................................................................. 71
Table 5 – Examples of problems addressed with dynamic simulation modelling methods to evaluate impacts of ICT-enabled social initiative ........................................................................... 75
Table 6 – List of the selected case studies ........................................................................................................ 86
Table 7. – Recommendations to further development of the i-FRAME methodology .................................. 119
Table 8 – Comparison of ABMS software toolkits .......................................................................................... 126
Table 9 – Methodology steps and tools ........................................................................................................... 130
Table 10 – Methodology steps and resources ................................................................................................. 132
Executive Summary

Rationale and scope of the report

Assessing the impacts of ICT-enabled social innovation initiatives promoting social investments in European social systems is not an easy task for several reasons:

- The complexity of the context in which the policy interventions and the related ICT-enabled social innovation initiatives are conceived. The assessment of their impacts requires a deep knowledge of the direct and indirect dynamics of causality relationships among relevant variables and their negative and positive interactions, which are in the vast majority of the cases not linear.

- The cost and feasibility of setting up a robust counterfactual approach measuring the causality relationships of all the relevant variables that hide the possibility to directly measure the impacts produced by social policy interventions and in particular the ICT-enabled social innovation initiatives on which we are focusing our attention.

- The need of achieving consensus among the relevant stakeholders on the results of the impact evaluation process in place, which usually lacks transparency and has different value dimensions and perspectives according to the role of different actors.

The scope of this report is to present the methodological framework to assess the social and economic impact of ICT-enabled social innovation initiatives promoting social investment in the European Union (i-FRAME V1.5) proposed by JRC-IPTS after consultation with experts and stakeholders. The theoretical model and the operational components advanced as part of the i-FRAME (V1.5) address the scope of the IESI research as it is currently designed, and thus focus is on the role of ICT-enabled social innovation initiatives promoting social investment in integrated approaches to social services provision, including active and healthy ageing and long term care. In doing so a special attention is also given to the systemic impact that such initiatives may have on social protection systems, in view of the need to modernise welfare models in the EU.

In particular, this report is the result of the current phase of the IESI research project, and it aimed at reaching the following objectives:

- To develop and validate the theoretical and methodological approach for building the operational components of the i-FRAME, able to evaluate (ex-ante, in-itinere and ex-post) the social and economic impacts of ICT-enabled social innovation initiatives promoting social investment at micro-meso-macro level.

- To design the structure and operational components of the future i-FRAME simulation model that should encompass all the possible levels of analysis (micro-meso-macro) by using the same structural environment.

Key results

The report presents several important results achieved during the development of this component of the research aimed at developing the i-FRAME methodological framework.

First of all, the analysis of the state of the art and the review of literature showed that there is limited application of dynamic simulation modelling approaches, especially in relation to social policies and ICT-enabled innovation initiatives. This is confirmed by the results of the validation activities conducted which demonstrate also little experience and capacity of social policy actors to implement such methodological approach to assess the impacts of policy interventions.
Within this context the research allowed designing and validating the **i-FRAME methodology** as a structured approach which identifies the actions that are suggested to be followed to shape a dynamic simulation model of the impacts of ICT-enabled social innovation initiatives promoting social investment. As demonstrated in the validation process of the i-FRAME methodology, the circular nature of the 10 steps composing it facilitates the consensus building on modelling the structure of ICT-enabled social innovation initiatives and their expected impacts on target beneficiaries on quantitative and less subjective ways.

The 10 steps of the 'i-FRAME Methodology (the i-FRAME Decalogue)' are the following:

1. **Start from a definition of a case/problem/need**, and reconstruct the logic model representing how the case/problem/need is addressed by the ICT-enabled social innovation initiative.
2. **Define the levers for output, outcome and impact assessment** in accordance with the logic model identified, and define the indicators for impact, outcome and output assessment in accordance with levers identified.
3. **Identify the impacted and impacting domains of the case/problem/need** and how they are addressed by the ICT-enabled social innovation initiative. To this end the proposed approach is to develop Causal Loop Diagrams (CLD) that help in understand which are the main cause-effects relationships of the problem under examination.
4. **Check for similar existing dynamic simulation models** (cases available in literature and i-FRAME collected sub-models) in order to identify possible domain related sub-models already developed, if any.
5. **Look for and check the Attributes and Methods for each domain related sub-model** of the existing dynamic simulation model, and adapt and improve them according to the case/problem/need addressed by the ICT-enabled social innovation initiative.
6. **Improve the dynamic simulation model adding the domain related sub-model not already included in the existing dynamic simulation model selected from the existing ones**, and complete the logical representation of the case/problem/need addressed by the ICT-enabled social innovation initiative. To this end, develop a methodological pathway in dynamic model development that combine qualitative (CLD) and quantitative (stocks and flows and agent based models) approaches.
7. **Adapt and improve each single domain-related quantitative sub-model** (Stocks & Flows Diagram and/or state charts with analytical description of the state transitions) also through Group Model Building Approach, and **combine the sub-models in the final dynamic simulation model representing the case/problem/need addressed by the ICT-enabled social innovation initiative**. To this end use aggregate approaches (i.e. hybrid models) that can build consensus around difficult policy problems and facilitate presentation of results, as well as to leave more rooms in policymakers’ and stakeholders’ capacity to concentrate on feedbacks and develop an endogenous perspective of the policy actions.
8. **Define the conditions** (initial data/information...) **for each scenario to be studied**.
9. **Analyse the scenario through different experiments** (by changing the internal levers of the model).
10. **Compare the scenarios and define/design policy recommendations**.

The proposed methodological approach has been tested to different cases of ICT-enabled social innovation initiatives in different welfare system across EU28, and for different combination of Personal Social services of General Interest (PSSGI). The validation process of the i-FRAME methodology has clearly showed that it not only meets the need of social policy actors in assessing the impacts of ICT-enabled social innovation initiatives promoting social investment, but it is also a **desirable tool that would be applied by practitioners and policy-makers**.
Conclusions: the way towards i-FRAME 2.0

The positive results of the qualitative and quantitative validation process, as well as the evidence of the interest showed by the stakeholders in the use of i-FRAME methodology clearly open the door for a **more extensive and systematic implementation of the proposed methodological approach** for supporting policy actors in simulating *ex-ante, in-itinere* and *ex-post* impacts of initiatives where ICT-enabled social innovation plays and important role in the governance and delivery of social services.

The research has also recognized the **potential role that could be played by JRC as intermediary between policy actors, stakeholders and domain experts** for the implementation of the i-FRAME methodology at policy level. The results achieved in this phase of the IESI research suggest promising future directions. These include in particular the further development and validation of the proposed i-FRAME methodology, which would be oriented towards three main goals:

1. **To develop the i-FRAME repository of models**, focusing on ICT-enabled social innovation initiatives and encompassing major social policy interventions. This could be an important break-through in the implementation of i-FRAME at large scale. In fact, the availability of the repository of models on one side will reduce the modelling and simulation costs; while on the other side it will help in better shaping the model of a given problem in shorter time and with a higher participation of policy actors and stakeholders. However, the development of this repository of models will require a quite significantly high research effort to turn problem-driven models into general-purpose frameworks that can be used as starting points for addressing new problem/issues.

2. **To develop a user-friendly computer-based interface** that would help policy actors and domain experts to directly interact with the i-FRAME repository of models to start shaping the model of a given problem/issue. This is a crucial step required to support a wider applicability of the i-FRAME methodology. In fact, whereas the dynamic simulation approach cannot avoid the direct engagement of a model expert in the whole modelling and simulation process of a given problem, a well-structured user interface of the relational database underpinning the i-FRAME repository of models, could enhance the direct engagement of other actors in all the simulation modelling process, especially in the initial stages where it is fundamental their engagement to better define the problem specifications and the key parameters and variables of the model.

3. **To develop effective engagement tools for policy actors and domain experts** aimed at supporting their involvement in all the stages of the i-FRAME methodological approach. It is important in fact to focus the attention on the importance of Group Model Building in this process, as it is considered to be a flexible approach to dynamic simulation modelling, where one can start the process from scratch or develop preliminary models; the main objective of Group Model Building is in fact to obtain knowledge enhancement within the team and bring out and share 'mental models' in order to reach consensus on the structure of the model and the variables to be considered. This is a cornerstone for the effective application of the proposed methodology as well as the key element to further validate the overall approach and allow possible scale-up.

For this purpose, building on the results of this phase of the research, and the approach now proposed as the i-FRAME V1.5, the JRC-IPTS will develop and pilot, with the support of external experts and stakeholders, a computer-based simulation model to implement the methodological framework to assess the impacts generated by ICT-enabled social innovation initiatives promoting social investment in the EU. This will allow to further validating the conceptual and methodological approach proposed and set out the foundations for the full-fledged proposal of i-FRAME V2.0.
1 Introduction

Box 1 Summary of content of Chapter 1

This chapter introduces the report and it is organized as follows:
- §1.1 provides an overview of the policy background and the scope of the research, describing the role of i-FRAME within the IESI project.
- §1.2 presents the objectives and structure of this report.
- §1.3 summarizes the methodology designed to develop the i-FRAME proposal, including the approach followed for literature review and validation of the current phase of i-FRAME development.

1.1 Policy background and research scope

The notion that the government is not the only possible provider of public services and the only actor entrusted to face social problems and challenges is not new. The history of government is neither a history of progressive interventionism nor one of progressive retreat (e.g. privatisation, outsourcing, horizontal subsidiarity of part of welfare services passed on to NGOs and charities) but rather an oscillation between these two poles.

The creation of the modern state in the 16th century somehow restarted the move towards centralisation and public provision, which culminated in the 20th century welfare state. The late 20th century, and mainly from the 1980s, saw a resurgence of privatisation and other processes of state hollowing in the western world. Also the role of philanthropy, the non-profit sector (Salamon & Anheier, 1996) and of self-help (Weinbren & James, 2005) can trace back to many century (Philanthropy), a few century (self-help) or decades (1980s for the non-profit sector). In many domains, the importance of horizontal exchange and collaboration has been acknowledged: tacit knowledge exchanged between workers in communities of practice is a factor of economic competitiveness (Nonaka & Hirotaka, 1995); peer tutoring between students is demonstrated to be effective in increasing pupils performance (Merrell & Tymms, 2011); shared value creation examples, thanks to the close collaboration amongst private and public sectors and the citizens, shows how this new way of producing goods and services can be profitable and at the same time sustainable (Porter and Kramer, 2011).

Equally not new is the identification of dire social challenges and problems faced by societies and humanity as a whole. Certainly since the publication of the oft-cited Meadows report on the state of humanity at the Club of Rome (Meadows et al., 1972 – revisited in 2004), if not earlier, there has been discussion on the limits of permanent and exponential growth in a confined system and the considerable role technological development has played in this context. Even assuming a non-oppositional stance towards technology, Meadows suggested that the use of technological measures did not resolve the world’s central problems and instead tended to intensify them, that unforeseeable social side effects and new social problems were generally associated with even very useful new technologies and that no technical answers existed whatsoever for the most significant social problems in the modern world. This prompted a discussion regarding the necessity of a different way of life and a different economy, particularly in affluent industrial economies, as pointed out for instance by the Vienna declaration (2011) that can be considered a sort of manifesto of Innovation in Social Services as it is aimed at identifying the most relevant topics in social innovation research addressing societal challenges that are perceived in even more dramatic way in this period of long-lasting world-wide economic crises.¹

¹ Declaration signed by key stakeholders in the field of social innovation during the conference: 'ICI-2011 International Conference on Indicators and Concepts of Innovation', 19-21 September, Vienna, AT. Organized by the EC project NET4ALL society and available at http://www.socialinnovation2011.eu
In the recent years, the European Union has devised several policies promoting social innovation and social investment. In addition to many research projects addressing social innovation and social services reforms funded under the FP7 or H2020 programmes, some examples worth mentioning are the 'European Platform against Poverty and Social Exclusion' (EPAPSE) aimed at designing and implementing programmes to promote social innovation for the most vulnerable sided of the society, the 'Innovation Union' flagship, setting new conditions to improve access to finance for social enterprises, or the 'Social Innovation Europe', which provides a virtual hub for social entrepreneurs, the public and third sector organisations. Other important policy initiatives that recently addressed social innovation can be found in the legislative package on cohesion policy for 2014-2020, which includes the European Social Fund (ESF), aimed at supporting scaling up and capacity building for social innovation; the European Regional Development Fund (ERDF), which includes innovative actions in the area of sustainable urban development; and the Programme for Employment and Social Innovation (EaSI).

In this context, in 2013, the European Union adopted the Social Investment Package (SIP) to support the implementation of the EU 2020 strategy. In particular, the SIP aims to contribute to the economic growth of Europe as well as to protect people from poverty and act as economic stabiliser from inequalities. It stresses that welfare systems have to fulfil three functions: 1) social investment; 2) social protection and 3) stabilisation of the economy. The social investment approach strongly relies on the assumption that social and economic policies are mutually reinforcing and that the former, when framed in a social investment perspective, does represent a precondition for future economic and employment growth. Social investment, as outlined in the SIP, is thus the set of policy measures and instruments that consist of investment in human capital and enhancement of people’s capacity to participate in social and economic life and in labour market. In so doing social investment involves strengthening people’s current and future capacities. In other words, as well as having immediate effects, social investment policies also have lasting impacts by offering economic and social returns over time, notably in terms of employment prospects or labour market incomes.

The SIP proposes a radical change in the approach to social services design and delivery where citizens’ centric perspective and public services transformation and modernisation are the key interrelated elements of the new and more sustainable welfare systems in Europe. This is clearly evident in the way the SIP has been conceived: on the one hand, policy interventions should be designed in a life course perspective (i.e. they should represent a continuous of measures accompanying people through the key stages of their lives: childhood, working-age, parenthood, and old age). On the other hand, measures related to the various policy areas should be contemporary and mutually reinforcing. In other words, the development of institutional complementarities is a necessary condition for the implementation of successful social investment strategies. In particular, the availability of quality and enabling social services has a key role to play in ensuring the integration of policy measures. Moreover, the changed focus on addressing needs of individuals all along their life implies also that innovative approaches to social services design and delivery are expected to contribute to the modernisation of European welfare systems.

2 http://ec.europa.eu/social/main.jsp?catId=961
3 http://ec.europa.eu/research/innovation-union/index_en.cfm
4 https://webgate.ec.europa.eu/socialinnovation/europe/it
6 Jon Kvist argues that to take full advantage of social investments, the SIP needs a more coherent framework that takes into account the dynamic and multidimensional nature of social issues and social investments. He suggests that such a framework should consist of generational, life course and gender perspectives on social investments. See Kvist, J., ‘A framework for social investment strategies: Integrating generational, life course and gender perspectives in the EU social investment strategy’, Comparative European Politics, Vol. 13, No. 1, pp. 131-149, 10.1057/cep.2014.45.
7 It is important to note that: the central role of the individual, its life course approach and the contemporary use of various policy measures are central element of the SIP and therefore they are crucial in the development of the i-FRAME which entails an approach encompassing a micro-meso-macro perspective.
The SIP Communication in fact urges Member States (MS) to prioritise social investment and the modernisation of their welfare systems in order to address unemployment, poverty and social exclusion challenges brought about by the economic crisis and sustainability challenges posed by the ageing population trends. In this connection, the SIP emphasises that the potential of social innovation is further increased by the growing range of available innovative solutions based on Information and Communication Technologies (ICTs).

In this respect, it is clear that social innovation and in particular ICT-Enabled Social Innovation play an important role in supporting the implementation of the SIP as ICTs help in digitalising social services processes, reducing social services fragmentation and duplication across organisations and countries, as well as contributing in making the services more proactive and closer to the point of need. It is also an opportunity to directly engage the citizens in the whole social services process design and management, and to activate continuous improvement processes of the European social protection systems making them more inclusive and self-sustainable in a mid-long term perspective.

In this context, the European Commission's DG Employment, Social Affairs and Inclusion (DG EMPL) and the Joint Research Centre, Institute for Prospective Technological Studies (JRC-IPTS), through its Information Society Unit, have entered in an Administrative Arrangement to conduct a research project entitled 'ICT-enabled Social Innovation in support to the Implementation of the Social Investment Package' (hereafter IESI).\(^8\)

The overall goal of IESI is to support the implementation of the EU Social Investment Package (SIP) by addressing how ICT-enabled Social Innovation can support social investment policies.\(^9\)

More specifically, the specific objectives of the research are to:

1. Provide a deeper understanding of how EU Member States can make better use of ICT-enabled social innovation to implement the actions suggested in the SIP.
2. Develop a methodological framework of analysis of the impacts generated - from micro to macro level - by ICT-enabled social innovation initiatives promoting social investment.
3. Contribute to building evidence-based input to social policy innovation gathering knowledge, providing results of a structured analysis of initiatives and sharing successful experiences implemented in EU Member States.

The main results expected from the research are to better understand how ICT-enabled social innovation initiatives can contribute to simplifying administrations; better targeting benefits and services (e.g. through simpler procedures, better information or one-stop-shops); improving the management, provision and coordination of services; designing high-quality and cost-effective services meeting the needs of citizens; and supporting access to and take-up of social services.

IESI is a three-year research project designed according to three interrelated Work Packages (WP), as shown in Figure 1 which describes schematically the IESI research design:

WP1 - Systematic mapping and analysis of ICT-enabled social innovation initiatives across EU28;
WP2 - Methodological framework of analysis of impacts: i-FRAME design, testing and validation;
WP3 - Thematic analysis/case studies: focusing on the role of ICT-enabled social innovation promoting social investment to support the modernisation of social protection systems in the EU. This also included - in 2015 - the analysis of specific focus themes, such as the role of social enterprises, active inclusion of youth; and the prevention and rehabilitation component of the active and healthy ageing and long term care for older people area of research.

\(^8\) See the IESI Project website for more details: http://is.jrc.ec.europa.eu/pages/EAP/eInclusion.IESI.html
In 2016 other focus areas will be explored, including for example the role of ICT-enabled social innovation initiatives to tackle long-term unemployment, or in relation to the labour market implications of the emerging collaborative economy, just to mention two possible themes of particular interest for research and policy.

**Figure 1 – IESI Research Design**

With regard to the scope of the research, the starting point for the analysis is to address the Personal Social Services of General Interest (PSSGI) i.e. the services that respond to vital human needs, contributing to non-discrimination and creating equal opportunities. These have been classified according to the following 10 types:

1. Childcare
2. Education and training
3. Social assistance
4. Social care
5. Social housing
6. Employability
7. Employment
8. Social inclusion/participation
9. Civic engagement
10. Active and healthy ageing and long-term care.\(^\text{10}\)

\(^{10}\) For the scope of this research, this area is further divided into three sub-themes according to the main EC policy objectives, namely: 1) prevention, health promotion and rehabilitation; 2) integrated care; and 3) independent living.
The following activities are carried out during the three-year of the IESI research project:

- Review of relevant literature, policies, theoretical approaches and the level of deployment and integration of ICT-enabled service provision amongst EU Member States.

- Collection and documentation of relevant examples of initiatives across the EU and beyond, including countries considered to be in the vanguard in the policy areas under investigation in order to analyse the services provided by various stakeholders and intermediaries, from the public, private and third sectors, with a specific focus on the role and relationships among them, and their network effects.

- A search for insights from EU Members States and an assessment of current initiatives in order to better understand the nature and impact of ICT-enabled social innovation in support of social investment, its drivers and barriers, determinants, and diffusion paths.

Within this context, as indicated above, a key aim of the IESI project is to develop a methodological framework to assess the impacts generated – from micro to macro level – by ICT-enabled social innovation initiatives promoting social investment in the EU.

The IESI methodological framework, titled in short i-FRAME\(^{11}\) has a twofold objective:

1. to provide a structured approach to analyse the initiatives collected through the mapping activities and as a guide to conduct in-depth thematic analysis through case studies, and thus provide insights for their replicability and transferability at policy/practice level across the EU. To this end, during the first phase of the research a conceptual framework for mapping and analysing initiatives of ICT-enabled social innovation has been developed and used to analyse a sample of initiatives across the EU.

2. to serve as a framework for conducting analysis of the economic- and social returns on investment which have as key component ICT-enabled social innovation and promote social investment approaches. This will allow providing recommendations on how the European Commission and Member States could analyse (ex-ante, in-itinere and ex-post) the impact of ICT-enabled social innovations initiatives promoting social investment through integrated approaches to social services delivery.

For this purpose the conceptual framework and methodological approach underpinning the i-FRAME has been outlined by the JRC-IPTS in February 2015 and further described in the proposal of i-FRAME (V1.0) together with an initial outline of how to build the operational components of such framework (see IESI Deliverable D2.1\(^{12}\)). The initial proposal of operational components of the i-FRAME has been then further elaborated according to a structured theoretical framework of a simulation model for social impact assessment with the support of external experts during the period July 2015 – January 2016 and it has been also tested and validated through its application to selected scenarios of use drawn from case studies conducted by JRC-IPTS across the EU.

More specifically, the research activities conducted in 2015 allowed to achieve the following results which are described in this report:

- **To develop and validate the theoretical and methodological approach for building the operational components of the i-FRAME** able to evaluate (ex-ante, in-itinere and ex-post) the social and economic impacts of ICT-enabled social innovation initiatives promoting social

---

\(^{11}\) The acronym i-FRAME has been also suggested to stand for Impact Framework for Real and Meaningful Evaluation at the 2\(^{nd}\) IESI Experts and Stakeholders Consultation Workshop held in Brussels, 24-25 February 2015.

investment at micro-meso-macro level. This has been tested on 5 scenarios of use (qualitative case studies through the use of cause-effect relationships).

- **To design the structure and operational components of the future i-FRAME simulation model that should encompass all the possible levels of analysis** (micro-meso-macro) by using the same structural environment.

### 1.2 Objectives and structure of the report

This report presents the **methodological framework to assess the social and economic impact of ICT-enabled social innovation initiatives promoting social investment in the European Union (i-FRAME V1.5)** proposed by JRC-IPTS after consultation with experts and stakeholders.

The theoretical model and the operational components advanced as part of the i-FRAME (V1.5) address specifically the scope of the IESI research as it is currently designed, and thus focus is on the role of ICT-enabled social innovation initiatives promoting social investment in integrated approaches to social services provision, including active and healthy ageing and long term care. In doing so a special attention is also given to the systemic impact that such initiatives may have on social protection systems, in view of the need to modernise welfare models in the EU.

In particular, the specific objectives addressed by the research activity underlying this report are:

a. **To develop the theoretical and methodological approach for building the operational component of the i-FRAME** with the aim of evaluating (ex-ante, in-itineré and ex-post) the social and economic impacts of ICT-enabled social innovation initiatives promoting social investment at micro-meso and macro level.

b. **To validate the relationships established and the dynamic hypothesis underlying the theoretical and methodological approach developed for building the operational components of i-FRAME by testing it on 5 scenarios of use relevant to the scope of IESI project** (i.e. addressing integrated approach to social service delivery, considering various social services of general interest – PSSGI – in different welfare systems/social services delivery models).

c. **To design the structure and the operational components of the i-FRAME simulation model that should encompass all the possible levels of analysis (micro-meso-macro) by using the same structural environment**, allowing to collect data at the micro and at higher level (meso and macro) through the definition of measurable, relevant and coherent indicators, considering also the need to take into account possible counter-intuitive behaviours and a flexible approach for re-calibrating the model as a consequence of ex-post analysis or changes in the theoretical assumptions/causal relationships and/or dynamics hypothesis underlying the model and its components.

To this end this component of the research builds on work conducted as part of **Work-package 2 of IESI** and it integrates the findings of the 'Study to support the development of an operational framework to assess the impacts generated by ICT-enabled social innovation initiatives promoting social investment in the EU' conducted under the supervision of JRC-IPTS by Fair Dynamics Srl (Contract Number: 198568-2015 A08-IT). This report thus presents the key findings of these activities and it is structured as follows:

---

13 In this connection it should be underlined that this Report integrates in a single document the IESI project deliverables D2.2.1 and D2.2.2 foreseen according to the Administrative Arrangement between JRC-IPTS and DG EMPL and focusing on active and healthy ageing and long term care (D2.2.1) and on integrated approaches to social services delivery (D2.2.2) respectively.

14 As anticipated above, the design of IESI is structured according to three interrelated Work Packages: Systematic mapping (WP1), Methodological framework of analysis of impacts (WP2) and Thematic analysis/case studies (WP3).
In the remainder of **Chapter 1**, after having introduced the policy background and the scope of the IESI research, and the objectives and structure of this report, the overall methodological approach designed to develop the i-FRAME is outlined. This is complemented by a summary of the approach followed for conducting this specific part of the research, detailing the methodology for carrying out the literature review and validating the proposed operational components underpinning the i-FRAME.

**Chapter 2** discusses the rationale of the research and presents the theoretical approach advanced, building on evidence gathered from the literature review on the capability of dynamic simulation to model and simulate complex systems in comparison to other approaches.

**Chapter 3** introduces the proposed methodological framework and the operational components of the i-FRAME, providing also a review of the state of the art of the dynamic simulation models used in literature to model impacts of ICT-enabled social initiatives.

**Chapter 4** provides an overview of the results of the qualitative validation of the i-FRAME methodological approach through its application to six case studies drawn from the repository of cases identified by JRC-IPTS.

**Chapter 5** describes the results of the quantitative validation of the i-FRAME methodological approach, providing the findings of the application of i-FRAME to two policy initiatives: the first is an USA programme aimed at sustaining needy families and support their members in finding jobs (TANF), while the second case is an initiative adopted in the Dublin region in Ireland to improve the planning, provision and monitoring the region’s social services of homeless people to find a permanent accommodation, making use of ICT-enabled social innovation (PASS / DRHE).

**Chapter 6** outlines the conclusions derived from the quantitative and qualitative validation of the i-FRAME methodological approach proposed. It also provides recommendations for further research and the next steps development of the i-FRAME computer-based simulation model.

The **Annexes** to this report include:

- **Review of technical and organizational options** to be considered for further development of the i-FRAME as a computer-based simulation model (**Annex I**).

- **Data gathering template for scenarios of use**: a checklist with exemplificative questions to acquire information and data useful to get insight from cases of ICT-enabled social innovation initiatives, and thus support the design and validation of the i-FRAME methodology (**Annex II**).
1.3 Methodological approach

1.3.1 Overall approach for co-developing the i-FRAME

The methodological approach proposed for developing the i-FRAME is composed of a number of sequential activities unfolding during the entire period of implementation of the IESI project and running in parallel to the other Work-packages (WP1 and WP3) receiving inputs from them as well as providing specific contributions to their development and implementation.

As described in the Figure 2 below, the approach is iterative and based upon desk research to conduct the review of the state of the art on social impact assessment in general and with a specific focus to the policy areas under investigation; conceptual work to outline and structure the proposal of i-FRAME meta-framework and related operational components and consultation with experts drawn from different research, practice and policy communities, including representatives of key relevant stakeholders and policy-makers at local, regional, national and international level.

Figure 2 – Methodological approach for developing and validating the i-FRAME

More specifically, following the initial research design agreed with DG EMPL in the first half of 2014 (Task 1) a review of the state of the art and conceptualisation work (Task 2) has been conducted in parallel to the implementation of the first Round of Mapping (WP1) in 2014. This allowed the JRC-IPTS IESI Team to define, in collaboration with external experts, an initial outline of i-FRAME and proposal of approach and operational components which have been presented for discussion at the 2nd IESI Experts and Stakeholders Consultation Workshop held in Brussels on 24-25 February. Based on the feedback received at the Workshop, integration of the results of the analysis of the review of the state of the art and further conceptualisation work, the initial proposal of the i-FRAME (V1.0) has been advanced (Task 3).
The initial proposal of i-FRAME (V1.0) has been further developed according to a structured theoretical framework of a simulation model for social impact assessment with the support of a team of external experts during the period July 2015 – January 2016. This included also the validation of the theoretical model and operational components advanced as part of the i-FRAME (V1.5) through the application to selected case studies and through experts review and consultation with stakeholders (Task 4). The resulting revised proposed methodological framework i-FRAME (V1.5) is presented in this report and it will be further elaborated through testing on a number of case studies during the course of 2016, in collaboration with external experts and stakeholders (Task 5). This will allow the JRC-IPTS to develop a final proposal of the i-FRAME (V2.0) which will be presented with policy recommendations for its further use and development as a computer-based simulation model and further scaling-up at EU level (Task 6).

In this respect using the experience of the application of the i-FRAME to selected case studies (conducted as part of WP3 of IESI), as well as additional desk research and interviews with experts, recommendations for practical use and further development of the i-FRAME will be developed. These recommendations will serve to offer indications to support the European Commission, Member states and relevant organisations to conduct ex-ante analysis of potential impacts of new social policy initiatives based on ICT-enabled social innovation, as well as in-itinere and ex-post analysis of the social returns of initiatives at the end of the policy cycle.

The consolidated version of the i-FRAME is expected to be submitted as part of the final deliverable of the IESI project due in December 2016 and it shall provide a common methodological framework structured according to a series of practical components that include: typologies of initiatives, stakeholders involved, dimensions of impact, indicators, methods and tools used to analyse the economic and social return on investment of initiatives based on ICT-enabled social innovation and promoting social investment to support the modernisation of social protection systems in EU Member States.

In practice, while the development of the initial proposal of i-FRAME (V1.0) proposed in 2015 (see D2.1) was based on a categorisation of the various typologies of initiatives labelled as ICT-enabled social innovation in the policy areas under investigation, and relevant to the SIP, the related impact dimensions and variables considered in modelling the i-FRAME have been further defined in the following phase of the research, and served to advance the structured methodological framework underpinning the i-FRAME V1.5. These would serve as guidance for structuring further the operational components of the modelling and simulation approach to be developed for assessing the effects of initiatives, and thus provide a comprehensive picture of potential impacts of ICT-enabled innovations in the selected policy areas identified, as well as associate them to specific indicators, methods and tools to measure them.

In this respect in fact, it should be underlined that while the logic model underpinning the i-FRAME is necessarily generic in order to address the broad spectrum of social policy initiatives, the operational components of the i-FRAME are structured in order to address the specificities of different policy areas under investigation, taking as a key discriminant however the potential impact of ICTs to enable innovation in the respective policy areas and related services.

For this purpose, it is fundamental to acquire expert knowledge in building the appropriate modelling and simulation approaches for concrete policy initiatives. An important component of the methodological approach for 'co-developing' the i-FRAME during the IESI project thus resides in the continuous involvement of experts and representatives of stakeholders through peer-review, workshops and dissemination of preliminary results in relevant scientific and policy events, engaging various communities of experts drawn from several research disciplines, and involving directly practitioners and policy-makers.

---

15 As part of the ‘Study to support the development of an operational framework to assess the impacts generated by ICT-enabled social innovation initiatives promoting social investment in the EU’ conducted by Fair Dynamics Srl for JRC-IPTS (Contract Number: 198568-2015 A08-IT).
1.3.2 Methodological approach for the literature review

The review of the literature conducted during this component of the research had two objectives:

1. On the one side, it aimed at comparing different methodological approaches that can be applied to the modelling and simulation of complex systems, and in particular in the field under investigation, which focuses on ICT-enabled social innovation initiatives promoting social investment in EU social services delivery. The results of this first literature review provided evidence of how Dynamic Simulation, and in particular Systems Dynamics (SD), Agent Based Modelling Simulation (ABMS) and their combination through a Dynamic Simulation Hybrid Model (DS-HM) seems to be the most suitable approach to the problem addressed by the IESI research which is characterized by non-linearity and retroactions that cannot be easily represented with other classes of modelling and simulation methods.

2. On the other side, it aimed at reviewing the existing applications of the approaches identified as the most suitable, either alone or in combination among them. In this case, the scope of the literature review was to identify examples of applications of modelling and simulation to assess the impacts of ICT-enabled social innovation initiatives, and to investigate their key characteristics, so to understand how to use them to shape i-FRAME.

To conduct the first type of literature review a cross-analysis of modelling and simulation capabilities of the following modelling methods has been conducted: General Equilibrium; System Dynamics; Markov; Agent Based; Discrete Event. They represent the most common methodological approach to modelling and simulation applied worldwide. To conduct this cross-comparison it was not performed an extensive literature review, but searching efforts concentrated in looking at recent papers discussing the advantages and disadvantages of the different methods of modelling and simulation listed above. The results of this comparison led to identify SD, ABMS and their combination in a DS-HM as the most appropriate methodological choice for this research work.

The literature review of applications of modelling and simulation approaches, on the contrary, has been developed through an extensive and systematic search. Scope of this search was the identification of clear examples of applications of SD and ABMS Modelling and simulation assessing the impacts of ICT-enabled social innovation initiatives promoting social investments, looking in particular at the so called Personal Social Services of General Interest (PSSGI).16

In this case the overall logic process flow that has been followed to conduct the literature review included the following key aspects:

- **Inclusion criteria and themes selected:** ICT innovation in social services, service innovation, social innovation, social investment; processes and impact assessment approaches of Innovation in Social Services in general and for the following PSSGI: childcare; education and training, social assistance, social care; social housing; employability; employment; social inclusion/participation; civic engagement; active and healthy ageing and long-term care.

- **Scientific databases and search engines:** Cochrane Database of Systematic Reviews, PUBMED, MED-LINE, EMBASE, Ovid, Database of Abstracts of Reviews of Effects (DARE), Dissertation Abstracts, Educational Re-sources Information Center (ERIC), Proquest, ISI Web of Knowledge., Academic Search from EBSCO Publishing; Scopus database from Elsevier; SSRN: Social Science Research Network from Social Science Electronic Publishing; SpringerLink from Springer; Web of science; Researchgate.

---

16 The list of PSSGI defined in the IESI research (see also § 1.1 above), and the ICT-enabled characteristics of the social service initiatives, which impacts are modelled through SD and/or ABMS were considered as main inclusion criteria in the literature review.
**Search strategy:** Selected terms and free text terms relating the domain of impact simulation and modelling of ICT-enabled social innovation promoting social investment in the EU were: dynamic simulation and modelling of impacts in social service delivery; dynamic simulation of ICT-enabled social services; dynamic simulation in social services delivery in general and for the specific PSSGI; combination of PSSGI with particular attention to the following links: employment and education; social inclusion; health and social care; System Dynamics and/or Agent Based Modelling applications in social service; Modelling and simulation of Social Innovation impacts, simulation and modelling of Innovation in Social Services, Modelling and simulation of ageing population impacts; Modelling and simulation of ageing society; dynamics of social service delivery processes; Process Innovation and Territorial-Local Development, Social Reforms Modelling and simulation; Evaluating Innovation in Social Services, dynamics simulation of cost-cost-benefit analysis.

**Year limitation for the reference search:** 2000 - 2015.

The initial search allowed the research team to identify 953 papers that potentially addressed the use of dynamic simulation in the fields of analysis. A further examination of the abstracts of these papers with the aim to consider only those explicitly containing the description of dynamic simulation models in the field of analysis, led to select a sub set of 137 papers, while the full reading of their contents further reduced the number of papers up to 65.

### 1.3.3 Methodological approach for validating the i-FRAME

In order to validate the theoretical and methodological approach underpinning the i-FRAME three complementary activities were carried out.

a) First of all, the i-FRAME methodology has been applied qualitatively to six 'scenarios of use' drawn from case studies conducted by the JRC-IPTS as part of a complementary component of the research (WP3). The case studies analysed qualitatively address the implementation of ICT-enabled social innovation initiatives in different EU28 Member States and for different PSSGI, and therefore they constitute an interesting testing environment to validate the possibility of using the i-FRAME methodology to dynamically simulate the impacts of such innovations in the context of social policy reforms in the EU.

b) Moreover, a quantitative validation of the degree of applicability of the i-FRAME methodology has been experimented using two cases related to the implementation of ICT-enabled social innovation in different programmes and contexts of social services delivery. The scope of this activity was to show in practical terms how the proposed approach to dynamic simulation can be applied to simulate the impacts ICT-enabled social innovation initiatives could play in various social service delivery processes.17

c) Finally, consultation with experts and representatives of stakeholders allowed the research team to gather insights from researchers, practitioners and policy-makers in order to better define the characteristics of the approach proposed. This included the organisation of a dedicated group model building session at the 3rd IESI Workshop in Seville, 7-8 July 2015 and at the i-FRAME Workshop at the ESN Seminar in Manchester on 4th November 2015; as well as the presentation of the i-FRAME for discussion in scientific and policy events, including the Social Innovation Research Conference (SIRC) in Shanghai, on 21st May 2015; the SIMPACT Workshop in Brussels on 25th June 2015; the International Conference on Complex Systems in Turin on 14th October 2015; the ICT Event in Lisbon on 21st October 2015 and at the European Institute of Public Administration (EIPA) Policy Lab on Public Sector Innovation in Barcelona on 10th of December 2015.

