NOVA SCHOOL OF SCIENCE & TECHNOLOGY

DEPARTMENT OF
ELECTRICAL AND COMPUTER ENGINEERING

MASS COLLABORATION AND LEARNING: STRUCTURE AND METHODS

MAJID ZAMIRI

Master of Business Administration

DOCTORATE IN ELECTRICAL AND COMPUTER ENGINEERING

NOVA University Lisbon

March 2022

NOVA SCHOOL OF SCIENCE & TECHNOLOGY

DEPARTMENT OF
ELECTRICAL AND COMPUTER ENGINEERING

MASS COLLABORATION AND LEARNING: STRUCTURE AND METHODS

MAJID ZAMIRI

Master of Business Administration

Adviser: Luís Manuel Camarinha-Matos
Full Professor, NOVA University Lisbon

Examination Committee:

Chair: Ricardo Luís Rosa Jardim-Gonçalves,
Full Professor, NOVA University Lisbon

Rapporteurs: António João Pina da Costa Feliciano Abreu,
Coordinator Professor, Instituto Politécnico de Lisboa
Maria Leonilde Rocha Varela,
Assistant Professor, Universidade do Minho

Adviser: Luís Manuel Camarinha-Matos,
Full Professor, NOVA University Lisbon

Members: Ricardo Luís Rosa Jardim-Gonçalves,
Full Professor, NOVA University Lisbon
Manuel Martins Barata,
Associate Professor, Instituto Politecnico de Lisboa
Ana Inês da Silva Oliveira,
Assistant Professor, NOVA University Lisbon

DOCTORATE IN ELECTRICAL AND COMPUTER ENGINEERING

NOVA University Lisbon
March 2022

Mass Collaboration and Learning: Structure and Methods

To the ones I love.

ACKNOWLEDGMENTS

I would like to primarily express my profound gratitude to my advisor *Prof. Luís Camarinha-Matos* for his unconditional support throughout this PhD long journey. His patience, motivation, encouragement, and especially pressure at the right moments were crucial for completing this work. I also thank him for sharing with me his valuable knowledge and experience, and for his rigorous comments and brilliant suggestions. He has been a tremendous mentor and I have been growing both as a scientific researcher and personally since I started to work with him.

I am also pleased to say thank you to *Prof. Ricardo Jardim-Goncalves* and *Prof. Joao Sarraipa* for all their support, insightful comments, and encouragement.

My gratitude extends to FCT-NOVA and the Center of Technology and Systems (CTS) for the funding opportunity that they provided me to undertake my studies.

Thank you to the *Department of Electrical Engineering and UNINOVA research institute*, for making this work possible, and providing available facilities and resources.

Last but not the least; my sincere thanks go to *my family* (parents, sibling, wife, and daughter), *colleagues, and friends* for supporting me spiritually throughout writing this thesis and my life in general.

"You cannot teach a man anything; you can only help him discover it in himself" (Galileo).

ABSTRACT

The rapid emergence of social networks and collaborative communities supported by the Internet and associated innovative technologies, and the increasing demand for continuous improvement and fostering lifelong learning have led to unprecedented waves of novelty in the ways people create and share knowledge in different spheres. In this regard, mass collaboration (MC) through Internet-based solutions has opened new windows of opportunity to collaborate massively and learn collectively in ways that seemed impossible even a few decades ago. Learning ecosystems can benefit from mass collaboration where large numbers of minds collectively drive intellectual efforts to learn in the form of knowledge building and sharing.

Mass collaborative learning (MCL) is a new paradigm that represents a significant shift away from the traditional teacher-centered approach towards a self-directed model in virtual communities in which contributing members take on creative roles to maximize their learning and that of their peers. Furthermore, MCL provides greater opportunities for distributed contributors to engage in virtual global learning and take the advantage of powerful social communities of experts and counterparts. Even though MCL opens up an apparently limitless field for promoting social inclusion in effective learning, not all aspects, features, and characteristics of this phenomenon are quite clear and discovered at present.

In order to design, implement, and exploit such a learning approach, influencing constituents should be identified, and appropriate conditions need to be provided. However, existing literature offers limited information, guidance, and support for the creation, operation, coordination, and development of MCL initiatives.

In this context, there are a number of identified critical issues, specific problems, gaps, and inconsistencies, and this thesis is correspondingly conducted to propose a Meta-Governance framework for MCL initiatives (MGF-MCL). This framework, by benefiting from various other related ideas, models, and methods, tries to give further insights into an integrated perspective of the most complex concerning issues and also some internal and external aspects of governance for the MCL initiatives. Furthermore, the MGF-MCL intends

to provide some directions, guidance, and support for the implementation, operation, and development of MCL initiatives.

In this thesis work, in order to (a) guide our research endeavor, (b) concretize our research design, (c) design, develop, validate, and apply the MGF-MCL, and (d) understand the practical value of our findings, we have followed the design science research process (DSRP) approach. We have evaluated the validity and applicability of the MGF-MCL through a mix of methods namely, case studies in EU projects, peer-review publications, and an MCL illustration case. A number of scenarios made within the case studies have brought together several industry and academic experts to evaluate the validity and applicability of MGF-MCL. The peer reviews of contributed publications also assessed the quality of the work and helped to establish the validity of MGF-MCL based upon the expert knowledge of other researchers. The MCL illustration case provided empirical evidence, relying on observation and experimentation. In terms of research, the findings of our work offer direction and support for the creation, operation, and implementation of MLC initiatives.

Keywords: Mass Collaborative Learning, Knowledge Creation and Sharing, Reliability of Knowledge or Information, Collaborative Networks, Organizational Structure.

RESUMO

A rápida emergência de redes sociais e comunidades colaborativas apoiadas pela Internet e tecnologias inovadoras associadas, e a crescente procura de melhorias contínuas e a promoção da aprendizagem ao longo da vida levaram a ondas de inovação sem precedentes na forma como as pessoas criam e partilham conhecimentos em diferentes esferas. A este respeito, a colaboração em massa (MC) através de soluções baseadas na Internet abriu novas janelas de oportunidade para colaborar massivamente e aprender colectivamente de formas que pareciam impossíveis mesmo há algumas décadas atrás. Os ecossistemas de aprendizagem podem beneficiar da colaboração em massa, onde grandes números de mentes impulsionam colectivamente os esforços intelectuais para aprender sob a forma de construção e partilha de conhecimento.

A aprendizagem colaborativa em massa (MCL) é um novo paradigma que representa uma mudança significativa da abordagem tradicional centrada no professor para um modelo auto-dirigido em comunidades virtuais em que os membros contribuintes assumem papéis criativos para maximizar a sua aprendizagem e a dos seus pares. Além disso, a MCL oferece maiores oportunidades a contribuintes geograficamente distribuídos para se envolverem na aprendizagem global virtual e tirarem partido das ricas comunidades sociais de especialistas e homólogos. Embora a MCL abra um campo aparentemente ilimitado para promover a inclusão social na aprendizagem efectiva, nem todos os aspetos, facetas e características deste fenómeno são totalmente claros e conhecidos actualmente.

A fim de conceber, implementar, e explorar uma tal abordagem de aprendizagem, devem ser identificados os constituintes relevantes, e devem ser criadas condições de suporte apropriadas. Contudo, a literatura existente apenas oferece de forma limitada informação, orientação e apoio para a criação, operação, coordenação e desenvolvimento de iniciativas MCL.

Neste contexto, há uma série de questões críticas, problemas específicos, lacunas e inconsistências identificados, e esta tese é correspondentemente desenvolvida para propor um quadro de Meta-Governança para iniciativas MCL (MGF-MCL). Este quadro, ao beneficiar de várias outras ideias, modelos e métodos relacionados, tenta fornecer uma perspectiva integrada das questões mais complexas e também de alguns aspectos internos e externos de governação para as iniciativas MCL. Além disso, o MGF-MCL pretende fornecer alguma orientação e apoio para a implementação, operação e desenvolvimento das iniciativas MCL.

Neste trabalho de tese, a fim de (a) orientar o nosso esforço de investigação, (b) concretizar o nosso projecto de investigação, (c) conceber, desenvolver, validar, e aplicar o MGF-MCL, e (d) compreender o valor prático dos resultados, seguimos a abordagem do "***DESIGN SCIENCE RESEARCH PROCESS***" (DSRP). Avaliámos a adequação e aplicabilidade do MGF-MCL através de uma combinação de métodos, nomeadamente, estudos de caso em projetos da UE, publicações com revisão por pares e, um caso de ilustração MCL. Vários cenários feitos no âmbito dos estudos de caso envolveram vários peritos da indústria e da academia para avaliar a validade e a aplicabilidade do MGF-MCL. As revisões por pares das publicações produzidas neste trabalho também permitiram aferir a qualidade do trabalho e ajudaram a estabelecer a validade do MGF-MCL com base no conhecimento especializado de outros investigadores. O caso da ilustração de MCL forneceu uma evidência empírica, apoiando-se na observação e experimentação. Em termos de investigação, os resultados do nosso trabalho oferecem orientação e apoio para a criação, operação e implementação de iniciativas MLC.

Palavras chave: Aprendizagem Colaborativa em Massa, Criação e Partilha de Conhecimento, Fiabilidade do Conhecimento ou da Informação, Redes Colaborativas, Estrutura Organizacional.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY

Collaborative Network	A set of entities that come together and collaborate on particular tasks toward reaching a common goal.
Mass Collaboration	A form of collective action that occurs when large numbers of people work independently on a single project, often modular in its nature.
Community	A social unit with commonality such as norms, religion, values, habits, or identity.
Collaboration	A process in which some entities work together to complete a task or achieve a goal.
Learning	Acquisition of knowledge or skills through study, experience, or being taught.
Structure	Arrangement of and relations between the parts or elements of something complex.
Method	A particular procedure for accomplishing or approaching something, especially a systematic or established one.

ACRONYMS

MC	Mass Collaboration
MCL	Mass Collaborative Learning
CI	Collective Intelligence
ICT	Information and Communication Technology
DSRP	Design Science Research Process
MGF-MCL	Meta-Governance Framework for Mass Collaborative Learning
DoCEIs	Doctoral Conference on Computing, Electrical and Industrial Systems
CTS	Center of Technology and Systems
CODIS	Collaborative Networks and Distributed Industrial Systems
VBE	Virtual Organization Breeding Environment
PVC	Professional Virtual Community
CoLTs	Collaborative Learning Techniques
MOOC	Massive Online Open Course
CNs	Collaborative Networks
ARCON	A Reference Model for Collaborative Networks
EDENCP	ED-EN HUB Collaborative Platform
KPIs	Key Performance Indicators

LeL Lifelong eLearning

LeLP Lifelong eLearning Platform

1

INTRODUCTION

Introductory background information about the research topic, and the major trends that motivated this work are introduced at the outset of this chapter. It is followed by introducing the research questions that guided the thesis development and the corresponding hypotheses. The adopted research method is then presented. Afterward, the aimed contribution of this thesis is presented, together with a detailed work plan. The integration of this work with other research activities is then pointed out at the end.

1.1 Background

The contemporary world is faced with a higher variety of challenges than at any other time in human history. Although revolutionary advances in science and technology show people more efficient ways to do things better, societies are still challenged with extremely specific problems. In this regard, emerging collaborative and networked practices have brought into focus new approaches for dealing with such problematic issues. Collaborative efforts, indeed, allow people to deliver smarter and better long-term solutions by leveraging joint energy, interests, talents, and resources.

With the advent of a pattern of complex and multi-faceted problems in social, economic, and environmental contexts, the attentions have turned to developing new forms of collaboration. In fact, it is believed that for solving such problems, the solutions should be designed in an adaptive way instead of selected from a repertoire of researched and tested technical solutions (Heifetz et al. 2010). To this end, one promising and emerging solution is mass collaborative engagement to substantially magnify the capabilities of participating citizens, and easily harness the potential insights and ideas of different minds. The emergence of the mass collaboration (MC) paradigm has opened some possibilities to benefit from the

expertise of large numbers of people for addressing and overcoming issues of concern that are shaping the quality of our life, both locally and globally (Ramaley 2016).

MC promises to be a cost-effective way to bring together multitudes of individuals that may have not had the opportunity to work together before and may even remain anonymous. It brings the opportunity to utilize the brainpower of participants in a collective effort and orchestrate their attempts in order to reach a common goal. In this context, Internet and Information and Communication Technologies (ICT) in general have a facilitating role to play. That is, MC is predominantly shaped by the convergence of supportive technologies with social phenomena in an online environment.

As it might be expected, participants in such collective endeavors can efficiently and quickly contribute to developing an idea, plan, action, process, project, or artefact, to help solving a complex challenge. Some well-known examples of MC such as the cases of Linux or Wikipedia development prove that if such community is properly coordinated, it can yield tremendous benefits. For instance, it provides the opportunities to obtain higher level of thinking, preserve information for longer, and create large scale of knowledge in a shorter period of time, at a fraction of the cost. Evidence clearly shows that MC, by harnessing the capabilities of thousands of people, can create a kind of agile knowledge production system which is almost superior to any type of intelligent artefact that is made to serve similar purpose.

Recent cases show that MC has been considerably helping organizations and communities to potentially reduce the barriers of starting huge projects, and successfully leverage the resources, energy, skills, talents, and knowledge. When large numbers of self-organized members (who are not directed by any central function) actively participate in a collective effort they will find the power and capability to save money, create a social spirit, increase transparency, outcome ownership, and awareness, and harness cognitive surplus (Cress et al. 2016).

1.2 Problem Introduction

As opposed to small groups where all members know each other, are explicitly directed, and the tasks are distributed among them, in MC, participants may remain anonymous, they are self-directed, mostly work in parallel instead of together, and can build a legacy for themselves and capacitate others. MC, by definition, channels resources, skills, efforts, and knowledge of many people who might come from different cultures, field of study, and socioeconomic backgrounds into a single outlet. The phenomenon of MC will only be shaped when interested participants come together or make connections, establish a real link, and form an active

community. The MC community can create a kind of self-referential system which is able to make a shared artefact or tackle a complex issue. The support, motivation, and friendly competition that are derived from collaboration can build a community power that considerably facilitates reaching the defined goals.

MC, by integrating and leveraging the resources that are provided by community members, can create a suitable environment (e.g., forum) for a promising form of learning and also can lead to new insights into the learning process. Unlike formal learning that normally takes place in educational institutions or small groups, being the process remarkably controlled, in MC learning occurs informally or semi-formally, outside the common classroom setting, and "in the wild". In MC, learning happens both at individual level (cognitive) and at community level (social).

At the individual level, a learner receives information or knowledge that is delivered through the community, tries to understand it on his/her own, and the learning takes place through a "mental process" while the learner might as well attempt to create some new knowledge. It is worth noting that the created knowledge at this level is limited by individuals' understanding, perceiving, reasoning, previous and current findings, and mental abilities. However, at the community level, learning relies on a "communication and collaboration process" based on community rules, norms, and criteria. It means that the possessed or created knowledge at the individual level is shared through the community. This knowledge is then available to all members to see, read, give feedback, edit, add, improve, and/or share. As this knowledge in the community is continuously modified by a large number of contributors with different abilities, experiments, and points of view, the output (particularly in terms of quality and reliability of co-created knowledge) might be higher than the results at the individual level.

Despite the advantages of traditional face-to-face and in-person learning, it faces some limitations or difficulties, for example, travel time and cost, fees, scheduling, low flexibility, etc. In contrast, in MCL the collaboration and interactions predominantly take place over the Internet which can reduce such constraints by itself. MCL not only hinders involvement with such limitations and difficulties but also it can be used as a flexible learning solution when face-to-face learning is impossible or at risk. Particularly, in the current condition of the Covid-19 pandemic which is causing alterations in educational systems and (temporary and compulsory) shifting away from the classroom to alternative modes of learning (e.g., virtual) (Corell-Almuzara 2021), MCL can respond to the current pandemic and create a long-term positive impact by providing some support for every student/citizen around the world. As an illustration, MCL can provide an innovative and suitable environment with specific features (e.g., safe, customizable, affordable, conventional, flexible, and accessible) equipped with

modern technologies (e.g., video conferencing, blogs, discussion forums, or platforms) that through which a large number of interested people (e.g., teachers, students, and even general public) at regional, national, or international level can engage in collaborative learning practices (e.g., sharing learning materials, discussion) throughout the crisis and even then after.

The fact is that people are now collaborating more than any time in human history. There is a growing willingness among communities of all sizes, from the emerging to the established ones, for reaping the benefits of mass collaboration. Despite notable progresses made in understanding the MCL intention and also achievements gained in this context, not all its aspects, characteristics, and components have been explicitly defined yet. For instance, the concept itself and associated mechanisms are still evolving. Different researchers have different viewpoints about this approach, so there is not yet an integrative view about the concept and thus we are still far from having a common understanding and unified definition of MCL. Therefore, the boundaries of MCL have not been precisely determined, and the processes of formation, organization, and development of MCL communities are still vague.

In addition, in MCL, as the size of the involved community is very large, and participants are not known and visible, it could regrettably enhance the likelihood of circulation of unhealthy materials such as, fabricated stories, fake news, conspiracy theories, misinformation and low-quality knowledge at individual level. Distribution of such materials that are provided with different purposes (e.g., personal, political, or commercial propaganda) could pose growing risks to both communities and individuals and might have serious negative consequences. When these unhealthy materials are diffused to the community level, a community needs to utilize, develop, and harness nearly all possible resources to properly react and withstand against such "polluting" elements to mitigate the rate of risk, recover from deviating moves, make the community resilient against them, and reduce the amount of created and shared low-quality materials. In a resilient community, through this collective effort, reliable materials will survive and be promoted whereas unreliable materials will fail over time. Resilience, indeed, enables community members to come together, intentionally promote their personal and collective capabilities, raise awareness of sustainability, respond effectively to turbulent changes, minimize impact of disasters, implement required plans and pay needed attention to urgencies, return to normal situations, and build development trajectory for future success.

When knowledge or information comes from the individual to the community level, it would be exposed to the community reaction. Other members might start developing some discussion or writing about it. Hence, it could trigger a dynamic process that leads to community contribution. Through this kind of contribution, the community can gain deeper

insight about the issue, and develop a shared understanding. In this regard, one main concerning issue is evaluating the quality of the co-created content and contribution of members. For instance, how can we ensure that the developed knowledge is reliable and meet the accepted standards of quality? How much improvement the co-created knowledge brings to the community? How much contribution is taken up? How many times the material is seen, read, or changed? How much active, passive, or neutral the contributors are? In other words, which roles can community members play? How can the community be organized to increase resilience? How can the quality of members' contribution be verified? etc. All these points and open questions show that this field of study is still evolving and requires further investigation and contributions to provide better clarification and evidence.

1.3 Motivation

Several successful instances of MC prove that it has high potential, and it is very appealing for applying in different realms such as social sciences. One possible application of MC is, for example, in the education and learning context. MC can provide a kind of structured approach that can lead to the development of some solutions to real-world problems which are incorporated into learning. A learning ecosystem and educational setting can potentially take advantage of MC to a great extent when a large number of independent contributors give themselves the chance to learn, adapt, and achieve impact together. In such ecosystem, the collective efforts of contributors can lead to knowledge creation. Such attempt builds on a reservoir of raw knowledge that develops as each contributor shares his or her own partial experience and knowledge. According to the Co-Evolution Model (Cress 2013), MC refers to a mechanism in which learners at individual level of performance not only proactively acquire and share a wide variety of materials but also autonomously contribute to knowledge creation and consolidation at community level. Moreover, within a collaborative learning environment, MC can help fostering interpersonal and social interaction skills to accomplish shared goals. MC can also promote the knowledge of both individuals and groups by persuading members to be actively involved in a learning network.

Nowadays, it is increasingly seen that individuals and organizations are willing to contribute to big communities to reap the advantages of MC, since the benefits of collaboration particularly at community level are undeniable. For instance, MC can lead to cutting some costs, creating more wealth, stimulating more creativity and innovation, increasing awareness, better utilizing the skills, building efficiency, harnessing of peer production and cognitive surplus. Greater stake in outcome; more advances in economy, culture, and education; quicker access to collective knowledge; and also ingenuity would be much more effective at mass level

than at individual level. It is note taking that the more participants engage with their community, the higher sense of community ownership they would get (Ramkumar Yaragarla 2016). That is why it is believed that MC without creating a dynamic environment, active contribution, and loyalty of community members is meaningless.

Despite of successful outcomes that MC already produced in various domains, we still need to clarify our thoughts and develop our understanding of the nature, infrastructure, formation, environment, and supervision of mass collaborative processes. For example, what kind of organizational structure is required for MCL communities; which management model can properly organize a large number of decentralized learners; what kind of tools are more suited for supporting the process, how can participants jointly develop the understanding of a shared goal; how can we make sure that all participants accurately undertake their roles, responsibilities and relationships, and meet the defined ethics, health or safety requirements on an agreed project; how can we appropriately switch from a traditional model of supervision such as a hierarchical one to learn-and-collaborate management model; how can we persuade learners to participate through passion; what kind of information should be kept to be viewed and shared; and what kind of knowledge should be protected; etc. (Lloyd et al. 2016), (Ghazawneh 2008).

One fundamental step in the process of learning, particularly in an online environment (like MC), is to ensure that the created and shared content (e.g., knowledge) is reliable, as well as the accuracy and credibility of the knowledge that people encounter with, are high. In principle, knowledge can appear in a different variety of kinds and forms (e.g., stories, interpretations, opinions, and facts) and created for various purposes (e.g., to sell, to inform, to present a viewpoint, to encourage). For each one of these diverse kinds and purposes, knowledge can enormously vary and differ in terms of value, reliability, nature, granularity, and lifespan. It can range from high to poor quality and include every shade in between, unlike traditional printed materials in books, reputed newspapers and magazines, and academic books which are considerably "regulated" for quality and accuracy (Dillenbourg & Baker 1995), (Weitzel et al., 2012).

It is also noteworthy that although the Internet is an attractive resource for providing immediate and easily available information, it is largely evidenced that in World Wide Web, and specifically in networked-collaborative activities neither all delivered materials are reliable nor will all stay stable. In addition, on one hand, the quality and value of various types of Internet sources (that are available in different formats like electronic books, journals, newsletters, websites, and blogs) are not all high, and on the other hand not all Internet users are able to accurately evaluate the appropriateness of all types of online sources (Kaushik 2012). Furthermore, even though Internet and social media offer exciting opportunities, both

for those searching information and for those intending to make it available, some of the materials that they provide are potentially harmful, misleading, or erroneous, and they fail to guarantee that the addressed knowledge is satisfactorily complete and trustworthy. Today, by increasing online environments and increasing the number of users, this problem just keeps getting bigger and bigger.

Opposite to formal learning delivered by instructors in a systematic intentional way within an educational setting, in informal form of learning which is common in MCL, knowledge is collectively created, revised, and shared in large scale within collaborative communities. In recent years, increased awareness about the importance of the quality issue has considerably warned many organizations and communities, particularly those that are engaged in mass collaborative projects, since there is a significant potential for users to be misinformed by inaccurate knowledge or misleading information.

Although the issue of quality in MCL is significant, entities planning to lead such process should be aware of several challenges. For instance, a great number of scholars from different fields during the years have been dealing with the issue of evaluating the quality of contents (e.g., knowledge, information, or data) in diverse areas, but there is still no common consensus in order to introduce a comprehensive mechanism that can assist learners to evaluate the quality (e.g., reliability and authenticity) of online materials effectively. As such there is no uniform way by which the quality of created and shared knowledge in MCL projects can be judged.

In addition to knowledge quality (mentioned above), it should be noted that there are still other unaddressed issues around these two emerging paradigms (MC and MCL), these including:

A. In terms of organizational and behavioral models, it is deemed necessary the identification of required organizational and behavioral patterns and models that steer establishing and developing specific MCL communities. Thus far there have been very few attempts to report on the role of organizational and behavioral models in the context of MC and learning. Furthermore, there are no clear evidence in the literature that show how mass collaborative projects can define, design, implement, and develop appropriate structures.
B. Despite notable progresses in understanding MCL and the achievements gained in this context, not all its aspects, characteristics, and components have been explicitly defined yet. For example, thus far there have been very few attempts to report on the role of organizational structures in the context of mass collaboration and learning. Furthermore, there is no clear evidence in the literature that show how mass

collaborative projects can define, design, implement, and develop appropriate structures.

Such problems remain a major concern for decision makers in this domain. Therefore, gaining a clearer insight about how collaborative learning communities, initiatives, and projects are performing and dealing with the mentioned issues and challenges is the first and foremost motivation for conducting this thesis work.

Given the above, the main objective of this thesis work is proposing a solution (Meta-Governance framework) that consolidates the integration of ideas from different governance styles (e.g., democratic, collaborative), a set of organizational and behavioral models (e.g., virtual, non-hierarchical) and assessment methods (e.g., collaborative knowledge assessment) and assessment indicators (e.g., learning assessment indicators) to guide and support the creation, implementation, operation, management, and development of MCL communities.

1.4 Research Questions and Hypotheses

Despite the well-documented advantages of MC, particularly in the learning context, as pointed out above, there are still a variety of challenges associated with the MCL environment, implementation, and operation. One potential solution to this problem is to review the specific issues, factors, features, needs, and challenges of successful examples of MCL projects, and then integrate the gained understanding and knowledge with promising and innovative solutions to be used in configuration, improvement, and supporting of future MCL projects. Given that, a key research question that emerges is:

Main Research Question:

RQ. *What could be an effective way of supporting community learning through mass collaboration (MC)?*

The following hypothesis is set for this work in order to answer the main research question:

H**.** *Community learning could be effectively supported through MC if three streams of work are appropriately rooted in the foundation of a community namely, through (I) identifying the positive and negative factors in existing and emerging successful examples of MC; (II) adopting contributions from collaborative networks in terms of structural and behavioral models; and (III) establishing adequate learning assessment indicators and metrics.*

An illustration of these three streams of work that can influence community learning, as addressed in above hypothesis, is depicted in Fig 1.1.

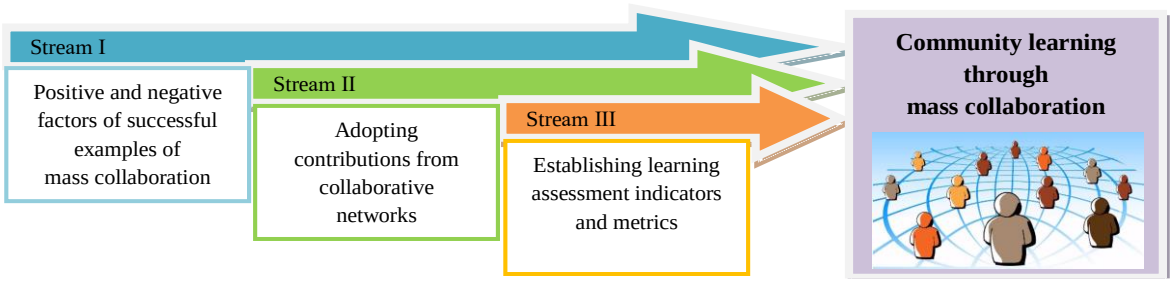


Figure 1.1. Three streams of work affecting community learning through mass collaboration.