---

17 As it will be shown in Chapter 5, the scenarios have been selected to choose examples where it is evident the trade-off between 'upstream' and 'downstream' policy interventions enabled by ICTs in a context where shortage of resources and recidivism of the social problem are relevant constraints for the successful implementation of the policy action.
2 i-FRAME as a 'meta-framework' for social impact assessment

Box 2 Summary of content of Chapter 2

This chapter presents the rationale and the key concepts underlying the theoretical and methodological approach outlining the proposed i-FRAME. To this end the key findings of the review of literature and the state of the art in the field of dynamic simulation and modelling are discussed in view of justifying the proposal of operational components for implementing the i-FRAME.

It is organized as follows:

- §2.1 presents the rationale, key concepts and outline of the i-FRAME.
- §2.2 provides a comparison among most known and used modelling approaches and Dynamic Simulation techniques which are suggested as being the most appropriate for the operationalization of the i-FRAME.
- §2.3 discusses the state of the art of the application of Dynamic Simulation techniques in the domain of social policies and social services.

2.1 Rationale, key concepts and outline of the i-FRAME

2.1.1 Addressing the challenges of social impact assessment

The review of the literature and practice in the field of social impact assessment in general and in particular the analysis of the state of play with regard to impact assessment in social innovation and social services conducted during the first phase of the IESI research (see Misuraca et al., 2015, IESI D2.1. Draft JRC Technical Report), complemented by the findings of the analysis of the initiatives gathered through the IESI Mapping exercise in 2014 and 2015 led us to conclude that:

- There is recognition that social impact assessment is still under-researched and evaluation approaches undertaken are methodologically weak.
- Social impact assessment is still largely perceived as a 'nice to have' but it is generally not included in the design of interventions.
- There is a lack of accepted and tested methods, tools and indicators to assess the social and economic impact of ICT-enabled social innovation initiatives in general and of those promoting integrated approaches to social services in particular.

However the review confirms that although Social Impact Assessment (SIA) is less developed than the assessment of economic and financial impacts, it is gaining momentum both from a research and a policy perspective.\(^\text{18}\)

This needs of combining economic and social value aiming at finding a positive correlation among the two is also referred to as '[(Social) Impact Investing]' (e.g. Bugg-Levine, A and Emerson, J.,

\(^{18}\) This is exemplified by a report of KPMG entitled 'A New Vision of Value' which argues that societal and corporate values are inter-connected and that the current methodologies for measuring impact should shift from the financial driven impact assessments to taking into account societal values when assessing the outcomes of an initiative (KPMG, 2014a). In this report it is moreover suggested the need to develop what is defined the 'True Value method of analysis', which aims to provide a model based on case study analysis to explore the potential of monetising impacts taking into account both positive and negative externalities of social investments.
However, despite the debate on this issue is well grounded since several years now, the indications emerging from the analysis of the state of the art conducted as part of the IESI research pointed toward the need to define a methodological approach and develop a meta-framework capable of assessing the social and economic returns of initiatives promoting social investments. This is even more when it comes to assess impacts generated by ICT-enabled social innovation initiatives addressing complex phenomena such as the one involving PSSGI.

Focusing on social investment approaches, and PSSGI in particular, it is clear that additional elements of complexity are introduced to the 'system' that has to be assessed: 1. on the one hand, policy interventions should be conceived in a life course perspective (i.e. they should represent a continuous of measures accompanying people through the key stages of their lives: childhood, working-age, parenthood, and old age; and, 2. on the other hand, measures related to the various policy areas should be contemporary (i.e. occurring at the same time) and mutually reinforcing. In other words, the development of institutional complementarities is a necessary condition for the implementation of successful social investment strategies.

Taken from this perspective, evidence from review of literature and practice demonstrates that traditional econometric and innovation models have not provided a comprehensive approach that integrates: a) social, economic and environmental concerns; and b) heterogeneous agents' behaviours, roles and relationships. Therefore, in line with interdisciplinary and innovative dimensions characterising social policies, it is required to make use of alternative methods to complement more traditional evaluation techniques. This implies using foresight, scenario building, and modelling and simulation techniques to support stakeholders in coping with innovation-related uncertainties. These methods contribute in fact to understanding the various factors influencing the evolutionary process of social policies and their innovation and defining favourable conditions by considering alternative development paths and outcomes.

In this connection, and when complexity is one of the dominant aspects of a phenomenon (or a series of interlinked phenomena), the most appropriate way to analyse it as a 'complex system' is by using modelling at first and then possibly simulation in order to understand its behaviour and attempt predicting its evolution. If, for example, the situation modelled is a socio economic issue, modelling and simulation can give a numerical indication about the need for resources, the possible transition times needed to achieve an objective, the duration of an initiative, and so on. This gives a detailed qualitative idea at first and quantitative values then – when the numerical simulation is applied - to the analysis and an assessment of all the possible performance indicators applied. Consequently, it can provide evidence to underpin the ideas, doubts, and intentions of the policy and decision makers involved in possible structural, operational and organisational changes. (Geppert, L., et al., 2015).

Approaches based on modelling of complex systems, although applied often in the health sector are rarely used to address social care or social work. However, considering that social work theorists have drawn extensively on 'Systems thinking' and simulation, methodological approaches such as Systems Dynamics appears to be appropriate to illustrate the variety of phenomena that can describe possible contributions of ICT-enabled social innovation to improve delivery of social services and its impact on social policies (McKelvie, D., 2013).

The difficulty of modelling complex phenomena in social policies is further increased by the presence of human activities and their impact on the whole system. While the working rules and the constraints of a policy can be appropriately defined, tested and deployed, the application of accompanying socio economics human based actions is often biased by human behaviour that, for many reasons, is not always in line with the specifications and directives given.

Addressing the ecosystem dynamics of ICT-enabled social innovation promoting social investment definitely shows new and emerging properties that do not belong to the units that are part of the system. While the properties, interacting rules and environmental
constraints of each single unit are usually known before (ex-ante), the emergent properties of a complex system are unknown before and manifest themselves only later in time (ex-post).

Clearly all this brings with it a number of challenges that can be grouped into three main areas:

- **Analytical**: the definition of the key variables and cause-effects relationships amongst them requires an extensive review of literature and the involvement of experts in group-modelling sessions;
- **Empirical**: the lack of availability of data to test the model may hamper its application, unless a gathering data approach based on the development of scenarios of use that are close to reality / possibly real-case studies is deployed since the initial design of the model.
- **Methodological**: the validation of the theoretical and methodological approach developed for designing a model based on systems thinking and simulation requires consensus on the characteristics of the case studies to be selected and analysed during the empirical activity. This can be achieved through experts and stakeholders involvement as well as using consolidated indicators or proxy variables as baselines when available. In this respect, an additional complication is given by the needs to address different levels of aggregation, where different behaviours arise and prevail.\(^{19}\)

### 2.1.2 Basic concepts and objectives of the i-FRAME

As we have anticipated in the introduction to this report (Chapter 1) and elaborated in details in the previous Deliverables the ultimate aim of the IESI research is to better understand the nature of ICT-enabled social innovation and to assess the impacts it has or can have on supporting social investment policies and the modernisation of social protection systems in the EU.

For this purpose, according to the IESI conceptual framework (see JRC Science and Policy Report, Misuraca et al, 2015) our definition of **ICT-enabled social innovation** is the following:

\[\text{\textbf{\textquote{A new configuration or combination of social practices providing new or better answers to social protection system challenges and needs of individuals throughout their lives, which emerges from the innovative use of Information and Communication Technologies (ICTs) to establish new relationships or strengthen collaborations among stakeholders and foster open processes of co-creation and/or re-allocation of public value}}.}^{20}\] (Misuraca et al., 2015)

The **unit of analysis** of the research is considered as follows:

\[\text{\textbf{\textquote{Policy relevant experiences and initiatives which involve ICT-enabled innovations in designing and implementing services, systems or social policies more efficiently and effectively, and which address the final beneficiaries, intermediary actors or public administrations}}.}^{21}\] (Misuraca et al., 2015)

We refer to this unit of analysis with the term 'initiatives'. Initiatives have to be policy relevant - address the policy objectives of the SIP, and in particular aim to simplify and/or modernise social policies, social benefit systems and/or administrative procedures and service delivery mechanisms through ICT-enabled innovations; and present some evidence of outcomes or impact generated.

Within this context, a key goal of the IESI project is **to develop a methodological framework to assess the impacts generated – from micro to macro level – by ICT-enabled social innovation initiatives promoting social investment in the EU.**

---

\(^{19}\) This means that the typical behaviours shown at micro level, can form new, sometimes unknown behaviours at the upper levels, meso and macro. The way these can be connected in a dynamic manner requires complex modelling techniques based on computer simulation tools.

\(^{20}\) We refer to social practice as the term used in psychology theory and referring to the phenomenon that seeks to determine the link between practice and context within social situations.
In particular, the IESI research focuses on exploring how different ICT-enabled social innovations contribute enhancing social service delivery through **integrated approaches**. A current trend in social services reform, in fact, is the move towards a greater integration of service provision, so special efforts are being made by countries around the world, and EU Member States in particular, to increase the coordination of operations within the social services system with the overall aim to improve efficiency and produce better outcomes for the beneficiaries.

Integration of services refers to different approaches to improving coordination between services in order to enhance outcomes for their users (Council of Europe, 2007).\(^\text{21}\) An OECD study on social services (OECD, 2011) confirmed that better access to integrated services in healthcare, childcare, housing and care for older people contribute significantly to reducing inequality in society and thus can reduce the level of poverty across various segments of the society.

Integration has evolved significantly over the last decade as governments search for ways to address beneficiaries’ needs better and, at the same time, manage increased caseloads with reduced resources. However, no clear and precise definition of the concept of ‘services integration’ has been proposed in the literature, where several different classifications can be found (Fischer and Elnitzky 2014, KPMG-Mowat 2013, Raeymaeckers and Dierckx 2012, Kodner 2009).

In this respect, social innovation - and more concretely ICT-enabled social innovation - can provide an important contribution to social policy reform, providing new/better/different ways of integrating the provision of social services. As a matter of fact, we are in an exciting period of innovation characterised by schemes based on traditional and emerging ICTs, new funding models, and a more dynamic relationship between governments, citizens, and service providers from the private and not-for-profit sectors (KPMG-Mowat 2013).

Our definition of **services integration** is thus the following:

> ‘The increased coordination of operations across traditional functional units in the public sector, and also across other non-public sector providers, the aim being to put the final users/beneficiaries (including service intermediaries) in the centre and treat their needs holistically’. (Misuraca et al., 2015)

The focus on integrated approaches to social services is due to the fact that whereas they can generally improve efficiency of social service systems, it is assumed that they can also better solve what are known as ‘**wicked problems**’, such as the ones characterising the provision of social services in the current context of economic and social turmoil.

These problems are related to a plurality of causes and effects, overlapping and intertwined. They require multifaceted solutions and multi services provision. Therefore, social services integration can be considered as an answer to these wicked problems, and ICT-enabled social innovation as a strong 'change' factor associated with it.

This means that in the design of the i-FRAME we are interested in developing a multi-level and multi-dimensional approach aimed at addressing the following perspectives:

- **From an operational perspective (or micro-meso perspective),** the integration of services enhances organisational performance and effectiveness of services in terms of improved outcomes, efficiency and reduced costs (Fischer and Elnitzky 2014). It also increases capacity and value for money, strengthen strategic planning and system integrity, and reduces

\(^{21}\) Two types of integration are generally identified: 1) vertical integration: which implies a stronger coordination between different levels of government; and 2) horizontal integration which brings together previously separated social services. In the IESI research however we adopt a different terminology to classify the aspects of services integration. This looks at the levels of governance of service integration (which includes vertical integration but expands it to include non-governmental integration of social services provision as well) and the types of service integration (which includes horizontal integration, but also other forms of functional integration that are not only related to the service delivery system) (See JRC-IPTS, Misuraca el al., 2015).
demand for crisis services (KPMG-Mowat 2013). Moreover, from the beneficiary's perspective, it provides simplified access, holistic and customised support, faster response times, improved outcomes and user experience.

- From a system perspective (or meso-macro perspective), it must be considered that a service does not have an autonomous existence as a physical thing with technical specifications does (Crepaldi et al., 2012). It is a social construction (with its world of reference), which fits into time frames in different ways (time horizon) and into matter (degree of materiality) (Djellal and Gallouj, 2000). Thus the relational dimension plays a central role, as the relationship between the user and the service provider is direct (Bandt and Gadrey, 1994; Gadrey, 2003; Laville, 2005). ICT-enabled innovation in social services impacts on and is influenced by the interaction between actors, roles and relationships between stakeholders and end users; governance, networks and ways of interaction/cooperation; new approaches to acquiring funding and monitoring results; and new perspectives, new targets and new practices for old targets. In this context, the technological dimension can play an important role in the social service innovation process and can contribute positively to the quality and productivity of services with new solutions to policy challenges (Randle & Kippin 2014). However, in order to ensure that ICT-enabled innovation has a positive effect on social services, technologies have to be embedded in the service delivery model. In this sense, innovations where a particular application of ICTs is seen to be the solution to a social problem have a low chance of success: ICTs have to fit the social problem to be addressed, rather than the other way around (Shaw et al 2009, White et al 2010; DIT 2011).

Therefore, to address the first objective of the i-FRAME, during the previous phase of the research an analytical framework for mapping and analysing initiatives of ICT-enabled social innovation in integrated approaches to social services delivery has been developed.

The framework elaborates on the interrelationship between the four main dimensions of analysis under investigation, namely: 1) ICT-enabled innovation potential; 2) levels of governance of service integration; 3) elements of social innovation; and 4) types of service integration, and it serves to analyse the initiatives collected as part of the research, positioning them in what has been called the 'IESI Knowledge Map'. Initiatives fall into two partially overlapping 'ellipses' indicating the areas in which ICT-enabled social innovation initiatives in integrated approaches to social services provision can be placed and/or have impact. This is then analysed in a qualitative manner considering the elements of social innovation and types of service integration of each initiative and other characteristics such as the sector they belong to (i.e. public, private, third sector or multi-sector partnership).

Building on the analytical framework developed, a preliminary proposal of operational components for assessing outcomes and impacts of ICT-enabled social innovation initiatives, mainly at a micro-level of analysis, but with implications also for the meso level, has been developed and it is based on a logic model, which is a representation of how a policy, a programme or an initiative functions theoretically under specific basic conditions to achieve the desired target objectives.

In simple terms, the conditions of an intervention, a programme or a policy are understood as the factors from which the initiative, programme or policy starts. These are normally:

- the general conditions, such as economic, political or social circumstances (i.e. the context in that an intervention takes place);
- the target group specifications (i.e. attitudes, knowledge, needs and compliance of the target group members must be taken into account);

---

23 We refer here to the graphical shape of an ellipse and not to the concept of ellipse in mathematical terms.
24 This proposal has been presented in the previous Deliverable D2.1 (§4.2 and §4.3) including the key dimensions of direct and indirect outcomes and possible indicators for measuring outputs and outcomes.
During the process, the measures intended to achieve the target are implemented. The directly provided contributions of the intervention, programme or policy are referred to as **outputs** (which are directly measurable results). The **outcomes** represent the desired conditions for the members of the target groups after completion of the activities. The outputs are to produce the desired outcomes and contribute to the achievement of specific (i.e. directly linked to the initiative, programme or policy) or broader global **impacts** (i.e. affecting socio-economic conditions of the context of reference) in a way that is logically, theoretically or empirically substantiated.

However, it is clear that while the logical derivation of impacts from policies, programmes or initiatives can be assumed and at best estimated through a logic model based on theory of change, the effective cause-effect relationships cannot be substantiated through such approach.

Therefore, in order to address the **second – broader and more ambitious - objective of the i-FRAME**, that is: ‘to serve as a framework for conducting analysis of return on investment of initiatives which have as key component ICT-enabled social innovation. This will allow providing recommendations on how the European Commission and Member States could analyse (ex-ante, in-itinere and ex-post) the impact of ICT-enabled social innovations initiatives promoting social investment through integrated approaches to social services delivery’, it is required to investigate both the direct and indirect impacts of ICT-enabled social innovation on individuals' (and their quality of life for instance), and the 'systems effects' that can be promoted through this process.

In this sense, although difficult to capture there is the need to consider unintended consequences of ICT-enabled social innovation and the network effects generated within the ecosystem in which they operate. Single initiatives in fact cannot alone explain the innovation dynamics triggered by the complex and multi-network process inherent in the phenomena under investigation in this research, where ICTs contribute as both an enabling and a game-changing factor. Instead, a systems approach should be considered which integrates a complexity theory perspective (e.g. Lane et al., 2007) and a multi-level and dynamic approach to innovation (e.g. Padgett, J., and Powell, W., 2012). For this purpose, the i-FRAME is proposed to be developed as a **meta-framework** comprising several methodologies and approaches that can be applied at different levels of analysis where and when appropriate, also depending on the conditions available and the specific degree of detail required. These, through the link with the operational tools developed to gather data and estimate effects at micro-meso level shall allow us to design a theoretical model capable of estimating social and economic return on investment of initiatives (i.e. policies/programmes and projects) which have as key component ICT-enabled innovation and that could be used by policy makers at various levels to analyse (ex-ante, in-itinere and ex-post) the possible consequences of policy relevant initiatives based on ICT-enabled social innovations promoting social investment.

---

25 See JRC-IPTS presentation 'Outlining the i-FRAME' at the 2nd IESI Experts Workshop, 24-25/02/2015.
2.1.3 Outlining the i-FRAME as 'meta-framework' for social impact assessment

As depicted in the Figure 3 below and anticipated above, building on the detailed discussion made in the Deliverable (D2.1) produced in the previous phase of the research, in order to assess social and economic impacts generated at micro, meso and macro level by ICT-enabled social innovation initiatives promoting social investment through integrated approaches to social services delivery, it is suggested to set up a specific methodological framework as current approaches are limited in scope. In so doing, however the i-FRAME can benefit of existing methodologies and approaches that can be combined depending on the specific needs and levels of analysis. To this end the i-FRAME should be considered as a methodological framework providing guidelines for further operationalising different methodologies and possibly building a comprehensive (computer based) simulation model that starting from micro-simulation analysis through a meso/system level elaboration can provide specific inputs to devise appropriate macro/policy indicators.26

To do this, the i-FRAME approach requires the capability of capturing the direct effects and indirect consequences of ‘initiatives’ (i.e. policy/programme/project/activity…) and understanding how these impact on beneficiaries, organisations and possible intermediaries, as well as the social innovation eco-system and more in general the welfare system in which such initiatives are embedded. This means that socio-economic effects on individuals, organisations and the context of reference should be studied and related to the social service delivery models and welfare systems in which they operate. The specific role of ICT-enabled innovations and the social nature of the initiatives under investigation should also be factored in the analysis, possibly through quantified (and if possible even monetised) indicators and variables. For this reason ‘proxy-indicators’ may be used when data are not available or value perception of stakeholders and beneficiaries may be considered.

Figure 3 – i-FRAME Outline – meta-framework to assess social and economic impacts of ICT-enabled social innovation initiatives promoting social investment


---

26 This will be the objective of the next phase of the IESI project following the design and validation of the model to be conceptualised and designed in the current phase of the research up to December 2016.
As anticipated in Chapter 1, the overall purpose and overarching structure of the i-FRAME has been outlined for discussion first at the 2nd IESI Experts and Stakeholders Consultation Workshop which took place in Brussels on 24-25 February 2015. The initial proposal of i-FRAME has been then structured in the IESI Deliverable D2.1 following further consultation with experts and presented at the 3rd IESI Experts and Stakeholders Consultation Workshop which took place in Seville on 9-10 July 2015. During this workshop the design of the i-FRAME has been further discussed together with the approach for developing the operational components for its implementation.

However, while the broader i-FRAME outlined above remains necessarily at an high level of abstraction, the purpose of this phase of the research is to propose a concrete methodological approach through defining the operational components that may be used for the purpose of assessing impacts of ICT-enabled social innovation initiatives promoting social investment at micro-meso and macro level of analysis.

At the micro-meso level, this implies that an analysis of the diffusion and net-contribution of ICT-enabled social innovation in social services should allow – through an aggregated measurement of outcomes on beneficiaries/intermediaries and social service providers – to provide an estimation of the direct impact on social value perceived and on the performance of the social innovation ecosystem in which an initiative (being it a policy, a specific programme of intervention or a group of projects) is implemented.

For this purpose, a number of methodologies and evaluation techniques can be applied.

First of all, baselines data and benchmark indicators need to be identified where possible through review of literature and thematic analyses. The review of the state of the art made so far and the qualitative and quantitative application of the i-FRAME approach experimented in this testing phase of the research provide a preliminary overview of the existing evidence. It will however be expanded and focused in the next phase of the research, looking at specific case studies and scenarios of use (see Chapter 6).

Moreover a crucial aspect for conducting the analysis of ICT-enabled social innovation initiatives and their contribution to social services reform is the availability of sufficient and quality data. To this end, the limited availability of data for measuring performance and impacts of initiatives in the social services domain in general and in social innovation in particular, raise the fundamental need of developing a systematic collection process to gather micro-data. These will be necessary for both analyzing impacts at micro level and also to feed the modelling and simulation tools required for assessing impacts at meso and macro level.

For this reason, as part of the IESI project a great effort is being made to develop a comprehensive data collection template and a relational database which also includes a web-platform with an interactive tool for online-survey and data gathering. This shall permit to build a structured sample of initiatives from which also draw case studies and scenarios of use for testing some of the tools of the i-FRAME and its underlying conceptual framework. In the future, however, the possibility to further expand such data-collection process – which clearly has a number of limitations in terms of resources needed for its implementation - with a more data-driven approach may be explored. This may involve the development of a practical data aggregation perspective for collecting and exchanging impact data through a machine readable data formatting protocols that can capture the key data generated by various impact reports and assessments, using data available on the web for context and other system's related variables.

---

27 See http://is.jrc.ec.europa.eu/pages/EAP/eInclusion/201502WS.html
28 The IESI Database and Web Application is structured according to a common Template for Data Collection composed of three separated but interconnected modules: 1. Inventory; 2. Mapping; and 3. Case Studies.
29 This approach has been experimented in the UK where social investors are working towards a common industry standard framework for exchanging financial data of social investments known as EXIST (OECD, 2015).
Additional data, including perceptions and value preferences, as well as relations among stakeholders, and agents’ behaviours are also needed to be captured in order to better understand implications and effects of initiatives on the social innovation ecosystem. For this purpose, an array of techniques including cost-benefit analysis and in-depth case studies, stakeholders' survey and behavioural analyses, including in particular Agent Based Modelling (ABM) can be performed.

Once again, the way data are collected and structured is pivotal as it would allow the standardisation of information for modelling and simulation purposes. The common template for data gathering mentioned above will serve exactly to collect information on key variables to perform both specific evaluations and simulations.

In addition, as an instrument to both elicit specific data and unknown variables of direct and indirect effect and to attempt reaching the 'holy grail' of impact evaluation (i.e. demonstrating causality in a scientific indisputable manner) specific methodologies based on counterfactual approach to policy evaluation can be conducted. These are ways to identify the causal effect of a treatment and can be distinguished in experimental and quasi-experimental approaches. These include in particular Randomized Control Trial (RCT), which are considered the golden rule among evaluation methods for achieving robust reliable evidence.\(^3\)

Another option to gather quite unique data and robust evidence of impact is through setting up Social Policy Experimentations to test a policy intervention on a small population so as to evaluate its efficacy before deciding whether it should be scaled up.\(^3\) In this regard, it should be considered that one of the main difficulties of impact evaluation, in addition to the identification of the causality relationships between interventions and related outcomes, capable of demonstrating impacts of these interventions, relies on the complexity to link effects of interventions intervening at the micro-meso level, to the broader effects that can be evidenced at the macro level and that are normally estimated by macro-economic indicators such as contribution on GDP, employment or competitiveness.

While assessing the contribution of ICT-enabled social innovation to such macroeconomic indicators would require probably too much a level of abstraction, what the i-FRAME propose to do is however to estimate these effects indirectly through the estimation of indicators of social value impact on the welfare systems. To do so it is suggested to design a simulation model that based on alternative scenarios of use may estimate the effects of key variables of impact through forecast methods, such as for instance Systems Dynamics and Agent Based Modelling Simulation, as will be elaborated further in the proposal of operationalization of the i-FRAME (see Chapter 3) and the theoretical validity of this approach (discussed in Chapter 4 and 5). Its further implementation will be then the object of the development and piloting of the i-FRAME computer-based simulation model and of its validation through testing it on concrete scenarios of use, in the next phase of the research (see Chapter 6).

This is in line with the long-term objective of the i-FRAME which aims at becoming a reference methodological framework to help policy makers and various stakeholders to better understand the effects of policy relevant initiatives related to integrated approaches to social services.

30 Randomised Control Trials (RCTs) are ‘a type of impact evaluation which uses randomized access to social programs as a means of limiting bias and generating an internally valid impact estimate’ (according to the Best Evaluation website). However, Cartwright and Hardie (2012), in a powerful critique, point out that, by itself, a given RCT can only ‘tell you that a policy worked there, where the trial was carried out, with a given population’. Their conclusion is that to be confident that a policy will work somewhere else, with a different population, it is vital to be confident that the right support factors are in place, and that causal roles are understood correctly.

31 Social policy experimentations require both designing a potentially policy-relevant intervention and measuring its actual efficacy. They tests the validity of new innovative policies by collecting evidence about the real impact of measures on people. The main principles of social policy experimentations are: they bring innovative answers to social needs; are small-scale probing interventions to test impact; are made in conditions where their impact can be measured; and they can be scaled up if the results prove convincing. See: http://ec.europa.eu/social/main.jsp?catId=1022
provision adopting modelling and simulation approaches to complex systems as a tool to assess potential impacts of ICT-enabled social innovation initiatives at micro-meso and macro level.

As it will be showed more in details in Chapter 3, the main assumption underlying the proposal of using dynamic simulation modelling as the operational element of the methodological approach underpinning the i-FRAME, is that - under certain circumstances - it can overcome the key problem of modelling and simulating policy decisions in complex social systems by allowing policymakers and other relevant stakeholders to better understand the impact of a given policy relevant initiative by reducing 'overconfidence' of the effects they shall produce according to a specific policy-design. **This is particularly important when policy-makers have to analyse 'Downstream' and 'Upstream' interventions that represent two opposite policy measures that can be considered when addressing social problems and design policy relevant interventions**, especially when related to PSSGI and the introduction (or not) of elements of ICT-enabled social innovation.

The 'Downstream' measures in fact try to cope with the consequences of harm, after it has occurred, by focusing on specific cases in an attempt to stop things getting worse (Coote, 2012). In other words 'Downstream' measures intervene on the 'effects' of a certain event, while, the 'Upstream' measures aim to prevent harm before it occurs, by intervening on the 'causes' of the problem, trying to stop it happening (Coote, 2012). This is of particular relevance in a social investment perspective since, as we have already seen above, it is based on a changed paradigm, when anticipating the possible negative consequences of a problem is a preferred option than repairing after the problem occurred.

As we can imagine, the 'Downstream' intervention which addresses structural changes of the social service delivery processes is certainly at higher costs and less effective that the preventive one as demonstrated in several cases (see Hirsh et al., 2004 and Maggio, & Pi-Sunyer, 1997). On the contrary, the impact of 'Upstream' interventions, may be more difficult to be implemented and evaluated without any evidence based approach which results from the dynamical changes of the context where the policies actions are conceived (Simulation of Upstream and Downstream reforms in Chronic disease care service delivery, Homer et al., 2007).

'Upstream' interventions represent the most far-reaching potential for changing population behaviours addressing complex social problems (Raine, 2010) and, at the same time, they turn out to be less expensive and wasteful in terms of resources used than the 'Downstream' interventions when addressing restructuring intervention on PSSGI. However, the decision for policy-makers to adopt one type of intervention, does not exclude the possibility to use the other, but rather, any social policy providing the best balance between the two measures produces more reliable results.

In a general perspective, and in a context of social services modernisation, where usually the scarcity of resources is an ordinary condition, policy-makers try to design policy initiatives that reach the best trade-off between these two types of interventions in order to minimize costs and resources used and maximizing the expected results and effects. However, the degree of balance between the two measures depends on the behaviour of the involved stakeholders, and the dynamic of the decisions is not easy to be modelled and simulated, especially in an ex-ante situation where the policy initiatives are not yet implemented and they are characterised by high overconfidence on the positive effects of the initiative.

This is a typical situation where dynamic simulation is useful since it helps policy makers and relevant stakeholders to better understand the consequences of their decisions before they happen. To this end however, it is required to combine at the same time and under several mutually interrelated perspectives:

- different layers of analysis (micro-meso-macro);
- individual perspective and behaviour with the view of the individuals as member of a given community and of the society;
• stakeholders perspectives and behaviours at different layer of interaction;
• effects that can be achieved in different time period over the time;

For this reason, assessing the impact of policy interventions based on ICT-enabled social innovation initiatives, and the impacts that such initiatives can produce on the modernization processes of social services delivery is not an easy task because of:

• the complexity of the context in which the policy interventions and the related ICT–enabled social innovation initiatives are conceived. The assessment of their impacts requires a deep knowledge of the dynamics of causality relationships among relevant variables and their negative and positive interactions that usually are not linear.

• the cost of setting up a robust counterfactual approach measuring the causality relationships of all the relevant variables that hide the possibility to directly measure the impact produced by the social policies and the related ICT-enabled social innovation initiatives.

• the need to achieve a wide consensus among the relevant stakeholders on the results achieved with the impact evaluation process in place that usually lacks transparency and consensus.

A possible representation of all the above characteristics of the problem under examination can be done as in the Figure 4 below, which describes the interaction of the human actions/behaviour in a multidimensional space (micro-meso-macro levels). The horizontal arrow represents the axes of the time along with the sphere of the health-related behaviour and actions of an individual moves from birth to the death. Along this time period, the individual interplays with a multidimensional space that represents the characteristics of the person (i.e. his/her lifestyle and related risk factors) and the external environment (i.e. the context) in which the individual lives from the micro level, to the meso and macro level of interaction.

Individual behaviour is influenced by structured contingency within the social and physical environment and by lifestyle and related risk factors. Structural contingencies are represented by opportunities and constraints that are generated by the environment where the individual lives and can be produced in different layers of interaction from micro to meso and macro, while lifestyles and risk factors are mainly influenced by actions and the behaviour of the person. At the same time, lifestyle and risk factors can produce negative/positive effects on the health status of the persons and they can also change the psycho-physical condition of the individual.
For instance, if we apply the conceptual model sketched above to the life-long learning and the employment status of a person (as showed in the Figure 5 below), the knowledge capital changes along with the life course of an individual and it can be influenced by the micro-meso-macro characteristics of the context where the individual lives. In particular, cultural norms and the structure of the cultural offer of a given context, together with the conditions of the area where he/she is born, and the psychological hazards to which he/she is subject, determine the initial accumulation of knowledge capital of the person. At the same time, the psycho-physical and health characteristics of the person him/herself are mutually influenced at various levels by the context and, at the same time they influence the behaviour of the person and their choices and capability to meet the opportunities offered by the context where he/she lives. Thus, along with the life course of a person, his/her knowledge capital and employment status are subject to change due to human behaviour and actions, his/her psycho-physical and health status and the opportunities and constraints characterizing the context at various levels of interaction. These considerations are represented by the feedbacks loops in the Figure 5 below.
This representation of the behavior/actions of an individual along the life course, and the mutual influence of the individual behaviour with the context - at various levels of interaction -, as well as the effects of this influence on his/her psycho-physical and health condition is a well-known situation as confirmed by the studies demonstrating sensitivity effects of certain exposures. For example, studies of work and health show that employment status and working conditions exert their strongest influence during mid-adulthood (Marmot et al., 2001), while exposure to social conditions appears to be cumulative (House et al., 1994). Furthermore, several studies have consistently observed an increase of disease risk due to economic and social disadvantage (see for instance Hallqvist et al., 2004; Singh-Manoux, et al., 2004).

From the example above is fairly evident the complexity of the context underpinning the i-FRAME. At the same time, it can be easily understood that the conceptual model described above can fairly represent all the situations in which ICT-enabled social innovation impacts on the social services delivery addressing specific PSSGI, given the personal characteristic of such services.

In fact, ICT-enabled social intervention could directly act on the individual by changing his/her psychophysical and health conditions, which in turn can influence his/her behaviour and actions. At the same time, ICT-enabled social innovation can modify the context in which the person lives, by changing opportunities and releasing constraints that, in-turn, can impact on his/her actions and behaviour as well. Moreover, all these situations can happen along the life course.

Therefore, modelling and simulating this complexity which contains a lot of causality relationships, feedbacks loops and non-linearity along with the temporal axes, can be satisfied by using dynamic simulation models as those represented by System Dynamics (SD) and Agent Based Modelling and Simulation (ABMS) and in particular their combination called in the following: 'Dynamic Simulation - Hybrid Model' (DS-HM).
In this specific context, DS-HM gives us a powerful methodological approach to address all the specificity and complexity of the problem of evaluating the impact of ICT-enabled social innovation initiatives promoting social investment in social service delivery related to PSSGI. In fact, as represented in the Figure 6 below, the ABMS component of the DS-HM can easily model the dynamic characteristics of each individual belonging to the target population and allowing to simulate their behaviour along their life course; at the same time SD can represent the complexity and the dynamic of the context in which the individual operates and the evolution of its characteristics over the time due to the interaction among different layers of the system represented by causality relationships and feedback loops that can interplay with the behaviour of the individuals.

**Figure 6 – Level of abstraction in the conceptualisation of hybrid simulation modelling**

As far the modelling and simulation methods are concerned, following what is underlined by ABMS experts (see e.g. Borshev, 20013), it is also our opinion that the HM method should be preferred to other approaches mainly for the following reasons:

- The SD’s based structure represent a well-defined paradigm to catch high-level perspectives and give a high-level abstraction of the problem. In the representation of the stocks and flows language, the general logic of the system is immediately shown, is easy to be understood and depict possible counter-intuitive situations.
- Yet, a pure SD approach does not immediately shows the behaviour of the single classes of objects (people, means, sub structures) involved in the problem, or, to be said better, the effort to be applied to take into account possible behaviours of single classes of objects that make part of the problem needs the introduction of other different structures (arrays of stocks and flows) that tend to complicate the overall model.
- A pure ABMS model is sometimes difficult to be understood in term of macro general behaviours. Being the ABMS paradigm based on a bottom-up approach, it focuses on the detailed aspects of each single class of agents. The macro properties and macro dynamics of

---

32 The Big Book of Simulation Modelling, A.Borschchev, 2013, pag 240-243
the whole system depicting the problem, are often lost at the first 'on the fly' look of the structure of model sketch and are evident 'ex post', as a result of the simulation.

The Hybrid Method, i.e. the method that appropriately combines SD structures with agent’s structures, gives the following advantages:

- Catching both the high-level structures and the single agent behaviour.
- The macro properties of the system emerge from the interaction of agents (if any); this reduces the use of 'heroic assumptions' which is limited and confined to the general structure of the problem (the related system).
- Dependency on both (agents') behaviour and structures.
- Use of both stocks and events as sources of the dynamics of the problem.