Additionally, two more detailed research questions are proposed, aiming to better understand and clarify the main research question:

Research Sub-Question a):

RQa. *What kind of organizational structure within a community should be established to help developing learning through MC?*

The proposed hypothesis to address this sub-research question is:

Ha. *Community learning through MC could be helped if existing models of organizational structures for long-term strategic networks are extended to allow more fluid borders and new roles, incentives and internal subgroups are defined to focus on learning and knowledge generation.*

Research Sub-Question b):

RQb. *What kind of assessment mechanism can help minimize the problems related to the reliability of created and shared knowledge through MC within a community?*

The hypothesis adopted for this sub-research question is:

Hb. *The problems related to the reliability of created and shared knowledge through MC could be minimized if the community benefits not only from the combination and application of a set of appraisal rules, criteria, and methods, but also the contributed content materials are critically assessed through a collective effort.*

1.5 Research Method

For this study the design science research process (DSRP) approach (Peffers et al. 2006) is adapted to incorporate principles, practices, and procedures required to carry out our research and meets three objectives: (i) it is consistent with prior literature, (ii) it provides a nominal process model for doing the research, and (iii) it provides a mental schema for presenting and evaluating the proposed solutions. DSRP paradigm has its roots in engineering and is basically used for the purpose of problem solving. DSRP aims to develop the organizational and individual capabilities by the creation of innovative artifacts and the generation of design knowledge. The method includes six main steps (Brocke et al. 2020) as shown in Figure 1.2. These steps are briefly explained as follows:

- *Problem identification and motivation*: identifying the research problems and justifying the value of the solutions. As mentioned in Section 1.2 and 1.3, this work faces some main challenges such as, topic complexity, insufficient structured information (in the literature) about different aspects of MCL. Thus, this step contributes to (a) identify the main components, features, and characteristics of MCL communities, (b) find the structural and behavioral aspects of MCL communities, and (3) address potential indicators for assessing learning and performance. This step is reflected in Chapters 1 and 2.

- *Definition of the objective of the solution:* defining how the identified problems should be solved. As pointed out in the motivation Section, this work strives to highlight the significance of supporting the processes of implementation, operation, and management of MCL communities. To understand, summarize, and synthesize the existing research, debates, and ideas around this body of knowledge, we conducted a deep literature review. This review helped us to provide a foundation of (general and specialized) knowledge on the topic. This step is reflected in Chapters 1 and 2.

- *Design and development:* designing an artifact (e.g., model, framework) that can solve the problems. In responding to the identified problems (addressed in prior step) and research questions (listed in Section 1.4), we propose a meta-governance framework for mass collaborative learning (MGF-MCL) (presented in Chapter 3). The framework emanates from the background knowledge and experiences in combination with some relevant solutions reported in the literature (summarized in Chapter 2).

- *Evaluation:* evaluating and observing how well the artifact works. In order to evaluate how well the MGF-MCL is successful in supporting and steering the target case studies, we used different assessment methods and processes. For example, through

a three-phase of evaluation, we have assessed the acceptability, capability, and effectiveness of the framework in the case studies. This step is presented in chapter 4.

- *Communication:* reporting the effectiveness of the proposed solutions. The inputs and outputs of this work are shared with others through some publications (presented in Chapter 4).

These 6 steps are illustrated in Figure 1.2.

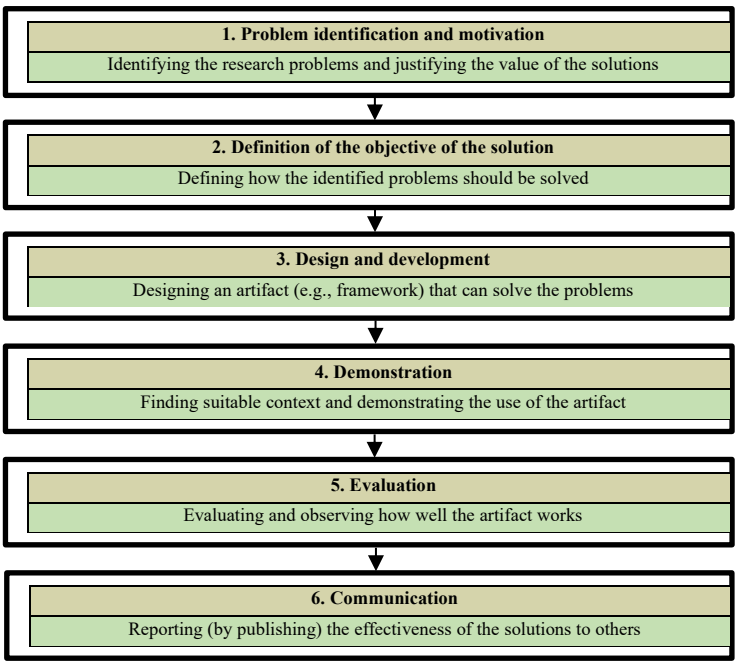


Figure 1.2. DSRP steps.

In addition to communication step (6), in order to (a) ascertain whether the study truly proves the hypothesis that it is intended to find, (b) determine how truthful the study results are, and (c) gain confirmation from our tests and provide objective evidence, the following channels of work validation are adopted for this thesis research:

- Through theory triangulation: to observe, study, and use multiple theories, proposed perspectives and answers in the research of others which can help better interpret and explain the research results.
- Through peer review: to have interpretations and conclusions of peers (focus group) who are experts in this area (it is about due diligence to ensure that the followed logic in the research is sound).
- Through case studies: to practically test the hypotheses and experiment the application of the proposed solutions on real and recognized case studies.

- Through MCL illustration: to run an experiment and evaluate the strength of evidence from the sample illustration.
- Through presenting this thesis work in accredited seminars and workshops.
- Through interactions with some successful collaborative learning communities.

The results of this PhD work are disseminated through submitting articles to recognized international journals and conferences indexed by Web of Science and Scopus. This activity provided a great opportunity to present intermediate results, and to have valuable feedback of experts from different areas of study. The list of targeted journals and conferences and the date of publication are given below in Table 1.1:

Table 1.1. Dissemination channels and schedule

Dissemination Channel	
Journals	**Publication**
. Applied Science	2019
. Computers	2022
Conferences	
. DoCEIS - Doctoral Conference on Computing, Electrical and Industrial Systems	2018
. DoCEIS - Doctoral Conference on Computing, Electrical and Industrial Systems	2019
. DoCEIS - Doctoral Conference on Computing, Electrical and Industrial Systems	2020
. International Conference on Interoperability for Enterprise Systems and Applications	2020
. DoCEIS - Doctoral Conference on Computing, Electrical and Industrial Systems	2021

It should be added that this PhD work was developed in the CoDIS group (Collaborative networks and Distributed Industrial Systems group) of the Center of Technology and Systems (CTS), UNINOVA.

1.6 Aimed Contribution

Considering the proposed research questions and hypotheses the main contributions of this work include:

1. **Mass collaboration mechanisms**
   - Identification of MCL environment and its organizational and governance structure,
   - Identification of effective ways that support learning through MC.
2. **Conceptual model**
   - Proposing a conceptual model aimed at representing the main concepts and components of organizational structures in MCL projects and showing their relationships.
3. **Integration of assessment methods and mechanisms**

- Elaboration of methods for assessing the reliability of created and shared knowledge in MCL communities,
- Identification of appraisal methods that can minimize problems of dissemination of unreliable knowledge,
- Adoption of metrics and indicators for knowledge reliability improvement in MCL environment.

1.7 Alignment with the 2030 Agenda

It is worth noting that the primary objective of this research work is well in line with the 4th goal of the 2030 Agenda for Sustainable Development of the United Nation (United Nations 2015). This Agenda is a plan of action for people, with 17 Sustainable Development Goals and 169 associated targets at its core. The 4th goal expects equitable quality education and promoting lifelong learning opportunities for all people around the world, especially in sub-Saharan Africa and Southern Asia, targeted to vulnerable populations, including persons with disabilities, indigenous people, refugee children, and poor children in rural areas. It is believed that this goal could be accomplished through building and upgrading education facilities that provide safe, non-violent, inclusive and effective learning environments by 2030.

To this end, this research contributes to develop a potential mechanism that can provide opportunities for acquiring and sharing of knowledge in the context of learning for all individuals who wish to participate in learning activities, and particularly for those who remain out of formal education.

This work also intends to help adopting a comprehensive approach that emphasizes lifelong learning in non-formal and informal settings of home, workplace, community, and society at large, by means of building an intelligent collaborative network.

1.8 Description of the Thesis Structure

This thesis is organized into five chapters and 5 supporting annexes. A brief abstract of each chapter is presented in order to give an overview of this thesis document.

- **Chapter 1 –** *Introduction and Research Methodology*: represents the introduction to our research, providing the backbone and basis for the remainder of the thesis. This introductory chapter begins with the problem statement and motivation, followed by the research questions and hypotheses. This chapter also presents the research design used in the thesis which is based on the DSRP. It elaborates on the objectives

of the design artefacts, the followed design approach, and the procedure applied for the evaluation of the artefacts.

- **Chapter 2 –** *Literature Review*: introduces the research background to our work, and highlights the core concepts, constructs, methods, and models that were used to achieve our research objectives.
- **Chapter 3 –** *Meta-Governance Framework for Mass Collaborative Learning (MGF-MCL)*: introduces our main contribution to research and practice. The framework has two main parts. A) organizational part that consists of (a) structural and behavioral structures, (b) endogenous and exogenous components of a typical MCL community, and (c) assessment indicators and a knowledge assessment method. B) governance part that evaluates the organizational part through three phases. The framework is proposed to guide and support the creation, operation, and implementation of MCL communities.
- **Chapter 4 –** *Validation*: presents the validation approach used for the thesis work. It includes a three-level validation methodology based on validation in two case studies from EU projects, validation in a MCL illustration case, and validation through peer reviewed publications, aiming at gathering evidence of the general fitness of the proposed solution in real scenarios.
- **Chapter 5 –** *Conclusion*: remarks the concluding points and proposes some directions for future research.

2

LITERATURE REVIEW

Having identified some substantial challenges in this field of study, a research literature review in related areas is carried out by following a systematic survey approach. This chapter provides a baseline for conducting this research work, and better characterizes current research gaps. Hence, the base concepts of this study are initially explained in order to facilitate their understanding and appraising. Then after, the main affecting factors and constituents of MC and MCL are identified and discussed in response to five guiding questions.

2.1 Survey Approach

For this study, a systematic literature review was adopted in an attempt to identify, critically analyze, and integrate the findings of multiple research works. This process aims to establish to what extent existing research has improved towards addressing a specific problem; to identify gaps, relations and inconsistencies in the literature; to synthesize findings and make conceptualizations, and to provide an implication for practice (Baumeister & Leary 1997). A fundamental eligibility criterion for selecting studies for this review was that they could relate to the formulated research questions. The search was performed on databases such as, SCOPUS, IEEE Xplore, Web of Science, and Google scholar, resulting in a selection of 253 articles within the period of 2010–2021. After reviewing keywords, abstracts, and conclusions for relevance, 157 full articles were selected for reading. Narrowing down and by applying all selection criteria, a total number of 115 articles were eventually included in the final analysis.

The selection criteria were defined to determine that the selected articles are directly relevant for our review. Thus, the original journal articles, book chapters, surveys, conference materials, and technical reports that are in the English language were included. Other types of documents, such as conference abstracts, editorials, position statements, expert opinion,

comments, and letters were excluded. As both MC and MCL are emerging paradigms, they are not well structured, and they are not yet well documented and represented in focused scholarly publications available in the literature. Therefore, to find relevant papers in database searching (for title, abstract, and body text), we had to include a range of keywords (alone and in combination). For each element addressed in the hypothesis, the used search terms are as the following:

- *Organizational structure:* "organizational structure of collaborative communities", "organizational structure of collaborative networks", "organizational structure of collaborative learning communities", and "organizational structure of collaborative learning initiatives".
- *Behavioral structure:* "behavioral structure of collaborative communities", "behavioral structure of collaborative networks", "behavioral structure of collaborative learning communities", and "behavioral structure of collaborative learning initiatives".
- *Endogenous elements:* "endogenous elements of collaborative communities", "endogenous elements of collaborative networks", "endogenous elements of collaborative learning communities", and "endogenous elements of collaborative learning initiatives".
- *Exogenous elements:* "exogenous elements of collaborative communities", "exogenous elements of collaborative networks", "exogenous elements of collaborative learning communities", and "exogenous elements of collaborative learning initiatives".
- *Learning assessment:* "assessing learning process in collaborative communities", "assessing learning process in collaborative networks", "assessing learning process in collaborative learning communities", and "assessing learning process in collaborative learning initiatives".
- *Performance assessment:* "assessing the performance of collaborative communities", "assessing the performance of collaborative networks", "assessing the performance of collaborative learning communities", and "assessing the performance of collaborative learning initiatives".
- *Quality of knowledge assessment:* "assessing the quality of knowledge in collaborative communities", "assessing the quality of knowledge in collaborative networks", "assessing the quality of knowledge in collaborative learning communities", and "assessing the quality of knowledge in collaborative learning initiatives".

The selected articles are grouped and classified into categorical themes (e.g., base concepts, related organizational and behavioral structures, main internal and external components, potential assessment methods, and assessment indicators and metrics). The most

important data (e.g., major topics, objectives, findings, open issues, remarks, and reference) are extracted, tabulated, and documented to be used in the work. The articles are then analyzed according to the thesis research questions. Next, the structures of the works are analyzed step-by-step. For example, the research methods used in the studies are reviewed to identify whether or not they appear to be suitable. The provided elements of evidence and facts are carefully checked. The collected data are qualitatively and quantitatively evaluated.

2.2 Base Concepts

In this study, the literature review is devoted to background studying of:

- Mass Collaboration (MC),
- Collective Intelligence (CI) (as the closest form of collective action to MC),
- Mass Collaborative Learning (MCL),
- Affecting factors on MCL, namely, organizational structure, collaborative learning techniques, supportive technologies, contributors' performance, and knowledge reliability mechanisms.

The review of the literature reveals that there is no universally agreed single definition of MC as the concept can be addressed from a variety of perspectives. MC, as a new and emerging area, overlaps in some ways with a number of other collective actions-related terms, including CI, crowdsourcing, crowd wisdom, peer production, user-powered systems, community systems, social systems, social collaboration, Wikinomics, smart mobs, and human computation (Cress et al., 2016). Even though, certain general characteristics of MC are addressed in most proposed definitions (a large number of participants who act collectively), some particular characteristics and features still remain controversial and confusing, e.g. what kind of problems are tackled? should technology be always used? if yes, what kind of technology is exactly needed? whether or not all forms of MC use a textual medium? etc. Furthermore, current literature, introduces the idea of MC from different perspectives, such as knowledge construction (Richardson & Domingos 2003), innovation (Cress et al., 2016), organizational sustainability (Campbell et al., 2011), knowledge management, and collaborative learning (Elliott 2007), (Cress et al., 2016).

Table 2.1 presents some partial definitions proposed for MC in order to gain a better insight into this concept. These definitions are presented as examples from the considered publications reviewed in this study.

Table 2.1. Some partial definitions of mass collaboration.

Definitions	Sources
"MC is characterized by the large number of people being involved in it, the digital tools they use (Web 2.0), and digital products they create".	(Cress et al., 2016)
"While most collaborations involve only a few people, new information technologies now allow huge numbers of people (separated by very large distances) to work together on a single project".	(Fallis 2009)
"MC is based on individuals and companies employing widely distributed computation and communication technologies to achieve shared outcomes through loose voluntary association".	(Tapscott & Williams, 2008)
"MC Problem Solver would utilize the brainpower of large numbers of humans and orchestrate their individual efforts to solve hard problems that are beyond the reach of purely computational methods. MC problem solving is an idea whose time has come. This has been brought about by an unprecedented convergence of technologies and social phenomena that have more fully accomplished the global nature of the Internet".	(Potter et al., 2010)
"MC involves the collective action of large numbers of people to perform a task. Users have evolved from passively receiving information through the web to playing an active role by forming communities, interacting with peers, sharing information, and adding value to the Internet as a result of their interactions".	(Panchal & Fathianathan 2008)
"MC system enlists a mass of users to explicitly collaborate to build a long-lasting artefact that is beneficial to the whole community. MC system enlists a mass of humans to help solve a problem defined by the system owners".	(Doan et al., 2010)

The closest notion to MC among the various overlapping concepts is CI. These two terms are even used as synonymous by some authors (Tapscott & Williams, 2008). They claim that principles such as openness, peering, sharing, and acting globally make it possible to apply them interchangeably. In order to better discern between MC and CI some related definitions and statements on CI are summarized in Table 2.2.

Table 2.2. Some partial definitions of collective intelligence.

Definitions	Sources
"CI is based on the concept that large groups of cooperating individuals can produce higher-order intelligence, solutions and innovation and come to function as a single entity. CI may receive various forms including volunteers that collaborate in order to achieve a common goal that will benefit their community, political parties that mobilize large numbers of people to run campaigns and select candidates, as well as large groups of individuals that collaborate or compete towards finding the best solution to a problem. CI may generally exist without the use of technology".	(Cress et al., 2016)
"CI is a form of universal, distributed intelligence, which arises from the collaboration and competition of many individuals. It is the general ability of a group to perform a wide variety of tasks. The phenomenon is closely related to swarm intelligence, which	(Fallis 2009)

means collective, largely self-organized behavior emerging from swarms of social insects".	
"When a group of individuals collaborate or compete with each other, intelligence or behavior that otherwise didn't exist suddenly emerges; this is commonly known as CI. The actions or influence of a few individuals slowly spread across the community until the actions become the norm for the community. As users interact on the web and express their opinions, they influence others".	(Tapscott & Williams, 2008)
"Large groups of cooperating individuals can produce higher-order intelligence, solutions and innovation and come to function as a single entity. CI may receive various forms including volunteers that collaborate towards achieving a common goal that will benefit their community. One may observe that CI may generally exist without the use of technology".	(Potter et al., 2010)
"CI is groups of individuals doing things collectively that seem intelligent".	(Panchal & Fathianathan 2008)

Based on definitions mentioned above, it can be clearly seen that there are various similarities between these two concepts. However, there are also some considerable differences. The identified differences and similarities through this work are addressed in Table 2.3.

Table 2.3. Identified differences and similarities between mass collaboration and collective intelligence.

Differences	MC	Aims	Solving complex problems
		Components	Collaboration
		Interaction	Mediated by content
		Group size	large number of participants
		Technology adoption	Exist with use of ICT
	CI	Aims	Solving cognitive problems
		Components	Collaboration & Competition
		Interaction	Mediated by social interaction
		Group size	Small/medium number of participants
		Technology adoption	May exist without use of ICT
Similarities	MC & CI	Control structure	Decentralized
		Location	Universally distributed
		Knowledge flow	Shift from individual to collective
		Process	Co-creation
		Relation	Informal
		Outcome	Intellectual / Physical

As shown in Table 2.3, a number of similar characteristics (control structure, location, knowledge flow, process, relation, and outcome) and different features (technology adoption,

aim, group size, interaction, and components) can be found between MC and CI although this Table deserves further analysis and development. Nevertheless, based on these findings (e.g., features and characteristics) it can be concluded that CI is not exactly the same as MC, but the two concepts have a large overlap. In Figure 2.1 their relationship is illustrated.

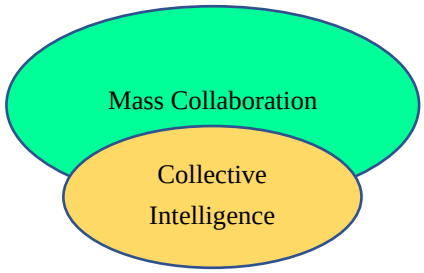


Figure 2.1. Relationship between mass collaboration and collective intelligence.

Having found the main features and specifications of MC, we reviewed the literature to find some active and successful cases of MC. In Table 2.4 there is a list of 15 identified examples of MC in different contexts. These cases are analyzed (in Chapter 4, Table 4.1) and their related functions and features are extracted to be used as a guide for our contributions.

Table 2.4. 15 cases of mass collaboration.

15 examples of mass collaborative community	
1)	***Wikipedia*** – a web-based, free-content encyclopedia used as an open collaboration project developed by a very large (open) community of volunteer editors. (Potter et al., 2010)
2)	***Digg*** – a social networking and news aggregating website. Contributors submit their stories for consideration and promotion, and they are either voted to be digged, or buried. (Fallis 2009)
3)	***Yahoo! Answers*** – was a question-and-answer website driven by a community in which participants can ask and/or answer questions about anything. (Fallis 2009)
4)	***SETI@home*** – an Internet-based public volunteer computing project which intends to evaluate radio signals, searching for signs of extra-terrestrial intelligence. (Fallis 2009)
5)	***Scratch*** – a block-based visual programming language and online community which enables participants to build and share their stories, games, animations, and music on the web. (Cress et al., 2016)
6)	***Galaxyzoo*** – a crowd sourced astronomy project that classifies the morphology of large numbers of galaxies through co-operation of interested participants. (Cress et al., 2016)
7)	***Foldit*** – an online puzzle video game about protein folding. It invites people to fold the structures of selected proteins (cancer) by using tools provided in the game. (Cress et al., 2016)
8)	***Applications of the Delphi method*** – a structured communication method that evaluates the results of multiple rounds of questionnaires sent to a panel of experts to gain group consensus. (Bonabeau 2009)
9)	***Climate Colab*** – an online crowdsourcing platform that invites people to address the global climate changes. (MIT Management SLOAN 2014)
10)	***Assignment Zero*** – an experiment in crowd-sourced journalism in which participants collectively produce a piece of work. (MIT Center, 2011)
11)	***DonationCoder*** – a website hosting a community of programmers and software fans that collectively organize and finance software development. (MIT Center 2011)

12)	***Experts Exchange*** – a trusted global online community that tries to solve the world's technology problems. (MIT Center 2011)
13)	***Waze*** – a community-driven GPS and navigational app that provides navigation information, route details, and travel times. (Silva et al., 2013)
14)	***Makerspaces*** – a collaborative workspace where people can come together to use tools for exploring, making, sharing, learning, and and/or completing a project. (Cress et al., 2016)
15)	***SAP community network*** – an open, online, and collaborative community of software users, developers, consultants, mentors and students who use the network to get help, share ideas, learn, innovate and connect with others. (Kawalek 2010)

Taking into account the above-mentioned points, examples, and contributions from the literature, the following working definitions are suggested based on our understanding:

Mass collaboration *is a collective process that takes place when a large enough number of distributed autonomous participants work together or in parallel on a single project and share their resources and commonalities to solve a complex problem that is often considered insoluble and/or is beyond one's ability and that needs the confluence of different contributions from a variety of backgrounds. Such collaboration is typically mediated by the contents or objects being created (a kind of stigmergy) and occurs mostly over the Internet, using social software and computer-supported collaboration tools (but not always).*

Collective intelligence *is a form of collective creativity that arises when a small to large number of self-organized and distributed contributors intelligently attempt to solve a cognitive problem collaboratively or competitively. It may exist without the use of ICT and is mediated by direct social interaction.*

2.3 Research Findings

2.3.1 Organizational Structures

An organizational structure determines how power, roles, and duties can be defined, controlled, and coordinated toward reaching organizational goals. It also specifies the way in which knowledge, information, or data flow across different levels of organization. Every organization (e.g., community) certainly needs a structure (even if it is self-organizing) in order to survive, take actions, and grow, otherwise it may face with a kind of chaos, mess or very little clarity everywhere (Galbraith 1987). Every community should select its structure based on its requirements and priorities. The type of organizational structure implicitly indicates in which ways internal works can be carried out.

2.3.1.1 Types of Organizational Structure

Various types of organizational structures can be defined to meet the requirements of an organization or community. Some authors (Chand 2016) categorize them into eight groups: (1) line organizational structure, (2) staff or functional authority organizational structure (3) line and staff organizational structure, (4) committee organizational structure, (5) divisional organizational structure, (6) project organizational structure, (7) matrix organizational structure, and (8) hybrid organizational structure. The organizational structures are also classified by (Paleri 2018) into sixteen categories: (a) pre-hierarchical, (b) hierarchical, (c) post-hierarchical, (d) functional, (e) divisional, (f) matrix, (g) flat, (h) committee, (I) wirearchy, (J) network, (k) virtual, (l) ecologies, (m) symphony, (n) hybrid, and (o) detached. In another classification (Mintzberg 1980) an organizational structure is sorted into five main classes: (1) simple form, (2) machine bureaucracy, (3) professional bureaucracy, (4) divisionalized form, and (5) adhocracy.

This diversity of structures shows that in the long run different organizations or communities can take the advantages of different structures. However, neither one universal organizational structure is recommended that can be used for every organization or community, nor exists a clear way to select the best structure.

2.3.1.2 Organizational Structure and Mass Collaboration

There are vast amounts of literature on organizational structures in various contexts. For instance, (Meunier-FitzHugh & Piercy 2008) discussed the importance of the organizational structure for collaboration between sales and marketing, (Zhang & Baden-Fuller 2010) assessed the influence of the technological knowledge base on the organizational structure, and virtual collaboration in a matrix organization was discussed by (Kates & Erickson 2008).

In the past, the structures of organizations or communities were mostly designed for effectiveness and efficiency although they are nowadays designed for agility, speed, and adaptability to be able to compete and win in today's global competitive environments. As organizations or communities are becoming more and more digital-based and there is a transformation towards performing projects collaboratively, they are also facing with an imperative to redesign their structures in order to learn more rapidly, move faster, respond to demands quickly, and adapt to the characteristics of new workforces and workplaces. While the business environment, customer needs, technology capabilities and the nature of work in organizations and communities are likely to change, the organizational structure needs to reshape as well in a deliberate and strategic way. In this way, the design of structures for adaptability is a shift away from traditional organizational structures such as, hierarchical, centralized, and bureaucratic models towards non-hierarchical, decentralized, unconventional

models where projects are fulfilled collectively by networking a variety of self-directed participants (Yaragarla 2016).

However, thus far there have been very few attempts to report on the role of organizational structures in the context of MC and MCL. Furthermore, there are no clear evidence in the literature that show how mass collaborative projects can define, design, implement, and develop appropriate structures.

Nevertheless, we may gain some insight on what kinds of organizational structures have more chances for adoption in MCL projects if we review the structures used in a closer area. For this purpose, the collaborative networks taxonomy presented in (Camarinha-Matos et al., 2009) was chosen as it can fit the type of structures that are applied by various virtual communities in the collected papers. As depicted in Table 2.5, two main forms of structures in networks - collaborative networked organizations and ad-hoc collaboration forms - can be found at the root of this taxonomy.

Table 2.5. Partial taxonomy of collaborative network based on (Camarinha-Matos et al., 2009).

<table>
<tr><th colspan="4">Collaborative Network</th></tr>
<tr><th colspan="3">Collaborative Networked Organization</th><th>Ad-hoc Collaboration</th></tr>
<tr><th colspan="2">Long-term Strategic Network</th><th colspan="2">Goal-oriented Network</th><td rowspan="3"></td></tr>
<tr><td>- Virtual organizations Breeding Environment (VBE)</td><td>- Professional Virtual Community (PVC)</td><td>- Grasping opportunity driven network</td><td>- Continuous production driven network</td></tr>
<tr><td colspan="2">- Industry cluster
- Industry district
- Disaster rescue network
- Business ecosystem
- Collaborative innovation network</td><td>- Extended enterprise
- Virtual Enterprise
- Virtual Organization
- Virtual team</td><td>- Supply chain
- Collaborative e-government
- Collaborative smart grid
- Distributed manufacturing</td></tr>
<tr><td colspan="3"></td><td>- Mass Collaboration
- Flash mob
- Informal network
- One-to-one informal collaboration</td></tr>
</table>

Taking into account this taxonomy, an analysis of the collected papers shows that the issue of organizational structure is addressed to some extent in 32 of them. The majority of these (88%) consider some form of collaborative networked organization, and the rest (12%) ad-hoc collaboration. Among the long-term strategic network structures, the PVC was the most applied form (19%) whereas business ecosystem was the least mentioned one (3%). Regarding goal-oriented networks, virtual team had the highest percentage of occurrence (22%) among all introduced structures. In ad-hoc collaboration, the most mentioned structure is MC (9%). It is remarkable that the type of organizational structure which was applied in three articles in collected papers falls between the VBE and PVC categories in the above taxonomy (a kind of hybrid model). The types and percentage of used organizational structures in collected papers are depicted in Figure 2.2.