In this perspective, it is proposed to further operationalise the methodological approach with the support of a Dynamic Simulation – Hybrid Model, in order for i-FRAME to:

- constitute a meta-framework allowing policy makers and stakeholders to better understand the impacts of ICT-enabled social innovation initiatives promoting social investments for the modernization of the social services delivery;
- drive the Modelling and simulation of impacts of ICT-enabled social innovation initiatives scaling-up in a given socio-economical contexts;
- support the comparison of the effects of ICT-enabled social innovation initiatives scaling-up in different welfare systems contexts.

This is particularly important considering that the primary reference actors of i-FRAME are policy makers at EC and Member States level that may derive suggestions from how they can assess from micro to macro level the impacts of ICT-enabled social innovations initiatives promoting social investment through integrated approaches to the provision of social services delivery while, at the same time, various stakeholders involved with different roles in the implementation of ICT-enabled social innovation initiatives can take advantages of i-FRAME to design their social intervention logic and understand how to measure and improve intended outcomes and maximize the social impacts of their initiatives.

### 2.2 Relevance and potential of dynamic simulation modelling: key findings from literature review comparing complex systems methods

In this section of the report, after introducing the key concepts and definitions related to modelling and simulation of complex systems (§2.2.1) the key findings of the literature review conducted to compare different methods that can be used for modelling and simulation of complex systems are reported (§2.2.2). This results from a comparison of the most common approaches used in the field, based on a critical review of the literature available in the domain. The results of the review of the state of the art with regard to the application of such approaches in the specific area under investigation in this research are then discussed (§2.2.3).

#### 2.2.1 Methodological approaches for complex systems modelling and simulation

In terms of definitions, a complex system is characterized to be adaptive to changes in its local environment and in general it is composed of other complex systems, behaves in a nonlinear fashion, and exhibits emergent behaviour (Padula et al. 2014). Following Balestrini and Robinson (2009), there is a set of features and properties common to most complex systems:
- **Dynamism**, characterized by the fact that the complexities of systems only arise as time progresses.

- The presence of a **high number of elements** (as recognized by Simon, 1976 and Corning, 1998).

- **Interdependency between the parts**, and sometimes time-dependent interdependency, with relations appearing and disappearing over time (Corning 1998, Simon 1996).

- **Nonlinearity**, leading to the fact that the interactions are not proportional to the causes, such in case of micro-nonlinearity (if-then rules), and macro-nonlinearity (feedback cycles) (Ilachinski 1996a, Lewe 2005).

- **Irreducibility**, according to which the complex system loses macro-behaviour if it is broken into its elemental parts (Ilachinski 1996b).

- **Hierarchies**, elements composing the complex system can be grouped in multiple scales in space and time, (Ilachinski 1996a).

- **Emergent and self-organizing behaviour**, given by the absence of central control or plan (Boccara 2004).

- **Many nearly equivalent configurations**, the system can have the same macro-state under different micro-states, so that non unique solutions are possible.

- **Adaptation**, which is the ability to respond to explicit or emergent perturbations in the environment (Holland 1995).

- **Life-like behaviour** as the systems can self-reproduce, adapt, evolve, and learn (Biltgen 2007).

- The presence of **intelligent agents**, individual cells of systems have an internal pattern of behaviour.

- **Non-equilibrium**, as the system is seldom in an equilibrium state (Ilachinski 1996b).

- **Collectivist Dynamics**, according to which there is a continuous feedback between the behaviour of the low-level and the high-level parts of the systems (Ilachinski 1996b).

These characteristics, as depicted in the **Figure 7**, can be grouped into two categories: those that are evident at the elemental (micro) level of the system, and those that are observed at the macro-level: complex systems in fact normally have a large number of elements, a certain number of relations (interdependence), as well as a set of shared rules by which they operate. All those features lead to a larger set of properties at the micro-level of the system.

On the other hand at macro-level there are two sets of characteristics: the observable phenomena, which are related to the emergent capability of complex systems allowing them to produce patterns at the macro level that cannot be induced from simply analysing the parts in isolation; and the properties, such as the resilience, robustness, non-linearity, flexibility, and fitness of the system.
Modelling and simulation characterize much, if not most, of the methodologies used in the complex systems realm, such as: Agent-based Modelling, Dynamic Macroeconomic Modelling, System Dynamics Modelling, Network Analysis, Discrete Event Simulation, Markov Modelling, Micro-simulation.

A model can be defined as 'a physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process' (DoD 1997), and the act of modelling as the 'application of a standard, rigorous, structured methodology to create and validate a physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process' (DoD 1997).

Under this perspective a model can be defined as a tool for aiding in the understanding and the predicting of a system’s behaviour, while simulation can be defined as the exercise (either statistically or over the time) of a model.

**Figure 7 – Features and Properties of Complex Systems**

![Diagram showing features and properties of complex systems]

Source: Couture (2007)

Simulation modelling can be useful for understanding and predicting future states. More particularly following Hughes (1997) simulation modelling is useful for exploration, explanation or extrapolation. **Exploration** can be defined as the process of searching for the purpose of discovery. On the other hand, **explanation** is the process of linking causes to effects in order to understanding, while **extrapolation** is the process of predicting outside of the known and observed. Simulation modelling can thus perform the following tasks:

- Identify critical functional and relational aspects in complex systems.
- Understand why a system behaves the way it does as a function of its structure.
- Informing decision-making by evaluating intended and unintended consequences of an intervention.
This approach gives the possibility to address only the aspects of a problem that we believe particularly meaningful while avoiding the introduction of those details that would be useless and confusing at the level of abstraction chosen for the representation of the problem. In addition, it reduces the structural complexity of the system and makes the depiction of the problem, a simplified frame where only the most important facts, properties, behaviours will be put in place, organized and analysed over the time. 

Another important aspect of a model is related to the above-mentioned expression ‘over the time’. The real goal of modelling and simulation is not only catching and representing the mere structure of cause-effect relationships generating the problem. The real goal is, instead, the ability to catch the relationship between the main variables of the problem and to include the appropriate hypothesis (feedback loops and/or state transitions charts) in order to assess the behaviour of the system (representing the problem) over the time (i.e. to include the ‘dynamic’ hypothesis that drive the evolution of the system behaviour over the time). This approach, if accompanied with a set of appropriate indicators, will show how the system changes, adapts and evolves over the time.

As for the problems of the modelling and simulation approach, we have that the solutions generated by the model are not the solutions to the problem that could be generated in the real world environment if we will able to control all the independent variables (Rainey 2004, Ackoff 1999, MchAney 1991, Neelamkavil 1987). The goodness of the solution(s) generated by the model will mainly depend: 1) on the capability to understand the problem; 2) on the expertise to make the right choice of the modelling technique; 3) on the capability to properly use them; and 4) on the capability to set up a proper validation process. Moreover creating models of complex system can demand an high amount of resources and time.

Following Marshall et al. (2015) the main elements for developing compex systems models are to:

- **Design the model and define the assumptions underlying it.** The design of the model is led by its purpose and scope, especially taking into account the endogenous factors calculated as part of model operation and exhibiting emergent behaviour, exogenous factors represented in the model, but according to pre-specified assumptions using constant values or time series; and finally a set of factors that are consciously ignored.

- **Define iterative model-building strategy and data requirements.** Simulation models have to be built and populated incrementally and adaptively through steps of adding small pieces, and running crosschecks for invariant behaviours. Empirical data is used for parameterization, incorporated into model formulation, or in model calibration, where the data is used as evidence to match against the emergent behaviour of a model.

- **Conduct a model validation, verification, and calibration.** As for validation, it is focused on the correspondence between a model and the real world phenomena under analysis. On the other hand, verification seeks to understand the extent to which the model is true to its original design, making use of assertions to check model assumptions. Finally as for model calibration, it consists in matching the model output against empirical data and often provides additional confidence into model suitability and fitn ess for purpose.

- **Make analysis of outputs and sensitivity analysis.** Obviously, an important element of the model consists in the analysis of the output related to different scenarios. Moreover, sensitivity analysis through the shock of relevant parameters is highly recommended in understanding the variability of model’s outputs in response to different assumptions.

- **Produce reporting and documentation before, during, and after the model building.** In order to ensure reproducibility it is important to publish a sufficient degree of detail on a model’s formulation, including the fundamental specifications and programming code of the model, the framework in which it was built, model parameters, any external sources of data used, and initial conditions. Furthermore, maintaining model documentation is crucial for enhancing model transparency, reducing the work associated with model changes,
communicating and sharing knowledge, avoiding model defects, supporting new members of the team, and facilitating model evolution.

- **Guarantee model maintenance and up-keep.** For the maintenance of the model, it is important to provide a periodic update reflecting the latest evidence, as it is to take into account changes in the system being modelled, in resources availability, and in interventions of interest. Often the update requires revisiting steps of the modelling process, or at least update some of the model parameters with new estimates. Sometimes new calibration and validation steps are required.

In literature there are several approaches based on modelling and simulation and used to provide evidence of social-economic impacts of policy initiatives. Here below, we provide a comparison of the most common approaches used, based on a critical review of the literature on this topic. The scope of the comparison is twofold: on one side we would like to understand their degree of applicability to modelling and simulation of complex problems as the evaluation of the impact of ICT-enabled social innovation initiatives promoting social investments; on the other side we intend to understand their degree of complementarity in modelling and simulation of such issues. The most common approaches used are the following:

- **General Equilibrium Models (GEM).** This type of models are based on economic theory and they attempt to explain the behaviour of supply, demand, and prices in a whole economy with several or many interacting markets, by seeking to prove that a set of prices exists that will result in equilibrium. More in particular the approach studies the mechanism by which the choices of economic agents are coordinated across all markets. There is a clear distinction between the general equilibrium theory and the partial equilibrium one, given by the fact that the first one attempts to look at several markets simultaneously rather than a single market in isolation. Central to the general equilibrium paradigm has been the idea that the competitive price mechanism leads to outcomes that are efficient. Pareto (1909) and Bergson (1938) have elaborated the notion of efficiency and its relationship with competitive equilibrium. This line of research culminated in the Welfare Theorems of Arrow (1951) and Debreu (1951), which states that there is equivalence between Pareto efficient outcomes and competitive price equilibrium. Arrow & Debreu (1954) and McKenzie (1959) elaborated the first complete general equilibrium model and formally demonstrated the existence of equilibrium with a productive sector formed by enterprises. In their analysis productive sector reached equilibrium when each enterprise chose the input–output combination of its set of technical possibilities that maximized profits at market prices, and Walras-style preferences through demand-side hypotheses.

- **System Dynamics Modelling (SDM).** This is a methodology for simulation used for representing the structure of complex systems and understanding their behaviour over time. It was developed in the 1950s by Jay Forrester at the Massachusetts Institute of Technology (MIT) with the goal of using science and engineering to identify the core issues that determine the success and failure of corporations. Forrester (2007), during his involvement in the study of managerial problems at General Electric, demonstrated, by the means of manual simulations of the stock-flow-feedback structure of the production plants, including the existing corporate decision-making structure for hiring and layoffs, that employment instability was due to the internal structure of the firm, not an external force such as the business cycle. Afterwards Forrester and his team at the Massachusetts Institute of Technology developed the first computer SD simulator, called DYNAMO.

- **Markov Modelling (MM).** Markov models are recursive (repetitive) decision trees that are used for modelling conditions that have events that may occur repeatedly over time or for modelling predictable events that occur over time (inter al. Briggs and Sculpher 1998). For any given system, a Markov model consists of a list of the possible states of that system, the possible transition paths between those states, and the rate parameters of those transitions. The use of Markov model simplifies the presentation of the tree structure, and it is explicitly
able to account for timing of events, whereas time usually is less explicitly accounted for in decision trees. There are four main classes of Markov models, depending on the type of system: **Markov Chain** (in which the system is autonomous and its state is fully observable); **Hidden Markov Model** (in which the system is autonomous and its state is partially observable); **Markov Decision Process** (in which the system is controlled and its state is fully observable); and **Partially Observable Markov Decision Process** (in which the system is controlled and its state is partially observable).

- **Discrete Event Simulation (DES).** This approach was formulated by Geoffrey Gordon in the 1960s (Gordon 1966, Gordon 1969), with the purpose of understanding the chronological sequence of events. It is an approach based on the concept of entities, resources and block charts describing entity flow and resource sharing (Borshchev & Filippov 2004). Discrete event simulation models systems as networks of queues and activities, where changes in state in the system occur at discrete points of time (Robinson 2004). In this respect, the objects in the system are distinct individuals, each possessing characteristics that determine what happens to that individual, and the activity durations are sampled for each individual from probability distributions. By contrast (Matloff 2008), a continuous simulation tracks the system dynamics over time, thereby it is called **Activity-Based Simulation**, and time itself is split into smaller time segments and the system state is updated according to the set of activities happening in the time segment. Another alternative approach is given by **Process-Based Simulation**, according to which each activity in a system corresponds to a separate process simulated by a thread in the simulation program. Following Pidd (1998), a more recent method is the three-phased approach to discrete event simulation, according to which in the first phase is to jump to the next chronological event, while the second phase is to execute all events that unconditionally occur at that time (B-events), and finally the third phase is to execute all events that conditionally occur at that time (C-events).

- **Agent Based Modelling (ABM).** This is the computational study of economic processes modelled as dynamic systems of interacting agents (Tesfatsion 2005, Tesfatsion and Judd 2006). In agent-based models, the atomic model element is not the social system as a whole, but it is rather the individual consumer (agent). According to this approach, consumers’ heterogeneity, their social interactions, and their decision making processes can be modelled explicitly, so that the macro-level dynamics of the social system emerge dynamically from the aggregated individual behaviour and the interactions between agents. In this way, the approach has the ability to model complex emergent phenomena that more traditional modelling approaches cannot capture easily. The agents are modelled to represent natural entities in the system under consideration, for instance human beings or institutions (Edmonds, 2000). Sometimes an agent-based simulation is referred to as **Multi Agent System**, having the following characteristics (Jennings et al. 1997): each agent has incomplete information and a limited viewpoint, there is no global system control, data is decentralized and computation is asynchronous. In such system the macro-level system behaviour is given by the micro-level behaviour of the agents (Schillo et al., 2000), so that the agent-based simulation approach can also be called **bottom-up simulation** (Axelrod 1997, Richardson 2003). The behaviour of an agent is defined by its internal state (Anderson, 1999), which can evolve and adapt by using feedback and learning algorithms (Phelan, 2001).
2.2.2 Comparison between macroeconomic equilibrium models and dynamic simulation models

Macroeconomic equilibrium models are used to estimate the potential impact of a policy issue (Arrow & Debreu 1954, McKenzie 1959). A macroeconomic model is a tool used to present a holistic view of the operation of an economy, usually in the form of a computer-based system. It is a way of collating research on the economy in a systematic and policy-relevant way.

The goal of this group of models is to replicate the main mechanisms of an entire economic system, which may consist of a region, a nation state, or a collection of nation states (e.g. the 28 members of the EU), and can consider a single sector or encompass multiple sectors of the economy. The only requirement is that the system being modelled is large enough to display the distinctive properties that are the subject area of macroeconomics. In this sense, macroeconomic models can be adapted to level of analysis depending on the sectorial and territorial coverage of the policy options as well as EC actions, which might be related to a single or multiple sectors, a single territory or to a group of countries or it could consider the whole EU. The versatility of this class of models allows taking into account different domains of analysis depending on the specific policy realms such as economics, society and environment.

Examples of these class of models are the following:

- **Macro-econometric models** (Kydland and Prescott 1991; Di Comite and Kanks 2015);
- **Input–Output models** (Miller and Blair 2009; Domonkos et al. (2013));
- **Overlapping Generation Models** (OLG) (Börsch-Supan et al., 2006; Börsch-Supan and Ludwig, 2010);
- **Computational General Equilibrium (CGE) models** (Martin and Winters 1996; Harrison et al 1997; Perry et al 2001; Goulder 2002);
- **Dynamic General Equilibrium Models** (Lucas, 1975; Kydland and Prescott, 1982; Long and Plosser, 1983);
- **Dynamic Stochastic General Equilibrium (DSGE) models** (Woodford 2003; Galí and Gertler 2007; Frank Smet and Raf Wouters, 2007).

These types of models are applied in several domains, especially in macro-economic analysis. However, as also described in the Table 2 below, it is fairly recognized that they have several disadvantages with respect to ABM and SD approach to complex systems modelling and simulation. In particular, the comparison conducted as part of the IESI research identified the following elements of weakness:

- **Difficult management of positive and negative feedbacks.** Feedback exists whenever decisions made by an agent in a system alter the state of the system itself, producing new information that conditions future decisions. In this way, the dynamics of a system emerge from the interaction of multiple feedback loops in its structure. General equilibrium models do not explicitly map the positive and negative loops taking place in a system.

- **Individual as rational agents and with perfect access to information.** General equilibrium models represent a simplification of reality in which homogeneous atomistic agents are assumed to be perfectly rational, having perfect access to information and adapting instantly to new situations in order to maximize their long-run personal advantage. Obviously, in reality agents are not perfectly rational nor all the information is available. Moreover, models with homogeneous atomistic agents fail in taking into account interactions and thereby are not able to cope with network externalities (see in the table below: Origin of Dynamics and Resolution).

- **Difficulties in managing non-linearity and emergent behaviour.** General equilibrium models work around non-linearity in order to keep the system within certain boundaries. A
typical example is given by diminishing returns of production factors. Therefore, this class of models is not able to anticipate non-linear potentially catastrophic impacts from phenomena such as climate change and social instability affecting economic wellbeing. On the other hand nonlinearities and emergent behaviour drive a system’s evolutionary behaviour as they cause the strength of its feedback loops to change over time (see in the table below: Basic Building Blocks and Resolution).

- **The system is always assumed at general equilibrium condition**, (i.e. that economic systems are always in equilibrium or move from an equilibrium to another). This assumption rules out the use of models for important policy decisions as it is assumed that all markets find the equilibrium and that no transaction or decision by the agents is made before the equilibrium is reached. Moreover, the stability of the system has to be assumed. So this class of model cannot be applied to macroeconomic issues related to stabilization policy, and in any case these models are not meant to function out of the equilibrium. On the other hand, in some situations there is a persistent disequilibrium and the economy continues operating before all markets clear. Moreover, to model dynamics and evolution of a system stability must not be assumed (see in the table below: Equilibrium Properties).

- **Require extensive use of resources**. General equilibrium models such as DSGE are very time and resource consuming, both in terms of skills set required, the cost associated with data, time for development and upkeep (see in the table below: Costs).
Table 1 – Comparison of Macroeconomic General equilibrium models with Dynamic Simulation models for modelling and simulation of complex systems

<table>
<thead>
<tr>
<th>Aspect</th>
<th>System dynamics</th>
<th>Discrete-event simulation</th>
<th>Agent-based Modelling</th>
<th>DSGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of problems</td>
<td>Strategic, operational</td>
<td>Operational, tactical</td>
<td>Strategic, operational, tactical</td>
<td>Strategic</td>
</tr>
<tr>
<td>Perspective</td>
<td>System-oriented, emphasis on dynamic complexity (top-down)</td>
<td>Process-oriented, emphasis on detail complexity (top-down)</td>
<td>Individual-oriented, dynamic and detail complexity (bottom-up)</td>
<td>System oriented, top down</td>
</tr>
<tr>
<td>Resolution</td>
<td>Homogeneous entities and emergent behavior</td>
<td>Individual heterogeneous passive entities, attributes, and events</td>
<td>Individual heterogeneous active agents, decision rules</td>
<td>Homogeneous agents and no emergent behavior</td>
</tr>
<tr>
<td>Origin of dynamics</td>
<td>Deterministic endogenous fixed structure</td>
<td>Stochastic endogenous fixed processes</td>
<td>Agent–agent, agent–environment interactions adaptive behaviour of agents</td>
<td>Stochastic endogenous fixed structure, rational expectations</td>
</tr>
<tr>
<td>Handling of time</td>
<td>Continuous</td>
<td>Discrete</td>
<td>Discrete</td>
<td>Continuous</td>
</tr>
<tr>
<td>Approach</td>
<td>Exploratory and explanatory</td>
<td>Explanatory</td>
<td>Exploratory and explanatory</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Basic building blocks</td>
<td>Feedback loops, stocks, and flows</td>
<td>Entities, events, queues</td>
<td>Autonomous agents, decision rules, emergent behavior</td>
<td>Entities such as sectors of the economy</td>
</tr>
<tr>
<td>Data sources</td>
<td>Broadly drawn: qualitative and quantitative</td>
<td>Numerical with some judgmental elements</td>
<td>Broadly drawn: qualitative and quantitative</td>
<td>Broadly drawn: qualitative and quantitative</td>
</tr>
<tr>
<td>Mathematical formulation</td>
<td>Differential equations</td>
<td>Mathematically described with logic operators</td>
<td>Mathematically described with logic operators and decision rules</td>
<td>Differential equations</td>
</tr>
<tr>
<td>Outputs</td>
<td>Understanding of structural source of behaviour modes, patterns, trends, aggregate key indicators</td>
<td>Point predictions, performance measures</td>
<td>Detailed and aggregate key indicators, understanding of emergence due to individual behavior, point predictions</td>
<td>Forecasts and predictions</td>
</tr>
<tr>
<td><strong>Model maintenance</strong></td>
<td>Upkeep may require large structure modifications, global</td>
<td>Upkeep may require process modifications, global. Allows for local modifications regarding individual heterogeneity</td>
<td>Upkeep may require simple local modifications</td>
<td>Upkeep may require large structure modifications, global</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Development time</strong></td>
<td>Dependent on the problem, purpose, and scope of the model; these models may require less time to be developed</td>
<td>These models are more data intensive. This requires more time regarding obtaining data and data analysis to prepare model inputs. Programming and calibration are usually very time consuming</td>
<td>These models can be data intensive, which requires data analysis and time to obtain the data. Programming and calibration are usually very time consuming</td>
<td>These models are more data intensive. This requires more time regarding obtaining data and data analysis to prepare model inputs. Programming and calibration are usually very time consuming</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>In general, SD is less costly than are DES and ABM. This involves data requirements, and skill sets needed</td>
<td>Because of costs associated with data and skill sets required, these methods tend to be more costly than is SD</td>
<td>If the model is data intensive or requires primary data collection, costs may increase. Skill sets required may also increase the costs</td>
<td>Because of costs associated with data and skill sets required, these methods tend to be more costly than SD</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Policy making: gaining understanding</td>
<td>Decisions: optimization, prediction and comparison</td>
<td>Decisions: optimization, prediction and comparison</td>
<td>Policy making: gaining understanding</td>
</tr>
<tr>
<td><strong>Level of Modelling</strong></td>
<td>Macro</td>
<td>Micro</td>
<td>Micro</td>
<td>Macro</td>
</tr>
<tr>
<td><strong>Equilibrium properties</strong></td>
<td>Works also in disequilibrium</td>
<td>Works in equilibrium</td>
<td>Works also in disequilibrium</td>
<td>Equilibrium is reached by assumption</td>
</tr>
</tbody>
</table>

Source: Fair Dynamics for JRC-IPTS, 2015
2.2.3 The quest for Dynamic-Simulation 'hybridization' to assess social systems

In the previous sub-paragraphs (§2.2.1.1 and §2.2.1.2) we have discussed the relevance and potential of Dynamic Simulation when it comes to modelling and simulating complex systems, and identified its advantages with respect to other modelling approaches.

Building on the results of the analysis carried out, and considering the nature of the analysis conducted within the scope of the IESI research, which involves dealing with social complex system, it seems emerging strongly convinced that Dynamic Simulation Modelling, and in particular the combination of System Dynamics (SD) with Agent Based Modelling (ABM) would be the most appropriate approach to use for modelling and simulation the interrelated phenomena we have labelled as ICT-enabled social innovation initiatives promoting social investment, and with specific regard to the effects these shall produce on social protection systems in the EU.

This is even more required since the complexity of the 'ecosystem' in which social protection 'organisms' operate, and which represent the realm within which we have to assess the impacts generated by ICT-enabled social innovation initiatives. This is in fact characterized by the presence of human behaviours and the unpredictable impacts they can have on the whole system.

While the working rules and the constraints of a policy can be appropriately defined, tested and deployed, the application of accompanying socio-economic human based actions is dependent on human behaviour that, for many reasons, is not always in line with the specifications and directives given by a specific policy intervention. For example in a recent paper of Borsh-Supan (2013), it is clearly evident that the effect of the labour reform and the pension reform are considerably damped by the behavioural reaction of the population. While the properties, interacting rules and environmental constraints of each single unit are usually known before (ex-ante), the emergent properties of a complex system are unknown before and manifest themselves only later in time (ex-post). In this respect, to be concrete, if for instance the situation modelled is a 'socio economic issue', Dynamic Simulation can give a numerical indication about the need for resources, the possible transition times needed to achieve an objective, the duration of an initiative, and so on. This gives a detailed qualitative idea at first and quantitative values then – when the numerical simulation is applied - to the analysis and an assessment of all the possible performance indicators applied.

Consequently, it can provide evidence to underpin the ideas, doubts, and intentions of the policy makers and stakeholders involved in possible structural, operational and organizational changes. Therefore Dynamic Simulation can be a formidable approach for 'check the reality' through applying dynamic hypotheses underpinning different - alternative - behaviours and exploring 'beyond yonder' solutions and ideas. This would also permit to downgrade possible overestimations of the potential impacts of a given policy or specific initiative.

To further support our argument, and the quest for the 'hybridization' between SD and ABMS in order to strengthen the potential of Dynamic Simulation when applied to ICT-enabled social innovation, it is worth recall what indicated by John Sterman in his book Business Dynamics: Systems Thinking and Modelling for a Complex World (2000). Sterman in fact argues that the Dynamic complexity arises because systems are (see also Sterman, 2006):

- **Dynamic.** Change in systems over time occurs at many time scales, and these different scales sometimes interact.

- **Tightly coupled.** The actors in the system interact strongly with one another and with the natural world.

- **Governed by feedback.** Because of the tight couplings among actors, our actions feed-back on themselves. Our decisions alter the state of the world, causing changes in nature and triggering others to act, thus giving rise to a new situation, which then influences our next decisions. Dynamics arise from these feedbacks.
- **Nonlinear.** Effect is rarely proportional to cause, and what happens locally in a system (near the current operating point) often does not apply in distant regions (other states of the system). Nonlinearity often arises from the basic physics of systems: Insufficient inventory may cause you to boost production, but production can never fall below zero no matter how much excess inventory you have. Nonlinearity also arises as multiple factors interact in decision making.

- **History-dependent.** Taking one road often precludes taking others and determines where you end up (path dependence). Many actions are irreversible: you cannot un-scramble an egg (the second law of thermodynamics). Stocks and flows (accumulations) and long time delays often mean doing and undoing have fundamentally different time constants.

- **Self-organizing.** The dynamics of systems arise spontaneously from their internal structure. Often, small, random perturbations are amplified and moulded by the feedback structure, generating patterns in space and time and creating path dependence. For example structures such as markets all emerge spontaneously from the feedbacks among the agents and elements of the system.

- **Adaptive.** The capabilities and decision rules of the agents in complex systems change over time. Adaptation also occurs as people learn from experience, especially as they learn new ways to achieve their goals in the face of obstacles.

- **Counterintuitive.** In complex systems, cause and effect are distant in time and space while we tend to look for causes near the events we seek to explain. Our attention is drawn to the symptoms of difficulty rather than the underlying cause. High leverage policies are often not obvious.

- **Policy resistant.** The complexity of the systems in which we are embedded over-whelms our ability to understand them. The result: Many seemingly obvious solutions to problems fail or actually worsen the situation.

- **Characterized by trade-offs.** Time delays in feedback channels mean the long-run response of a system to an intervention is often different from its short-run response. High leverage policies often cause worse-before-better behaviour, while low leverage policies often generate transitory improvement before the problem grows worse.

As it becomes evident from analysing the characteristics of complex systems, the modelling approaches described above (§2.2.1.1 and §2.2.1.2) are not sufficient to represent the complexity of such systems, as they only offer a partial view of the whole picture not having the possibility to fully address the characteristics of a complex. This is particularly the case when dealing with social protection systems and the socio-economic effects that can be generated by ICT-enabled social innovation initiatives intervening (directly and/or indirectly on such 'ecosystem'. On the contrary, as we will see more in details in Chapter 3, the proposed approach based on a combination of SD and ABMS is emerging in literature and practice as a possible solution as it could provide a more robust and consistent method to modelling problems of truly complex phenomena.

The proposed approach that can be defined **Hybrid Model (HM),** and which is based on the combination of SD and ABMS, has been investigated in literature by Shanthikumar and Sargent (1983) who identify four main classes of hybrid models (see **Figure 8**): 33:

- **Class I:** 'models whose behaviour over time is obtained by alternating between independent analytic and simulations models'. In this class of models the time-dependent behaviour of the system can be completely decomposed so that some part of it can be solved analytically, and then based on efficiency. Moreover the output from analytic and simulation models are

---

33 It has to be noticed that both in Class III and IV are present sequential designs, whichever way around one type of model is used to inform the other. In this case there is the use of one simulation paradigm strictly before the use of another to be a sequential hybrid simulation. In fact, the first simulation produces the required input for the second simulation and then terminating before the second simulation begins.
interfaced, meaning that there exists a point of interaction or communication between elements of different simulation models. When the simulation models come from different paradigms, there is an interfaced hybrid simulation design.

- **Class II**: 'a model in which an analytic and simulation model operate in parallel over time and with interactions between them'. In this case both model types are required to operate in parallel with respect to time and with interactions between them. In this class of models it is possible to decompose sub-systems using appropriate Modelling techniques, which need to be run in parallel and include feedback, so that probably this design involves more integration of the techniques than the other classes. An integrated hybrid simulation thus contains feedback between simulation models from different paradigms.

- **Class III**: 'a model in which a simulation model operates in a subroutine way for an analytic model of the system'. When this occurs a complete decomposition is not possible.

- **Class IV**: 'a model in which a simulation model is used to model the total system but which requires values for a portion of the system or input parameters, from an analytic model'.

**Figure 8 – Shanthikumar and Sargent’s four classes of HM**

Building on the Shanthikumar and Sargent (1983) classification it is possible to identify three classes of design for HM. In the same vein, Martinez-Moyano et al. (2007) describe three types of interaction between modules, in relation to different modes of usage of the hybrid model: scenario exploration, according to which the agent based model is run first and results are sent to the SD model (aligning to the Class III or IV design); intertwined models, in which ABM and SD models alternate and potentially pass information between them (similar to an integrated Class II design); and crisis response, according to which the ABM is run first on empirical input data and results are then passed onto the SD model (similar to a sequential Class III or IV design).

Source: Shanthikumar and Sargent (1983)

**Figure 9 – Three classes of HM**

Swinerd and McNaught (2012) have identified three classes of design for HM (see Figure 9). The first class, the integrated HM design, makes explicit use of different simulation paradigms within the model architecture (examples are Sterman 1985, and subsequently Sterman and Wittenberg 1999, and Akkermans 2001). The integrated HM design concept is implemented according to three main options: 1) Build a SD module within agents of an ABM module (agents with rich internal structure); 2) Use a level within an SD module in order to bound an aggregate measure of an ABM one (stocked agents); and 3) Use an aggregate measure of an ABM module in order to influence a parameter within a SD module (parameters with emergent behaviour).

Source: Swinerd and McNaught (2012)
Another class is given by the **interfaced HM design**, in which there is no direct feedback between the SD and the ABM (see also Dubiel and Tsimhoni 2005). The final class is the **sequential HM design** (examples are Homer 1999, Schieritz and Milling 2009 and He et al. 2004), in which either modelling techniques (SD or ABM) are used to inform the design, use or starting conditions of the other approach.

As we will see better in the following Chapters, the advantages of the combination of SD and ABM for the scope of our research work is also evident in the capability of such hybrid approach to build dynamic simulation models maintaining a continuum among layers of complexity and highlighting the causality relationships within each layers and their interplay (see also Glass and McAtee, 2006).

### 2.3 State of the art of dynamic simulation applied to ICT-enabled social innovation and personal social services of general interest

This paragraph outlines the results of the literature review of Dynamic Simulation applications assessing the impacts of ICT-enabled social innovation initiatives promoting social investment and, more in general, designed to improve performance and quality of social service delivery.

While the methodological approach followed has been described in Chapter 1 (Sub§1.3.2), the outcomes of the literature review described in this paragraph have been organized according to the two main 'areas' that are addressed by the IESI research in its original design, namely:

- **Active and healthy ageing ad Long-Term Care (LTC) for older people**, which groups the Personal Social Services of General Interest (PSSGI) related to health and social care of the ageing population.
- **Integrated approaches to the provision of social services**, that for the scope of this component of the research has been further divided in two policy sub-areas, namely:
  - **Employment and life-long learning services**, which emphasize the role of training and education along the life course of an individual, and the importance to maintain a high intellectual capital to leverage employment opportunities over the time.
  - **Social inclusion services**, which groups all the other PSSGI, (i.e. childcare; social assistance, social housing; social inclusion/participation; civic engagement) with the exception of all those related to health and care services which are addressed in the separate area of the research).

As discussed in the previous paragraphs, **Dynamic Simulation, which makes use of SD and/or ABM, has been applied since its beginning in the early 60\textsuperscript{th} (e.g. Forrester, 1961)** to model and simulate complex problems in various domains including social policies and related services, with particular reference to health care. **However, only in the last decades it has been recognized its relevance in simulation of social problems**, which are more and more frequently characterized by high instability of the context, scarce predictability of the phenomena and high complexity due to the interplay of micro-meso-macro characteristics of the problems that need to be tackled by policymakers (e.g. Sterman, 1985).

The review of literature conducted on Dynamic Simulation applications developed in the contexts of social services since the beginning of years 90\textsuperscript{th} (e.g. Sterman, 1991) suggests that the **health care sector is the most addressed with several examples of simulation models, often with implications for social care at the boundaries of health and social care systems**. For instance, in the USA since the early 2000 a vast literature on this topic can be found. Homer, Hirsh and Milstein (see e.g. Hirsh & Homer, 2004; Homer et al. 2004a; Homer et al., 2007) are the authors that more than others have contributed to the development of a quite significant number of simulation models in the health and social care policy arena.
Interesting examples of Dynamic Simulation models applied to simulate the impacts on health and social policies can be found in Homer et al. (2004a and 2007). The models aim at simulating the impacts of US policy reforms on population with chronic disease (e.g. diabetes). The scope of the models is to demonstrate the effects on the cost of health care systems due to an increase of preventive activities on population lifestyle, and simulate the consequences of these actions for the development of downstream care services. An upgraded version of these models were further used by Homer et al. (2010) to simulate and evaluate policy interventions to improve cardiovascular risk of the population in the USA. The proposed model is an interesting example of how the health risk factors (e.g. the cardiovascular one) can be represented with dynamic simulation approaches.

All this knowledge has been used to develop the 'rethinkHealth' initiative (see Hirsh et al, 2012) that can be considered as a compendium of all the past experiences of US authors in dynamic modelling and simulation of health care systems. The model simulates the changes in the local health services due to the health policy interventions addressing health, care, and cost over time. The model simulates the care characteristics of the population living in a local community and it is represented by age distribution, income and insurance ownership. Health risk due to environmental-socio-economic and behavioural conditions is also represented in the model together with upstream (preventive) and downstream (care) interventions that can influence risk factors, care system delivery organizations and costs. Savings in care services are also considered in the model as possible instruments for funding the intervention initiatives themselves.

As recognized by McKelvie (2012), the key theme of the US authors working on modelling and simulation of care systems is the impact of early detection and case management to slow down the risk factors, and thereby reduce the number of people with long-term, irreversible complications of conditions. Typical interventions simulated with these models belong to three categories: 1) the first one groups upstream initiatives that have been already cited and are aimed at reducing health risks faced by the population (e.g. behavioural risks related to smoke and sedentariness; environmental hazards related to pollution and workplace injuries, crime and poverty reduction or prevention); 2) the second group simulates the intervention initiatives on care system delivery (e.g. increase efficiency, support patient adherence, etc.); 3) the last group of initiatives is aimed at increasing the coordination and collaborations amongst different care processes and actors.

Significant examples of modelling and simulation applied to policy interventions in health care can also be found in the European scientific literature. For instance in a recent paper of Jankuj & Voracek (2015), the functioning of national health care systems in Europe have been simulated through a dynamic model to demonstrate that additional investments to the quality of health care can, in a mid-long term perspective, break currently growing financial demand for health care maintenance of services, and turn falling satisfaction of domain stakeholders. A more comprehensive approach to policy modelling and simulation has been adopted by Logtens, Pruyt, & Gijsbers, (2012) and Auping et al (2015) looking at the impact of ageing population on national health care system, social security and economy of The Netherlands. In particular, the impact of the increase of life expectancy and the dramatic decrease of birth rate with a consequent change in the population structure, and the increase of chronic diseases, has been simulated not only in relation to the sustainability of both social security and health care systems, but also in relation to the consequences of an increase of ICT-enabled home care services (e.g. telecare; telehealth; telemonitoring) on both the real estate market and the labour market for ICT and construction industries. Brittin et al. (2015) provide an interesting example of use of Dynamic Simulation in analysing the dynamic effects on chronic disease prevention produced by interventions on low-income households. Instead of assessing the impacts of the improvement of the health care system delivery process, the proposed model tackles socio-environmental risk-factors affecting the target population (e.g. housing capacity; social cohesion level; employment status income level; neighbourhood attractiveness) to formulate viable and sustainable solutions to improve community-level health outcomes.
Dynamic Simulation has been also widely used to simulate impacts on changes of care system delivery processes. For instance, Hirsh & Homer (2004) have developed a model aiming at simulating the effects of disease management approach to slow the progression of chronic illnesses and reduce the frequency of acute episodes. While Wolstenholme et al., (2007) have provided an example of dynamic simulation applied to the cost-benefit analysis of mental health services in the UK. Through the lens of Dynamic Simulation the authors analyse the effects of mental health services not only on the treatments and recovery processes infrastructure, but also in relation to the capability of the care system to recruit additional personnel in a cost effective-way.

In more recent years Dynamic Simulation models have been applied to the various facets of the ageing population phenomenon. Besides the already cited examples of policy impacts on ageing population (e.g. Logtens, Pruyt, & Gijsbers, 2012; Auping et al, 2015), Ansah et al. (2014a and 2014b) developed a dynamic simulation model assessing the impacts of current and future policies on informal caregivers and their role in the LTC demand and supply matching process in Singapore. As in the other cases discussed in this literature review, the proposed model encompasses informal caregivers risk factors (e.g. depression, reduced labour force participation, increase of health care utilization) with the characteristics of the LTC system in Singapore (see also Ansah et al., 2014b), and the dynamics of the foreign immigration of both homemade workers that can provide support to informal caregivers allowing them to come back to work without risk of losing their jobs. On the other hand, the model also investigates the impacts of foreign qualified workers that, instead, can become competitors of informal caregivers in the job market, and prevent their possibility to come back to job again.

Finally another important streamline of Dynamic Simulation models in the health care policy domain refers to impact assessment of operational structure of care systems. An interesting example is provided by Wolstenholme et al., (2004). It describes a dynamic model aimed at simulating the efficiency gains of integration of all the local health care agencies in an UK context along with the patient pathways. Other examples are those provided by Barber & López-Valcárcel (2010) that use dynamic simulation to assess the evolution of supply and demand of medical specialists in Spain, and Masnick & McDonnell (2010) that apply dynamic simulation to link population and medical needs to the workload of a clinical workforce.

For the other two policy sub-areas (i.e. employment and life-long learning, and social inclusion services) the numbers of studies who apply dynamic simulation are significantly less than the ones available for the health and social care domain. Moreover, this is a recent research area, as relevant papers related to these topics have been found only in the last fifteen years.

Perhaps, the most interesting Dynamic Simulation model addressing both policy sub-areas as well as the one related to health and social care is the already cited model related to societal ageing impact simulation in The Netherlands (Auping et al, 2015). From an employment perspective, the model looks explicitly at the impacts of the retirement policies (i.e. formal and delayed retirement age comparison; formal and actual retirement age comparison; formal and forecasted retirement age comparison), and their consequences on the potential size of the workforce and the direct and indirect effects on the social security and social protection systems, as well as on the health care system. The model is a further elaboration of the model by Logtens, Pruyt, & Gijsbers, (2012) and Puryt and Logten (2015). It contains 1137 variables and 80 stocks. Similar in scope is the model proposed by Ghaffarzadegan et al., (2011) which looks at the sustainability of the Temporary Assistance Needy Family (TANF) policy and its impact on the labour market. The model shows that adding capacity upstream can swap downstream resources, increasing the recidivism rate and resulting in still more demand upstream. In other words, the model shows that without a combined policy aimed at supporting both upstream initiatives for permanent employment conditions, and downstream initiatives temporary supporting low-income families, the TANF policy initiative become unstable and unsustainable in a mid-long term perspective.
Instead, the dynamic model proposed by Ghaffarzadegan et al., (2011) simulates the functioning of the real estate market and the impacts on the cost of the houses due to economic and population growth, and progressive reduction of the land availability. This model starts from the Forrester's original models (see Forrester, 2000) and simulates the feedbacks relationships among three sectors: population, housing supply and demand market, and construction industry. A similar model has been proposed by Eskinasi, Rouwette & Vennix, (2011) for simulating governmental policies regulating the housing market. It is based on a previous work of DiPasquale & Wheaton (1996) on real estate dynamics. Scope of the model is to support policy makers in understanding how rent regulations and mortgage tax reduction can influence the house prices in the owner occupied sector, and the value gap produced in the rental sector.

For what concern employment and education services, one the most interesting example is the dynamic simulation model described by Hu & Vetter (2010). The model aims at simulating the optimal and sustainable labour market reintegration of an individual through rebalancing between his or her job, biography, and social embedding capability. The proposed model simulates the dynamic of 'work-life-balance' along the working life of an individual, and it helps in understanding which are the influencing factors that affect the decision of a person seeking for a job. Similar in scope, but with a focus on vocational college students is the work of Chen (2014). The proposed dynamic simulation model aims at providing a clear understanding of the key variables related to training and education characteristics, labour market needs and attitudes of the students influencing the employability and employment degree of the students themselves.

For what concern the policy sub-area related to social inclusion, perhaps the most prominent recent example of contribution of Dynamic Simulation to the field of social work (as opposed to adult social care) is Lane’s Analysis of impact of increased prescription in social work published as an appendix to the Munro Review of Child Protection (Department for Education 2011). The analysis explores the unintended consequences arising from attempts to improve practice through standardisation; in particular the impacts on staff morale, time spent working directly with service users and the scope for dealing with the variety of needs.

Financial sustainability of social security systems due to the increase of importance of the ageing population phenomenon is another issues addressed by the dynamic simulation of social inclusion policy sub-area with a quite significant numbers of recently published scientific papers. For instance, Yavas & Bacaksizlar (2012) simulated the impacts on social security institutions of 'pay-as-you-go' scheme as financing method. The proposed model addresses the impact of the ageing population and the effects of Turkish government’s retirement policies by simulating under which conditions is guaranteed the sustainability of the national security system. Other examples in this direction are the already cited paper of Logtens, Pruyt, & Gijsbers, (2012) which simulates the effects of the societal ageing on national social security and economy of The Netherlands, and the revision of the model proposed by Auping et al. (2015). As already mentioned, this latter constitutes a very interesting case of modelling and simulation of the older workers behaviour in relation to their decision to prolong their permanence in the job market beyond the time limits defined by the law, or to ask for a pension according to the current rules and regulation. The first case should produce a positive balance in terms of social security financial and economic impact, while the second case should increase the financial and economic pressure on the national security system. The model allows understanding under which conditions and at what time the national security system become self-sustainable.

A totally different case is addressed by the model proposed by McKelvie (2012) which looks forward to the simulation of the effects of social impact bonds in criminal justice. The crucial point of the model is whether the reduced imprisonment rates result due to the bond schema is enough of a reduction in the prison population for a cut in prison places to be made.
To complete the analysis of existing literature we have also investigated the existence of specific applications explicitly addressing the modelling and simulation of ICT-enabled social innovation. Unfortunately our search has produced very limited results and no clear examples of such models. The majority of cases we have found are related to the simulation of the impacts of the diffusion of ICTs among the general population. For instance Dutta, Roy & Steetharaman (2012) simulate the penetration of ICTs in the Pacific Asia region which is characterized by substantial differences in contextual variables that drive ICTs diffusion, such as literacy rates, economic development and infrastructure sophistication, besides having wide diversity in cultural norms, while Howick & Whalley (2008) simulate the impacts of broadband adoption in rural and remote areas of Scotland. Among all the applications we have reviewed on this topic, perhaps the most interesting is the one proposed by Lee Sang et al., (2009) which simulates the impacts of Wi-Fi adoption in cities or local governments. The impacts are demonstrated with a comparison of the expected Wi-Fi performances, and the consequences of its adoption on safety (i.e. expected impact on crime reduction), tourism (i.e. expected impact on visitors increase), and other economic benefits.

Deserve of notice is also the work of Charabilidis, Loukis & Androutsopoulos (2012) which investigate the estimation of the impact of planned government initiatives promoting the diffusion of digital inclusion policy. However, the clearest example of Dynamic Simulation of ICT-enabled initiatives addressing public service delivery seems to be the one proposed by Bivona et al., (2011) which simulates the impact of Web 2.0 governance model on the modernization process of public services delivery.

The reason for the lack of evidence of Dynamic Simulation of ICT-enabled social innovation in social services has to be found probably in the novelty of the topic, which is emerging as a relevant potential solution to societal challenges only in the recent years, especially when seen in conjunction with the changed paradigm brought about by the Social Investment perspective.

However, whereas all the reviewed models do not explicitly analyse the impact of ICT-enabled social innovation in relation to social service delivery, reforms, the impact of ICTs is widely simulated under different perspectives in all the analysed literature, as follows:

- **In upstream interventions, ICT-enabled innovations are simulated as time reduction to address a specific risk factor.** See for instance Homer et al., (2004a, 2007 and 2010) where ICTs are simulated as time reduction to turn population behaviour into a more healthy lifestyle thanks to tool/media advice and support. Under this perspective ICTs should induce active prevention and contribute to reduce insurgence of chronic diseases, with positive consequences on the care system sustainability. Other examples of simulation of ICT-enabled innovation in upstream initiatives are provided in Logtens, Pruyt, & Gijsbers, (2012) and Auping et al., (2015). In these models ICTs are considered in the simulation effects on the real estate market of houses suitable to address the need of home care services (e.g. telecare, telemonitoring, etc.). In these cases the models also simulate the impacts on employment due to the increase of demand of workers in construction and ICT industries. Instead in Ghaffarzadegan, Lyneis, J., & Richardson (2011) upstream intervention of ICTs are simulated as time reduction in matching of labour demand and offer due to on-line services provided by the job agencies. The occupational life course simulation model proposed by Hu & Vatter (2010) is also another interesting example where ICT-enabled innovation is simulated with the reduction of time in 'job integration' due to a better capability of the individual to better and faster understand the changes in both social environment and the job opportunity thanks to their engagement in social media and collaborative networks. Chen (2014) modelled a similar topic looking at the better matching rate between education policies and employment demand of vocational college students in Singapore to reduce unemployment rate of the graduates. In this case ICT-enabled innovation refers to the possibility to increase teamwork competences, individual stability and resistance to stress of the students themselves.
• **In relation to downstream interventions** - that are more related to the cost reduction of the social service delivery systems and the management processes associated with it, **ICT-enabled innovation is simulated as efficiency gains due to the increase of coordination and collaboration among complementary stakeholders/services.** Example of these simulations can be found across all the social policy domains. For instance Hirsch et al., (2012) simulate the introduction of ICTs in the LTC service delivery as reduction of duplication and unnecessary procedures in post-discharge care for patients who have been hospitalized, and in the improvement of coordination among primary, secondary and tertiary care organizations. Similar examples of simulation of ICT-enabled innovation can also be found in Ansahe et al., (2014b). Another example of the simulation of ICT-enabled downstream interventions can be found in Wolstenholme et al., (2007), and in Auping et al., (2015) where the models simulate the ICTs as exogenous innovation drivers that can improve the quality of care system and its productivity.

In other words, as discussed by Tarafdar, Singh, & Anekal, (2013) and explained in the **Figure 10** below, **ICT-enabled innovations is an important instrument to increase social inclusion of the marginalized population by reducing the market separation of those people with the more advantaged ones.** The work of Tarafdar, Singh, & Anekal refers to Bottom of the Pyramid Population (BOP), however, these considerations can be easily extended to all groups of disadvantaged or at risks groups of population (e.g. ageing population with chronic diseases that have difficulties in living autonomously; young people that are excluded/at risk of being excluded from the job market; etc.). According to the authors the need of satisfying these market segments with societal inclusive ICT-enabled solutions, could lead to the development of innovative products and services, as well as to both create new entrepreneurial opportunities and strengthen skills and competences, furthering increasing the sustainability of the social services.

**Figure 10 – Logical impact of ICT-enabled innovation of BOP population**

Before concluding this analysis of the literature reviewed on Dynamic Simulation, it is important to underline that, **despite having argued for the importance of the use of an hybrid approach (i.e. a combination of ABMS and SD) to the development of the i-FRAME, we have not found any clear example of such approach applied to the impact of social innovation and in particular to ICT-enabled social innovation initiative promoting social investments in social services delivery.**
The lack of evidence of ABMS and Hybrid models in such domain of applications reflects probably the novelty of these domains to be addressed with Dynamic Simulation approaches as we propose with the development of i-FRAME methodology. However, as shown by existing examples in other more mature application domains such as: agriculture (e.g. Gaube et al., 2009); science (e.g. Sterman, 1985 and Sterman & Wittenberg, 1999); manufacturing (e.g. Akkermans, 2001 and Schieritz & Größler, 2003); land use (e.g. Verburg & Overmars, 2009); environment (e.g. Kieckhäfer et al., 2009); governance (e.g., Chaim and Streit, 2008), the hybrid approach presents an high degree of applicability and transferability across and between application domains, and therefore it is clearly applicable also for the development of i-FRAME as it will be discussed in the following Chapter 3.

Summarizing, the results of the literature review allow us to advance the following considerations about the use of Dynamic Simulation for supporting the methodological development of the i-FRAME:

- **There is already a vast literature of dynamic simulation of the impacts of policy interventions addressing social service delivery with particular references to health and social care.** However, the evidence collected for the other policy sub-areas (i.e. employment and education, and social inclusion) underline how in the recent years dynamic simulation approaches have been extensively used to support stakeholders and policy makers to better understand the complexity of the phenomena underpinning innovation in social services, and in particular to highlight the impacts of counterintuitive retroactions due to the non-linearity of the tackled social problems.

- **In the reviewed literature, there are not examples of application which explicitly address the impact of ICT-enabled social innovation.** This is most probably because of the research topic is rather new for the scientific community. However, in the majority of the examples that we have found, the impacts of ICT-enabled interventions have been simulated as endogenous and/or exogenous factors shaping the characteristics of upstream and/or downstream interventions conceived for improving the performance of social services delivery processes. Typical examples of ICT-enabled innovations impacting on upstream interventions are those simulating time reduction in adopting behaviours and life style mitigating specific risk factors (e.g. health related risks or loss of competitive capability and distinctive knowledge). Instead, examples of ICT-enabled innovations impacting on downstream interventions are those simulating better coordination and collaboration capabilities as well as quality and productivity gains due to the use of social media and ICT-based applications.

- **For the same reasons, despite a quite significant literature on hybrid approach combining ABMS and SD in modelling and simulation of complex systems, no clear examples of this approach has been found in our literature review addressing the scope of IESI research.** However, from a methodological perspective the hybrid approach seems to be the most suitable to shape the development of the i-FRAME. In particular, for the scope of the IESI research, the most appropriate combination of the two modelling and simulation techniques in the HM should consider ABMS for the micro-level of analysis (as it simulates the behaviour of the individuals belonging to the relevant population), and SD for the meso and macro levels of analysis (to better explain the logic underpinning the organizational and strategic characteristics of the social service delivery system addressed by the ICT-enabled social innovation.)
Finally in all the investigated papers it has been clearly underlined the relevance of the proposed approach to learn and design effective social policies. The main reasons of it are the following:

- The possibility to explicitly simulate counterintuitive behaviours through feedback loops that can help the policymakers understand how policy resistance can arise (Ghaffarzadegan, Lyneis, J., & Richardson, 2011).
- The possibility to simulate in an aggregate manner (i.e. the hybrid approach) both the dynamic of the problem addressed through stocks and flows (i.e. typical approach to SD modelling and simulation), and the behaviours of groups of individuals through ABMS. In this respect, aggregation reduces the size of the model and decreases the cost of developing and running models thus allowing for more experimentation. Furthermore, aggregation also allows users to focus on feedback ahead of agent level detail and therefore develop a more holistic and endogenous perspective to the problem (Rahmandad & Sterman, 2008).
- The possibility to run mathematical simulations that give opportunity to run experiments. This creates and additional added value to the policy makers that goes beyond the lessons learned from a paper causal-loop diagram and allows showing quantitative impacts trends illustrating why intentionally rational policies lead to policy resistance (Ghaffarzadegan, Lyneis, J., & Richardson, 2011).
- The size of the observed models that whereas the full applications is constituted by thousands of mathematical functions (e.g. Auping et al., 2015) all of them are constituted by self-consistent sub-models which are simpler and own limited numbers of stocks and flows. This ensures that the dynamic hypothesis and the results of the experiments are easily communicable and shareable with stakeholders that are not accustomed to a dynamic or holistic view of complex systems (Repenning, 2003).

The above considerations bring to the conclusion that the i-FRAME methodological approach should be shaped in a way to become a reference instrument to support policy makers and relevant stakeholders to overcome the possible overconfidence in the expected impacts of policy interventions, and help them in better understanding the complexity of the social problems, and look forward achievable and sustainable policy impacts. Therefore the rationale underpinning the i-FRAME should have the following characteristics which lead to the methodological approach described in the following Chapter 3:

- Supporting policy resistance environment providing feedbacks and simulations driving more robust policies.
- Allowing to conduct experiments at low costs of developing and running models, allowing more experimentation.
- Decomposing complex problems in small size sub-problems that can be simulated with simple models easily understandable by policymakers and stakeholders.
- Using aggregate approaches (i.e. hybrid models) that can build consensus around difficult policy problems and facilitate presentation of results, as well as to leave more rooms in policymakers’ and stakeholders’ capacity to concentrate on feedbacks and develop an endogenous perspective of the policy actions.
- Developing a methodological pathway in dynamic model development that combines qualitative (causal loop diagram) and quantitative (stocks and flows and agent based models) that can elucidate and address the counter-intuitive nature of the policy challenges.

---

34 According to Ghaffarzadegan, Lyneis, J., & Richardson, (2011): 'Further, simulation models provide learning environments where modellers, policymakers, and others can design and test policies. Given the complexity of many policy environments, experimentation is essential for the design of effective policies. Simulations provide a helpful environment where policymakers can experiment and learn about the effects of different policies without any significant social and economic cost for policymakers'.

3 i-FRAME methodology and operational components

Box 3 Summary of content of Chapter 3

This Chapter presents in details the proposed methodology underpinning the i-FRAME development and the operational components proposed to implement according to the key characteristics of the phenomenon under investigation identified through review of literature and practice.

It is organised as follows:

- §3.1 describes the i-FRAME approach, including the main assumptions and key aspects underlying it, and describing the ten steps of the proposed methodology (the i-FRAME Decalogue).
- §3.2 advances the proposal of using a Dynamic Simulation Hybrid Modelling approach to implement the i-FRAME.
- §3.3 provides an analysis of the main features and characteristics of dynamic simulation modelling applied to understand the impacts of ICT-enabled social innovation initiatives through review of cases available in literature.

3.1 i-FRAME methodological approach

3.1.1 Assumptions underlying the design of the i-FRAME

As it emerged from the review of the state of the art of the science and practice of modelling and simulation discussed in the previous Chapter 2, it is evident that a general model including all the elements of detail of any single issue composing a complex system does not exist. This means that any attempt to build a general simulation model addressed to study, assess and evaluate the effects (i.e. the outcomes and impacts at different levels of scale: micro, meso, macro) of an ICT-enabled social innovation initiative would not produce any valuable result.

As well underlined in the prominent literature in the domain, a simulation model should start from a 'well defined and specific problem' that in turn has its specific characteristics and properties as well (for all see: Sterman, 2000)\(^35\). Those peculiar characteristics must be stemmed from both the background of the identified problem and the experience and knowledge of the problem’s stakeholders. In other words, we have to discard the idea to model a general system 'everywhere applicable for an identified subject'. We can only model a specific problem and, starting from that problem, we can model the system to which the problem belongs, by taking into account that the model will be as much more effective as many proactive stakeholders will give their appropriate contribution.

Consequently, simulation models are driven by 'specific problems' and should be thought and developed with the aim to explain the problem. In this perspective, the 'system' represents the set of components surrounding the problem that have to be modelled in order to understand the dynamics of the surrounding environment where the problem is formed, fed and generates other effects.

Yet, according to the main purpose set out in the IESI research to develop the i-FRAME as a 'meta-framework' to assess the social and economic impacts generated – at micro, meso and macro level - by ICT-enabled social innovation initiatives, the objective to propose a robust methodology able to support the development of simulation models for a well-defined problem and that contains the main key points to be used in any practical simulation applications is valuable and seems to be feasible, as the results of the validation activities carried out demonstrate (see Chapter 4 and 5).

In order to support this approach, aiming at assessing - through the use of simulation modelling - the outcomes and the impacts of specific ICT-enabled social innovative initiatives promoting social investments in specific contexts of applications, the following assumptions - that are in line with the findings from the literature review on the applications of dynamic simulations outlined in §2.2 and §2.3 should be made:

1. A general simulation model that includes the details of each situation does not exist.
2. Any dynamic simulation model for a given context can be decomposed in a set of 'domain-related' sub-models (for an impact study in a social context). **Domain-related sub-models** are defined as sub-models for the following **domains** (as an example):
   a. Population, Financials, Employment, ...
3. Possible 'domain-related' **sub models schemes** for a particular class of situations can be gathered from the appropriate **literature**, i.e. the accompanying documentation and 'case studies' in particular.
4. The final simulation model can be developed through:
   a. the active contribution of the **domain expert and stakeholders, including policymakers** of both the domain and the specific problem;
   b. the contribution of **simulation experts** with the appropriate functional background, able to facilitate the 'map' from the problem and the 'simulation perspective';
   c. the appropriate, context-specific **combination** of those different domain-related sub models.

By accepting these assumptions and by using this approach, the model developer should be able to gather all those hints that, in combination with the contribution offered by the expert stakeholders involved, represents an excellent starting point leading to the development of a robust and realistic model.

The presence of the domain experts and stakeholders, including policymakers, is a key point. No model in fact can be robust and/or realistic if it is not resulting from the suggestions, the ideas and the 'mental models' of the field experts. In particular, during the development phase, the domain experts and stakeholders must be involved in specific workshops (also called Group-Model Building) where they can discuss, debate and offer their competence about the scope of the problem and share their opinions and ideas, in order to allow the developer to shape the structure and the details of the model step by step. Furthermore, in this context the model developer should act as a 'simulation expert' mentor that drives, elicits, stimulates both the discussion and the ideas of the experts, without directly biasing the audience with his/her own ideas about the problem: the experts are the only stakeholders of the problem.

Under this perspective the requirement of decomposing the complex problem in domains at first and then in domain-related sub-models, which are simpler and easier to be understood by domain experts, stakeholders and policy makers, is the key activity in the development of the methodological approach underpinning the i-FRAME, as further discussed in the following sub-§.

---

36 The main assumptions identified are the results of several discussions held between the IESI team and the research team and members of the Advisory Board of the support study conducted for JRC-IPTS by Fair Dynamics.
37 The simulation process should be based on the organization of an appropriate number of workshops where simulation experts and stakeholders catch the problems (if not already identified) and build the structure step by step. See J. Sterman, 'Business Dynamics: systems thinking and modelling for a complex world', McGraw-Hill Higher Education, 2000
3.1.2 Key aspects of the proposed i-FRAME methodology

The analysis of the literature conducted in Chapter 2 on the dynamic simulation applications developed in the social policy areas addressed by IESI research, leads to the identification among the others of the following main domains as relevant for building the i-FRAME approach:

- **Relevant population**: the sub system that depicts the behaviour of some relevant population (e.g. needy families living with subsidies; chronic disease population; unemployed vocational college students; etc.).

- **Investing & Financing**: the sub system that includes aspects and indicators for valuing the financial and investment aspects of the problem (e.g. use of social impact bonds; establishing private public partnerships; etc.)

- **Impacted domains**: the sets of aspects that drive and change the domains that are impacted by the ICT-enabled social innovation initiatives (e.g. Labour market; Economic development; Industrial sector; Occupational life course; etc.)

- **Service delivery system**: the sets of aspects that drive the related sub-system providing services to the relevant population (e.g. Social security delivery; Care service delivery; Education service delivery; etc.)

These domains contain the outcome/impact indicators and can be defined as 'impacted' domains, as they receive the effects from the other more 'scope-specific' domains that can be called 'impacting' domains. These impacting domains contain the resources that deliver the services that affect the 'impacted' domains.

With specific regard to the case under analysis, the impacting domains host the ICT-enabled innovation levers (drivers) that 'changes' and affects the impacted domains. For example, as we will see both in the TANF and the PASS/DHRE examples (see Chapter 5) the domain that contains the support capacity (number of operators 'equivalent') involved in the services delivery is the lever that encapsulates the modifications produced by the ICTs and changes both the performances and the effects of the initiative. In fact, in those cases, the ICTs increase both the upstream and the downstream support capacity that, in turn, reduces respectively the probability of recidivism and the time to support families. Hence, in this perspective, the impacting domains are the domains that describe the way ICTs produce their effects and usually address the 'process' and/or the resources that deliver an impacting service.

For simulation modelling purposes, the main attention has to be addressed to catch and depict the structure of the impacted domains, as, usually, the impacting domains are represented by collections of variables acting on the elements of the impacted domain.

Going through some specific dynamic simulation technicality, this means that each domain-related sub model is based on its own internal structure.

The **structure of a model** (domain related sub model) is usually defined as follows:

- The general technical structure can be represented through a set of **attributes and methods**.
- The **attributes** represent the variables and can be appropriately divided in Structural, Logical and Key Performance Indicators (KPIs).

---

38 The domain can be represented through an appropriate system of variables or just some variables as in the above mentioned example TANF, where the 'p_TANFSupportCapacity' variable represents the number of 'equivalent supporting operators' that is virtually increased by the appropriate use of ICTs.


40 Other authors use different approaches, for example J. Sterman, 2007.
For example, the general structure of the domain 'Relevant Population' can be described as in the following tables, where, for the Attributes, an application of both SD and ABMS have been sketched out:

Table 2 – Attributes for domain 'relevant population' and their representation with SD and ABMS (source: Fair Dynamics elaboration)

<table>
<thead>
<tr>
<th>Domain 'Relevant Population'</th>
<th>Attributes (variables)</th>
<th>System Dynamics (SD)</th>
<th>ABMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (number):</td>
<td>structural/resource/stock type</td>
<td>States</td>
<td></td>
</tr>
<tr>
<td>Birth Rate:</td>
<td>structural/rate/flow type</td>
<td>Transition</td>
<td></td>
</tr>
<tr>
<td>Carrying Capacity:</td>
<td>structural/resource type</td>
<td>States</td>
<td></td>
</tr>
<tr>
<td>Death Rate:</td>
<td>structural/rate/flow type</td>
<td>Transition</td>
<td></td>
</tr>
<tr>
<td>Fractional Birth Rate:</td>
<td>structural/rate type</td>
<td>Transition</td>
<td></td>
</tr>
<tr>
<td>Fractional Death Rate:</td>
<td>structural/rate type</td>
<td>Transition</td>
<td></td>
</tr>
<tr>
<td>Initial Population:</td>
<td>data</td>
<td>Data</td>
<td></td>
</tr>
<tr>
<td>Net Birth Rate:</td>
<td>structural/rate/flow type</td>
<td>Transition</td>
<td></td>
</tr>
<tr>
<td>Net Change in Population:</td>
<td>structural/rate type</td>
<td>Transition</td>
<td></td>
</tr>
</tbody>
</table>

Table 3 – Methods for domain 'relevant population'

<table>
<thead>
<tr>
<th>Domain 'Relevant Population'</th>
<th>Methods (that form the logics of the model):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Relationships,</td>
</tr>
<tr>
<td></td>
<td>Formulas</td>
</tr>
<tr>
<td></td>
<td>Graphical Functions</td>
</tr>
<tr>
<td></td>
<td>Table Functions</td>
</tr>
<tr>
<td></td>
<td>Other non-structural variable (usually 'auxiliary variables')</td>
</tr>
<tr>
<td></td>
<td>...</td>
</tr>
</tbody>
</table>

Herein an example of domain sub model for 'Relevant Population' (as realized through a System Dynamics model):

41 The tables indicate only the general main attributes and methods of the 'relevant population'. Other more detailed pictures of the domain can be obtained.
Figure 11 – Example of a System Dynamics model of 'relevant population'

In this System Dynamics based example, the stock 'Population' is a structural attribute, while the flows 'Birth Rate' and 'Death Rate' are the rate attributes. The indicated Stocks and Flows represent the structural attributes.

The indicated relationships, that we called 'methods', represent 'the logics of the model', along with other auxiliary attributes.

Even though a strict categorization is almost impossible in simulation modelling, generally speaking and making reference to the already mentioned 'variables and indicators' scheme, if the model is developed through a System Dynamics approach, the attributes are the variables (structural, rate, ...) and the indicators, while the methods represent the logics. In the case of using ABMS instead of System Dynamics, the attributes are both the 'state' and the variables/indicators, the methods are the 'state transitions'.

Though this is beyond the scope of this work, depending on the simulation methods used, Attributes and Methods may be further clustered in technical sub categories and cross comparisons, as, for example for Variables and Indicators:

---

The final model will result from the aggregation of different domain-related sub models, depending on the specific context, as qualitatively depicted in the following figure.
3.1.3 The i-FRAME Decalogue for implementing the proposed methodology

Building on the assumptions and key aspects introduced above, the practical steps for implementing the i-FRAME methodology for modelling and simulation of complex systems can be summarised by the i-FRAME Decalogue presented below.

1. **Start from a definition of a case/problem/need**, and reconstruct the logic model representing how the case/problem/need is addressed by the ICT-enabled social innovation initiative (for a definition of logic model see for instance Epstein & Yuthas, 2014).

2. **Define the levers for output, outcome and impact assessment** in accordance with the logic model identified at point 1, and identify the indicators for impact, outcome and output assessment in accordance with levers.

3. **Identify the impacted and impacting domains of the case/problem/need and how they are addressed by the ICT-enabled social innovation initiative.** To this end the proposed approach (see §3.3) is to develop Causal Loop Diagrams (CLD) that help in understanding which are the main cause-effects relationships of the problem under examination (references to CLD can be found in Sterman, 2000 and in Forrester, 1994).

4. **Check for similar existing dynamic simulation models** (cases available in literature and i-FRAME collected sub-models)\(^{43}\) in order to identify possible domain related sub-models already developed, if any.

5. **Look for and check the Attributes and Methods for each domain related sub-model** of the existing dynamic simulation model, and adapt them according to the case/problem/need addressed by the ICT-enabled social innovation initiative.

6. **Improve the dynamic simulation model adding the domain related sub-model not already included in the existing dynamic simulation model selected from the existing ones**, and complete the logical representation of the case/problem/need addressed by the ICT-enabled social innovation initiative. To this end, develop a methodological pathway in dynamic model development that combine qualitative (Causal Loop Diagram) and quantitative (stocks and flows and agent based models).

7. **Adapt and improve each single domain-related quantitative sub-model** (stocks & Flows Diagram and/or state charts with analytical description of the state transitions) also through Group Model Building Approach (Vennix, 1999; Zeigler et al., 2000; Vanden belt, 2004), and **combine the sub-models in the final dynamic simulation model representing the case/problem/need addressed by the ICT-enabled social innovation initiative.** To this end use aggregate approaches (i.e. hybrid models) that can build consensus around difficult policy problems and facilitate presentation of results, as well as to leave more rooms in policymakers’ and stakeholders’ capacity to concentrate on feedbacks and develop an endogenous perspective of the policy actions.

8. **Define the conditions** (initial data/information...) **for each scenario to be studied.**

9. **Analyse the scenario through different experiments** (by changing the internal levers of the model).

10. **Compare the scenarios and define/design the policy recommendations.**

Of course the above listed steps should not be considered the 'perfect scheme' to be used to achieve the rather ambitious objectives of assessing the impact and designing policy recommendations. However, they represent a valuable support for Stakeholders and Policy Makers - together with the assistance of domain experts - to achieve realistic results in relation to the impact assessment of a given policy relevant initiative, and to give the overall hints to identify all the elements necessary to show and describe the problem in its 'entire complexity'..

In this respect, it is important to notice that the proposed methodological approach has not to be considered sequential, but rather it is circular and reiterative and requires an higher involvement of Domain Experts, Stakeholders and Policy Makers. It is therefore important to notice how it

\(^{43}\) On the i-FRAME Repository of Models to be developed as part of the IESI research see Chapter 6 of this report.
would be fundamental to foresee the implementation of a structured Group Model Building (GMB) approach together with the application of the proposed i-FRAME methodology. The main objective of GMB is in fact to obtain knowledge enhancement within the team and bring out and share mental models across all the stages of problem modelling and simulation.

The involvement of the various actors in the modelling and simulation process foresees different way of GMB implementation, structured in a series of workshops, as indicated below and in the Figures 14 and 15 which outline the level of interaction of the two typologies of actors (Stakeholders and Domain Experts), following the 10 steps of the i-FRAME methodology.

- **Workshop 1 – Definition of the problem.** The objective of such workshop would be to involve all the stakeholders with the intent of gaining understanding of the situation, by defining the boundaries of the problem/issue, along with the objectives and the expected results. During the workshop it has to be taken into account that the outputs produced in this phase are very important for the next steps of implementation of the methodology, which is why they require as much involvement of the stakeholders as possible.

- **Workshop 2 – Conceptualization.** Two main objectives should be reached with proper workshops where both Stakeholders (including policy makers) and Domain Experts are invited: the first one is to define impact measurement metrics, in terms of outputs, outcomes and impacts, that can define overtime the effects of the policy action underpinned by the ICT-enabled social innovation; the second one should be defining the causal-loop diagram (CLD) with the proper impacted and impacting domains that expresses the dynamics of the problem and helps in better understanding it. In this phase, the experts should be involved along with the stakeholders, in particular when it comes to defining the KPIs of the logic model of the problem.

- **Workshop 3 – Modelling.** The objective of this kind of workshop is to develop the model addressing the specific problem/issue under observation. This is a very technical activity that requires the involvement of Domain Experts in collaboration with experts of modelling and simulation of complex systems. The contribution of Domain Experts is the definition of variables and attributes and related metrics that can be used by the modelling experts to shape the final model.

- **Workshop 4 – Simulation.** The scope of this type of workshop is to support the Modelling Experts with the contribution of the stakeholders (including Policy Makers) in gathering all the necessary information to build the scenarios that will be analysed in the final phase.

- **Workshop 5 – Analysis of results.** The scope of this type of workshops is to rich consensus on the achievements of the results of the modelling and simulation processes. In this last phase, the stakeholders, aggregated in proper workshops, have to make several comparisons of the results collected in different simulation scenarios, and through these evidences achieve consensus on possible policy actions and recommendations.