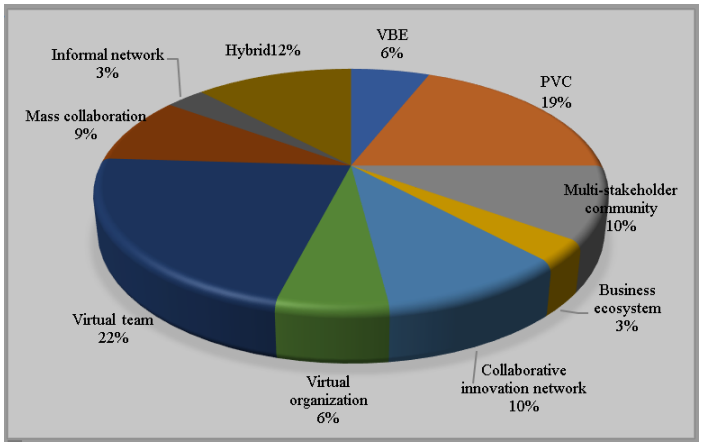


Figure 2.2. Types and percentages of mentioned structures in the collected papers.

Table 2.6 lists some examples of addressed structures and corresponding references.

Table 2.6. Examples of addressed structures and corresponding references.

VBE	(Toprak & Genc-Kumtepe 2014), (Diki 2013)
PVC	(Franks & Oliver 2012), (Halatchliyski et al., 2014), (Short 2012), (Halatchliyski 2015), (Hairon & Tan 2017), (Franks & Oliver 2011)
Multi-stakeholder	(Allen et al. 2011), (Manouselis et al., 2010), (BerG-Weger & Schneider 1998)
Business ecosystem	(Cress et al., 2016)
Collaborative innovation network	(De Moor 2013), (Fischer 2016), (Sun & Shen 2014)
Virtual organization	(Gea et al., 2011), (Campbell et al., 2011)
Virtual team	(Urquhart et al. 2013), (Cress et al., 2016), (Louder 2011), (Domik & Fischer 2011), (Bosch-Sijtsema & Sivunen 2013), (Maries & Scarlat 2011), (Awal & Bharadwaj 2014)
Mass collaboration	(Joyce et al., 2013), (Daxenberger 2016), (Nathaniel 2010)
Informal network	(Cress et al., 2016)
Hybrid	(Nielsen et al., 2010), (Persico & Pozzi 2011), (Zhu 2008), (Luo et al., 2009)

From the findings mentioned above, it can also be added that as the level of collaboration is shifting from small and medium size to large scale, thus the structures should be respectively reconfigured. Additionally, if a community in mass collaborative projects intends to acquire more knowledge, not only its organizational structure needs to be adequately dynamic, but also its members' position in the network should be well matched with the organizational perspective. Nevertheless, in this context there are some important issues that remain unaddressed, including:

- As MC is a form of decentralized and self-directed action, how and by whom should its structure be defined, designed, developed, and coordinated?
- How can all participants be well prepared for a defined task that needs to be accomplished?

- How can participants with similar abilities work effectively together on specialized tasks (differentiation by specialization)?
- Whether some recommended structures like, Holacracy (the community becomes a hierarchy of self-directed and self-organized teams, governed by a constitution) (Robertson 2007), or Flatter (unlike the traditional hierarchy, a flatter structure opens the lines of communication and collaboration, and there is no job titles, seniority, managers, or executives) (Anne 2011) can be suitable alternatives for MCL projects or not?

2.3.2 Methods and Mechanisms in Collaborative Learning

Collaborative learning, in a broad sense, is an educational approach for learning and teaching in which learners create a group (two or more people) working together by face-to-face conversation or over the Internet, with the purpose of solving a problem, completing a project, creating something new, and/or maximizing their own and each other's learning. Various Collaborative Learning Techniques (CoLTs) have been developed to support this process. These techniques can provide good directions for improving the quality of teaching and learning. Furthermore, they can deliver helpful guidelines to teachers and learners for being more productive. Each of these techniques is designed for adoption in a different educational context (Barkley et al., 2004).

These techniques have succeeded to provide a number of social and psychological benefits, for example, having more positive attitudes toward ourselves, our group, and collective learning; being exposed to different viewpoints; learning how to collaborate in group; and how to enhance group productivity, to name a few (Johnson, et al., 1981). From a cognitive perspective also, these techniques can ensure knowledge is jointly built, not just shared (Lee et al., 2016). Literature has documented ample positive yield regarding to effectiveness of CoLTs that could for example, turn learners into critical thinkers and reflective learners, and boost learners' capability in decision-making and problem-solving (Hwang 2008).

2.3.2.1 Collaborative Learning Techniques and Mass Collaboration

The conditions for applying CoLTs in general collective learning are relatively distinguished from MCL due to some specific characteristics. For instance, group size (the prominent feature of MC) shifts from small or medium to a large number of learners; learning shifts from knowledge acquisition (at individual level) to knowledge building (at group level); communication and collaboration for distributed learners could be facilitated by applying digital technologies; the co-created product in a MCL project is jointly produced in the form

of a virtual artifact. Lastly, community satisfaction is the ultimate aim of learners' participation instead of just being satisfied personally (Cress et al., 2016).

In recent years, several research works have studied and reviewed the contexts in which MCL can take place (e.g., Wikipedia (Halatchliyski et al., 2014), Innovative Socio-Technical environments (Fischer 2016), MOOCs (Cress et al., 2016), Yahoo answer (Doan et al., 2010), etc.). Different aspects are also evaluated (e.g., the role of learners and the way of organizing them in MC process (Cress et al. 2016), qualifying and measuring the learning output (Sancho 2016), and the role of collaborative methods (Cress et al., 2016), etc.). However, very few researchers thus far have studied and reported the role of CoLTs in MCL projects. Neither a comprehensive list of adopted CoLTs in this context has been presented. Therefore, so far not enough evidence elements for this purpose are in the literature to clarify what kinds of techniques are exactly required and how they can support learners effectively in mass collaborative projects.

Despite such limitations, in order to identify the most promising techniques for the purpose of learning in MC, the taxonomy recommended in (Barkley et al., 2004) is selected (as one of the most fit taxonomies with the nature of MCL). This taxonomy encompasses 5 main categories of general learning activities namely, (1) discussion, (2) reciprocal teaching, (3) problem solving, (4) graphical information organizing, and (5) collaborative writing. Each category can be used for different purposes, and it includes a set of techniques. Each technique is defined for a specific group size and period, and amount of time to be devoted to the task. To understand better the concepts, categories and techniques, some short descriptions are presented in Table 2.7.

Table 2.7. Collaborative learning techniques and their partial descriptions (Barkley et al., 2004).

Categories and their techniques	Some descriptions
Techniques for discussions (By these techniques learners can share their viewpoints and respond others' ideas).	
Think-Pair-Share/ Write-Pair-Share	Learners before sharing their ideas with the entire community, first think individually and look for a partner's opinion about them.
Round Robin	Generated ideas move from one learner to the next.
Buzz Groups	In a small group, learners informally discuss about the topic.
Talking Chips	It provides equal participation in discussion for all members.
Three-Step Interview	In a question-and-answer session one member is the interviewer and another is the interviewee, and at the end they give a report from what they learnt.
Paired Annotations	In order to deliver a summary of an ongoing task, members prepare a composite annotation.
Critical Debates	Members argue about an issue in favor or opposite of their personal views.
Techniques for reciprocal teaching	

(Members by means of four skills namely, Questioning, Clarifying, Summarizing, and Predicting, help promoting others' reading comprehension).	
Note-Taking Pairs	Members work collectively to improve their individual notes.
Learning Cell	Members by creating question and answer activities try to develop their learning.
Fishbowl	Members seated inside the "fishbowl" have participatory discussion, while those sitting around observe without interpreting.
Role Play	Members act out the role of different identities and represent in action.
Jigsaw	For a given topic, members first develop knowledge and then share it with others.
Test-Taking Teams	Members first take an individual test, and then retake it in their community.
Techniques for problem solving (Members help each other to solve problems).	
Think-Aloud Pair Problem Solving	Members try to solve problems aloud in order to help analytical reasoning skills.
Send-A-Problem	Problems and respective solutions are passed among groups to find a final solution.
Case Study	Members try to develop a solution for a real-world scenario.
Structured Problem Solving	In order to solve a problem, members try to follow a structured format.
Analytic Teams	Members evaluate a specific task with critical points of view.
Group Problem Solving/Investigation	Members in community make plan, conduct, and report on projects.
Techniques using graphic information organizers (In order to organize and present information, members use visual tools).	
Affinity Grouping	Generating ideas, organizing them, and identifying common themes by group.
Group Grid	Members are asked to put given information into the blank cell of a grid.
Team Matrix	Members distinguish between similar concepts by considering defining features.
Sequence Chains	Series of actions will be depicted and analyzed graphically.
Word Webs	The relationships of generated ideas are graphically organized by lines or arrows.
Techniques for collaborative on writing (Members through group collaboration help to learn important course contents).	
Dialogue Journals	In a journal, members record their thoughts and share them with others for comments.
Round Table	Members try to respond questions in turn, before passing to others.
Dyadic Essays	The developed questions and answers for an essay are compared with a model answer.
Peer Editing	For a piece of writing a critical review and editorial feedback are provided.
Collaborative Writing	Members try to write a formal paper collaboratively.
Team Anthologies	Compile course-related readings with members and annotations.
Paper Seminar	Participate in writing a paper, engaging in discussion, and receiving feedbacks.

Among the collected papers only 23 explicitly mention CoLTs. In this group, techniques for discussion are the most applied (43.44%) and within this category, paired annotation techniques are the most used (21.73%). In contrast, techniques for reciprocal teaching received the least attention (8.69%). Techniques that focus on collaborative on writing are the second most applied (21.82%). Techniques for problem solving and techniques that use graphical information organizers received (almost) equal attention (13.03%) by those papers. More details about the type and percentage of applied techniques are shown in Figure 2.3.

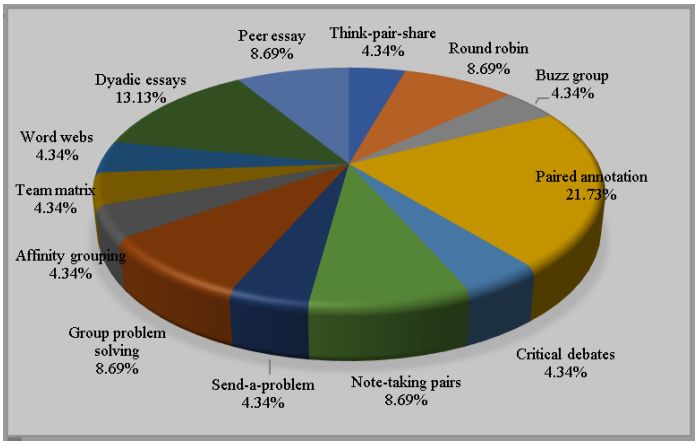


Figure 2.3. Type and percentage of adopted collaborative learning techniques in collected papers.

Table 2.8 addresses some examples of adopted CoLTs and corresponding references.

Table 2.8. Examples of adopted collaborative learning techniques and corresponding references.

Think-pair-share	(Cheng et al., 2016)
Round robin	(Cress et al., 2016), (Shen et al., 2012)
Buzz group	(Pombo et al., 2010)
Paired annotation	(Cress et al., 2016), (Daxenberger 2016), (De Liddo et al., 2012), (Rodriguez et al., 2010), (Gao 2013)
Critical debates	(DeLiddo & Shum 2013)
Note-taking pairs	(Grigore & Rosenkranz 2011), (Wang et al., 2015)
Send-a-problem	(Nerantzi 2013)
Group problem solving	(Heylighen 1999), (Mason & Watts 2012)
Affinity grouping	(Görs et al., 2012)
Team matrix	(Wang et al., 2011)
Word webs	(Nickel et al., 2011)
Dyadic essays	(Aritajati & Narayanan 2013), (Oh et al., 2011), (Li et al., 2012)
Peer editing	(Daxenberger 2016), (Caspi & Blau 2011)

From the performed analysis it can be also concluded that:

- Although the categories and techniques mentioned above are developed for the purpose of collaborative learning in general, some of them, e.g., peer editing, paired annotation, group problem solving, etc., (according to Table 2.3,) have potential features to be used in MCL projects. On the other hand, techniques such as dialogue journal and tree-step are not able to serve this purpose.
- Techniques for discussions seem to be relatively convenient for learning in mass collaborative projects.
- Techniques for reciprocal teaching (except note-taking pairs) do not seem to have as much application as techniques for discussion in MCL projects.

There are also some open issues in this context that need further investigation and contribution, for example:

- What are the ways in which CoLTs can be effectively adopted to leverage MCL?

- How often and how much can CoLTs help in MCL?
- How can CoLTs unify various analytical issues and make them easily accessible for learners in MC? etc.

2.3.3 Adopted Technologies in Mass Collaborative Learning

Over the years, various research works (Chan et al. 2006) from different fields of study have addressed the importance of utilizing supportive tools in collaborative learning namely, computer-assisted instruction, educational computing, educational technology, virtual learning, distributed learning, synchronous and asynchronous learning, and Computer Supported Collaborative Learning (CSCL), etc. In recent years, considerable effort has been made to incorporate emerging tools into collaborative learning. Some researchers, for example, pointed out the importance of using blogs in developing collaboration among students (Du et al., 2013). Another study advocates the plausibility of applying Wiki tools in learning improvement (Zaffar & Ghazawneh 2012). However, (Wang & Tunzelmann, 2000) also argued that "when an organization's technological knowledge is deep, collaboration may be discouraged, due to the greater risks of knowledge being disclosed and the lower chances of benefiting from learning from partners".