---

**Figure 14 – Stages of stakeholders’ involvement**

Source: Fair Dynamics elaboration on A. Tako and K. Kotiadis (2010)

**Figure 15 – Stages of domain experts’ involvement**

Source: Fair Dynamics elaboration on A. Tako and K. Kotiadis (2010)
In order to give a more practical idea of the application of the i-FRAME methodology specifically adapted to the dynamic simulation of complex social problems addressing ICT-enabled social innovations promoting social investments, here below we describe an example, although this stops at the step 8, as the implementation of steps 9 and 10 would require the availability of a computer-based simulation model, which is not yet implemented.\footnote{45}

The example derives from Sutrisno, & Handel, (2011) who developed a SD model to understand the socio-economic impact of demographic changes of the German population. In this example, the methodological steps of the i-FRAME can find an application as follows:

1. **Describe the problem/case/need**: the impact of increasing ICT-enabled services on the ageing population.

2. **Reconstruct the logic model**: resources allocated to ICT-enabled initiatives promoting social services for the ageing population – functioning of social services provided to older people – cost and quality of services provided – benefits for elderly population (e.g. increase of healthy years) – impacts on welfare system (e.g. reduction of care cost and social security savings)

3. **Identify the main Domains**: Relevant Population, Employment (Job), Financials, ...

4&5. **Check the literature existing models, Attributes and Methods**: Sutrisno, & Handel, (2011).

6,7&8. **Adapt and improve each single domain/sub-models; combine the sub-models and define the levels for output, outcome and impact assessment**: The application leads to the sketch below, where are reported only CLD, while Stock and Flow Diagrams and state charts (step 6 of the i-FRAME methodological approach) have not been developed for this example.

\footnote{45 As we will see in Chapter 6 this is foreseen as a next step of the IESI research.}
Figure 16 – Example of a dynamic simulation model (in CLD) assessing the impact of ICT investments on Silver Age

Source: Fair Dynamics elaboration on Sutrisno, & Handel, (2011)
Figure 17 – Domain–related sub-models of the Example of a dynamic simulation model (in CLD) assessing the impact of ICT investments on Silver Age

Source: Fair Dynamics elaboration on Sutrisno, & Handel, (2011)
3.2 Operationalising the i-FRAME methodology

3.2.1 Dynamic Simulation - Hybrid Modelling

The proposed i-FRAME methodology, as described in §3.1, is aimed at supporting experts and stakeholders in using an applied simulation modelling approach for analysing and evaluating outcomes and impact of the adoption of ICT-enabled social innovation initiatives promoting social investment.

Practically speaking, the methodology describes the steps of the framework that may drive the problem owners to use modelling for simulation purposes. In particular, it underlines an iterative path that may bring users to realize coherent and 'ad hoc' models representing a well-defined problem.

Using a simulation modelling approach thus work under the assumption that modelling is based on the mental models we all use to understand how things work in the real world. All of our decisions are based on mental models. Mental models of a problem are usually caught and depicted through the contribution of both 'problem owners' and experts that, through appropriate discussions and workshops, give the 'logical shape' to the model (as seen above in §3.1 with regard to Group Model Building for instance).

The resulting shape of the mental model can be formed through an appropriate diagram (implementable through the use of market available software tools) of relationships and/or state transition charts that represent the shared language of the model. **The most common way to represent mental models are the so-called Causal-Loop Diagrams (CLD) and State Charts (SC)** (see Figures 18 and 19 below) that are considered also as baseline of the impact assessment methodology proposed by the European Commission\textsuperscript{46}.

**CLD and SC are useful instruments to represent the real world before designing a model.** In particular the CLD represents the cause-effect relationships amongst variables, while the SC can be used to represent the dynamic behaviour of a single variable within the complex system to be modelled. As discussed before, the importance of these tools is twofold: on the one side they allow to downgrade the complexity of the reality by representing the only relevant variables that affect the impacts of the complex system under analysis. On the other side, they are easy to share and discuss with experts and stakeholders achieving a better representation of the 'real world' in a fastest, transparent and less costly way.

In addition, if represented with computer-supported graphical tools (available in largely diffused commercial software for modelling complex systems with SD/ABMS), they can also offer the possibility to easily modify the causal-loops and the state chart characteristics during the Group Model Building / Validation workshops achieving a better understanding of the characteristics of the problem – and possibly consensus through a transparent validation process.

This represents a major advantage, as it is relatively easy to embed the results into a software tool code for the quantitative validation of the model and its use for simulation and evaluation purposes.

\textsuperscript{46} See http://ec.europa.eu/social/main.jsp?catId=307
Going further in the implementation of the i-FRAME decalogue, as anticipated in the example concluding §3.1, once the steps helping define the sub domains and the associated possible attributes and methods of the problem have been implemented, the methodology brings to the step related to the development of a (computer-based) simulation model.

At this point, it depends on the experts to choose the most appropriate simulation modelling method, which could be selected among:

- A pure System Dynamics based method (SD).
- A pure Agent Based Modelling and Simulation method (ABMS).
- A mixed SD and ABMS method: the so called Hybrid Model (HM) method.
As a further guide to the possible choice, the following indications should be taken into account:

**Table 4 – Modelling and Simulation methods comparison**

<table>
<thead>
<tr>
<th>Paradigm</th>
<th>System Dynamics</th>
<th>Agent-Based Modelling</th>
<th>Hybrid Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perspective</strong></td>
<td>Top-down</td>
<td>Bottom-up</td>
<td>Top-down and Bottom-up</td>
</tr>
<tr>
<td><strong>Level of aggregation</strong></td>
<td>Aggregates (homogeneity)</td>
<td>Individual agents (heterogeneity)</td>
<td>Aggregate structure and Individual agents</td>
</tr>
<tr>
<td><strong>Unit of analysis</strong></td>
<td>System's structure</td>
<td>Agents' rules</td>
<td>Combination of System's structure and Agents' rules</td>
</tr>
<tr>
<td><strong>Main building block</strong></td>
<td>Feedback loop</td>
<td>Individual agents' behaviour</td>
<td>Combination of Feedback loops on System's structure and Interactions of Individual agents' behaviour (state charts)</td>
</tr>
<tr>
<td><strong>Major mechanism</strong></td>
<td>Feedback between different parts of the system</td>
<td>Emergent behaviour due to interactions</td>
<td>Combination of feedbacks between parts of system's structure and emergent behaviours due to agents' behaviours interactions</td>
</tr>
<tr>
<td><strong>System structure</strong></td>
<td>Fixed</td>
<td>Flexible</td>
<td>Fixed in the general system's structure and flexible in the Individual agents</td>
</tr>
<tr>
<td><strong>Origin of dynamics</strong></td>
<td>Levels</td>
<td>Events</td>
<td>By a combination of Levels (micro-meso-macro) and Events (behavioural changes of the agents)</td>
</tr>
<tr>
<td><strong>Handling of time</strong></td>
<td>Continuous</td>
<td>Discrete</td>
<td>Continuous in the system's structure and discrete in the agents' behaviour</td>
</tr>
<tr>
<td><strong>Simulation time</strong></td>
<td>Relatively low</td>
<td>Relatively high</td>
<td>Relatively high</td>
</tr>
<tr>
<td><strong>Calibration and validation time</strong></td>
<td>Relatively low</td>
<td>Relatively high</td>
<td>Relatively high</td>
</tr>
</tbody>
</table>

*Source: FD elaboration from different sources*

Indeed it should be underlined and made clear that **there is not a general rule to adapt one specific method** among the ones mentioned above. The choice of the method depends on several considerations, not mentioning the specific expertise of both the experts and stakeholders involved and the nature of the problem.

However, following the review of the state of the art and the scope of the problems addressed in this research, it seems fair to suggest that the Hybrid Model method should be mainly preferred for the following reasons:

- The SD’s based structure represent a well-defined paradigm to catch high-level perspectives and give a high-level abstraction of the problem. In the representation of the stocks and flows language, the general logic of the system is immediately shown, is easy to be understood and depict possible counter-intuitive situations.
• Yet, a pure SD approach does not immediately show the behaviour of the single classes of objects (people, means, sub-structures) involved in the problem, or, to say it better, the effort to be applied to take into account possible behaviours of single classes of objects that make part of the problem needs the introduction of other different structures (arrays of stocks and flows) that tend to complicate the overall model.

• A pure ABMS model is sometimes difficult to be understood in term of macro general behaviours. Being the ABMS paradigm based on a bottom-up approach, it focuses on the detailed aspects of each single class of agents. The macro properties and macro dynamics of the whole system depicting the problem, are often lost at the first 'on the fly' look of the structure of model sketch and are evident 'ex post', as a result of the simulation.

The HM method, i.e. the method that appropriately combines SD structures with agent’s structures, gives instead the following advantages:

• It catches both the high level structures and the single agent behaviour.

• The macro properties of the system emerge from the interaction of agents (if any); this reduces the use of 'heroic assumptions' which is limited and is confined to the general structure of the problem (the related system).

• It includes dependency on both (agents’) behaviour and structures.

• It uses both stocks and events as sources of the dynamic modelling and simulation of the problems.

As far as the hybrid combination to be chosen for a possible representation of the model, the following more detailed suggestions can be taken into account to illustrate the potential benefits of such approach (Borshchev, 2013):

**Agents in an SD environment.** Think of a demographic model of a city. People work, go to school, own or rent homes, have families, and so on. Different neighbourhoods have different levels of comfort, including infrastructure and ecology, cost of housing, and jobs. People may choose whether to stay or move to a different part of the city, or move out of the city altogether. People are modelled as agents. The dynamics of the city neighbourhoods may be modelled in system dynamics way, for example, the home prices and the overall attractiveness of the neighbourhood may depend on crowding, and so on. In such a model agents’ decisions depend on the values of the system dynamics variables, and agents, in turn, affect other variables. The same architecture is used to model the interaction of public policies (SD) with people (agents). Examples: a government effort to reduce the number of insurgents in the society; policies related to drug users or alcoholics.

**System dynamics inside agents.** Think of a consumer market model where consumers are modelled individually as agents, and the dynamics of consumer decision making is modelled using the system dynamics approach. Stocks may represent the consumer perception of products, individual awareness, knowledge, experience, and so on. Communication between the consumers is modelled as discrete events of information exchange. A larger-scale example is interaction of organizations (agents) whose internal dynamics are modelled as stock and flow diagrams.47

Source: Borshchev, 2013

---

47 The Big Book of Simulation Modelling, A.Borshchev, 2013, pag 240-243
In order to operationalise further the i-FRAME methodological approach, it can be observed also that, as a general consideration that should be attentively applied case by case, **SD could be the modelling technique to be used to represent the general structure of the problem**, i.e. the structure that models the relationship between the variables included in the problem (see 'attributes' and relationships in §3.1), while **ABMS could be used as the modelling technique that can describe the behaviours of the single units that make part of the problem** (i.e. classes of stakeholders involved in the problem).

For example the attribute 'population' included as a stock in a SD model is a number that changes over the time as a consequence of the combined action of the 2 rates 'birth rate' and 'death rate'. The content of the SD attribute 'population' may be the sum of different classes of people having different behaviours in terms of 'birth rate' and 'death rate'. Each class of people gives a different contribution to those rates depending on their behaviours (their state chart) that change over the time differently.

In other words, **through the combined modelling of SD and ABMS we can identify the contribution of each single class to the number contained time by time in the SD attribute 'population'**. In this case, the SD model structure is included in each agent's behaviour with different transition rules. In other cases, the SD structures represent a separate part of the problem and are not included in the agent’s behaviour, which affects different parts of the problem.

In this perspective, the proposal advanced for building the operational components of the i-FRAME is that **SD should act as 'leading methodology' and will be accompanied by Agent Based Modelling Simulation (ABMS)**, which will help the modellers to depict the levels of detail of the behaviour of the actors of the systems. The possibility to apply simultaneously both SD and ABMS will then drive the modeller, to **build a 'hybrid' simulation model** where both methodologies work together.

However the application of the hybrid approach does not necessarily exclude the possibility to adopt simpler SD or ABMS models alone if it is suggested by the specific problem to be addressed. As already mentioned above, the choice of the most appropriate modelling and simulation approach would be conducted during the application of the initial Steps of the i-FRAME methodology.
3.3 Defining relevant domain related sub-models for modelling the impacts of ICT-enabled social innovation initiatives

3.3.1 The role of ICT-enabled social innovation promoting social investment

Having introduced the general methodological approach proposed and the possible operational components suggested for its implementation, in this paragraph we aim at deepening our understanding of how the i-FRAME could be applied to the specific area under analysis: i.e. ICT-enabled social innovation initiatives promoting social investment.

In this respect it should be recalled that, in general terms, ICTs can be defined as electronic means for creating, storing, managing and disseminating information. Thereby ICTs can be seen as a means for processing information and as a vehicle for communication. On one side, the technology is part of the economic infrastructure supporting global production, trade, investment and capital flows. On the other side, ICTs are used to take part to the development process. Last but not least, ICTs foster innovation and productivity, as well as changes in markets and user behaviour, in countries moving towards a knowledge-based economy.

Taking into account more specifically the use of ICTs in social services, we have that one of the most important contribution that ICTs can bring into social systems is related to its capability in leveraging social relationships that are considered fundamental cornerstones for the generation, development and up-scaling of such systems (Hochgener, 2012). First, ICTs lower the cost of collaboration. Obviously not so much ICTs in general, but in particular social media and collaborative technologies that are fundamentally built around social relationships. They enables easy, on the fly encounters and collaboration between similarly minded people. According to Shirky (2009), this not only enables an increase in the productivity of existing social and economic relations, but also enables new forms of social innovation, through project-based initiatives and informal groups. Secondly, the web enables the large-scale outreach of social innovation. Thirdly, web-based social technologies provide incentives to volunteers by providing immediate satisfaction. Fourthly, web technologies typically increase the social pressure by exposing the individual behaviour. Therefore, peer pressure tends to reward positive behaviour such as volunteering, and stimulate imitation. But most of all, ICTs, and particularly web technologies benefit from network economies. In the social innovation context, this reinforces the self-help and mutual approach, and enables potentially an exponential growth of benefits. Traditionally, in public services, the quality of services is measured in such a way that increased usage corresponds to lower quality. On the other hand, when services scale up thanks to ICTs the quality remains constant.

Summarizing, ICTs can act as enabler for social innovation and thereby social services due to the potential opportunities for open collaboration and participation, giving voice to stakeholders and citizens, providing them with a better understanding of the choices affecting them, giving them direct ownership of and action in the decisions that affect their daily lives, and contributing to tackling social problems and renewing social policies. ICTs, when combined with participative and collaborative innovation, are no longer a neutral General-Purpose Technology in the canonical sense, but instead it provides a medium that changes the social context of interaction (Bresnahan & Trajtenberg, 1995; Helpman, 1998; Crafts, 2004). In this sense, ICTs in their open collaborative and participative components are a fundamental game changer for social innovation as they reduce the costs of coordination and help the move from institution to collaboration (Shirky, 2009) by providing an important contribution to social services transformation in a more sustainable and effective way (Kramer and Porter, 2011).48

48See also http://www.goelinsights.com/clay-shirky-collaboration-institutions/

49 If we look at the process of social innovation, we can easily understand how ICTs can play a significant role in accelerating it and in making it closer to societal needs, as well as we can also foresee how ICTs can support the process of social services transformation. In particular it can support to: identify new or unmet social needs; develop new
In the previous Chapter 2 (see in particular §2.3) we have provided evidence that at the moment there are not clear examples of dynamic simulation applied to modelling the impact of ICT-enabled social innovation initiatives. However, the results of the literature review show how ICT-enabled social innovation can be an important instrument to increase social inclusion of marginalized population with societal inclusive and innovative ICT-enabled products and services, as well as to create new entrepreneurial opportunities and increase skills and competences, furthering increasing the sustainability of the social services. At the same time ICT-enabled social innovation is considered in dynamic simulation applications assessing the impacts of policy interventions in social service delivery. In this case ICT-enabled social innovation is mainly seen as exogenous variable that can contribute in both improving preventive actions (i.e. upstream interventions) aimed at reducing risk factors of impacted population, and in increasing efficiency and effectiveness (i.e. downstream interventions) of service delivery processes.

Building on these preliminary indications emerged from review of existing literature, in the following of this paragraph we attempt to adopt the initial steps of the i-FRAME methodology proposed in §3.1, discussing the relevant domain related sub-models in which can be decomposed the dynamic simulation applications identified in literature and which directly address the modelling and simulation of impacts of ICT-enabled social innovation initiatives. The aim of this exercise is to identify the recurrent domain related sub-models used by the authors in decomposing the complex problems related to dynamic simulation of the impacts of ICT-enabled social innovation.

The Table 6 below classifies the applications identified on this topic during the literature review in relation to the type of the problem addressed and the system level to which it is associated.

### Table 5 – Examples of problems addressed with dynamic simulation modelling methods to evaluate impacts of ICT-enabled social initiative

<table>
<thead>
<tr>
<th>System level</th>
<th>Type of problems</th>
<th>Problem examples (references)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macro</td>
<td>Policy</td>
<td>ICT1. Simulation of the eGovernment policies for digital inclusion (Charalabidis, Loukis, &amp; Androutsopoulou, 2012)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ICT2. Impact of ICT diffusion on population (Dutta, Roy &amp; Steetharaman, 2012)</td>
</tr>
<tr>
<td>Meso</td>
<td>Beneficiaries related</td>
<td>ICT3. Impact of broadband diffusion in rural areas in Scotland (Howick &amp; Whalley, 2008)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ICT4. Impacts of the wireless technology on local eGovernment services (Lee Sang et al., 2009)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ICT5. Simulation of WEB 2.0 initiatives on public services delivery (Bivona et al., 2011)</td>
</tr>
<tr>
<td>Micro</td>
<td>Operational</td>
<td>Not found during the literature review</td>
</tr>
</tbody>
</table>

Source: Fair Dynamics for JRC-IPTS, 2016

Among the five examples found, two are related to the simulation of ICT policies for digital inclusion, while three address ICT-enabled interventions targeting specific groups of beneficiaries (e.g. people living in rural areas; Wi-Fi users). None of the applications specifically address impact on social service delivery, however mostly of them refers to e-Government services that, to some extent can be compared to them, at least in terms of intervention logic.

---

solutions in response to these social needs; monitor and evaluate the effectiveness of new solutions in meeting social needs; scale up effective social innovations (see e.g. Maase & Dorst, 2007, Mulgan, 2006 and Desa & Kotha, 2006),
Among the applications addressing e-Government services impacts modelling and simulation, perhaps the clearest example is the one which simulates the impacts of wireless technology on local e-Government services (Lee Sang et al., 2009). To simulate the ICT-enabled social innovation (i.e. the Wi-Fi services) the authors identify four interrelated domain-related sub-models (see the ICT4 case description below): Relevant population (Wi-Fi subscribers) sub-model; ICT-enabled (Wi-Fi) initiative takes-up sub-model and its consequences in relation to business efficiency gains; Economic market (business development & labour market) sub-model which is impacted by the efficiency gains due to the increase of the Wi-Fi quality connection and impact the employment rate and the wages of the population; attractiveness of the reference (Wi-Fi) area sub-model that has positive influence in the take-up of the Wi-Fi diffusion with positive indirect impacts on the other sub-models.

Looking at the other examples of applications we can raise the following conclusions in relation to the domain-related sub-models used to decompose the complex problem simulated:

- All the applications start from the model of relevant population, which represents the characteristics of the beneficiaries of the initiative;
- Some applications (e.g. Dutta, Roy & Steetharaman, 2012, and Howick & Whalley, 2008) combine the sub-models of the relevant population with the one of the general population. In our opinion the choice of combining or not the two dynamics (i.e. general and relevant population dynamics) depends on the relevance of the stock of general population that can potentially become beneficiary of the ICT-enabled social intervention.

- Financing of the intervention sub-model is another domain related sub-model that is considered by most of the examined applications (e.g. Charalabidis, Loukis, & Androutsopoulou, 2012; Dutta, Roy & Steetharaman, 2012). It aims at explaining how the investors and the policy makers interact to increase the adoption and the uptake of the initiative, and maximise its impacts.

- Close to the financing of the intervention sub-model is the one related to simulate the initiative uptake (e.g. Lee Sang et al., 2009; Bivona et al., 2011). In our opinion, for the scope of i-FRAME, the two sub-models can be merged since they represents the 'two face of the same coin': on one side they model the financing dynamics, that, on the other side, depend on the potential adoption dynamics, and vice-versa.

- Impacted domain sub-model is represented by the economic market dynamics (Lee Sang et al., 2009).

In the following sub-§s each application described in the table and its domain related sub-models are discussed in details.

### 3.3.2 Dynamic simulation addressing impact assessment at policy level

The dynamic models listed in the above table and their relevant domain related sub-models are described for the following cases:

**CASE ICT1 – Simulation of the eGovernment policies for digital inclusion** (Charalabidis, Loukis, & Androutsopoulou, 2012). The system dynamic model investigates the estimated impact of planned government initiatives. Simulation applies to the diffusion of ICTs.

---

50 As we will explain in the following Chapters 4 and 5 the same considerations can be made also in relation to the simulation of impacts from social inclusion policies.
The model addresses the problem of the 'Digital divide in Greece'. The application of the model can be considered as an attempt to foster a higher level of e-Inclusion and increase the diffusion of complementary activities such as eGovernment and eParticipation.

The Figure 21 below describes the overall dynamic simulation model that is composed by the following domain-related sub-models:

- **Domain-related sub-model A** – Relevant population (digital divided) sub-model
- **Domain-related sub-model B** – Financing of the intervention (public-private) sub-model
- **Domain related sub-model C** – Demand-Offer of ICTs (Broadband & Internet access) sub model

The model describes the dynamics of the broadband and Internet adoption by users: percentage of broadband users increases according to the broadband take-up rate reducing in parallel the stock of Internet potential users. Then, the flow of broadband take-up rate is determined by the cost of broadband access, the technology adoption factor and the rate of broadband coverage.

**Figure 21 – Dynamic simulation model of ICT diffusion (example A)**

![Dynamic simulation model of ICT diffusion](source)

**CASE ICT2 – Impact of ICTs diffusion on population** (Dutta, Roy & Steetharaman, 2012). The system dynamic model simulates the ICTs diffusion in the Pacific Asia region, which is characterized by substantial differences in contextual variables that drive ICTs diffusion, such as literacy rates, economic development and infrastructure sophistication, besides having wide diversity in cultural norms.

---

51 Digital divide is a term coined to characterize the inequality in the relationship between groups of individuals with regard to the availability and use of ICTs.
The Figure 22 below describes the overall dynamic simulation model composed by the following domain-related sub-models:

- **Domain-related sub-model A – General population sub-model**
- **Domain-related sub-model B – Relevant population (adopters) sub-model**
- **Financing of the intervention initiative (public-private) sub-model**

The model captures the dynamic relationship between network capacity and adoption rate and, by separating the expansion of network capacity, the SD model also allows to examine the impact of certain dimensions of diversity in user populations.

For instance, ICT adopters in the service sector tend to be quite sensitive to network performance. If the Network Performance degrades, there will be negative word of mouth effects in this user segment, slowing down the adoption process. On the other hand, rural users tend to be much more tolerant of Network Performance degradation as even a slow connection offers them so much value compared to pre-adoption conditions. This diversity can be represented by two different functional forms for Network Performance, and the impact on adoption can be determined.

**Figure 22 – Dynamic simulation model of ICT diffusion (example B)**

Source: Dutta, Roy & Steetharaman, 2012
3.3.3 Dynamic simulation addressing impact assessment on beneficiaries

The dynamic models listed in the above table and their relevant domain related sub-models are described for the following cases:

**CASE ICT3 – Impact of broadband diffusion in rural areas in Scotland** (Howick & Whalley, 2008). This system dynamic model simulates the impact of broadband adoption in rural and remote areas in Scotland.

The Figure 23 below outlines the CLD of the dynamic simulation model that is composed by the following domain-related sub-models:

- **Domain-related - General population sub-model**
- **Domain-related - Relevant population (adopters) sub-model**

**Figure 23 – Dynamic simulation model of broadband adoption**

The causal diagram in the figure represents the main elements of the Bass model (Sterman 2000). The Bass diffusion model assumes that adoption for a product stems from two main sources; innovators who adopt the product due to external sources of awareness, usually interpreted as the effect of advertising and from imitators who adopt the product as a result of contact with previous adopters i.e. from word-of-mouth. In particular, the figure highlights three feedback loops. The first is a positive feedback loop; as more people adopt the product there are more people to communicate its benefits through word-of-mouth and hence further people will adopt. There are also two negative feedback loops, as more people adopt the product, there are less potential adopters left (due to a finite population of potential adopters) to adopt through the effects of either word-of-mouth or advertising.
CASE ICT4 – Impacts of the wireless technology on local eGovernment services (Lee Sang et al., 2009). The system dynamic model simulates the Wi-Fi impacts in cities or local governments. The method is demonstrated with a comparison of the expected Wi-Fi performance for small and metropolitan locations, and an evaluation of safety (expected impact on crime), tourism (expected impact on visitors) and other economic benefits.

The Figure 24 below describes in a CLD format the overall dynamic simulation model that is composed by the following domain-related sub-models:

- Domain-related sub-model A – Relevant population (Wi-Fi subscribers) sub-model
- Domain-related sub-model B – ICT-enabled (Wi-Fi) initiative take up sub-model
- Domain-related sub-model C – Attractiveness of the reference (Wi-Fi) area sub-model
- Domain-related sub-model D – Economic market (business development & Labour market) sub-model

Based on the primary goals of wireless municipal broadband business plans, it can be assumed that cities and municipal governments not only expect to bring together wireless broadband users, city employees, residents, employers, and visitors, but also expect wireless technologies to bring more efficiency to government operations through seamless connectivity for residents and travellers, and to help bridge the digital divide in low-income and underserved neighbourhoods. The model simulates several expected results of the Wi-Fi technology uptake (i.e., the rate of increase in population, change in the crime increase rate, rate of effective Wi-Fi use, and so on) in evaluating the effectiveness of city-wide Wi-Fi network for public service in municipal cities.

Figure 24 – Dynamic simulation model of Wi-Fi diffusion

Source: Lee Sang et al., 2009
CASE ICT6 – Simulation of WEB 2.0 initiatives on public services delivery (Bivona et al., 2011). The system dynamic model simulates the impact of Web 2.0 governance model on the modernization process of public service delivery.

In the **Figure 25** below is outlined the CLD of the Domain-related sub-model – ICT-enabled (web 2.0) initiative take up sub-model.

The CLD describes how the openness of the Public Administration improves effectiveness and efficiency, thus increasing levels of satisfaction, trust and participation by citizens, conversely creating the conditions for the socio-economic revitalization of the area. In details, from the interaction among the actors cause-effect loops have been identified, which can generate a virtuous spiral in the phenomenon under consideration.

A first identified loop underlines the importance of the resources openness, designed as an attitude of public authorities to listen and dialogue with citizens, and trust in order to generate an increase of participation in all phases that precede, accompany and follow the delivery of a public service. The increase in the number of relevant reports and requests received from Local Government in turn, generates greater efficiency of the public body, resulting therefore in an improved performance of the public administration and increase in citizens' satisfaction, which also enhance their level of confidence in institutions and therefore the extent of their participation, providing new suggestions to improve the performance of the public administration in the entire public services delivery process.

**Figure 25 – Dynamic simulation model of web 2.0 diffusion**

Another loop instead highlights the importance of detention by the public administration of financial resources such as to generate sufficient investment in organizational systems and increasing the available human resources within the services delivery.

These investments, as remarked by the authors of the study based on interviews with stakeholders and users, have a positive impact on waiting times for the delivery of a service, thus having an effect on both the relationship quality/cost and hence the citizens' satisfaction.
They also have an impact on competitiveness, as a high level of competitiveness of the public administration is also able, for example, to attract investment by private companies or other public bodies (e.g., the EU.

The aim of this approach is thus to create conditions for sustainable socio-economic development of the territory that can generate new financial resources, under grants or tax revenues, ready to be re-invested. These resources could be exploited for example by the public administration in innovation investments, and also to further improve the quality of services provided and consequently the competitiveness and socio-economic development of the area.

The cases discussed above are examples – though limited in scope and depth - of how the i-FRAME methodology could be applied to decompose complex systems and set the basis for understanding the role and impact of ICT-enabled social innovation initiatives promoting social investment. This will be further investigated in the next Chapters 4 and 5 where it will be applied to qualitative and quantitative case studies drawn from the work conducted as part of complementary components of the IESI research.
4 Qualitative validation of the i-FRAME methodology

This Chapter provides evidences of the qualitative validation of the i-FRAME methodology. To this end several validation scenarios have been developed from selected case studies drawn from the IESI knowledge base. The results of the qualitative validation show that the i-FRAME methodological approach is flexible enough and adaptable to several contexts of use where ICT-enabled social innovation can be applied.

It is organised as follows:

- §4.1 provides an overview of the criteria used for selecting case studies and the type of validation conducted.
- §4.2 describes the case studies selected from the IESI Knowledge base to validate the i-FRAME.
- §4.3 presents the results of the qualitative validation of the methodological approach underpinning the i-FRAME conducted through scenarios of use in different domains relevant to the topic under investigation.

4.1 Criteria for case study selection and type of validation

The criteria that we have adopted to select the case studies are the following:

- **Reasonable coverage of EU28 welfare state regimes**: 1) Anglo-Saxon (Ireland and UK); 2) Central-Eastern European (Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia); 3) Continental (Belgium, France, Germany, Luxembourg and the Netherlands); 4) Mediterranean (Cyprus, Greece, Italy, Malta, Portugal and Spain); and 5) Nordic (Denmark, Finland and Sweden).

- **Reasonable coverage of PSSGI categories**: Childcare; Education and Training; Social assistance; Social care; Social housing; Employability; Employment; Social inclusion/participation; Civic engagement; Active and health ageing and long-term care.

- **Degree of stakeholders participation in the social service delivery model.** It represents the capability of SI initiative to develop a collaborative service delivery model (across public, private and non-governmental actors). This is an important dimension that measures to what extent a social innovation initiative is able to integrate multi-stakeholders perspective in the co-design and co-create of innovative solutions of social services delivery processes.

- **Degree of representation of trade-off between upstream and downstream intervention in policy decision making.** Shows the extent of diffusion of types of decision-making in the social innovation context, and therefore it helps in justifying how extensively the quantitative model developed in Chapter 5 for dynamic simulation can be applied in other policy contexts.
To conduct a qualitative validation of i-FRAME methodology described in Chapter 3 the first 5 steps of the i-FRAME methodology was applied and are reported below:

1. Start from a definition of a case/problem/need, and reconstruct the logic model representing how the case/problem/need is addressed by the ICT-enabled social innovation initiative (for a definition of logic model see for instance Epstein & Yuthas, 2014).
2. Define the levers for output, outcome and impact assessments in accordance with the logic model identified at point 1, and identify the indicators for impact, outcome and output assessments in accordance with levers.
3. Identify the impacted and impacting domains of the case/problem/need and how they are addressed by the ICT-enabled social innovation initiative. To this end the proposed approach is to develop a casual-loop diagram (CLD) that helps to understand which are the main cause-effect relationships of the problem under examination (references to CLD can be found in Sterman, 2000 and in Forrester, 1994).
4. Check for similar existing dynamic simulation models (cases available in literature and other i-FRAME sub-models) in order to identify possible domain-related sub-models already developed.
5. Look for and check the Attributes and Methods for each domain related sub-model of the existing dynamic simulation model and adapt and improve them according to the case/problem/need addressed by the ICT-enabled social innovation initiative.

The initial 5 steps of the proposed methodology do not require quantitative modelling as the subsequent 5 ones. Therefore they are the most suitable steps of the i-FRAME methodology to be applied to a qualitative validation process.

Nevertheless the qualitative validation of the first 5 steps of i-FRAME is very useful for several reasons:

- It allows understanding the flexibility and adaptability of the proposed methodology in different policy contexts and for different policy measures where ICT-enabled social innovation can play an important role in modernising social services.
- It allows to reveal the extent that the 'logic model' definition of a policy solution in relevant 'impacting' and 'impacted' domains could be considered in the simulation of the impacts of the ICT-enabled social innovation in social service delivery processes.
- It allows verifying the extent that the 'logic model' approach can be used for the identification of the 'Key Impact Indicators' in a simulated social policy action as well as the extent it is useful for the definition of the CLD of that policy action.
- It allows to understand the extent that the proposed classification of the dynamic simulation variables in 'Attributes' and 'Methods' might be useful for to collect all the relevant data to build up the dynamic simulation model addressing the specific policy action.
4.2 Selected case studies for scenario building

Table 7 lists the selected case studies used for the developing scenarios for the qualitative and quantitative validation of the i-FRAME methodology. The selected case studies cover all the different typologies of Welfare Systems in EU. In fact, we have:

- 2 cases in the Anglo-Saxon welfare system (National Telecare Development Programme, Scotland, UK; Pathway Accommodation and Support System (PASS), in the Dublin Region, Ireland)
- 1 case for Eastern Europe welfare system (Express Train to Employment, Poland)
- 1 case for Continental welfare system (Societal Ageing Impact, the Netherlands)
- 1 case Mediterranean welfare system (Italian National Institute of Social Security (INPS), Italy)
- 1 case for the Nordic welfare system (EKSOTE, Finland)

The cases selected cover – as types of PSSGI – Education and Training; Social assistance; Social care; Social housing; Employability; Employment; Social inclusion/participation; Civic engagement; Active and health ageing and long-term care to various extents.

Table 7 also provides information about the participation of different stakeholders in the social service delivery models, and most cases are implemented with the collaboration of stakeholders from both the private and public sectors.

Finally, with the exception of two cases (‘Strategy for digital welfare in Denmark, and the Italian National Institute of Social Security’), the others represent a trade-off between upstream and downstream interventions in policy decision-making. Initiatives are focusing on prevention as well as on resolving/alleviating the problems that may arise, and this should aim – as described in chapter 5 – lowering the probabilities of recidivism by providing an effective and sustainable measure.
Table 6 – List of the selected case studies

<table>
<thead>
<tr>
<th>Case study (Country)</th>
<th>PSSGI addressed</th>
<th>Aim of the case and description of upstream and downstream intervention</th>
<th>Type of validation</th>
<th>Degree of stakeholders participation</th>
</tr>
</thead>
</table>
| Societal Ageing (Netherlands) | • Active and healthy ageing and long-term care  
• Social care  
• Social assistance  
• Employment  
• Social inclusion | The case analyses the effects of demographic changes in the Netherlands and it aims at understanding to what extent the Social Security System is affordable in the long-term period. Upstream interventions concern initiatives that make the Social Security and Retirement Systems more efficient and flexible. Downstream interventions concern those initiatives that addressed to people who are in need of support in terms of retirement and social security assistance. | Qualitative | Public and private sector stakeholders |
| National Telecare Development (United Kingdom) | • Social assistance  
• Social care  
• Active and health ageing and long-term care | The program has the aim of promoting the use of telecare to the population through provision of a development fund and associated support, in order to increase safety and security. Upstream interventions include initiatives aiming at promoting ICT enabled health and social care services. Downstream interventions instead aim at supporting those who are in need of health and social assistance. | Qualitative | Local authorities; health boards; Telecare network |
| EKSOTE (Finland) | • Social assistance  
• Social care  
• Employment  
• Social inclusion  
• Active and healthy ageing and long-term care | The program targets older people (75+) and it provides integrated care services in order to promote health and wellbeing. The upstream interventions include initiatives aimed at promoting strategies for centralized health and social care for the population. The downstream interventions include the initiatives concerning assistance care and support to patients and families in need. | Qualitative | District for health and social services; municipalities; private stakeholders. |
| Express train to employment (Poland) | • Employment  
• Employability  
• Social inclusion/participation | The program aims at designing and testing a model of outsourced employment services that enables an individualized and effective approach to engage the long-term unemployed and to increase the efficiency of public spending. Upstream initiatives aim at implementing a model that allows the long-term unemployed to return to employment. Downstream | Qualitative | Public labour services; social aid institutions; non-governmental organizations; non-public operators |
<table>
<thead>
<tr>
<th>Initiative</th>
<th>Services Provided</th>
<th>Description</th>
<th>Type</th>
<th>Implementor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy for Digital Welfare (Denmark)</td>
<td>Social assistance, Social care, Education and training, Active and health ageing and long-term care</td>
<td>The initiative aims at developing welfare technology and digital welfare solutions on a country-level, with the aim of providing digital welfare services to the citizens, in order to enhance their quality of life in a cost-effective way.</td>
<td>Qualitative</td>
<td>Public service; government</td>
</tr>
<tr>
<td>Italian National Institute of Social Security (Italy)</td>
<td>Social care, Social assistance, Employment, Social inclusion/participation</td>
<td>The initiative, implemented by the Italian National Institute of Social Security (INPS), aims to a digitalization and automation of the relationship between the Public Administration and citizens in reducing digital divide and improving the accessibility of services.</td>
<td>Qualitative</td>
<td>Public institution; government</td>
</tr>
<tr>
<td>Pathway Accommodation Support System (Republic of Ireland)</td>
<td>Social assistance, Social care, Social Housing, Education and training, Employability, Social inclusion</td>
<td>PASS is an online platform adopted for the implementation of Dublin Homeless Region Executive initiative. This aims at providing to the public authorities and other stakeholders involved, statistical information on the homeless population profile and use of services, in order to monitor the effectiveness of the strategy; identify emerging trends related the homeless issue; monitor and improve service delivery, facilitating the agencies to work together to provide a continuum of care and integrate service delivery; plan future service developments.</td>
<td>Quantitative</td>
<td>Local authorities; Homeless services executive; European Social Funds.</td>
</tr>
</tbody>
</table>
4.3 Qualitative validation of the i-FRAME through scenarios of use

4.3.1 Scenario 1: Social Security Service delivery reform in the Netherlands

4.3.1.1 Problem addressed, objectives and logic model of the scenario of use

The initiative addresses the challenges of the demographic change in the Netherlands. In particular, it aims to assess the long-term affordability of the pension system and the long-term social care components of the Social Security System in the light of the societal ageing on the Dutch government retirement and social care service delivery policy. The demographic change causes the shrinking of working-age population and the increasing demand for Long-Term Care (LTC) services. Keeping pace with the rising demand for LTC poses a key challenge for health and social care systems and to policymakers, who may be slow to scale up capacity and to address medium and long-term societal challenges. Nevertheless, ICT could play an important role to modernize the health and social care delivery system for the ageing population. The Logic Model of the consequences of societal ageing on the Dutch society underlines the main inputs, activities, outputs, outcomes and impacts of the initiative, and can be structured as follows:

- **Inputs:** They consist in the funds allocated by the state in order to finance the Social Security System; the local service-delivery agencies/entities; and the Social Security Delivery structures.

- **Activities:** The activities or interventions to address the problem of the initiative are, respectively:
  - **Upstream:**
    - interventions to the retirement system to make it more flexible;
    - interventions to the Social Security System to make it more efficient; and
    - interventions to retirement policies to support the capacity of the pension system.
  - **Downstream:**
    - interventions with specific programs to provide financial assistance to people in retirement age;
    - interventions to the labour market to increase the labour productivity; and
    - Interventions with specific programs to support needy people with social security assistance.

- **Outputs:** They are primarily the number of interventions to the pension system, in order to make it more flexible, to support the capacity of retirement policies and to provide financial assistance people in retirement age. Other outputs are the number of interventions to the Social Security System, in order to make it more efficient and provide people in need with social security assistance. A further output is identifiable in the number of interventions to support the labour market with the aim of increasing the level of its productivity.

- **Outcomes:** The outcomes identified are related to the different interventions or programs adopted, and are summarized below:
  - increased flexibility of the retirement rules, facilitating persons already in retirement to re-enter the labour market according to their needs/possibilities. This provides a greater 'flexicurity' for the already retired workers and alleviates the pressure on the welfare system;
  - increased share of people in retirement age who receive income support;
  - better dependency ratios and economically active / passive ratios in society;
  - increased number of people receiving support and assistance from the social security system;
- increased level of labour productivity.

- **Impacts:** the possible impacts of the interventions identified are:
  - reduced demand for long-term care services;
  - increased quality of health care, and healthier workforce;
  - increased flexibility and efficiency of Social Security System;
  - decreased pension costs and increased fiscal sustainability;
  - increased capacity of retirement policies and improved retirement age - policies;
  - increased level of labour productivity.

4.3.1.2 Causal loop diagram of the societal ageing impact simulation on Social Security Services delivery reform in the Netherlands

All domain-related sub-models of the case and the relative impacted and impacting domains are illustrated in the Causal Loop Diagram (Figure 26):

**Figure 26 – CLD of Societal Ageing Impact Simulation**

Source: own elaboration

The figure shows the relationships between the different domains and subdomains. First of all, it shows how the general population model (the demographic characteristics), influences the other subdomains, in particular the labour market model, as the age-distribution determines the level of workforce. It also demonstrates the importance of the perception of policy, as it influences the
policy-desirability. It features the health care system as well, as it affects the health care demand and supply. Finally, it includes the social security system, as it influences the social security payments.

Moreover, the Causal Loop Diagram shows the relationships between the different subdomains: in particular the Labour Market domain may influence the Social Security System, and this could affect the health care system. Also, aggregated income provides social security funds, and available funds influence health care level. Furthermore, the health care system may influence the policy perception and the labour market. In fact, better health care leads to an increase in life expectancy, and that may influence the regulation for retirement age; and then the demand for health care services may influence the demand for workforce in healthcare provision.

4.3.2 Scenario 2: Active and health ageing and long-term care delivery services in Scotland and Finland
4.3.2.1 Problem addressed, objectives and logic models of the scenarios of use

In order to describe the scenario of active and health ageing and long-term care delivery services, two cases have been selected that refer to initiatives that take place in the United Kingdom (in Scotland) and Finland. They are:

**National Telecare Development Programme (Scotland, United Kingdom):** The Scottish Telecare Development Programme was launched in 2006 with the aim of helping more people live at home for longer, in safety and security, by promoting the use of telecare through the provision of a development fund and associated support. The programme is a policy initiative to drive the adoption of telecare by local health- and social care providers (or 'care partnerships') with the intent of improving the productivity of the national health system and to reduce their cost. The project aims at increasing the number of people in receipt of telecare services; reduce the number of avoidable admissions to care homes; reduce the number of unplanned admissions and readmissions to hospital; reduce the need for other more expensive forms of intervention; reduce the pressure on informal carers; improve the quality of life of health- and social care service users; mainly older people, but also others with physical disabilities, learning disabilities or long term medical conditions. The logic model of this initiative can be structured as follows:

- **Inputs:** these are identifiable with the budget provided to finance the initiative (reportedly £20.35 million from 2006 until the end of the Programme in 2011) and to encourage the diffusion of telecare practices; the Scottish Telecare Learning Network with the role of supporting staff in making progress with telecare programmes; 32 local authorities involved in delivering telecare services; 14 health boards that took care of strategic planning of the initiative.

- **Activities:** the actions undertaken to provide the initiative are divided into Upstream and Downstream:
  - **Upstream:**
    - development of ICT-enabled health- and social care services;
    - integration of primary care, specialists' services and social care.
  - **Downstream:**
    - promotion and implementation of telecare and telehealth;
    - direct support to local health-, housing and social care partnerships;
    - support activities from training to self-management.

- **Outputs:** from the data collected it emerges that the outputs of the initiative can be measured in terms of:
people beginning telecare services through TDP funding (44,000);
- expedited hospital discharges (2,500);
- avoided care home admissions (3,800);
- avoided unplanned hospital admissions (8,700);
- assisted people with dementia diagnosis (4,000).

**Outcomes:** the outcomes of the initiative related to the interventions are:
- improved productivity of formal and informal caregivers;
- increased cost-effectiveness of social services;
- improved access and take-up;
- increased number of people reached by telecare services;
- increased capacity of self-management;
- reduced incidence and prevalence of frailty and disability.

**Impacts:** the impacts of the initiative can be measured in terms of:
- improving quality of life of the population, especially older people, those with physical disabilities, long-term medical conditions;
- increased savings in health care system thanks to telecare and telehealth;
- better performance of the health- and social care system;
- increased digital literacy of the population;
- increased rate of people living independently.

**EKSOTE (Finland):** The EKSOTE case – South Karelia District of Social and Health Services – has strong similarities with the TDP Scotland case described above. The case addresses the 75+ ageing population. It provides integrated care services to targeted population for promoting health, wellbeing and the ability of independent living in everyday life. ICT helps in better coordination and communication across organizations and between carers, patients and families. Thanks to the development of digitalization and ICT, it has been possible to step from a service-system based on hierarchy and autonomy to a functionally integrated service-system that is a part of a well-being ecosystem. In this scenario, the main focus is on the citizens, and the added value comes from the use of Big Data and data analysis to increase the effectiveness of the resources-allocation between 1) actions preventing risks (upstream interventions) promoting healthier life styles and self-care management of the user at home, and 2) health and social care intervention (downstream interventions) as provision of rehabilitation services for adverse events. The logic model of the initiative can be structured as follows:

**Inputs:** these are identifiable with the centralized information system:
- collecting various types of information from different sources;
- integrated economic and financial system for all municipalities;
- employment of new people;
- training and specialization of workers;
- a better decision-making and system management.

**Activities:** the actions undertook to provide the initiative are divided to Upstream and Downstream:
- **Upstream:**
  - development of municipal ownership strategy;
  - efficient support of logistics and integration of new processes;
  - training for management at all levels;
  - centralized administration and support to families and social services.

- **Downstream:**
  - care services provided by the health system, such as rehabilitation for patients in need;
  - information and support for patients and their families;
  - rehabilitation and home care provided by formal and informal caregivers for those patients who need support because of interventions, disabilities or chronic illnesses.

**Outputs:** from the evidence collected it emerges that the outputs of the initiative can be reported as follows:

- people currently using the service on a regular basis (reportedly 30,000; although during the years, there have been 50,000 people served in total);
- building of multidisciplinary teams (doctors, specialized nurses, social workers);
- implementation of e-services for health care;
- service of Mobile clinic, useful for reaching population living in rural areas;
- services of rehabilitation at home, as well as supported housing;
- cooperation with different health and social care associations and companies.

**Outcomes:** the outcomes of the initiative related to the interventions are:

- customers have more independent living in their own homes and have less need of receiving visits by nurses and going to the emergency wards;
- since 2010, the number of days spent in long-term care decreased and the number of days spent in short-term care has increased;
- improvement of ICT skills for population;
- improvement in population’s quality of life.

**Impacts:** the impacts of the initiative can be measured in terms of:

- cost effectiveness and savings in health care system (e.g. the total cost of the rehabilitation patients have decreased since 2012, due to the fact that patients have used less other social or health care services. The total costs of rehabilitees have decreased from around 23 million euros in 2012 to around 20 million euros in 2014);
- transition to an integrated network of social and health care system;
- better performance of welfare system.

### 4.3.2.2 Causal loop diagram of the active and health ageing and long-term care delivery services in Scotland and Finland

The Causal Loop Diagram shows the domain related sub-models found for the Telecare Development program for Scotland and EKSOTE.
As shown in the figure, the impacting domain can be identified with the Care sub-model. This in particular concerns the care service delivery, which has impacts on the demography, social inclusion and economy domains. Social Inclusion is impacted in terms of Social service delivery, especially for services such as social care for the population and indirectly also social housing (depending on the programme characteristics). The demography impacted domain concerns the general population, in terms of ageing, and relevant population, regarding older people but also the formal and informal caregivers of the services. The economy domain is impacted in terms of Industry, housing and labour market. Industry concerns both housing and ICT, which is fundamental for providing the initiatives. Thus, the housing market is impacted as new infrastructures and equipment for home automation is needed. The labour market is impacted has it is necessary to provide adequate training to the resources in order to deliver the services.

4.3.3 Scenario 3: Employment and Life-Long learning
4.3.3.1 Problem addressed, objectives and logic model of the scenario of use

The Express Train to Employment approach, also known as Welfare-to-Work, has been used successfully in various countries around the world and it is based on the adoption of a cooperative model that involved the public employment services, social aid and institutions, non-governmental organizations and non-public operators. The initiative was introduced in Poland as a follow-up to the new labour act reform introduced in 2014 and it aims to address the problem of long-term
unemployment in the central region of Krakow and to improve the quality of activation measures for unemployed people registered at the Labour Office.

The benefit of the initiative resides in engaging the non-public providers in offering support to get long-term unemployed people back into employment status. The model enables an individualized, and thus more effective, approach to engage the unemployed and it aims to increase the efficiency of public spending through incentives, as payments are only made when specific outcomes are achieved. The ICT-enabled platform serves as a new model to engage people who have been unemployed for a long period of time, and includes all the information needed to do a better profiling of unemployed people and matching between demand and supply of workforce. The initiative also offers incentives to all stakeholders once they find employment solutions for those who have been unemployed for long-term.

The logic model of the initiative can be structured as follows:

- **Inputs:** They consist mainly of the funds that have been allocated thanks to the European Social Fund and that have been used by a partnership of organizations in the public and private sectors. Their joint efforts, along with the implementation of a digital platform, have created the cooperative model necessary to realize the activities of the initiative.

- **Activities:** there were conducted different activities in order to make the initiative possible:
  - a digital platform have been created, thanks to the use of ICT, in order to allow the unemployed to upload their own data for job profiling;
  - companies and operators offering vacancies have access to the platform to share information about recruitment and employment;
  - the platform is used for monitoring and controlling the ongoing activities related to the initiative;
  - assistance to long-term unemployed in transition to labour market to identify their skills and competence.

- **Outputs:** first of all, 1,000 long-term unemployed people were chosen for testing the initiative for a year before launching it to a wider area. The outputs are measured in terms of participants that were able to take a job during the first 6 months, which was the 66% of the total. Also, it was measured how many participants worked in part time as opposed to full time (77 %). Finally, the share of employees able to work for at least 6 months (51 %) during the testing phase was also measured.

- **Outcomes:** First of all, it is expected that the rate of long-term unemployed was decreased and that the job was lasting more than 6 months in order to allow them to get out of unemployment. Also, it was expected a better rate of demand and offer of job matching thanks to the use of the digital platform, that could make easier to companies to find resources and help them getting out of unemployment. Also, it has been created an updated model of outsourcing employment service to non-public providers.

- **Impacts:** the main impacts of the initiative can be identified in an increased efficiency of the welfare and social system performance and an increased efficiency in the use of resources and synergy between the private and the public sector. Also, thanks to the decreased rate of unemployment, the quality of life of the population can be generally improved.

4.3.3.2 Casual loop diagram of the Express Train to Employment in Poland

All domain-related sub-models and the relative impacted and impacting domains address by the initiative are illustrated in the Causal Loop Diagram, shown in the following picture:
The CLD provided in the figure above shows how the impacting and impacted domains of the model are related. Social inclusion is the impacting domain, as it concerns social security and employment that are the main focus of the initiative. The social inclusion domain impacts the sub-model of financing of the intervention initiative that in this case is provided by the European Social Fund and with the help of partnership in the private and public sector. In regards to the demography, the relevant population domain is impacted, which in this case includes the beneficiaries of the service that are the long-term unemployed that are trying to get back to employment status. This implies that the economy domain is impacted, in particular the Labour market, which includes the people that are unemployed but are part of the initiative and trying to find a job, the companies and the job agencies that do the recruiting. Also, the demand-offer of ICT industry is impacted in the economy domain as, in order to implement the digital platform necessary to provide the service, the companies in the industry have to be involved in order to provide the necessary resources.

4.3.4 Scenario 4: Strategy for Digital Welfare
4.3.4.1 Problem addressed, objectives and logic model of the scenario of use

The Danish Strategy for Digital Welfare is a national policy framework that aims at modernizing and rethinking public services in order to ensure a more cost-efficient and effective provision of services by accelerating the adoption of ICT in frontline delivery; focusing on healthcare for older people, social services and education through dedicated specific initiatives and objectives. The Strategy has both a focus on digital solutions as a means to increase service capacity and value for money through greater efficiency, cooperation, and knowledge sharing, and as enablers for communities, families and individuals to contribute to societal wellbeing. The project is a response to the need of the public authorities to exploit digital solutions to collaborate and share knowledge.
and information across administrations, sectors and specialist disciplines. The Logic Model of the Strategy for Digital Welfare in Denmark is structured as follows:

- **Inputs:** funds allocated by the state to finance and sustain the Digital Welfare Strategy; and the collaboration between the government, local governments and regions, required to implement the strategy.

- **Activities:** several new activities or interventions are necessary to implement the strategy:
  - digitalization of services in the health sector (e.g. telemedicine, communication channels between users and healthcare providers);
  - digitalisation of services in the education sector (e.g. digital learning materials, digital tools, digital written exams, common user portal as a digital entrance to the primary and lower secondary school system);
  - digitalization of social services and healthcare sector;
  - digitalization of services in the public sector and the relationship between these and the citizens (e.g. services of speech recognition technology for public employees, municipal electronic care records system in all municipalities).

- **Outputs:** Number of people affected by the activities described in the previous point or the number of products or services provided by the same activities.

- **Outcomes:** There are many different outcomes expected by the outputs of the activities:
  - digitalisation of services in healthcare may lead to different outcomes, such as increased efficiency through telemedicine or increased efficiency in the transactions between patients and the health system, and reduced waiting lists.
  - digitalization of services in education may lead to an overall more efficient education system
  - healthcare and social services:
    - reduced demand for assistance by people living with disabilities in their own home or in nursing homes;
    - enhanced capacities and improved quality of life for people living with disabilities to manage and plan their own lives;
    - increased efficiency of public services.

- **Impacts:** the main impacts of the activities should be:
  - increased quality of healthcare;
  - increased flexibility and efficiency of healthcare provision;
  - increased efficiency and quality in the education sector;
  - decrease of the costs in the healthcare sector;
  - increased cost-efficiency of public services;
  - increased general wellbeing of service users.

### 4.3.4.2 Causal loop diagram of Strategy for Digital Welfare

All domain-related sub-models and the relative impacted and impacting domain of the initiative are illustrated in the Causal Loop Diagram, shown in the following figure:
The Causal Loop Diagram shows how the Strategy for Digital Welfare produces significant impacts in several sectors and domains. The digitalization of services may affect:

- social protection system (education, employment and public sectors);
- economic system (workforce and ICT-industry);
- overall population;
- healthcare system.

In conclusion, the Causal Loop Diagram shows that for the successful implementation of the Strategy for Digital Welfare there is the need of financial resources from the public sector.

4.3.5 Scenario 5: Telematization of Social Security Services in Italy

4.3.5.1 Problem addressed, objectives and logic model of the scenario of use

This case describes the telematization project of services, implemented by the Italian National Institute for Social Security (INPS). The project aims to digitalise and automatisre the relationship between the Public Administration and citizens by reducing the digital divide and improving the accessibility of services. The services offered online are targeted to a wide range of users: Italian citizens, immigrants, workers, pensioners, and taxpayers working abroad but residing in Italy. The
added value of this project is the innovation in its methodological approach, which favours the logic of corporate performance management and business performance management in an intervention that integrates business process reengineering techniques, methodologies and software development tools. The role of ICT was crucial for this process, also due to the introduction of processes of IT-demand and IT-governance, and resulted in simplification for the end users and improvements in the welfare benefits rendered by INPS. The telematized services belonged to the following social services areas: social assistance, social care and social inclusion. The telematization of services ensures simplified administrative procedures, improved access and control of information for citizens, savings for the public administration. The Logic Model of the telematization of services is addressed as follows:

- **Inputs:** public funds allocated to finance and sustain the initiative of telematization of services and the integration between INPS and the related intermediary institute(s).
- **Activities:** several activities or interventions necessary to implement the initiative.
  - careful revision of internal procedures and processes necessary for delivery of services
  - improvement of the monitoring processes/products/services delivery.

In order to achieve the digitalization of services, it has been necessary to proceed with:
- development of an online tool to support the new business model and delivery;
- extension of telematic services in for mobile platforms;
- development of the 'Portal of payments' to mobile payment solutions through the implementation of a digital bulletin, or payment notice and payment MAV via the mobile;
- progressive improvement of the 'Open data' section
- development of intelligence solutions on large volumes of information ('big data').

- **Outputs:** The outputs expected by the interventions are:
  - increased processes managed electronically (99.8%) (approximately 94.8 million services managed online in a year as result of the interventions of modernization and revision of the processes and procedures);
  - increased number of visitors of the website per year (by over 44%, over 299 mln, with a daily average over 818,000);
  - increased number of e-mails received (+43%);
  - increased download of online forms (+50%);
  - increased number of web pages accessed (3.4 billion/year);
  - increased number of access to services through mobile devices (630,000).

- **Outcomes:** The main outcomes expected by the telematization of services are:
  - increased awareness of services offered;
  - increased interaction and information transfer between citizens and public administration;
  - increased automation of services to citizens and an easier access to services through mobile devices.

- **Impacts:** the interventions aimed to a telematization of services can lead to relevant impacts on system levels:
  - increased cost-efficency of social security services;
- possible reallocation of resources within the social security system saved by the more cost-efficient services;
- increased efficiency, quality and reaction time for the services provided.

4.3.5.2 Causal loop diagram of Telematization of social security services in Italy

All domain-related sub-models and the relative impacted and impacting domains of the initiative are illustrated in the Causal Loop Diagram (Figure 30):

**Figure 30 – CLD of Telematization of Services**

![Causal Loop Diagram](source)

**Source: own elaboration**

The telematization of services influences other subdomains, in particular the economic development system. The transformation of these services can be considered as an impulse towards a development of the economic system through the 1) realization of intelligence solutions on large volumes of information ('big data'); 2) the standardization of procedures; and 3) by providing services for users of mobile platforms, guaranteeing at the same time an adequate level of privacy and security. Moreover, the Causal Loop Diagram shows the relationships between the social security system and the relevant population domain, the latter composed by workers and taxpayers. Finally, the diagram shows how the initiative of telematization needed public financing to be implemented.
5 Examples of quantitative application of the i-FRAME approach

Box 5 Summary of content of Chapter 5

This Chapter aims at quantitatively validate the i-FRAME methodology. To this end, two initiatives were selected as representative of relevant policy interventions in order to test the operational components proposed to implement the i-FRAME methodology through dynamic simulation modelling.

It is organised as follows:

- §5.1 presents the application of a dynamic simulation modelling approach applied to the Temporary Assistance of Needed Families (TANF) policy intervention in the USA.
- §5.2 describes the possible application of the i-FRAME methodology through quantitative dynamic simulation modelling applied – as an example - to the case of Pathways Accommodation and Support System (PASS) deployed by the Dublin Region Homeless Executive (DRHE) in Ireland. This example is drawn from the case studies conducted as part of IESI and it shows the feasibility of the approach proposed.
- §5.3 provides a brief comparison of the results of the two quantitative applications in view of further research and development of the i-FRAME as a computer-based simulation model. It also discusses the results of the stakeholders’ validation activities conducted.

5.1 TANF as example of quantitative application of the i-FRAME

5.1.1 The problem addressed, the objectives and the logic model of the Temporary Assistance of Needy Families (TANF) initiative

Temporary Assistance for Needy Families (TANF) initiative is one of the United States of America's federal assistance programs. It began on July 1st, 1997, and succeeded the Aid to Families with Dependent Children (AFDC) program, providing cash assistance to poverty-stricken American families with dependent children.

The TANF program was designed to help needy families to attain self-sufficiency. In order to benefit from this support, people/families must belong to some particular disadvantaged categories, such as: people awaiting child-birth or responsible for children under 18 years of age; families that have low or very low income; and people under-employed (working for very low wages), unemployed or about to become unemployed.

The objectives of the TANF program are described below, including a categorisation whether they belong to downstream or upstream interventions:

- to provide assistance to needy families so that children can be cared for in their own homes (downstream);
- to reduce the dependency of needy parents by promoting job preparation, work and out of wed-lock pregnancies (i.e. for teenagers) (upstream);
- to prevent and reduce the incidence of out-of-wedlock pregnancies (upstream);
to encourage the formation and maintenance of two-parent families (upstream).

The logic model of the initiative can be structured as follows:

- **Inputs.** They consist in the funds allocated by the state for TANF, in the social service delivery structures of states available for the initiative, like the organizational, technological and human resources, and finally in the delivery system of the initiative, i.e. the local service entities or agencies.

- **Activities.** The activities, in which the interventions have been organized to address the objectives of the problem, can be divided in downstream and upstream interventions. The upstream interventions are:
  - intervention in order to review of state plan for use of block funds;
  - specific program to encourage job skill development;
  - specific program to facilitate job searches;
  - specific program to provide transportation, childcare, etc.;
  - specific program to prevent and reduce the incidence of out-of-wedlock pregnancies.

While the downstream interventions are:
  - specific program to support the mainstream employed, in order to reduce the probability of recidivism;
  - specific program to encourage the formation and maintenance of two-parent families;
  - specific program to assist needy families so that children can be cared for in their own homes.

- **Outputs.** They consist of the specific products or services provided by the upstream and downstream interventions:
  - number of subsidies to needy families to increase the probability to find a job;
  - number of programs to encourage job-skill development;
  - number of programs to facilitate job research;
  - number of programs to reduce the probability of recidivism to families on TANF;
  - number of programs to prevent and reduce the incidence of out-of-wedlock pregnancies;
  - number of programs to provide assistance to needy families so that children can be cared for in their own homes.

- **Outcomes.** The outputs of upstream and downstream interventions:
  - higher number of mainstream jobs;
  - higher number of temporary jobs;
  - higher rate of families receiving subsidies on total;
  - reduction of time to find the first job;
  - development of sense of personal responsibility and strong work ethic in those served through TANF;
  - increasing formation and maintenance of two-parent families;
  - increasing ratio of children that can be cared for in their own home;
  - reduced incidence of out-of-wedlock pregnancies.
**Impacts.** Results of the entire system of outputs of upstream and downstream interventions:
- Declined unemployment rates;
- Increased number of trained workforce;
- Reduction in welfare dependency cycle for families at risk of long term dependency;
- Increased job skill level and employability;
- Increased mainstream employment;
- Decreased recidivism;
- Substantial cost savings in social services delivery due to caseload-reduction;
- Reduction of childcare-costs for the healthcare system.

### 5.1.2 The TANF dynamic simulation model

To demonstrate the applicability of the i-FRAME to the TANF initiative, we have developed a dynamic simulation model by following the steps of the i-FRAME methodology (see D2 Executive Summary and Chapter 3 of D3). The System Dynamics Model simulates the sustainability of the Temporary Assistance Needy Family (TANF) policy and its impact on the labour market.

In the TANF case, the overall dynamic simulation model is composed by two Domain-related sub-models: Relevant population—Temporary Assistance Needy Families – Families on TANF and People Post-TANF Employed, which have been described in the following Causal Loop Diagram:

**Figure 31 – Causal Loop Diagram representing the Dynamic simulation model of TANF**

The model uses an aging chain structure to represent the flow of potential recipients of TANF support, i.e. total families at risk. The chain includes two main stock variables: Families on TANF and Post-TANF employed. Families on TANF receive TANF support, while those in the Post-TANF employed stock remain at risk but do not receive direct support. The number of families on TANF increases as families enter the program and decreases as they find employment and move to the Post-TANF employed stock. Most of the individuals from Post-TANF employed families are employed in low-wage and temporary jobs. Thus, these families are still at risk of recidivism and
can return to the former stage (Families on TANF) if individuals lose their job. The model considers the flow rates based on two variables representing supportive capacities in the system. TANF support capacity influences the Job finding rate such that, as support capacity increases, people find jobs more quickly and move to the next stage. A similar effect exists for the downstream capacity (Post-TANF employment support capacity), which captures the economic condition of the region and number of jobs available for Post-TANF families. Usually Post-TANF jobs are low-wage or temporary jobs, and Post-TANF families therefore face a high risk of losing employment and returning to a state of deprivation. Alternatively, families may graduate from Post-TANF employment into mainstream employment, after which they could have a greater overall job security.

The model captures the phenomenon of recidivism by defining a variable named Probability of recidivism as a function of the Post-TANF employment support capacity: the higher this capacity gets more people exit the risk of recidivism, attain mainstream employment and avoid the return to the TANF program.

The main focus of TANF policymakers was at allocating TANF support capacity among families involved in TANF (the upstream part of the chain). Yet, in contrast to what policymakers intuitively expect, a rise in the upstream capacity makes outcomes worse by increasing the number of families on TANF as well as the total number of families at risk. In reality by increasing the upstream capacity more people gets to the downstream and the load on the downstream increases. In contrast, an increase in the downstream capacity (Post-TANF employment support capacity) has a positive effect on the system by decreasing the number of families on TANF and the total number of families at risk. Such a policy decreases the load on downstream as well as decreasing the load on upstream by decreasing recidivism.

Overall, this model shows that adding capacity upstream can swamp downstream resources, increasing the recidivism rate and resulting in still more demand upstream. In other words, adding capacity upstream, by itself, can increase the upstream load and make the entire system worse off (Richardson et al., 2002). The approach used to model the problem is a hybrid approach, which combines System Dynamics and Agent Based Simulation models. Figure 32 shows the representation of ABM Hybrid Model: the top of the figure represents the Agent Based Model while the System Dynamic Model can be found at the bottom. In particular the ABMS has been used to simulate the behaviour of the target population (i.e. 'Needy Families' and 'Needy Families' members'), while the structural functioning of the upstream and downstream policy measures underpinning the social inclusion service-delivery is modelled through a System Dynamics approach.

**Figure 32 – Hybrid Model of TANF**

![Hybrid Model of TANF](image)

*Source: own elaboration*
The Agent Based Model shows the transition between the different categories of agents over time: Needy Families, Families on TANF, Post-TANF Employed and the Employed. The lower half of Figure 33 shows the parameters of the System Dynamics Model: TANF Support Capacity and Post-TANF Employment Support Capacity. The model shows that a load on TANF Support Capacity impacts the time to find a first job, while a load on Employment Support Capacity impacts on probability of recidivism, i.e. the probability of return to Families on TANF.

Moreover, through a vision of the hybrid model, a load on TANF Support Capacity may increase the probability of moving from Families on TANF to Post-TANF Employed, while a load on Employment Support Capacity may increase the probability of moving from Post-TANF Employed to Employment, decreasing the probability of recidivism. In this way, Load on TANF Support Capacity represents the upstream interventions, while Load on Employment Support Capacity the downstream interventions. In the figure below are shown the results of the Hybrid Model:

**Figure 33 – The results of Hybrid Model of TANF**

![Graph showing the results of Hybrid Model of TANF](image)

*Source: own elaboration*

It is supposed that the number of initial families in need and the number of initial families on TANF is the same and equal to a thousand families. The Load on Employment Support Capacity, that influences the probability of recidivism, has a value equal to 2; this means that in this model every 2 Post-TANF Employed have a support 1 operator. In the same way, the Load on TANF Support Capacity, that influences the variable of the time to find a job, has the same value, and this means that in this model every 2 families on TANF have 1 support operator. Moreover, in this model the rate of families in TANF at the week has value equal to one hundred; this means that every week there are one hundred new families in TANF.

Under the conditions described, Figure 33 shows that by an initial number of 1,000 families on TANF after approximately 40 months achieve an equilibrium-value equal to 4,400, and then stays on the same value for the following lengthy period. This model shows an important result, because it represents how a perfect combination of upstream and downstream policies is able to absorb the quantity of needy families over time, causing them to settle to an equilibrium value. The ICT-based technology here applied is represented by an IT system supporting the operators through a set of 'real time' and continually updated information about TANF and Post-TANF Employed families. By using this database it is possible to reduce the intervention time of the service-operators and to increase the quality of service.

In this simple simulation model, the effect of the IT system is simplified through a decrease of the variables representing the 'load' for each operator (or, conversely, an increase of the figurative number of operators), that means an increase of both the efficiency and effectiveness (less recidivism) of the TANF system. In fact, by decreasing the 'load' or, equivalently, by increasing the number of figurative operators, both the 'time to find the first job' and the 'probability of recidivism' decrease and the TANF system achieve more efficiency and global effectiveness.
5.2 Social housing homeless provision in Dublin region (PASS/DRHE)

5.2.1 The problem addressed, the objectives and the logic model of the PASS service in favour of the homeless people in the Dublin region

In 2001, homelessness became a specific policy focus in Ireland with the adoption of the national policy framework 'Homelessness: An integrated Strategy (HAIS)'. Prior to the adoption of this framework, Irish housing, health, welfare, education and justice policy in relation to homelessness was characterized by little or no integration and few attempts at inter-agency coordination and action. Another problem identified was the absence of sufficient data on the causes and consequences of homelessness, and this represented an obstacle to informed policy decisions. The adoption of the HAIS framework was the first step to address this data-deficit and also to make policies about homelessness more efficient and outcome-oriented.

The Homeless Agency was established as a part of the strategy on homelessness in 2001, in response to the higher levels of homelessness experienced in and around Dublin than elsewhere in the country at that time. It was responsible for planning and coordination of the delivery of quality services to people who are experiencing homelessness in the Dublin Region. The Agency coordinated homeless services in Dublin providing training and other supports, monitored and evaluated the effectiveness of the services, carried out research and administrated the funds to the homeless services. The Dublin Region Homeless Executive organisation formally replaced the Homeless Agency in 2011.

The Dublin Region Homeless Executive (hereby named DRHE) works in partnership with a range of voluntary and statutory agencies to implement the Homeless Action Plan Framework for Dublin 2014-2016, and manages interventions that are targeting homeless people in Dublin. The aim of the organization is to prevent homelessness; eliminate the circumstances that result in people sleeping rough; reduce the length of time people experience homelessness to less than six months; and address unmet housing needs of people experiencing homelessness through increased housing options that delivers affordable, accessible housing with supports as required. Also, DRHE aims to produce the sought-after; and proven, documented and evaluated person-centred outcomes.

DRHE adopted a nationally developed database called Pathways Accommodation and Support System (PASS), an online system that can track the pathways of service users into, through and out of the homeless service system over time. The PASS has been implemented in the Dublin Region since 2011, replacing a LINK system as the single shared system in operation across statutory and voluntary homeless services. The system can provide 'real time' information in terms of homeless presentation and bed occupancy across the Dublin region. This tool allows enhanced 'live' collation of information on presentation to homeless services and service occupancy. The database is able to flag up when someone has been in homeless emergency accommodation for longer than 6 months. This is in line with the Government's strategy to end long-term homelessness and limit stays in emergency accommodation by facilitating move-on to permanent solutions.

A Logic Model of the initiative is detailed below:

- **Inputs.** Different resources that are fundamental for the implementation of the initiative. In particular, the first fundamental resource is the budget, which is allocated entirely by the public sector (mainly Central and Local government funds). Another essential input is the implementation of the tool that allows the shared tracking and data management of homeless people registered in the system. The tool provides 'real time' information in terms of homeless presentation and bed occupancy across the Dublin region. All network actors, in this case, use the single IT system. In addition, the human resources involved in the initiative include social assistants, social workers, volunteers and informal carers.

- **Activities.** The interventions made to address the problem can be divided in upstream and downstream activities.
Upstream activities are related to preventing the phenomenon of homelessness. The activities aim at planning and developing the services to meet the needs of the beneficiaries of the initiative in the best way possible, and also at improving service delivery, by ensuring that resources are used effectively by reducing duplication of effort and facilitating agencies to work together to provide a continuum of care and integrate service delivery.

Downstream activities that are aimed at finding solutions to problems related to homelessness. This is mainly done through the monitoring and evaluation of services, resulting in recorded outcomes and effectiveness of the interventions.