2.3.3.1 Supportive Tools and Technologies Used in Mass Collaboration and Learning

New digital tools have a significant facilitator role to play when involving hundreds of thousands of learners from around the world who are geographically, temporally, and conceptually dispersed but want to learn. The advantages of these tools are undeniable as for instance, they can empower countless learners to access educational resources anytime and anywhere, equip them for easy communication with other peers, provide opportunities for all who are eager to exchange their knowledge and experiences, etc. (Tapscott. & Williams 2008). Literature also shows that tools such as CSCL (Cress et al., 2016), social media (Wolf et al., 2012) along with Internet (Shen et al. 2012) are about deriving value from collective efforts, and thus can be conveniently adopted for collaborative learning in large scale. For such level of learning, which is intrinsically linked to social interaction, digital tools are a must (Cress et al., 2016). Table 2.9 includes some examples of supportive tools in MC.

Table 2.9. Some examples of supportive tools and technologies in mass collaboration.

Some evaluated aspects	Sources
Internet-based mass collaboration	(Bernardo 2007)
Open-Source Software and mass collaboration	(Panchal & Fathianathan 2008)
Mass collaboration and Web 2.0 tools, such as wikis, weblogs, podcasts, folksonomies, file sharing and virtual online worlds	(Bernardo 2007), (Cress et al., 2016)
Mass collaboration and social media (e.g., Wiki, Blog, Twitter, LinkedIn, Facebook, YouTube)	(Bernardo 2007), (Azua 2010)
Mass learning and Synchronous Audio graphic web Conferencing (SAC)	(Neumann & Carrington 2007)

technology	

Even though various references in the literature address the importance and advantages of technology in support of collective learning, real applicable tools for MC are still evolving, and as such, their appropriateness for self-directed learning still needs to be verified. In order to gain better insight about potential tools for this purpose, the Project-Based Collaborative Learning Model (Deal 2009) was selected (as one of the most fit models with the nature of MCL) to compare it with adopted tools in collected papers. As its name implies, this model is a synthesis of project-based and collaborative learning approaches. Project-based encourages learners to engage in activity-investigation, problem-solving, decision-making, and artefact-designing. Collaborative learning involves groups of learners working effectively together to understand meanings, find solutions, complete a task, and achieve common goals. This model consists of seven distinct phases and allows classifying some important supportive tools under each phase (see Figure 2.4).

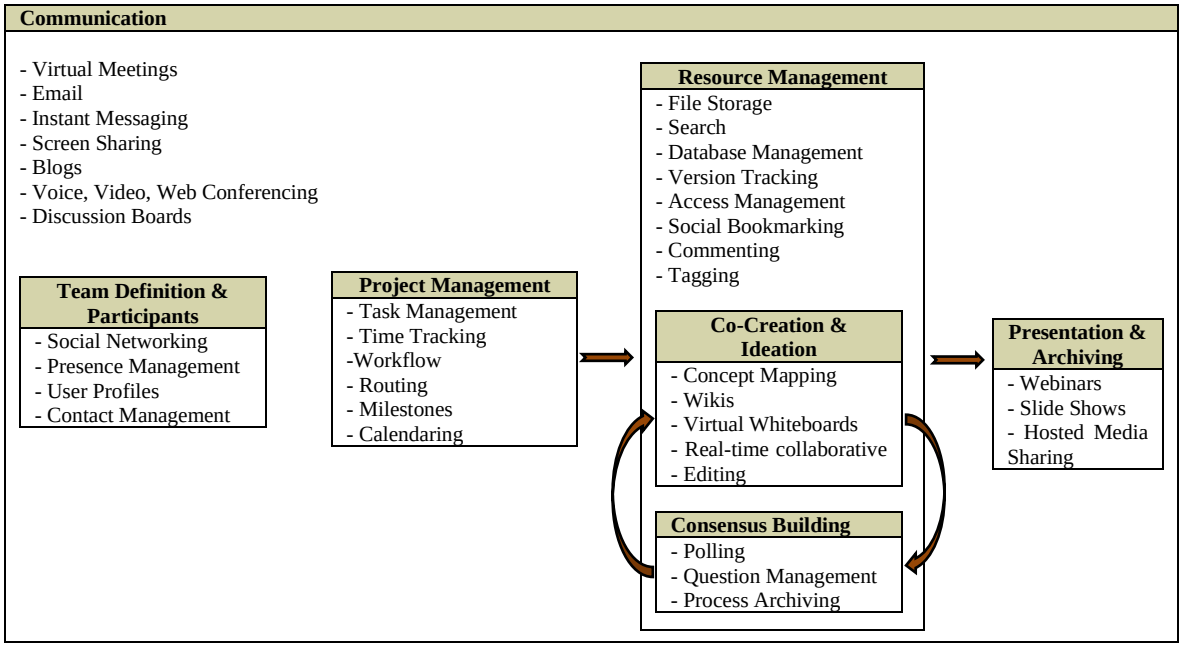


Figure 2.4. Project-Based Collaborative Learning Model, based on (Deal 2009).

As shown in this model, the process is divided into separate phases, and a sequence is defined among them in order to make the model easily understandable although it does not mean that the collaboration is basically a linear process. To facilitate the understanding of these phases, Table 2.10 presents some descriptions for each addressed phase.

Table 2.10. Some descriptions for proposed phases in Project-Based Collaborative Learning Model (Deal 2009).

Phases	Partial Descriptions
Communication	The entire project-based collaborative effort takes place in the context of communication. Majority of collaborative software are equipped to facilitate communication among participants.
Team definition and participants	In this phase tools enable members to find key players in the community and manage their participations in different tasks.
Project management	Logistical aspects of planning, scheduling, workflow, and task management are handled by tools in this phase.
Resource management	Common issues such as, accessing to a shared storage space for project files, and keeping up with multiple versions of the same document are addressed by tools in this phase.
Co-creation and ideation	Both direct interaction among members and building or editing project artefacts are facilitated by tools in this phase.
Consensus building	The proposed solutions by community members are refined through consensus-building tools.
Presentation and archiving	The presented outcomes to instructors, clients, or public are facilitated by tools in this phase.

Among the collected papers, 35 address the technological support for collaboration and learning. Communication and resource management phases attracted the most attention (31.41% and 28.54% respectively), whereas, both consensus building phase, and presentation and archiving phase are equally the lowest used (2.85%). Besides, 5.71% of the applied tools belong to both Team Definition & Participants phase and Project Management phase. Among all suggested tools, Wiki was the most applied (22.94%) that belongs to Co-Creation & Ideation phase. Figure 2.5 gives more details about the type and percentage of used tools in the collected papers.

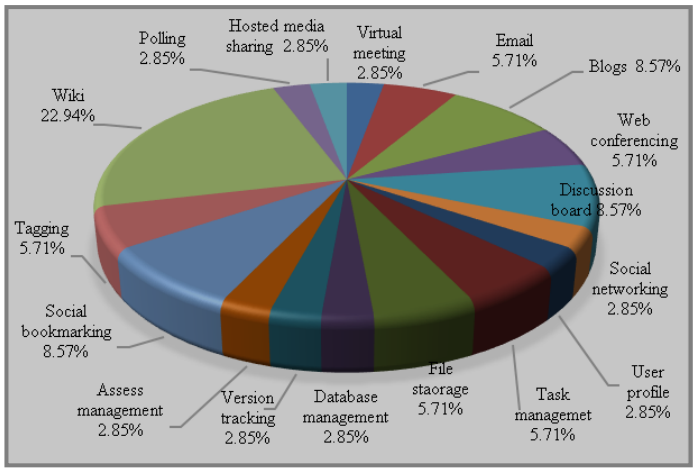


Figure 2.5. Types and percentages of adopted tools in the collected papers.

Table 2.11 lists some examples of adopted tools and their corresponding references.

Table 2.11. Examples of adopted tools and corresponding references.

Virtual meeting	(Du et al., 2013)
Email	(Doan et al., 2010), (Lloyd et al., 2016)
Blogs	(Du et al., 2013), (Zaffar & Ghazawneh 2012), (Espitia & Olarte 2011)
Web conferencing	(Lloyd et al., 2016), (Liu et al., 2012)
Discussion board	(Du et al., 2013), (Wolf et al., 2012), (Espitia & Olarte 2011)
Social networking	(Zaffar & Ghazawneh 2012)
User profiles	(Gholami & Safavi 2010)
Task management	(Doan et al., 2010), (Lloyd et al., 2016)
File storage	(Doan et al., 2010), (Du et al., 2013)
Database management	(Rogers et al., 2007)
Version tracking	(Rogers et al., 2007)
Access management	(Du et al., 2013)
Social bookmarking	(Du et al., 2013), (Gholami & Safavi 2010), (Gray & Smyth 2012)
Tagging	(Gholami & Safavi 2010), (Rogers et al., 2007)
Wiki	(Du et al., 2013), (Zaffar & Ghazawneh 2012), (Lloyd et al., 2016), (Gholami & Safavi 2010), (Hughes & Narayan 2009), (Jones 2010), (Bradley et al., 2010), (Tsai et al., 2011)
Polling	(Turban et al., 2011)
Hosted media sharing	(Zaffar & Ghazawneh 2012)

From the performed analysis it can also be concluded that:

- Resource management tools can provide professional opportunities for mass users to access, evaluate, use, and share their resources properly.
- Our evaluation shows that some suggested tools (e.g., Routing, Milestones, and Calendaring) are not as much used in mass collaborative projects as Wiki, Discussion board, and Blogs.

There are some issues in this context that have not been adequately covered, including:

- How to promote adoption and develop competence in designing technology-mediated mass collaborative projects?
- How can massive load of textual material be effectively processed by intelligent tools?
- How to deal with issues such as, privacy and security arisen from introducing new tools?
- How to provide needed information or training for those in the community who do not have enough technical information?
- Etc.

2.3.4 Evaluating Learners' Performance

In its simplest terms, evaluating performance needs learners to demonstrate that they have acquired specific knowledge, capabilities, and proficiencies by doing or creating something. The goal is to gauge the extent to which learners add value to the organization or community, and whether their achievement is below or above defined norms. Any standard evaluation

system is mainly based on a set of collected data, translated into a specific rating scale (Shaout & Yousif 2014).

Over recent decades, several authors have assessed collaborative processes from different points of view. A number of scholars have recommended diverse procedures (e.g., the use of behaviorally anchored scales, grading, benchmarking, self-efficacy, etc.) for evaluating individuals' performance in group projects (Zhu 2008). In this regard, various techniques for performance evaluation have been suggested such as, peer evaluation, 90 degree, 180 degree, 270 degree, balanced score card, mixed standard scale, human resource costing and accounting, forced distribution method, behavioral observation scale, paired comparison, mixed standard scale, electronic performance monitoring, confidential reports, etc. (DeNisi & Pritchard 2006), (Aggarwal et al., 2013). The importance of performance evaluation in an education and learning context has been receiving growing attention by researchers (Short 2012), (Wang et al., 2015), (Pallot et al., 2010). The relationship between performance and learning is quite tied, that is, without learning learners are not able to improve their performance, and on the other hand improvement in performance can yield significant learning (Zhu 2008).

2.3.4.1 Evaluating Learners' Performance in Mass Collaboration

So far very few research works have been conducted to specifically evaluate learners' performance in mass collaborative projects. Only a few papers we found that addressed the related topics. For instance, (Jehn & Bezroukova 2004) explores how the context of an organizational workgroup affects the relationship between group diversity and various performance outcomes. The work described in (Pallot et al., 2010) evaluates distance factors affecting the performance of distributed collaboration. In (DeNisi & Pritchard 2006) the authors present trust-based techniques with the aim of assisting instructors in performance appraisal in open and collaborative environments. Because of this scarcity of relevant literature, we first reviewed several proposed methods for performance evaluation in closely related areas, and then compared them with applied methods in the collected papers.

2.3.4.2 Performance Evaluation Methods

A number of methods for performance evaluation, and some concrete experiences have been reported which are appropriate for different situations and characteristics of an organization or community. Based on (Jafari et al., 2009) there are three performance evaluation categories: (1) absolute standards (compare learners' performance to a standard, and the evaluation is independent of others), (2) relative standards (compare learners' performance against others), and (3) objectives-based (learners are assessed on how well they fulfil a specific set of objectives). This taxonomy can be extended with three techniques (named "added methods")

borrowed from (Shaout & Yousif 2014), (Venclova et al., 2013), see Figure 2.6. In order to further clarify, a brief description for each method is presented in Table 2.12.

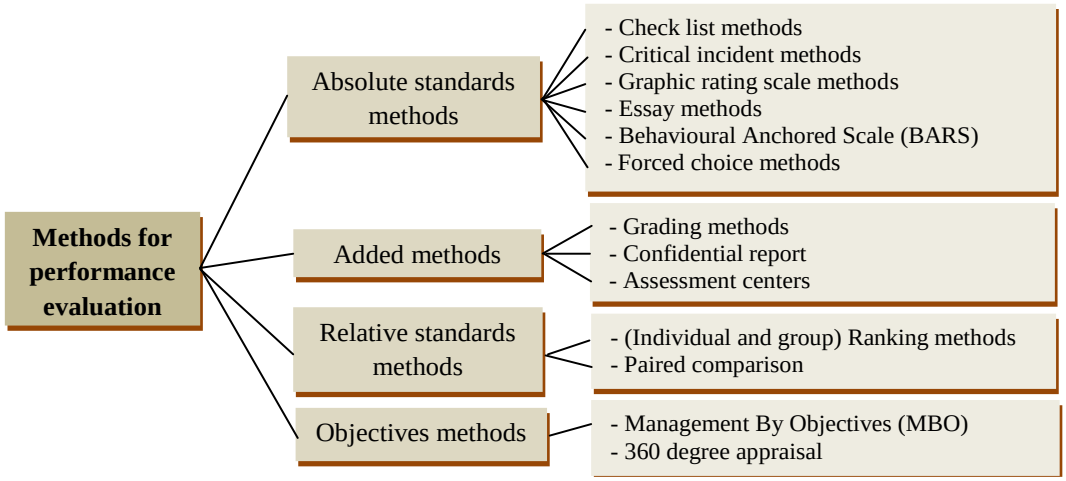


Figure 2.6. Methods for performance evaluation, based on (Šalková 2013).