- **Outputs.** They consist in the specific products or services provided by the upstream and downstream activities described above. As the activities described are related to the tracking and monitoring provided by the PASS online platform: number of individuals accessing the homeless services; bed occupancy; housing support delivered; length of service use; number of exits from the service. There is also information about homeless population profiling, such as name, date of birth, gender, current homeless accommodation.

- **Outcomes.** Effects of the initiatives on target beneficiaries. In this case, it has been detected that the number of individuals accessing homeless accommodation has steadily been increasing. This expansion has been in response to increasing demand for access to emergency accommodation arising from reduced access to housing options and resulting in lower than needed moves to tenancies. Also, the demand was further increased by the influx of families who lost their private rented accommodation and typically wouldn't previously have engaged with homeless services. In particular, from the last quarter of 2014 to the third quarter of 2015 the number of adult individuals accessing homeless accommodation has increased of the 25%, as showed by the PASS system.

- **Impacts:** In this case the participants of the program reported less rough sleeping; better general health; a decrease in everyday life problems related to the criminal justice system; better experience of everyday discrimination; increased sense of personal autonomy and control over their living situation. This translates to a positive effect on the higher levels: increased efficiency of public services; the performance of the welfare system; and a better societal integration/inclusion of homeless people.

### 5.2.2 Identification of the impacted and impacting domains of the service in favour to the homeless people in the Dublin region

In this particular case, the impacting domain can be identified in the **Social Inclusion** domain. DHRE services address the needs of homeless people living in Dublin region, the 'relevant population' addressed by the service. In this context, ICT acts as an enabler in providing Social Housing services for the relevant population in a more appropriate way, thanks to the instrument of PASS. The initiative provides real-time information on homelessness and bed occupancy across the Dublin region, including the following data:

- whether or not homeless people are registered in the PASS system;
- whether or not they have a personalised support plan in place;
- the number of times they have accessed emergency accommodation;
- the number of contacts they have had with the Housing First / Outreach teams;
- the number of sleeping bags they have booked;
- the length of time since they first accessed homeless accommodation.

Overall, in the context of the DHRE initiative, through PASS, ICT acts as an enabler for:

---

52 For further reference, see data available for consultation on [www.homelessdublin.ie](http://www.homelessdublin.ie)
• **Upstream activities:**
  - implementation of the Pathway Accommodation and Support System that can track the pathways of service users into, through and out of homeless service provision;
  - control of availability of adequate, accessible and affordable housing;
  - support of inter-agency cooperation;
  - collection of real time data.

• **Downstream activities:**
  - decision-making and service responses to homeless’ needs;
  - support towards pathway of independent living;
  - promoting personal development of soft skills and empowerment;
  - promoting social and active participation, networking and engagement in local community.

The impacted domain related sub-models in this case are reported in the following:

• **Relevant Population**, which includes in this case the homeless people living in the Dublin area as well as volunteers and workers in the third sector. Homeless people are the main beneficiaries of the initiative, while social assistants, along with social workers and volunteers are intermediary actors involved in the services provided.

• **Social Housing Delivery**, due to the fact that the main objective of the initiative is to respond to and prevent homelessness. The aim is to prevent homeless users from being hosted in emergency accommodation and help them settling in temporary or long-term housing. In this case, the aim of transitional housing is to provide accommodation and support for those who cannot move into long-term housing and need further interventions to live as independently as possible. The long-term housing accommodation facility consists of self-contained housing in a building or block(s) of flats that have been specifically built or converted for use as supported housing, where on-site staff can provide appropriate level of support to residents as necessary.

• **Care Service Delivery**, because along with social housing delivery there are also several collateral services for the beneficiaries, like health- and social care services. In emergency accommodations healthcare services are provided. Access to health- and social services is facilitated by some providers, public health nurses and community welfare clinics. The service also allows rehabilitation and detox treatments if needed.

• **Financing of the intervention initiative**, as mainly the public sector provides the necessary financial resources for the implementation and operation of the initiative and the services. DHRE is fully funded by central government annually and it is aligned with the national policy. The majority of funds are spent annually for local initiatives and a quantum of revenue is spent on the national PASS system.

• **Labour market** is affected in two different ways. First of all, in order to increase the efficiency of the services further and specialized workers are needed to be involved: social assistants, social workers, volunteers and informal caregivers. On the other hand homeless people are expected to find a job thanks to the activity of social re-integration. By providing personal development support, life-skills training and employment initiatives, caregivers and social workers can help users to acquire the right skills to get back to the labour market and employment. The support provided includes activities of capacity building, and covers areas like the development of life-skills, budgeting, parenting, home management, advice and advocacy.
5.2.3 Causal loop diagram of the PASS services in favour to the homeless people in the Dublin Region

A general model for this case is very articulated and complex, as the number of situations involved are very numerous and interacting with each other. Yet, in order to test the i-FRAME methodology, a simple model was prepared that tends to catch the effects of the PASS systems for the transition from the initial 'emergency accommodation' to a more stable accommodation (tenancies). The realized model is coherent and reproduces over time some data officially published by DRHE\textsuperscript{53}.

Some of the domain-related sub-models described above and the related impacted and impacting domains are illustrated in the Causal Loop Diagram (Figure 34):

**Figure 34 – CLD of Dublin Region Homeless Executive with PASS (simplified)**

![CLD model of simplified PASS-like case](image)

*Source: own elaboration*

The Closed Loop Diagram features 3 main stocks in the model: Homeless People, People in Emergency Accommodation, People in Other Accommodation. The flow rate is based on the support capacity of the system variable, in this case the Transitional support capacity, which influences the rate of people going from Emergency Accommodation into the Other Accommodation.

The whole dynamic mechanism is based on the increase or decrease of the Probability of Success to transfer people from Emergency to Other Accommodations. This probability depends on the load of support that, on turn, depends on the PASS’s Transitional Support Capacity.

\textsuperscript{53} See previous footnote for data reference.
In other words, in the simplification of this model, the PASS systems effects the Transitional Capacity, i.e. the number of 'figurative' operators providing the service and the Load of the Support offered.

The model captures the dynamic relationship between the support capacity of the services offered through the PASS system (transitional) and the rate of homeless people going into the type of service. The logic of the reinforcing loop is: People in emergency accommodation → Load of transitional support (affected by the PASS system through the change of the support capacity) → Probability of success → In Transitional rate → People in other accommodation. The support capacity of the service underlies the loop.

5.2.4 Representation of the PASS through the use of Simulation Modelling

The PASS (DRHE) case can be represented through simulation modelling using data provided by The Homeless Agency Partnership. Group Model Building Approach has been used to provide the dynamic simulation model of the PASS case. ICT acts in this case as an enabler to increase the number of figurative operators providing and coordinating services, that, on turn, increase the probability of success: more people moving to housing from emergency accommodations. Figure 35 shows the stock and flow diagram used for simulation modelling.

The dynamic simulation model is a re-elaboration of the TANF model presented in the previous paragraph. This evidence shows how the methodological approach designed with the 10 steps of the i-F RAME methodology allows the effective and efficient application of a dynamic simulation model for evaluating an ICT-enabled social innovation policy. It also shows the high degree of replicability of the proposed model for social policy impact simulation.

Figure 35 – Stock and Flow diagram of PASS-like model

Source: own elaboration
As reported, the stocks in this case are:

- homeless people;
- people in emergency accommodation;
- people in other accommodation;
- accumulated costs.

These are also the indicators of the model. The first stock is composed by the Homeless People in the Dublin area. Thanks to the PASS system and the DRHE program, the service end beneficiaries can be brought into the stock of People in emergency accommodation, which is the first type of accommodation provided. The transitional service capacity, fed by the PASS system, influences how many of the homeless can enter into the other accommodation. From this stock of People in emergency accommodation, the homeless can go in the stock of People in Other accommodation, which is a facility provided by the program. The Accumulated Costs refer in this case to the budget that has been allocated in order to provide the initiative for the indicated services.

The flows are related to the rates that allow the people to go from one stock to the other. Homeless people In rates indicates the fraction of the population that becomes homeless. The Emergency rate regulates the flow of people going into the Emergency Accommodation. The Other Accommodation rate regulates the flow of people going respectively from Emergency to Other accommodation.

The levers that regulate the flows used for the calibration of the model are:

- Initial (Q1-2014) New homeless in Emergency accommodation (437).
- Initial Existing homeless in Emergency accommodation (1869).
- Transitional support capacity, measured by number of figurative operators affected by the PASS system (15). The number is for calibration of the model.
- Homeless rate, measured by number of homeless per week (as per data collected from the case documentation)\(^54\).
- Unit cost, measured by cost (€) per homeless per week (25.000).

The time period that has been used to run the model is 78 week from Q1-2014 to Q3-2015.

By using the levers with the values reported above, it emerges that over the indicated period, the number of Homeless People amounts to 3,383, the number of people in Emergency Accommodation to 3,371 and the number of people in Other Accommodation to 1,449 (this latter, by supposing 0 at the initial time of the simulation, Q1-2014).

As for the cost, the lever of unit cost has been adjusted to a value of 25,000 euros that seems to be coherent for the delivery of the indicated service.

\(^{54}\) http://www.homelessdublin.ie/homeless-figures
It can be concluded from the evidences provided by the quantitative validation, that the instrument of PASS is useful in terms of efficiency and effectiveness for the planning and execution of services provided by the Dublin Region Homeless Executive. The real-time tracking of homeless people as well as the availability of beds allowed the system to increase the efficiency of bed occupancy to a rate of 99% capacity, thanks to the sharing of information between all agencies and other stakeholders, including volunteer organisations supporting homeless people. This ensures that the resources available are used efficiently, also by reducing the duplication of efforts. The introduction of PASS allows the local government to promptly use the generated information to manage, monitor and evaluate the services efficiently.

PASS provides statistical information on the homeless population's profile and the usage of services that can be used to monitor the effectiveness of the strategy, identify emerging trends and to monitor service delivery. Every record is unique and customizes tracks, progress, and assessments of needs in relation to income, employment, training, education and health. The improvement of the service delivery is obtained through the shared information system that enables the agencies and other involved stakeholders in provision to track and share the tasks and to provide a continuum of care and integrate service delivery. The statistics provided can be used to plan future service developments and monitor the quality of the services dispensed. It provides an overview on the challenges of homelessness, profiling the characteristics of the homeless persons using the services, contributing to a reconfiguration of the provision of services and the introduction of key operational changes in service delivery in order to attain long-term strategic policy objectives.
One important effect of the initiative is that it helps to optimize financial and human resources by reducing the overall costs of homelessness in society by delivering the essential required service to any households experiencing homelessness. This response resulted to be highly preferable in comparison to previously adopted approach to get people ‘housing ready’. In this respect, individuals enter and exit homelessness in different moments in their lives. Statistics show a significant improvement in the number of individuals whom have entered and then moved into independent living and integrated in society having full employment and better health conditions.

This process of quantitative validation of the PASS scenario indicates that this approach could be used in ex-ante, in-itinere, and ex-post simulation of the impact and the functioning of a given policy action that involves ICTs as enablers in services planning, design or provision.

Furthermore, the proposed approach is also very useful for simulating the impacts of different policy decision. For instance, by experimenting with the levers used for the simulation model, it has emerged that even by changing the number of operators in the system, the probability of success reaches a cap over time and it does not affect the number of beneficiaries anymore.

Similarly to the evidence in the TANF model showed earlier, in this simple simulation model the effect of the IT system is also simplified through an increase of the figurative number of operators, that means an increase of both the efficiency and effectiveness (probability of success) of the ICT based social initiative. By decreasing the 'load' or, equivalently, by increasing the number of figurative operators, the 'probability of success' increases and the 'time to move to housing' decreases ensuring more efficiency and global effectiveness to the whole social intervention.

5.3 Cross-case comparison and stakeholders' validation

5.3.1 Comparison between the examples of i-FRAME Application

The two initiatives that underwent quantitative validation can be compared and analysed in terms of satisfaction of the validation dimensions that will be further commented in Chapter 7. They are:

- **Adaptability:** in order to be adaptable, the methodology needs to be adjustable readily to different conditions and circumstances. The cases that were validated can in fact be considered adaptable. The dynamic structure of the models that have been built for simulation can be re-used (i.e. as described in previous paragraphs, it can be put in the model-bank that should be created to collect all the models useful for consultation) and adapted/extended to study and analyse further initiatives.

- **Replicability:** the methodology can be considered replicable when it can be repeated multiple times and/or in different contexts in order to be considered valid. The cases were validated through different experiments (simulation scenarios) throughout the process, and the results can be considered valid as they are coherent with the data that has been found in literature regarding the initiatives.

- **Scalability:** the methodology has to be adjustable to different measures and increased number of variables and still maintain its validity. In this context, the validation was possible only in terms of micro dimensions, in both cases analysed. The validation was made by changing values of the levers and appropriately combining the related subdomains. This offers a valid base for further validation, in terms of meso and macro dimensions of the initiative.

- **Transferability:** the transferability of the methodology is realised by adapting it to different initiatives and combinations of sub-models and variables, without losing its validity. So far, these cases can be considered transferable in terms that they themselves have been adapted from cases found in literature and described in Chapter 2. The software that was used for simulation modelling allowed the structure of the model to be adapted and replicated for obtaining validations of different cases.
• **Implementation costs:** the costs of implementation have to be affordable and sustainable for long periods of time. This is because the process of efficient and effective implementation is time-consuming, as the process is iterative and requires the contribution of different stakeholders and experts that support them through workshops. Also, the costs of the software and tools have to be added. The quantitative validation of the initiatives presented (prior to acquiring proper information and data) was mainly based on the preliminary validation workshop and a software supported back then.

5.3.2 Stakeholders’ validation of the i-FRAME approach

In order to get a preliminary assessment of the degree of acceptability and the feasibility of the proposed i-FRAME methodological framework, several activities of validation have been organised, (as indicated in §1.3.3). in particular, in addition to internal and external peer-reviews and discussion in policy and scientific events, a specific Validation Workshop has been organised involving a group of practitioners and representatives of stakeholders.\(^{55}\)

As anticipated, the aim of the i-FRAME methodology is to support in an effective way social services’ decision makers in developing and assessing their policy interventions. To this end, it is crucial to get feedback and evaluation about the approach from users that could potentially use it.

The validation process had three specific objectives:

1. Understanding to what extent is simulation modelling known/applied in different activities and organizations involved in social policy and social services, and assessing if simulation modelling is considered a useful approach in these contexts.

2. Assessing the potential of the i-FRAME methodology as a possible solution for supporting policy-makers in social policies and social services design and implementation

3. Evaluating the degree of feasibility of the approach proposed and the practical needs for its implementation, in terms of technical and organisational capacities required.

5.3.2.1 Perceived importance of simulation modelling for evaluating social policies

The majority of the stakeholders involved in the workshop had none or little experience in simulation modelling, also because it is not widely applied in the activities/organizations they work for. This is especially true in the public sector. In addition, the current practices in the organizations interviewed show a lack of use of this methodology and tools.

However, despite this, simulation modelling was perceived as useful in all the sectors in scope and the majority of the stakeholders interviewed considered that the i-FRAME methodology could be applied in their organizations. It is evident from the charts below that the majority, which had none or few experience in simulation modelling. The feedback provided proves how it is necessary to operate in the right context along with experts and proper tools to fully appreciate and understand the importance of the outcomes derived from simulation in policy modelling.

In fact, detailed results show how 82% of the participants had none or few experience in simulation modelling. The remaining 18% had average or quite high experience and none had very high familiarity with simulation modelling (see figure below).

---

\(^{55}\) The workshop was organised by JRC-IPTS in collaboration with Fair Dynamics alongside the European Social Network’s Seminar on Integrated Services in Manchester, on 4\(^{th}\) November 2015 and it was attended by around 30 participants.
The 18% of the stakeholders that had average or quite high experience with simulation modelling belongs to the Organization Type 'Industry', covering roles of strategy, marketing and ICT development responsibilities. As for Public Authority, all the participants involved in this sector reported to have none or few experience with simulation modelling. This proves that there is room to educate people working in the Public sector about simulation modelling and the practical applications that it can have on social services policies.

**Figure 37** shows to what extent simulation modelling is applied in activities/organizations where stakeholders work.

**Figure 38 – Application of simulation modelling**

As shown in the **Figure 38**, only 9% is involved in activities/organizations where simulation modelling is applied to an average extent. As for the rest, 64% of the stakeholders work in a context where simulation modelling is barely applied and 27% of the participants belongs to organizations were simulation modelling is not applied at all.

**Figure 39 – Perceived usefulness of simulation modelling**

In **Figure 39**, it is reported the opinion of stakeholders with regard to the usefulness of simulation modelling for the activity/organization they are involved with. Only 27% of the participants reported that it could be little or average useful; the majority of the audience, the 73%, responded that simulation modelling could be useful or very useful.
As reported in the Figure 40, among the 73% that evaluated useful or very useful the approach of simulation modelling in the activity/organization where they are involved, 67% are employed in the Public Authority Sector. This is an important result: in fact, it indicates that the main target of the i-FRAME methodology, which is indeed the Public Sector, finds this type of approach valuable and useful for modelling policies for social services.

The analysis shows that there is a gap between the perceived importance of simulation modelling in certain working contexts while at the same time there is a perceived high potential for simulation modelling as a methodology for evaluating impacts of social policies.

Source: Fair Dynamics elaboration

5.3.2.2 Perceived applicability of the i-FRAME methodology in supporting social policies

As mentioned, one of the aims of validation activities was to understand if the approach proposed is considered applicable in the activities or organizations working on social policy implementation.

From the observations collected, it can be detected that 91% of the stakeholders consider the i-FRAME methodology to be applicable to different extents in their activity/organizations. Only a very small percentage, 9%, considers it not applicable in the context in which they are involved.

A large majority of respondents, (82% altogether) believes that the i-FRAME methodology based on simulation modelling could be applied in their activity or organization. More specifically, 27% of them considers simulation modelling could actually be applied quite often while 55% sometimes.

Source: Fair Dynamics elaboration
Figure 42 – Sector of activity of who considers applicable the i-FRAME approach

Figure 42 shows the sectors where simulation modelling is thought to be sometimes or quite often. It is relevant to see that 67% of the respondents that believes that the i-FRAME methodology can be applied quite often operates in the Public sector. This means that the methodology is perceived as a useful tool that could allow to have repeated applications in the organizations throughout the building and implementation of social policies. It thus appears that the i-FRAME methodology is considered an applicable approach inside different types of organizations and activities in different countries.

Source: Fair Dynamics elaboration

5.3.2.3 Perceived feasibility of the i-FRAME approach

The final objective of the validation process was to verify how to implement the before mentioned approach that is believed to be feasible for the organizations and activities involved.

Figure 43 – Degree of feasibility of the i-FRAME approach proposed

Figure 43 shows that the stakeholders consider feasible the possibility to use the simulation modelling approach proposed to support social policies. In particular 64% of respondents believes that if would be useful for the activity/organization to receive the i-FRAME 'as a service' provided with the support of JRC, as suggested during the validation workshop. Despite the limited experience of the stakeholders in simulation modelling, in fact, the proposed approach has been perceived useful and applicable especially by stakeholders from the Public Sector.

Source: Fair Dynamics elaboration

In conclusion, overall, the approach proposed has also been considered feasible, with regard to the idea of using simulation modelling to support design and evaluation of social policies. The majority believes in fact that the implementation of the approach could be consistently useful for the activities and organizations in which they operate. This proves that developing the i-FRAME methodology as a service supported by JRC would most probably have a positive impact on the way social policies are implemented and to improve the delivery of social services.
6 Conclusions and recommendations

Box 6 Summary of content of Chapter 6

This Chapter outlines the conclusions of the research work conducted in this phase of development and testing of the i-FRAME proposed approach. It also provides for future research and practical indications on the way forward.

It is organised as follows:

- §6.1 summarizes the key results of the research activity discussing the findings of the validation of the i-FRAME methodology.
- §6.2 provides recommendations on future research to further develop and scale-up the i-FRAME methodological approach.
- §6.3 presents the next steps of the IESI research aimed at developing and piloting a computer-based simulation model to implement the i-FRAME

6.1 Validation of the proposed i-FRAME methodology

The results of the research conducted during this phase of the IESI project, aimed at developing a proposal of methodological approach to assess the social and economic impacts of ICT-enabled social innovation initiatives, show the high potential hold by dynamic simulation modelling to understand complex social systems.

More specifically, findings from the review of relevant literature and the analysis of the state of the art of the application of such approaches in the field under investigation, demonstrated that exploiting the capabilities of Systems Dynamics (SD) and Agent-Based Modelling Simulation (ABMS), and in particular their combination in an Hybrid Approach, seem to be the most appropriate and promising option for modelling and simulating complex systems such as ICT enabled social innovation promoting social investment.\(^{56}\)

The analysis made also evident that, without a structured methodological framework as the one proposed as part of the IESI research (i-FRAME methodology), the dynamic simulation approach is not easy to be implemented, either because it requires a high level of expertise for its adoption, and because of the cost of its applicability to any specific given problem.

The proposed i-FRAME methodology, instead, suggest, through the development of ten steps (the i-FRAME Decalogue) that the applicability cost of Dynamic Simulation can be significantly downsized and, at the same time, through as sort of 'standardization', it facilitate to engage

\(^{56}\) In this respect, however, it should be underlined that the suggestion of using Hybrid Models as the most appropriate option should be considered not in absolute terms, rather with respect to the specific domain of application under investigation in the IESI research. This means it should not be considered as the only option for the implementation and application of the i-FRAME methodology and there may be circumstances where System Dynamics and Agent Based Modelling simulation techniques can be more suitable (alone) for the implementation of certain types of initiatives and contexts.
policy-makers, relevant stakeholders and domain experts in the dynamic modelling and simulation process of a specific problem. Whereas each problem that needs to be modelled and simulated presents its own specificities and peculiarities that cannot be generalized, the proposed methodology provides a clear pathway to reuse already developed models, with significant savings in time and costs.

In doing so, the i-FRAME methodology allows to represent the problem-solving process as a circular process that starts from the definition of the problem and goes to the simulation of the impacts of given policy measures, passing through the direct and active participation of all the policy actors and domain experts in both shaping the problem into a dynamic simulation model, and in the definition of the most suitable policy instruments to maximize positive impacts of the planned policy actions on the target beneficiaries.

The applicability of the proposed methodology in various cases and its qualitative and quantitative validation in real world settings clearly demonstrates its validity and robustness in addressing the problem of modelling and simulation of social problems where ICT-enabled social innovation could have positive impacts. Moreover, the validation process of the i-FRAME methodology has clearly showed that it not only meets the need of social policy actors in assessing the impacts of ICT-enabled social innovation initiatives promoting social investment and supporting the reorganization of social services delivery processes, but also it is a desirable tool that they would apply.

To this end, the positive results of the qualitative and quantitative validation process described in details in the previous Chapters 4 and 5, as well as the evidence of the interest showed by the stakeholders in the use of i-FRAME methodology (see §5.3 for further details) clearly open the door for a more extensive and systematic implementation of the proposed methodological approach for supporting policy actors in simulating ex-ante, in-itinere and ex-post impacts of initiatives where ICT-enabled social innovation plays and important role in the governance and delivery of social services.

6.2 Recommendations for further development of the i-FRAME

The analysis of the state of the art and the review of literature showed that there is limited application of dynamic simulation modelling approaches, especially in relation to social policies and ICT-enabled innovation initiatives.

This is confirmed by the results of the validation activities conducted which demonstrate little experience and capacity of social policy actors to implement such methodological approach to assess the impacts of policy interventions.

In this connection, the research has also recognized the potential role that could be played by JRC as intermediary between policy actors, stakeholders and domain experts (including dynamic modelling ones) for the implementation of the i-FRAME methodology at policy level.

To this end, a number of recommendations for further research and application of the i-FRAME methodology have been identified in order to reach the validation dimensions defined as required for its further development, as described in Table 7.
Table 7. – Recommendations to further development of the i-FRAME methodology

<table>
<thead>
<tr>
<th>Validation dimension</th>
<th>Definition</th>
<th>Value</th>
<th>Recommendations</th>
</tr>
</thead>
</table>
| **Acceptability**    | The methodology has to be capable of meeting established minimum requirements in order to be considered valid. | High | • Support the involvement of domain experts.  
• Promote the convergence of mental models leading to univocal representation without misunderstanding.  
• Promotion of dynamic simulation at stakeholder’s level. |
| **Easiness to use**   | The methodology has to be approachable by the users after receiving proper training and education by simulation modelling experts and group model building. | Medium | • Promote the involvement of expert in the simulation domain as mediator of the modelling process.  
• Use of group model building to involve stakeholders and reach consensus.  
• Promote the establishment of a policy lab, which should support the modelling and simulation approach. |
| **Adaptability**      | The methodology has to be able to be adjusted readily to different conditions and circumstances. | High | • Support the creation of a model-bank for different but similar uses.  
• Use of common language and methodology for simulation modelling, including system dynamics and ABMS software in one commercial bundle. |
| **Replicability**     | The methodology has to be repeatable multiple times and/or in different contexts in order to be considered valid. | High | • Similar recommendation as for Adaptability. |
| **Scalability**       | The methodology has to be adjustable to different measures and increased variables and still maintain its validity. | High | • Use through different dimensions (micro-meso-macro) by changing either the levers of the model or the appropriate combination of subdomains. |
| **Transferability**   | The methodology can be adapted to different cases, use different combinations of sub-models and variables, and still maintain its validity. | High | • Support the development of a tool that allows the combination of subdomains as described in the methodology.  
• Use of common language and methodology for simulation modelling, including system dynamics and ABMS software in one commercial bundle.  
• Support the use of a model-bank for different but similar uses. |
| **Implementation cost** | The implementation costs have to be affordable and sustainable for long periods of time. | Medium | • Support the development of a tool that allows the combination of subdomains as described in the methodology.  
• Promote the establishment of a policy lab which should support the modelling and simulation approach. |

Source: Fair Dynamics elaboration
In order to be operationalized in fact, the i-FRAME methodology has to meet minimum established requirements so to be deployed in a real context of use. To this end, it is needed to define specific consultation procedures to support the engagement of domain experts in Group Model Building. For this purpose, the adoption of graphical representations such as problem trees and causal loop diagram would be beneficial so to allow the convergence of different 'mental models' towards a common view of the problem and the related solution to be supported by simulation modelling techniques. Thanks to this approach, different the stakeholders can benefit of the advantages of the methodology and develop a more in-depth knowledge of the problem, reducing at the same time the risk of overestimating potential policy impacts.

The dimension of easiness of use of the methodology can be reached thanks to the already mentioned Group Model Building, which can be done with the proper support and knowledge brought by experts in simulation domains. This approach also aims at involving the interested stakeholders and reach consensus among them. In this respect, it is important to consider the possibility to implement a 'policy-learning lab approach' that provides the proper support in modelling and simulation approaches and makes them as clear as possible to the users. The learning process, in this particular context, is fundamental. This procedure has to be effective and incisive in such a way that, by looking at the outcomes and impacts that a certain initiative has had in the past, the stakeholders interested in implementing a new initiative can understand what factors have caused certain effects. To this end, proper 'guidance' is recommended, especially when provided by experts in the field that have a better understanding of the micro-meso-macro levels that can be impacted by a certain initiative.

This is also important in terms of what is defined as 'counterintuitive dynamic behaviour'. If this concept is not properly comprehended, it could eventually lead to wrong expectations in terms of understanding the effects of ICT-enabled social innovation initiatives, as the relationship between a dynamic development and the underlying structure could not be fully understood. This is one of the reasons why the approach of Group Model Building is very important in this circumstance: the modelling and domain experts should be involved in proper workshops with the stakeholders and provide further and deeper understanding of these aspects of the methodology and the relationship between dynamic development and the underlying structure, so that the analysis of results and effects of the initiative will be understood in the correct manner. The methodology is based in fact on an iterative process, and the participation of different actors is required to operationalize effectively the various steps defined in the so called 'i-FRAME Decalogue'.

The dimensions of adaptability and replicability of the model can be reached through adapting to different contexts and scenarios of use, and through multiple-iterations of simulation and modelling options. To obtain this result, it is recommended to build a structured 'i-FRAME model-repository' where various models can be stored and made accessible and adaptable for users that approach modelling in a similar way as the ones already provided with the methodology. On the technical side, this would require the use of a common programming language and interoperable simulation modelling software applications. This shall include the possibility for System dynamics and Agent-based modelling simulation software to be brought together in one bundled tool.

As for scalability, this is accomplished by the methodology once it can be properly adjusted even with different measures and values that the ones provided initially. This is the reason for recommending the use of the methodology through different dimensions (micro, meso and macro) by providing changes to the values of the levers and/or an appropriated combination of subdomains. In doing so, the methodology should also be able to maintain its validity by adapting it to different cases and combination of models and variables so to properly fulfil the dimension of transferability. Thus, the methodology can be transferred to different cases by combining various sub-domains and it can be adapted to different contexts though appropriate scenarios of use.
Another factor that has to be taken into consideration is the **implementation costs** of the methodology. In this respect, on the one side it should be considered the cost to acquire specialized software to perform simulation modelling (also considering the limited availability of ‘off-the-shelf’ Hybrid Models that combine System Dynamics and Agent Based Modelling elements) and the related hardware infrastructure to host and run such dynamic simulation models, especially if this is intended to be a continuous – iterative / real time large-scale process. On the other side, the results of the validation workshop with the stakeholders - although limited - show that despite the high level of interest and perception of the usefulness of the approach, there is limited capacity among practitioners and policy makers in using simulation modelling. Advanced training and making available resources to support the process and exploit the capabilities of simulation modelling techniques on a permanent basis would have a very high cost.

In order to avoid excessive expenditure that can be mainly related to acquiring skills and instruments that allow the implementation of the methodology, it is therefore suggested a **possible architectural scheme of implementation of the 10 Steps of i-FRAME methodology** that could be used for any contexts and problems/issues to be modelled.

The scope of this proposed scheme is to show a **model design process** that having in mind the impossibility to design a 'meta-model' suitable for all the situations, tries to leverage existing knowledge in modelling and simulation from previous problems already addressed, and to provide an initial contribution to modelling and simulation of the current problem/issue, saving time and costs in model design. This approach would present several advantages and constitutes a step forward the application of dynamic simulation modelling to the policy relevant initiatives as the one addressing the ICT-enabled social innovation initiatives promoting social investment, but potentially applicable to other complex systems problems. However, this approach cannot be automatized because of the peculiarities of each problem and the needs of a direct engagement of domain experts, stakeholders and policy makers in all the steps of the modelling and simulation of a given problem.

This consideration has to be extended to the **data-gathering template** and provide the reasons why a fully comprehensive template for collecting data in an automatic manner cannot be realistically implemented, rather the data-gathering template have to be interpreted as a guideline that, starting from existing examples available in literature, defines the type of indicators and variables that can be collected to support the modelling and simulation process of a given problem.

The **proposed architecture of the application of i-FRAME methodology for modelling and simulation** is based on the hypothesis that a **repository of i-FRAME models** (a structured database of pre-defined SD/ABMS models, as the one collected during the state of the art analysis described in details in Chapters 2, 4 and 5) is developed. This would then allow implementing the following approach (see **Figure 44**):

1. The problem under investigation can be decomposed in domain related sub models. They can be developed from scratch and or adapted from already existing sub models appropriately collected, classified and grouped in the i-FRAME repository of models (relational structured dynamic database).
2. The i-FRAME repository of models should contain a collection of domain related sub models and models appropriately gathered from both the literature and from other research and contributors derived from the continuous collaboration with domains experts and stakeholders, including policy makers and practitioners.
3. The definition of the problem, the decomposition of it in domain-related sub-models and the extraction of them from the database for a further elaboration to the addressed problem is part of the 10 Steps of i-FRAME methodology.

The new model developed should then become part of the i-FRAME repository of models itself for further use in other modelling and simulation processes.
In this regard, the development and the maintenance of the i-FRAME repository of models and the underpinning database should be carried out by the JRC-IPTS activity, that could play a double role: on one side it can become a sort of *super partes* entity that guarantee to all the policy actors the same possibility of applying the i-FRAME methodology; on the other side it can act as a catalyst of domain experts, stakeholders and policy makers in better addressing the impact assessment policy relevant initiatives.

If properly developed, such approach could be implemented according to the following procedural steps. First of all, the case/problem has to be studied and analysed in terms of domains and related i-FRAME attributes. The result of this process can be put in a structured table of attributes and methods. The clearer the needs are in the first part of the implementation of the methodology, the easier it should be to build the logic model of the initiative and understand the essential elements that need to be taken into consideration.

These activities lead to the research of an already existing model that possibly matches or has comparable similarities to the one object of study. In this context, there is a need to identify sustainable solutions, also in financial terms, which can be applied systematically, when it comes to policy-making process and analysis of initiatives. This process would allow stakeholders and domain experts to verify the similarities that are present in cases that are apparently very different in many aspects. The study of the cases should help in understanding the underlying structure and replicate or adjust the elements that can be useful for the implementation of the methodology in other initiatives.

After the proper verifications, it is possible to proceed in two ways. In case a similar model is found in the JRC i-FRAME repository of models it can be used to make the proper adaptations and adjustments to the case object of study. Otherwise, a new one can be created through the use of the i-FRAME methodology. The recommended approach in both cases is to use Group Model Building, as already mentioned, as it is one of the best ways of acquiring skills and knowledge about the case studied and the related models. To this end, the JRC could set up specific sessions of Group Model Building through a ‘policy-learning lab on dynamic simulation modelling’.

At the end of this process, the newly built model should be added to the JRC model database, which will in this way be expanded and filled with further useful knowledge and information for users that will want to confront or build their models by checking the already existing ones.
6.3 Next steps: towards i-FRAME 2.0

The results achieved in this phase of the IESI research suggest promising future directions. These include in particular the further development and validation of the proposed i-FRAME methodology, which would be oriented towards three main goals:

1. **To develop the i-FRAME repository of models**, focusing on ICT-enabled social innovation initiatives and encompassing major social policy interventions. This could be an important break-through in the implementation of i-FRAME at large scale. In fact, the availability of the repository of models on one side will reduce the modelling and simulation costs; while on the other side it will help in better shape the model of a given problem in shorter time and with an higher participation of policy actors and stakeholders. However, the development of this repository of models will require a quite significantly high research effort to turn problem-driven models into general-purpose frameworks that can be used as starting points for addressing new problem/issues.

2. **To develop a user-friendly computer-based interface** that would help policy actors and domain experts to directly interact with the i-FRAME repository of models to start shaping the model of a given problem/issue. This is a crucial step required to support a wider applicability of the i-FRAME methodology. In fact, whereas the dynamic simulation approach cannot avoid the direct engagement of a model expert in the whole modelling and simulation process of a given problem, a well-structured user interface of the relational database underpinning the i-FRAME repository of models, could enhance the direct engagement of other actors in all the simulation modelling process, especially in the initial stages where it is fundamental their engagement to better define the problem specifications and the key parameters and variables of the model.

3. **To develop effective engagement tools for policy actors and domain experts** aimed at supporting their involvement in all the stages of the i-FRAME methodological approach. It is important in fact to focus the attention on the importance of Group Model Building in this process, as it is considered to be a flexible approach to dynamic simulation modelling, where one can start the process from scratch or develop preliminary models; the main objective of Group Model Building is in fact to obtain knowledge enhancement within the team and bring out and share 'mental models' in order to reach consensus on the structure of the model and the variables to be considered. This is a cornerstone for the effective application of the proposed methodology as well as the key element to further validate the overall approach and allow possible scale-up.

For this purpose, building on the results of this phase of the research, and what is now defined the **i-FRAME V1.5**, the JRC-IPTS will develop and pilot, with the support of external experts and stakeholders, a computer-based simulation model to implement the methodological framework to assess the impacts generated by ICT-enabled social innovation initiatives promoting social investment in the EU.