Table 2.12. Some partial descriptions of performance evaluation methods (Shaout & Yousif 2014), (Venclova et al., 2013), (Šalková 2013).

Categories and methods	Descriptions
Absolute standards (Compare learners' performance to a standard, and the evaluation is independent of others).	
Check list methods	It provides a series of statements e.g., 'yes' or 'no' questions and their answers for ratter to mark right answers.
Critical incident methods	The focus of ratter is on behaviors that make difference between performing a task in a noteworthy manner.
Graphic rating scale methods	Influential behaviors on performance are listed and learners are rated based on them. The rates are helpful for quantifying the behaviors.
Essay methods	In order to improve learner's performance, a narrative description is written by the ratter about learner's status.
Behavioral Anchored Rating Scales (BARS)	"It combines the benefits of narratives, critical incidents, and quantified ratings by anchoring a quantified scale with specific behavioral examples of good or poor performance".
Forced choice methods	A learner is being evaluated and rated based on before written statements. One common method in this group involves positive and negative statements.
Added methods	
Grading methods	Outstanding, satisfactory, and unsatisfactory are three established categories of worth for evaluation.
Confidential report	A confidential report rates learner's performance with respect to items such as, teamwork, attendance, reasoning and technical abilities, etc.
Assessment centers	Methods such as, social or informal events, tests and exercises, are used to evaluate learners' performance for future responsibilities.
Relative standards (Compare learners' performance against others).	
Ranking methods	Ranks from the highest to the lowest are used for comparing learner with others.
Paired comparison	Based on one trait or one- on one basis, learner is compared with others.
Objectives (Learners are assessed on how well they fulfill a specific set of objectives).	
Management By Objectives	Learners are evaluated periodically based on defined objectives.
360 degree appraisal	Learners are evaluated by people working around them through confidential, anonymous feedback from.

Considering the collected papers, only 25 papers addressed methods of performance evaluation. The majority of these papers preferred to use absolute standards and relative standards in their study. These categories have the highest percentage of application (48%) and (32%) respectively among the suggested categories, while objective methods have the lowest degree (4%) of application. The usage of added methods with (16%) was half of the relative standards methods. Among all proposed methods, the ranking method was the most applied (24%). More details are illustrated in Figure 2.7.

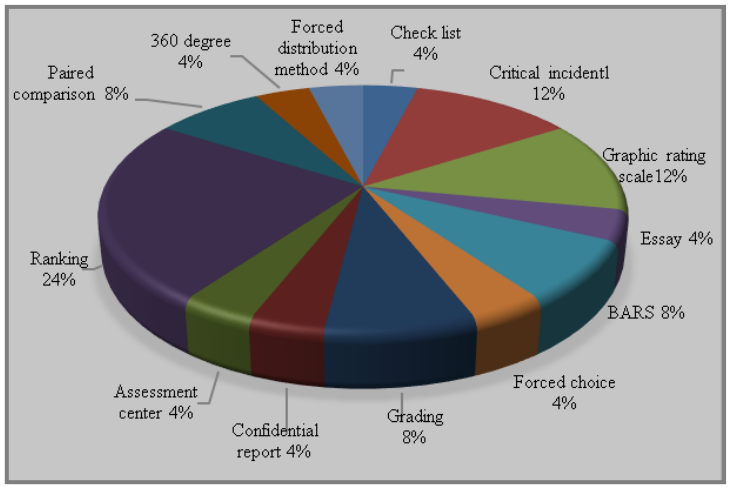


Figure 2.7. Types and percentages of applied methods for performance evaluation in the collected.

Table 2.13 lists some adopted methods and their corresponding references.

Table 2.13. Some adopted methods and corresponding references.

Check list	(Short 2012)
Critical incident	(Miguel et al., 2014), (Liu & Wu, 2010), (Schumann et al., 2012)
Graphic rating scale	(Sancho 2016), (Lambropoulos et al., 2011), (Rabbany et al., 2013)
Essay	(Alkhattabi et al., 2010)
BARS	(DeLiddo & Shum 2013), (Qi et al., 2013)
Forced choice	(Richardson & Domingos 2003)
Grading	(Blagojević & Milošević 2013), (Huang et al., 2013)
Confidential report	(Awal & Bharadwaj 2014)
Assessment center	(Riedl et al., 2010)
Ranking	(Wang et al., 2015), (Wolf et al., 2012), (Dondio & Longo 2011), (Duque et al., 2015), (Blohm et al., 2011), (Agichtein et al., 2008)
Paired comparison	(Aperjis et al., 2010), (Yu et al., 2010)
360 degree	(Nitti et al., 2012)
Forced distribution method	(Li et al., 2012)

From the performed analysis it can be concluded that:

- The focus of performance evaluation should be related to the learning objectives.

- For all learners, it is important to gain not only the sense of responsibility for their performance but also the sense of community learning that can help to see how their individual contributions could affect the way in which knowledge will flow.
- Developing a culture of openness to evaluation, and also a great deal of active engagement in this process is essential for all learners.
- Co-created and co-designed evaluation resulting from group agreement might be promising, especially when considering the community perspective.
- Access to the results of performance evaluation by all learners might provide a basis for improvement.

There are also several issues in this context that remain a challenge, such as:

- What foundations need to be built for incorporating performance evaluation into MC?
- When the learning activity takes the form of a large-scale project, by whom, when and how should performance evaluation be conducted?
- How can we ensure that the evaluation is objective enough, comprehensive, fair, and truly reflect the learner's performance and contribution at mass level?
- Etc.

2.3.5 Quality of Created Knowledge

Undoubtedly, it is vital in this new context to be able to evaluate how much accurate the acquired knowledge is, because knowledge is power and it serves as a basis for understanding the world, improving the society and economy, making choices and decisions, and solving problems more easily. A strong base of knowledge helps brains function more smoothly and effectively. Naturally, unreliable, or low-quality knowledge may lead to failure at individual and collective levels.

There are different meanings of the term quality. We judge quality by making comparisons, based on our own experiences, but defining it in terms that convey the same meaning to others can be difficult. There are a number of definitions in use, each of which is valid when used in a certain context. Quality may be defined as "fitness for use", "fitness for purpose", "conformance to requirements". Each of these statements represents a facet of quality. It is therefore the context that defines the meaning under which the term quality is used (Hoyle 2009). For example, (Hovland et al., 1953) states that knowledge quality refers to believability of knowledge and its source. In this study, we regarded quality as the reliability of knowledge, being reliability understood as a tendency to produce true knowledge.

Evaluating the quality of generated knowledge is a multidimensional challenge by its nature, and has turned into a central challenge in various fields of study, e.g., organization

management (Madnick et al., 2009), web information system (Naumann 2002), etc. Knowledge quality, however, remains a vaguely defined concept because of its abundance and variability (Poston et al., 2005). Although knowledge is an important resource, its effective use will depend, to a large extent, on its quality (Rao 2007). As such, research on knowledge quality should grow in scope and prominence. Various research works have been conducted from different perspectives to find practical ways for evaluating the quality of knowledge. For instance, regarding the reliability of online contents (e.g., knowledge), a number of questions can provide some guidelines for this evaluation:

1) *Who* is the author or publisher (individual or organization)?
   - Has the author or publisher high expertise with good qualifications and reputation?
   - Can they be contacted for discussion or clarification?
2) *What* can be said about the structure, style, context, content, and completeness of the knowledge that is provided by the author?
   - What is implied by the content?
   - Are there any evidence that support it?
3) *When* was the knowledge published?
   - Is it up to date?
   - Is a publication and expiration date provided?
4) *Where* else can the provided knowledge be found?
   - Is the knowledge authentic?
   - Is the piece of knowledge original or was it copied?
5) *Why* was the provided knowledge published?
   - What are the biases, assumptions, perspectives, and opinions of the author?
   - Who are the intended audiences for the published knowledge?

Furthermore, (Todoran et al., 2013) introduces two different ways of quality evaluation (local and global measuring) as a part of the information fusion system. (Meola 2004) offers a contextual model of web site evaluation (that focuses on information external to a particular site). (Metzger 2007) recommends a checklist model that focuses on assessing the internal characteristics of web sites (e.g., author identification, checking last update, etc.)

The literature shows that many researchers, e.g., (Fritch & Cromwell, 2001), (Meola 2004), (Alexander & Tate 2000), (Kapoun 1998) do concur that for evaluating the quality of generated knowledge, learners need to critically take into account some classic criteria that are listed in Table 2.14. For each addressed criteria there are some considerations that need to be taken into account. As an example, and for clarification, a number of such considerations are presented in Table 2.14.

Table 2.14. Some classic criteria for evaluating the created knowledge.

Criteria	Consideration
Authority	Is the author credible enough? Is he/she well-known?
Accuracy	Is the knowledge free from errors, and can it be verified?
Accessibility	Is the knowledge easily retrievable?
Currency	Is knowledge up to date?
Coverage	Is the knowledge comprehensive and depth enough for respective audience?
Relevance	Is the knowledge respected to your need (your topic or answer of question)?
Purpose	What is knowledge served for? (Teaching, informing, selling, entertaining)
Objectivity/ Point of view or bias	Are all perspectives presented in an unbiased manner and balanced viewpoint? Are opinions separated from facts?
Soundness	Is the created knowledge reasonable for the intended application?
Applicability and utility	Is the created knowledge suitable for the intended learner?
Clarity and completeness	To what extent the created knowledge is clear and complete?
Uncertainty and variability	To what extent the created knowledge is certain and variable?
Safety	Are the privacy policies and data protection procedures presented?
References	Are the qualifications of the owner, reference or reviewer addressed?
Policy	Which policy the knowledge is following up? (Advertising, political, etc.)
Technical criteria (e.g., links, navigation, proper operation)	Is the knowledge created in the structured way?

2.3.5.1 Evaluating the Quality of Knowledge in Mass Collaboration

There is a well-developed body of research (Meola 2004), (Todoran et al., 2013) on evaluating various aspects of knowledge (and even information and data) in different contexts (e.g., management science, medicine, multimedia, information systems engineering) and different businesses (e.g., health care, manufacturing). However, for MC in particular we could not find any substantial study that provides a comprehensive list of recommended methods that can be broadly used for evaluating the quality of created knowledge. Moreover, no systematic study in this context seems to have been already carried out to address this important issue. Perhaps the exception is Wikipedia, a prominent example of MC, from which we can gain some insight that might be used for guiding other mass collaborative cases. A number of research works appraised the quality of shared materials (e.g., knowledge) in Wikipedia from different points of view. For instance, (Lih 2004) assesses Wikipedia content construction and qualification from the perspective of participatory journalism. (Viégas et al., 2004) recommends a technology called "history flow" to visualize Wikipedia content appraisal by means of article version histories. (Wöhner & Peters 2009) appraises the quality of Wikipedia articles with lifecycle-based metrics (based on tracking the changes in the editing intensity throughout the entire existence of an article).

There are at least 3 types of processes for quality checking in Wikipedia, including:

1. The process of evaluating the quality of an article by direct actions like, modifying, changing, or deleting the status,

2. The process of Wikipedia editor's performance evaluation and selection of quality assurance agents, and
3. The process of creating and maintaining the work coordination artefacts of Wikipedia.

Besides, to assess the quality of featured articles in Wikipedia, eight major criteria need to be considered namely, (1) accuracy, (2) comprehensiveness, (3) stability, (4) well written, (5) uncontroversial, (6) compliance with standards of Wikipedia, (7) having appropriate style, and (8) having appropriate images. In addition to them, some popular methods (e.g., nominating featured article, peer review, feedback, and reputation mechanism) are also considered by Wikipedia community (Stvilia et al., 2008). In order to compare these criteria and methods considered in Wikipedia with those proposed in collected papers, we summarized them in Table 2.15 along with brief explanations and respective references.

Table 2.15. Suggested methods in collected papers for evaluating the quality of knowledge.

Suggested methods	Explanations	Sources
- Credit assignment - Machine learning - User feedback - Experts statements	- Using web of trust - Automatically propose to contributors for refining their entries	Richardson & Domingos, 2003
- Initialization - Ganging user weights - User feedback	- Manually specify the correct topics from the title - Each user measures the quality of his or her feedback	McCann et al., 2003
- Type of contributor activity - Number of anonymous contributors - Top contributor experience	- The type of contributor activity spent shaping an article for general consumption - It shows the level of social presence (the degree to which contributors establish personal connections in a communication setting) - They often exert considerable influence over collaboration in online communities	Kane, 2011
- User feedback - Ranking method - Expert valuation	- By comments and ratings - Measure both the value and transaction volume of knowledge	Bothos et al., 2009
- CI model (lay citizens and traditional experts)	- It relies on contributions, administration, reviewing and consensus from both lay citizens and traditional experts	Lichtenstein & Parker, 2009
- Structure of groups	- Systems should be designed in the way to foster conditions for producing CI	Spielman, 2014
- Content facilitation - Process facilitation	- Direct intervention in the content to improve the quality of contribution - Procedural intervention by facilitator in structuring of group processes	Bothos et al., 2012
- Argumentation - Consensus - Selection - Expert evaluation	- Submit arguments in support or oppose the topic - Drive a community towards a consensus - All knowledge is ranked from best to worst based on the consensus	Maleewong et al., 2008
- Reputation - Peer review - User feedback	- Editors who previously established records of valuable contributions	Stvilia et al., 2008
- Group observation		Qi et al., 2013

Taking into account Table 2.15 and the collected papers it can also be concluded that:

- User feedback and expert evaluation were the most suggested methods for evaluation.
- Top contributors (e.g., community managers, leaders) are also important, as they could bring their rich experiences to improve the process of evaluation.
- Evaluation seems to be more effective when built on a combination of machine learning and human work. In fact, when addressing large volumes of contributions, it is not practical to consider manual approaches.
- When the results of evaluation are published for all learners, it could be helpful not only for error detection but also for error correction.
- There is a pressing need for learners to be well trained for taking the advantages of knowledge evaluation.