This will allow validating further the conceptual and methodological approach proposed and set out the foundations for the full-fledged proposal of **i-FRAME (V2.0)**. More concretely, the specific objectives of the next steps of the research are the following:

a. **Review and improve as required the theoretical and methodological approach underpinning the i-FRAME (V1.5)** aiming at providing a comprehensive framework for evaluating (ex-ante, in-itinere and ex-post) the social and economic impacts of ICT-enabled social innovation initiatives promoting social investment at micro-meso and macro level.

b. **Develop, pilot and validate the operational components of the improved methodological approach of the i-FRAME (V2.0)** through the application to real-life
cases of the structured operational framework and simulation model for social impact assessment on selected case studies/scenarios of use relevant to the scope of the IESI project (i.e. addressing integrated approaches to social services delivery, considering various personal social services of general interest - PSSGI - in different welfare systems/social service delivery models and drawn from different EU Member States).

c. **Elaborate the final version of the proposal of i-FRAME (V2.0) as a computer-based simulation model** which relational structure should encompass all the possible levels of analysis (micro-meso-macro) by using the same structural environment, allowing to collect data at the relevant level of analysis through the definition of measurable and coherent indicators. In doing so it should be also considered the need to take into account possible counter-intuitive behaviours and a flexible approach for re-calibrating the model as a consequence of ex-post analysis or changes in the theoretical assumptions/causal relationships and/or dynamics hypothesis underlying the model and its components.

d. **Propose technical and policy recommendations for the application and use of the computer-based simulation model (i-FRAME V2.0) and further scaling-up at EU level of the methodological approach.** These recommendations will serve to offer indications to support the European Commission and relevant organisations of EU Member states to conduct ex-ante analysis of potential impacts of new social policy initiatives based on ICT-enabled social innovation, as well as in-itinere and ex-post analysis of the social returns of policy initiatives at the end of the policy cycle.

To achieve these objectives, the approach to be followed will principally rely on desk research, scenarios-forecast, qualitative case-studies and cause-effect modelling based on piloting the methodological approach and operational components composing the i-FRAME on selected case studies/scenarios of use that could be also drawn from current mapping and case study analysis conducted by JRC-IPTS as part of the IESI project.

In addition to this, experts review through focus groups and workshops will be conducted as part of the development and validation process. An important component of the approach for 'co-developing' the i-FRAME during the IESI project resides in fact in the **continuous involvement of experts and representatives of stakeholders** through engaging scientific communities drawn from relevant research disciplines, and involving directly practitioners and policy-makers using 'group-model building' and/or 'policy lab' approaches. In this respect using the experience and results of the pilot applications of the methodological approach underlying the i-FRAME to case studies, as well as additional desk research and interviews with experts, recommendations for practical use and further development and scale-up of the i-FRAME shall be developed.

The **next phase of the IESI research** shall permit to reach the following results:

- **To validate the theoretical and methodological approach of the i-FRAME**, able to evaluate *(ex-ante, in-itinere and ex-post)* the social and economic impacts of ICT-enabled social innovation initiatives promoting social investment at micro-meso-macro level by developing it further and piloting it through the application to selected case studies/scenarios of use (i.e. qualitative/quantitative case studies including the use of cause-effect relationships and simulation approaches).

- **To elaborate the final version of the i-FRAME 2.0** as a computer-based simulation model that should encompass all the possible levels of analysis (micro-meso-macro), by using the same technical and policy recommendations for its use and further scaling-up at EU level.
Annex I – Review of technical and organisational options

In this Annex an overview of the toolkits available on the market for modelling and simulation is presented along with preliminary suggestions of the tentative requirements that may be needed for implementing the i-FRAME methodology as a computer-based simulation model.

Agent Based Modelling and Simulation Toolkits and Platforms

Recently, an increasing number of modelling toolkits have become available to support agent-based modelling and applications. Each software toolkit has a variety of characteristics, and much effort was put in to review and compare these toolkits. These toolkits are in general integrated tool suites or software development platforms, designed to simplify the construction of agent-based models and the development of agent applications. There is no universal definition of an agent toolkit. According to review articles (Serenko and Detlor, 2002), an agent toolkit could be defined as a software package, application, or development environment that provides modules with a sufficient level of abstraction to allow them to implement agents with desired attributes, features, and rules. Serenko and Detlor (2002) provided a good summary on why agent-based toolkits are needed in general:

- They provide a certain level of abstraction in which programmers can develop their objects.
- They incorporate some features of visual programming, which saves much time and makes development easier, more attractive, and enjoyable.
- They offer run-time testing and debugging environments.
- They allow programmers to reuse classes (definition of objects) created by libraries or other programmers.

Railsback et al. (2006) classified ABMS platforms into two categories.

- The first category follows the framework and library approach, which includes most of the commonly used ABMS toolkits, such as AnyLogic, Repast, Swarm, and Multiagent Simulator of Neighborhoods (MASON). These tools in general provide a framework, which is a set of standard concepts for designing and describing ABMS models. A library of software that implements the framework is also available as a simulation tool. For example, in AnyLogic, a model is constructed with one or more active object classes. A Java application programming interface (API) is provided to guide the use of state charts, variables, functions, and other miscellaneous tools.
- The second category consists of approaches designed to provide a high-level platform that allows people to build and learn from simple agent-based models. The NetLogo family belongs to this category.

In addition, offering a different review, Macal and North distinguished ABMS toolkits based on their simulation scalability. Although AnyLogic, Repast, Swarm, and MASON can be applicable to large-scale agent development environments, NetLogo was designed to fit the agent-based prototyping environment that runs on desktops. Railsback et al. (2006) reviewed six ABMS platforms: NetLogo, MASON, Swarm, Repast, Ascape, and AnyLogic. The characteristics of the six toolkits are summarized in Table 8 and uses the results from both reviews mentioned previously.

---

57 Partially extracted from The Exploratory Advanced Research Program, A Primer for Agent-Based Simulation and Modelling in Transportation Applications, CHAPTER 3: Agent-Based Software Toolkits, available at https://www.fhwa.dot.gov/advancedresearch/pubs/13054/004.cfm
In terms of animation capabilities, the most updated versions of MASON, AnyLogic, and NetLogo offer both geographic information system and three-dimensional (3D) capabilities.

Table 8 – Comparison of ABMS software toolkits

<table>
<thead>
<tr>
<th>Platform</th>
<th>Scalability</th>
<th>Execution Speed</th>
<th>Programming Language</th>
<th>Primary Domain</th>
<th>Web site</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>NetLogo</td>
<td>Desktop computing</td>
<td>Intermediate</td>
<td>NetLogo</td>
<td>Social and natural sciences</td>
<td><a href="http://www.cel.northwestern.edu/netlogo/">www.cel.northwestern.edu/netlogo/</a></td>
<td>Free of charge</td>
</tr>
<tr>
<td>MASON</td>
<td>Large-scale</td>
<td>Fast</td>
<td>Java</td>
<td>Social complexity, physical modelling, AI/machine learning</td>
<td><a href="http://www.cs.gmu.edu/~eclab/projects/mason/">www.cs.gmu.edu/~eclab/projects/mason/</a></td>
<td>Free of charge</td>
</tr>
<tr>
<td>Swarm</td>
<td>Large-scale</td>
<td>Slow</td>
<td>Objective-C;Java</td>
<td>General purpose</td>
<td><a href="http://alumni.media.mit.edu/~nelson/research/swarm/">http://alumni.media.mit.edu/~nelson/research/swarm/</a></td>
<td>Free of charge</td>
</tr>
<tr>
<td>Repast</td>
<td>Large-scale</td>
<td>Fast</td>
<td>Java;Python;C++</td>
<td>Social sciences</td>
<td><a href="http://repast.sourceforge.net/">http://repast.sourceforge.net/</a></td>
<td>Free of charge</td>
</tr>
<tr>
<td>Ascape</td>
<td>Large-scale</td>
<td>Fast</td>
<td>Java</td>
<td>General purpose</td>
<td><a href="http://ascape.sourceforge.net">http://ascape.sourceforge.net</a></td>
<td>Free of charge</td>
</tr>
<tr>
<td>AnyLogic</td>
<td>Large-scale</td>
<td>Fast</td>
<td>Java</td>
<td>General purpose, distributed simulation</td>
<td><a href="http://www.anylogic.com">www.anylogic.com</a></td>
<td>To be paid (only PLE Professional Learning Edition is Free of charge)</td>
</tr>
</tbody>
</table>

Sources: Macal, North, and Railsback et al.

In the following subsections, the authors briefly summarize the characteristics of the six ABMS toolkits individually. Most of the reviews come from Allan, Lytinen and Railsback, and Railsback et al.
**NetLogo**

NetLogo is a multiagent programming language and modelling environment for simulating natural and social phenomena. Authored by Uri Wilensky in 1999, it has been in continuous development ever since at the Center for Connected Learning and Computer-Based Modelling. It is designed for both research and education and is used across a wide range of disciplines and education levels. Although the primary purpose of NetLogo has been to provide a high-level platform that allows one to build and learn from simple agent-based models, it now contains many sophisticated capabilities (behaviours, agent lists, and graphical interfaces).

NetLogo includes its own programming language that is simpler to use than Java or Objective-C, an animation display automatically linked to the program, and optional graphical controls and charts. Its programming language includes many high-level structures and primitives that reduce programming efforts. NetLogo runs on the Java virtual machine; thus, it works on all major platforms (Mac, Windows, and Linux) and runs as a standalone application, or from the command line.

**MASON (MultiAgent Simulator of Neighborhoods)**

MASON is a joint effort between George Mason University's (GMU) Evolutionary Computation Laboratory and the GMU Center for Social Complexity. MASON is a single-process, discrete-event multi-agent simulation library core in Java, designed to support many agents relatively efficiently, or be the foundation for large custom purpose Java simulations. It is designed to provide more than enough functionality for many lightweight simulation needs. MASON contains both a model library and an optional suite of visualization tools in 2D and 3D. MASON is open source software licensed under the Academic Free License, Version 3.0. MASON was designed as a smaller and faster alternative to Repast, with a focus on computationally demanding models with many agents executed over a variety of iterations.

**Swarm**

Swarm was the first reusable software tool created for ABMS. It was developed at the Santa Fe Institute in 1994 and was specifically designed for artificial life applications and studies of complexity. Swarm was originally developed for multi-agent simulation of CAS. Until recently, the project was based at the Santa Fe Institute, but its development and management is now under control of the Swarm Development Group, which has a wider membership to sustain the software. For more information on Swarm, see [http://www.swarm.org](http://www.swarm.org).

Railsback et al. summarized Swarm's design as follows:

Swarm was designed as a general language and toolbox for ABMS, intended for widespread use across scientific domains. The developers started with a general conceptual approach with respect to agent-based simulation software. Key to Swarm is the concept that the software must both implement a model and, separately, provide a virtual laboratory for observing and conducting experiments on the model. Another key concept is designing a model as a hierarchy of swarms, a swarm being a group of objects and a schedule of actions that the objects execute. This is similar to the concepts of context and project now included in Repast Simphony. One swarm can contain lower level swarms whose schedules are integrated into the higher level swarms; simple models have a lower level model swarm within an observer swarm that attaches observer tools to the model.

Swarm is a powerful and flexible simulation platform; however, these virtues come at a price. In practice, Swarm has a very steep learning curve. It is necessary to have experience in Objective-

---


C, and possibly Java, to be familiar with object orientation methodology and be able to learn some Swarm code.

**Repast (Recursive Porous Agent Simulation Toolkit)**

Railsback et al. summarized that Repast development has been driven by several objectives. The initial objective was to implement functionalities similar to Swarm in Java but without adopting all of Swarm's design philosophy and without implementing swarms. The additional objective of making it easier for inexperienced users to build models has been approached in several ways, including a built-in simple model, as well as interfaces through which menus and Python code can be used to begin model construction.

Repast was started as a Java implementation of Swarm but diverged significantly from Swarm. It focuses on modelling social behaviour, in the social science domain, and offers support tools for social network modelling. Repast Toolkit Version 3 can be considered as a specification for agent-based modelling services or functions. There are three concrete implementations of this conceptual specification: Repast for Java (Repast J), Repast for the Microsoft.Net framework (Repast.Net), and Repast for Python Scripting (Repast Py). Repast J is the reference implementation that defines the core services. In general, Repast developers recommend that basic models be written in Python by using Repast Py, because of its visual interface, and that advanced models be written in Java with Repast J or in C# with Repast.Net. Repast 3 is available on virtually all modern computing platforms including Windows, Mac OS, and Linux. The platform support includes both personal computers and large-scale scientific-computing clusters.

The Repast Simphony version, or RepastS, uses a new conceptual approach and is a different platform from previous versions. Part of the Simphony version is ReLogo, which is based on NetLogo as it includes many of NetLogo's primitives and its graphical interface tools.

**Ascape**

Ascape is a framework for developing and analysing agent-based models and was developed by Miles Parker of the Brookings Institution Center on Social and Economic Dynamics, which also developed the well-known Sugarscape model.

Ascape follows some of the ideas behind Swarm; however, it is somewhat easier to develop models with. Ascape is a high-level framework supporting complex model design, while end-user tools make it possible for non-programmers to explore many aspects of model dynamics. It is written entirely in Java and runs on any Java-enabled platform.

Ascape is released under a Berkeley Software Distribution standard open-source license and thus is free to use and redistribute.

**AnyLogic**

AnyLogic is claimed to be the only tool that supports three major simulation modelling methodologies in place today: system dynamics (SD), discrete-event (DE), and agent-based modelling (ABMS). It is also the only one tool that currently makes possible to implement hybrid models, i.e. models that host and combine the three methodologies at the same time. Part of the model can be, for example, ABMS based and other parts DE and/or SD based.

It provides a visual language that simplifies the development of agent-based models significantly. For example, Unified Modelling Language states that charts are used to define agent behaviours; action charts are designed to define algorithms; environment objects are used to help describe the agent environment; and collect statistics, and events are used to describe occasional or time-certain occurrences. These constructions allow users to describe almost all the behavioural aspects of agents. In addition, users can always write specific Java code to model something more specific or unanticipated. As agent-based models can be combined seamlessly with discrete-event and system dynamics models, the agents themselves may be included inside system dynamics stock and flow diagrams or flow charts. In other words, AnyLogic provides an environment for
multi-paradigm modelling that combines different simulation methods within one model in various ways: hierarchical, series hand-off, or parallel.

As a widely used commercial software product for agent-based simulation, AnyLogic has wide exportability and animation capabilities. For example, models can dynamically read and write data to spreadsheets or databases (to the most common database formats available on the market, like Oracle, MS SQL, MS Access, MYSQL) during a simulation run as well as charting model-output dynamically. Furthermore, external programs can be initiated from an AnyLogic model for dynamic communication of information, and vice versa. A recent version, AnyLogic 7.2, allows the integration of AnyLogic models with external Java applications and has made AnyLogic 3D animation compatible with Java applets. In other words, users can publish their models with 3D animation on the Web, and remote users are able to view and navigate them in the 3D scene from their own Web browsers. AnyLogic offers different versions for three types of operating systems: Microsoft, Mac, and Linux. As previously mentioned, once compiled, the simulation can be run on any Java-enabled operating system.

**System Dynamics Simulation Toolkits and Platforms**

For the time being Anylogic seems to be the only software toolkit that allows the building of hybrid models. The strength of Anylogic is the ability to combine non-SD elements with SD models, and this makes it a particularly flexible tool.

System dynamics modelling approach is supported mainly by four software tools: PowerSim, Vensim, iThink/STELLA and AnyLogic. The modelling language of system dynamics is well-defined and minimalistic: models are built using standard variables (stocks, flows, auxiliary), formulas and equations, etc. The tools differ in details. For example, iThink offers special types of stocks like Queue or Oven, which are not present in other tools; Vensim and AnyLogic offer more powerful and flexible arrays.

Moreover, AnyLogic enables the user to better structure the model: it allows encapsulating a certain SD diagram into an object and defining its 'interface' parameters. This feature allows the user to reuse the SD component several times with different values of the parameters.

Visualization and animation capabilities of AnyLogic are broader than in other tools. It allows the user to develop interactive animations with graphical front-ends and even to export models to applets and publish them online. AnyLogic supports also two major approaches namely discrete-event and agent-based modelling and allows the user to combine all simulation techniques within one model. So, generally, AnyLogic is a more flexible simulation tool. Any problem which can be solved in PowerSim, Vensim, iThink/STELLA can also be solved in AnyLogic.
Software technical specifications for i-FRAME\textsuperscript{63}

Table 9 provides a pairing for the steps of the i-FRAME Decalogue and the available tools when applicable.

<table>
<thead>
<tr>
<th>Step Title</th>
<th>Accompanying generic SW tool</th>
<th>Specific tool for development\textsuperscript{64}</th>
<th>Specific tool for running</th>
<th>Specific tool for comparing/sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 Definition of problem and Logic model</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 2 Levers and indicators of output, outcome and impact</td>
<td>Excel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 3 Impacted and impacting domains</td>
<td>Excel</td>
<td>CLD Designer (Vensim)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 4 Check existing models</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 5 Look for and check Attributes and Methods</td>
<td>Excel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 6 Add domain-related submodels</td>
<td>Hybrid SD+ABMS or SD or ABMS software development tool (Anylogic)</td>
<td>(Anylogic)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 7 Combine submodels in final dynamic simulation model</td>
<td>Hybrid SD+ABMS or SD or ABMS software development tool (Anylogic)</td>
<td>(Anylogic)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 8 Define conditions for scenario to be studied</td>
<td>(Anylogic)</td>
<td></td>
<td>(Anylogic, OptQuest, experiments for sensitivity montecarlo and Optimization)</td>
<td></td>
</tr>
<tr>
<td>Step 9 Analyse scenario though experiments</td>
<td></td>
<td></td>
<td>(Anylogic)</td>
<td>(Anylogic, OptQuest, experiments for sensitivity montecarlo and Optimization)</td>
</tr>
<tr>
<td>Step 10 Define policy recommendations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Fair Dynamics elaboration

\textsuperscript{63} See footnote of previous paragraph
\textsuperscript{64} The name of specific market tools indicated in (...), if present, is purely suggested
Implementation of the i-FRAME simulation methodology

Development of the simulation models: operationalization

As indicated in the I-FRAME methodology\textsuperscript{65}, the steps from 1 to 5, lead to the following summarized deliverables (output) to be used for the technical development of the simulation model (steps 6 and 7 of the methodology):

1. A clear definition of the problem.
2. The boundary of the problem (and the related system) for the identified domains, appropriately checked through the database (collections of existing models) in order to make a comparison with other similar models, if any:
   a. the list of Attributes and Methods.
   b. the Causal Loop Diagram (CLD) of the problem.

Those primary stages of the development prepare the structure of the model and outline the possible sustaining dynamics. The actors involved are:

- stakeholders: policy makers, agencies, problem owners, etc.;
- domain expert(s);
- modelling expert(s).

The main results of those steps are usually achieved through a number of expert workshops, involving the actors listed above.

As far as steps 6 and 7 are concerned, the main aim here is the creation of both the domain related sub models and the final combined model by using some simulation methods, for example the hybrid (SD+ABMS) or SD or ABMS. Result of step 7 is the final simulation model that can run and produce numerical (graphical) results, depending on the values of the levers.

For those stages further expert workshops are required with the involvement of the following actors:

- a technical expert, i.e. the expert of the technical platform/tool used, along with an appropriate number of other resources (model programmers) in the software implementation of the model;
- policy makers, agencies, problem owners, etc.;
- modelling expert(s).

The level of involvement and the number of workshops is sketched in the following table:

\textsuperscript{65} See Chapter 3 of this report.
### Table 10 – Methodology steps and resources

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>STEP 1</th>
<th>STEP 2</th>
<th>STEP 3</th>
<th>STEP 4</th>
<th>STEP 5</th>
<th>STEP 6</th>
<th>STEP 7</th>
<th>STEP 8</th>
<th>STEP 9</th>
<th>STEP 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTIVITY</td>
<td>Definition of the problem and Logic model</td>
<td>Levers and indicators of output, outcome and impact</td>
<td>Impacted and impacting domains</td>
<td>Check existing models</td>
<td>Look for and check Attributes and Methods</td>
<td>Add domain-related submodels</td>
<td>Combine submodels in final dynamic simulation model</td>
<td>Define conditions for scenario to be studied</td>
<td>Analyze scenario though experiments</td>
<td>Define policy recommendations</td>
</tr>
<tr>
<td>SW Platforms/Tools</td>
<td>Excel</td>
<td>Excel CLD Designer (Vensim)</td>
<td>Hybrid SD+ABMS or SD or ABMS software development tool (Anylogic)</td>
<td>Hybrid SD+ABMS or SD or ABMS software development tool (Anylogic)</td>
<td>(Anylogic, OptQuest, experiments for sensitivity montecarlo and Optimization)</td>
<td>(Anylogic, OptQuest, experiments for sensitivity montecarlo and Optimization)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stakeholders</td>
<td>&lt;------ YES -------&gt; mainly</td>
<td></td>
<td>&lt;-------- YES ------&gt; mainly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domain Experts</td>
<td>&lt;------ YES -------&gt; mainly</td>
<td></td>
<td>&lt;------ YES -------&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modeling Experts</td>
<td></td>
<td></td>
<td>&lt;------ YES -------&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical Experts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical Experts workshop</td>
<td>&lt;------ YES -------&gt; many</td>
<td>&lt;------ YES -------&gt; some</td>
<td>&lt;-------- YES ------&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Fair Dynamics elaboration

### System architecture

As described in §6.2 of this report, a possible future evolution is depicted in Figure 45 below, where the presence of a 'cases' database become the structural part of a possible system architecture.
The system architecture is owned and maintained by a service provider that makes it available to a community of subscribers of the service.

The architecture is mainly focused on a 'case' database and on a class of services offered to the community, including the possibility to:

1. access to a complete description of the case (related documentation);
2. access to complete models (already realized, if any);
3. access to domain related sub-models (to be possibly used and as starting sketches);
4. organize workshop with external domain experts and/or modelling experts, possibly intermediated by the provider; in order to give the user the possibility to aggregate the right competences for simulation modelling;
5. find some technical skills (directly offered by the provider or offered by third party);
6. access to simulation skill (education).

For the provider, the services delivered around the system architecture can also be an interesting opportunity to set up a sort of 'center of excellence' for simulation modelling applied to social impacts based topics.

The typical 'clients' of the service include different types of stakeholders as, for example, policy makers, agencies, consultancy companies, experts of social modelling, ICT global players, etc. They can be appropriately grouped in a community that share similar interests and create a well-defined social network.

Figure 45 – A possible architectural scheme of the i-FRAME based modelling and simulation deployment

In particular, the indicated database must contain the widest array of all the relevant information about interesting cases collected systematically as well as all simulation models stemmed from the literature and realized on this platform over time.
That database should be built on any of the most common platforms (for example: MySQL, Oracle, MSSQL, etc.) must be appropriately:

- designed and developed;
- maintained constantly in terms of updating the case-related information and the added models over time. The models of the case shall be introduced into the database directly by the users.

**Organizational aspects and Skill and Competences needed for developing models and managing the system architecture**

This service provider may create the institutional system environment where all the main stakeholders could operate and implement the steps of the i-FRAME simulation methodology.

That system may give the provider the possibility to deliver a complete 'simulation modelling' service supporting the main mission of i-FRAME, i.e. the ability to evaluate and assess the outcomes and impacts of the ICT based social innovative initiatives promoting social investment.

In more general terms, the main competences of the provider shall include the ability to manage:

1. **Delivery of the related IT components:** the system environment and database environment. The IT competences required could also include some programming competences (Java language base or similar) along with some operating system and database system-related IT competences.

2. **Updating of the 'cases' database:** this includes the ability to understand, select and filter the cases to be introduced and updated (also by the subscribers of the service). The competences here are related to the understanding of policy-relevant problems and social services initiatives for social investment.

3. **Ability to manage domain-, functional- and simulation experts for an efficient teamwork.**

4. **Dissemination and awareness-raising to keep the interest high for the system, i.e. the ability to organize a 'marketing' activity to sustain and increase the clients subscriptions over time.**

5. **Other activities necessary to sustain the initiative.**

As far as ICT competences are concerned, a possible outsourcing for an external ICT-services provider could be necessary for the IT-maintenance of the system.
**Annex II – Data gathering template**

This draft Data-gathering template can be applied as a guideline for the collection of data for the development of a Dynamic Simulation model measuring the impact of ICT enabled social innovation initiatives.

As described in Chapter 3, i-FRAME provides a methodological framework that can be applied to model and simulate the impact of an initiative that require a dynamic simulation to assess its impacts. However, simulation models are driven by 'specific problems' and should be developed with the aim of explaining the problem. In this perspective, the 'system' represents the set of components contextualising the problem, in order to understand the dynamics of the context where the problem is formed, fed and might generate side effects.

However, in line with the validating experts' contribution as well as the scientific literature in the field, it is easy to affirm that a general simulation model that includes the details of each situation does not exist. Consequently, it is not possible to determine a template to gather data automatically on a particular problem that cannot be fully understood and foreseen in its complexity in advance.

Having said that, the following data-gathering template has to be considered as an example of the type of data that could be required for modelling and simulation a given problem in the related domains of IESI research. The variables and indicators included in the template derive from both the case studied for the validation of the methodology and the state of the art analysis.

<table>
<thead>
<tr>
<th>Case study evaluation checklist</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Case study context</strong></td>
</tr>
<tr>
<td><strong>Context, objectives and target beneficiaries</strong></td>
</tr>
<tr>
<td>a. Which is the main problem addressed by the case? (free text)</td>
</tr>
<tr>
<td>b. Which are the strategic objectives addressed? (free text)</td>
</tr>
<tr>
<td>c. Which are the operational objectives addressed? (free text)</td>
</tr>
<tr>
<td>d. Which is the social sector addressed by the initiative?</td>
</tr>
<tr>
<td>1. Employment and Life Long learning</td>
</tr>
<tr>
<td>i. Education and training</td>
</tr>
<tr>
<td>ii. Employability</td>
</tr>
<tr>
<td>iii. Career guidance</td>
</tr>
<tr>
<td>iv. Literacy</td>
</tr>
<tr>
<td>v. Distance learning</td>
</tr>
<tr>
<td>2. Social inclusion</td>
</tr>
<tr>
<td>i. Childcare</td>
</tr>
<tr>
<td>ii. Homeless</td>
</tr>
<tr>
<td>iii. Social assistance</td>
</tr>
<tr>
<td>iv. Independent living at home environment</td>
</tr>
<tr>
<td>v. Digital divide</td>
</tr>
<tr>
<td>vi. Social assistance</td>
</tr>
<tr>
<td>vii. Civic engagement</td>
</tr>
<tr>
<td>viii. Other (specify)</td>
</tr>
<tr>
<td>3. Care</td>
</tr>
<tr>
<td>i. Integrated health and social care</td>
</tr>
<tr>
<td>ii. Prevention, health promotion and rehabilitation</td>
</tr>
<tr>
<td>iii. Long-term care</td>
</tr>
<tr>
<td>iv. Health intermediaries</td>
</tr>
<tr>
<td>d. Which are the target beneficiaries?</td>
</tr>
</tbody>
</table>
Unemployed persons
Employed persons
Young unemployed persons
Children/prenatal
Older workers
Senior citizens
Retirees
Families with new-borns
Temporary assistance needy families
Foreign workers
People going through criminal justice
Population with diabetes
Population with disabilities (eg. physical, learning, ...)
Population with chronic disease
Persons needing LTC services
Activity of Daily Living (ADL) limited persons
Informal caregivers
Persons with mental health issues
Low income residents
People living in remote areas
Local administrations
Other (specify)

Risk factors addressed
(un)healthy lifestyle
Unequal access to health services
cardiacoVascular disease
unemployment
adverse living conditions
public security
excessive hospital visits
no housing
learning disabilities
distance
Other (specify)

Which are the characteristics of the general population in the reference context?
Fertility rate
Life expectancy (male, female per age classes)
Mortality rate (male, female per age classes)
Morbidity rate (male, female per age classes and disease)
Migration rate (male, female per age classes and reasons of migration)

Boundary of the Initiative mapped with the Case study

What domain related sub-models are addressed by the case? (multiple choices are allowed)

General population

Relevant population

Unemployed persons
Employed persons
### Social Protection Delivery

**iii.** Social protection delivery  
- **i.** Housing  
- **ii.** Other (specify)

### Social Security Delivery

**iv.** Social security delivery  
- **i.** Social welfare

### Care Service Delivery

**v.** Care service delivery  
- **i.** Infrastructural characteristics  
  1. Primary-secondary-tertiary care  
  2. Maternity and child healthcare  
  3. Treatments and recovery  
  4. Emergency treatment  
  5. Therapies  
  6. Social and health care  
  7. Long Term Care  
  8. Telecare  
  9. Schools  
  **10.** Other (specify)  
- **ii.** Personnel composition  
  1. Clinical care specialists  
  2. Chronic personnel  
  3. Acute personnel  
  4. GPs  
  5. Nurses  
  6. Employers  
  7. Counsellors  
  **8.** Others (specify)  
- **iii.** Other (specify)  

### Financing the Intervention Initiative

**vi.** Financing the intervention initiative  
- **i.** Social bonds
<p>| ii. | PPP |
| iii. | Local authority funding |
| iv. | Public innovation funding |
| v. | Other (specify) |
| vii. | Other impacted domains |
| i. | Occupational life course |
| ii. | Economic development |
| iii. | Community safety |
| 1. | Buildings |
| 2. | Other (specify) |
| iv. | Supply and demand |
| 1. | Housing |
| 2. | ICT |
| 3. | Other (specify) |
| v. | Labour market |
| 1. | Career centre |
| 2. | ICT |
| a. | Teleworking service |
| vi. | Industry |
| 1. | Construction |
| 2. | ICT |
| 3. | Other (specify) |
| Attributes, methods and KPI | a. In relation to the selected domain related sub-models specify which are the main rates of the key variables of the model? |
| b. | Which are the KPI that have been used in the case study? |
| c. | Which are the reference values of the selected KPI? |
| ICT-enabled intervention | a. In relation to the ICT-enabled innovation characterizing the case, please specify: |
| a. | Which are the domain-related sub-models impacted from which have been already selected? |
| b. | How the domain-related sub-model is impacted? (multiple choices are allowed) |
| i. | Coordination |
| ii. | Collaboration |
| iii. | Productivity |
| iv. | Cost savings |
| v. | Increase of effectiveness |
| vi. | Time reduction |
| vii. | Patient’s satisfaction |
| viii. | Employment |
| ix. | Lower incidence of hospital admittance |
| x. | Safety |
| xi. | Wellbeing |
| xii. | Other (specify) |
| c. | What is the key role played by ICT in the service? (free text) |</p>
<table>
<thead>
<tr>
<th>Relevance of the policy/policies</th>
<th>a. Was the right target addressed by the policy? (yes, no, I don’t know)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a. Are the needs of the targets satisfied by the policy? (Likert scale: 1-low; 2-3;4-5-high)</td>
</tr>
<tr>
<td></td>
<td>b. Is the design of the policy appropriate with respect to the needs of the targets? (Likert scale: 1-not at all; 2-3-4-5-completely)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acceptability of the policy/policies</th>
<th>c. To what extent is the policy initiative agreed by the relevant stakeholders? (Likert scale: 1-low; 2-3;4-5-high)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>d. To what extent is the policy initiative agreed by beneficiaries/social innovators? (Likert scale: 1-low; 2-3;4-5-high)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Efficiency of the policy/policies</th>
<th>e. Was the policy able to satisfy more beneficiaries than analogous policy initiatives? (Likert scale: 1-low; 2-3;4-5-high)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>f. Could we obtain the same results with less expenditure? (Likert scale: 1-low; 2-3;4-5-high)</td>
</tr>
<tr>
<td></td>
<td>b. Was the policy initiative the best way to promote ICT-enabled social innovation initiatives? (yes, no, I don’t know)</td>
</tr>
<tr>
<td></td>
<td>g. Has the administrative burden associated to the policy initiative increased/decreased in respect to the other similar policies? (Likert scale: 1-low; 2-3;4-5-high)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effectiveness of the policy/policies</th>
<th>h. Did the policy initiative reach the expected outcomes? (Likert scale: 1-low; 2-3;4-5-high)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>i. Was the policy initiative and the related funding schema adequate to achieve the policy objectives? (Likert scale: 1-low; 2-3;4-5-high)</td>
</tr>
<tr>
<td></td>
<td>j. To what extent were the products/services generated by the ICT-enabled social innovation initiatives adopted by the beneficiaries? (Likert scale: 1-low; 2-3;4-5-high)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Utility of the policy/policies</th>
<th>k. To what extent did the ICT-enabled social innovation initiatives produce positive results (outputs, outcomes, impacts) beyond those expected by the policy initiative? (Likert scale: 1-low; 2-3;4-5-high)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>c. Did the policy initiative produced spill-over effects? (yes, no, I don’t know)</td>
</tr>
<tr>
<td></td>
<td>a. Have the policy initiative produced unexpected positive/negative results (output, outcome, impacts)? (yes, no; don’t know)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sustainability of the policy/policies</th>
<th>l. To what extent did the policy initiative promote the openness of the related public administration towards transferability, replicability and knowledge exchange among social innovation communities and relevant stakeholders? (Likert scale: 1-low; 2-3;4-5-high)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>d. Have the ICT-enabled social innovation initiatives continued after the time span of the policy initiative and its related funding schema? (yes, no, I don’t know)</td>
</tr>
<tr>
<td></td>
<td>m. What is the degree of sustainability of the results (outputs, outcome, impacts) produced by the ICT-enabled social innovation initiatives underpinned by the policy initiative? (Likert scale: 1-low; 2-3;4-5-high)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Additionality of the policy/policies</th>
<th>n. Did the policy initiative induce stakeholders to invest more on their own funds than they would have done under any other policy schema perceiving the similar objectives? (Likert scale: 1-low; 2-3;4-5-high)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>o. Did the policy initiative reduce the risk related to the development of the ICT-enabled social innovation initiatives in respect to other policy initiatives perceiving similar objectives? (Likert scale: 1-low; 2-3-4-5-high)</td>
</tr>
<tr>
<td></td>
<td>p. Was the policy initiative able to reach beneficiaries that normally are not reached by other policies? (Likert scale: 1-low; 2-3-4-5-high)</td>
</tr>
</tbody>
</table>

| Coherence of the policy/policies | q. To which extent is the intervention logic underpinning the policy initiative not contradictory in its key elements (problems-needs-objectives-input-
<table>
<thead>
<tr>
<th>Allocative/distributional degree of the policy/policies</th>
<th>r. To which extent is the intervention logic underpinning the policy initiative not contradictory with other intervention pursuing similar objectives? (Likert scale: 1-low; 2;3;4;5-high)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>s. To which extent are spill-overs onto other economic, social or environmental policy areas being maximized/minimized? (Likert scale: 1-low; 2;3;4;5-high)</td>
</tr>
<tr>
<td></td>
<td>t. To which extent are the negative/positive distributional effects of the policy initiative minimized/maximized? (Likert scale: 1-low; 2;3;4;5-high)</td>
</tr>
<tr>
<td></td>
<td>u. Which is the degree of inclusiveness of the policy initiative? (Likert scale: 1-low; 2;3;4;5-high)</td>
</tr>
</tbody>
</table>
References


Anylogic website, www.anylogic.com


Porter, M., & Kramer, M., (January 2011). *Creating Shared Value*. HBR.


Europe Direct is a service to help you find answers to your questions about the European Union
Free phone number (*): 00 800 6 7 8 9 10 11
(*) Certain mobile telephone operators do not allow access to 00 800 numbers or these calls may be billed.

A great deal of additional information on the European Union is available on the Internet.
It can be accessed through the Europa server http://europa.eu

How to obtain EU publications

Our publications are available from EU Bookshop (http://bookshop.europa.eu),
where you can place an order with the sales agent of your choice.

The Publications Office has a worldwide network of sales agents.
You can obtain their contact details by sending a fax to (352) 29 29-42758.
JRC Mission

As the Commission’s in-house science service, the Joint Research Centre’s mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

Serving society
Stimulating innovation
Supporting legislation