From our analysis, the evaluation of the quality of knowledge in MC contexts is still at its embryonic stage. Therefore, various issues remain unaddressed, for example:

- While countless content is disseminated through the Internet and social media from different sources (while little is known about most of them) how can we determine the quality of created and shared knowledge that might be readily altered, misrepresented, plagiarized, or built up anonymously under false claim?
- How can communities gain a common sense for perceiving the expectations of evaluation?
- How can we motivate learners to contribute to the evaluation process?
- How to entice learner to give feedback? And what kinds of feedback should be solicited? And how can we combine collected feedback?
- How can participants formulate and distribute the data from evaluation?
- Etc.

Given the above-mentioned concerning issues and open questions, in this work the focus is put to a great degree on the:

- Type of the organizational and behavioral structures and their main components that can be potentially applied to MCL communities,
- Type of CoLTs that can support MCL communities,
- Type of technologies that can support MCL communities, and
- Type of assessment method and indicators that can be potentially used for MCL communities.

3

META-GOVERNANCE FRAMEWORK FOR MASS COLLABORATIVE LEARNING COMMUNITIES

The main contributions of this thesis work and the proposed solutions for the identified research questions are presented in this chapter. The proposed solutions are integrated in a Meta-Governance framework to represent an interconnected, unified, and consistent scheme that can be potentially used by MCL communities. Thus, an overall picture of the Meta-Governance framework is first introduced, followed by the detailed information about the various parts of the framework (solutions). Discussed solutions include (a) an organizational and governance model for MCL, (b) a conceptual model that addresses the main concepts and components of organizational structures of a MCL community, and (c) an appraisal method for assessing the reliability of knowledge or information in a MCL community.

3.1 Meta-Governance Framework

Even though MCL communities have been increasingly used for a range of public benefits, still little is known about, for instance, what are the major factors and variables that constitute their governance, how they interact internally and externally, and how they are affected by influential factors. In the context of a complex system like MCL (with an increasingly growing environment), its organizational, behavioral, and governance structure can be viewed from different perspectives. Additionally, the principles, processes, procedures, elements, and rules associated to such structures can also be defined in diverse ways. To streamline the identification of the associated elements, it is better to look at the governance structure holistically as a system of interdependent but harmonious elements.

Additionally, it is necessary to raise the importance of a comprehensive organizational and governance framework for MCL that provides a clear understanding and oversight about the (a) management and organization of the MCL community, (b) main components, features,

and procedures of MCL, and (c) mechanism by which we can minimize the discrimination caused by low-quality or unreliable materials. In that account, the MGF-MCL is proposed, aiming at driving and supporting the implementation, operation, and management of such communities.

In this work, the MGF-MCL is considered as a comprehensive, organized, and specified structure, containing the fundamental elements that can drive and support MCL communities in different ways. The proposed MGF-MCL is a generic and conceptual structure intended to highlight the main concepts, factors, and connections associated with MCL communities. The MGF-MCL consolidates the integration of ideas from different governance styles (e.g., participatory or democratic governance, corporate governance, and network governance), organizational models (e.g., non-hierarchical, networked), and assessment methods (e.g., content assessment), addressing all the considered points in the thesis' hypotheses under a single envelop. The MGF-MCL intends to introduce a structure (with mixed dimensions) that can serve as a guide for supporting the creation, operation, and implementation of MCL communities. For example, there should be a set of processes, functions, and activities (e.g., assessments, social participation, interactions) in each MCL community that should be properly carried out to meet and accomplish the goals of the community. Hereupon, the MGF-MCL could portrait, guide, and streamline such particular works. The MGF-MCL and its containing elements and features are defined to be used at a mass scale. However, the framework can be used for learning communities of any size. The fact is that since MGF-MCL is a dynamic framework, so it should be then adapted according to the objectives, requirements, and conditions of each concrete case. Considering the thesis' hypotheses, the proposed MGF- MCL framework includes three main associated parts:

A. *Structure Part*: which refers to the type of structures that can be used for building, arranging, and organizing the MCL community. It comprises two types of structure:
   - Organizational Structure: outlining how certain activities are delegated toward achieving the goals of the MCL community.
   - Behavioral structure: identifying the behavioral patterns and the culture of the MCL community.

   This part covers the first hypothesis (stream II) and the second hypothesis of thesis.

B. *Component Part:* which addresses the main internal and external components of the MCL community:
   - Internal components: focusing on the identification of the main elements that can together describe the internal environment of the MCL community.

- External components: focusing on the interaction of the MCL community with its external environment.

This part covers the first thesis' hypothesis (stream I).

C. *Assessment Part:* which emphasizes the importance of community evaluation and thus provides a picture of community changes, both positive and negative. It consists of three assessment mechanisms:
   - Learning assessment indicators: to address the main indicators that reflect the individual's learning.
   - Performance assessment indicators: to highlight the main indicators to assess the community's performance.
   - Assessment of the quality of contents: identifying the potential methods to assess the quality of the content shared among individuals within the community.

This part covers both the first hypothesis (stream III) and the third hypothesis of thesis.

It should be added that these three parts of the framework not only are not separable in reality but also have different levels of support, interaction, overlap, and synergy that lead to strengthening the framework and increasing its potential value. As shown in Figure 3.1, the main objectives of the Meta-Governance framework (derived from the goals of thesis) are first addressed. Fulfillment of the objectives can help in achieving the added value for the MCL community. The framework is developed in two main parts:

- *Part 1* (organizational) – identifying the principal components for supporting the implementation, operation, and development of MCL communities. This part focuses on three main tasks:
  - Identifying the potential organizational and behavioral models, aiming at clarifying the community scaffold, scope, authority, and human resources.
  - Identifying the main internal and external elements to raise awareness of the related concepts, environments, entities, relationships, and interactions.
  - Identifying the potential assessment indicators and methods toward gathering relevant information about the positive and negative changes in the community such as individual's learning progress, community performance, and distribution of low-quality materials within the community.

Part 2 (governance) – evaluating the identified/proposed components (in the organizational part) against the requirements, conditions, and objectives of a target MCL community. It means that when the Meta-Governance framework is adjusted for application to a specific MCL community, it then needs to be evaluated to ensure that it can meet the expectation and objectives of that community. The evaluation process proceeds in three main phases namely, evaluation of the adequacy, feasibility, and effectiveness of the organizational

part. This process can help to appropriately measure the applicability of the framework for the target community. The process of evaluation can be taken over either by internal members of the community, or outsourced, even mixed. Depending on community strategies, various methods can be used for evaluation such as the Delphi method. This part is presented in Section 4.

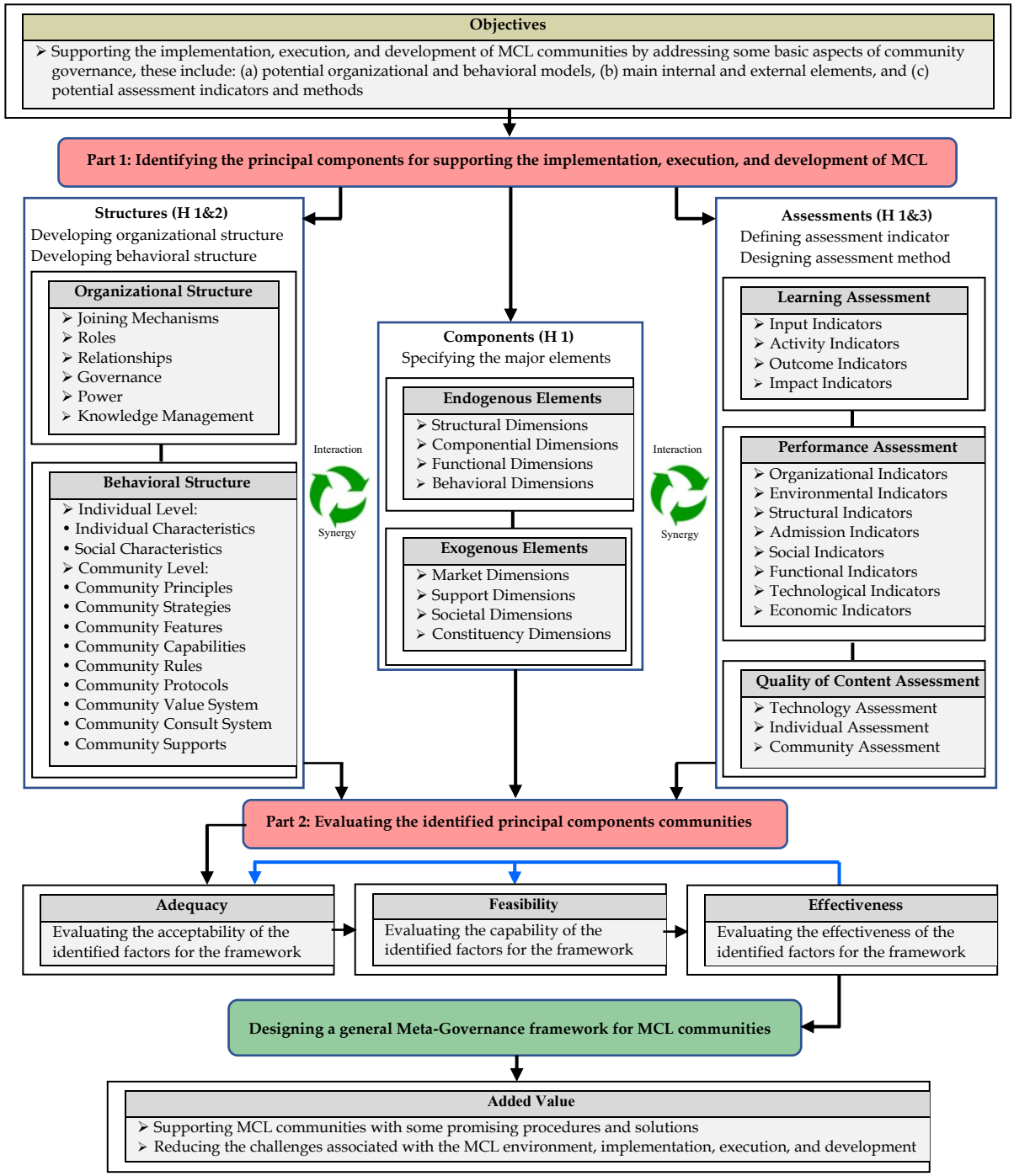


Figure 3.1. Meta-Governance framework for MCL communities.

In Table 3.1, a brief description is provided for the terms addressed in Figure 3.1.

Table 3.1. Brief description for the terms addressed in MGF-MCL.

Terms	Descriptions
Organizational Structure	
Joining Mechanisms	The methods and processes to be taken by participants for joining to the MCL community
Roles	The defined positions to be taken by the participants in the MCL community
Relationships	The ways in which the participants are connected in the MCL community
Governance	The system by which the MCL community will be controlled
Power	The ability to manipulate or control the activities of others in the MCL community
Knowledge Management	The collection of methods relating to creating, sharing, using, and managing the knowledge and information of MCL community
Behavioral Structure	
Individual Characteristics	Refers to specific attributes of participants in MCL community
Social Characteristics	Refers to social, cultural, religious, and other features of participants in MCL community
Community Principles	Refers to general and basic values of MCL community that guide its behavior or evaluation
Community Strategies	Refers to general plan to achieve one or more long-term or overall goals of MCL community
Community Features	Refers to distinctive attribute or aspect of MCL community
Community Capabilities	Refers to quality, power, or ability of MCL community to do something
Community Rules	Refers to prescribed guide for conducting or performing something in the MCL community
Community Protocols	Refers to a set of rules for formatting and processing something in the MCL community
Community Value System	Refers to the system of established values, norms, or goals existing in the MCL community
Community Consult System	Refers to information and communications technology system used by the consultant in performing the consultancy services within the MCL community
Community Supports	Refers to various types of help that the MCL community provides
Endogenous Elements	
Structural Dimensions	Refers to participants in the network, and their relationships and roles
Componential Dimensions	Refers to all tangible resources and intangible resources of the network
Functional Dimensions	Refers to all those functions, operations, and processes that are related to the network
Behavioral Dimensions	Refers to the principles, policies, and rules that drive the behavior of the network
Exogenous Elements	
Market Dimensions	Refers to issues that are related to interactions between the network and its clients, competitors, and potential partners
Support Dimensions	Refers to interactions with the support services that are provided by third-party entities outside the network
Societal Dimensions	Refers to general interactions between the network and the society
Constituency Dimensions	Refers to interactions between the network and its new participants
Learning Assessment	
Input Indicators	Refers to resources and contributions necessary to implement the learning program
Activity Indicators	Refers to activities or present progress of learning program
Outcome Indicators	Refers to expected results or delivered materials by the learning program
Impact Indicators	Refers to tangible and measurable pieces of change that the learning program create
Performance Assessment	
Organizational Indicators	Show how MCL community sets up and achieve its goals
Environmental Indicators	Show the forces or institutions surrounding of MCL community

Structural Indicators	Show the arrangement of and relations between the parts or elements of MCL community
Admission Indicators	Show the process or fact of entering or being allowed to enter t MCL community
Social Indicators	Show the companionship and interactions within the MCL community
Functional Indicators	Show how the things work or operate in MCL community
Technological Indicators	Show the sum of any techniques, skills, methods, and processes used in the MCL community
Economic Indicators	Show how MCL community creates, spends, or wastes money
Quality of Content Assessment	
Technology Assessment	Refers to the contribution of potential tools in content assessment
Individual Assessment	Refers to content assessment at individual level
Community Assessment	Refers to content assessment at community level

In the following subsections, different parts of the framework (solutions) are separately presented.

3.1.1 Organizational Structure for Mass Collaborative Learning

There are several factors that differentiate small organizations and communities made of large entities, such as the type of organizational structure. An organizational structure determines how power, roles, and duties can be defined, controlled, and coordinated toward reaching community goals. The organizational structure acts as an "instruction" for decision makers to more easily assign plans, strategies, and decisions which are useful for their group (Morten 2003). The organizational structure also specifies the way in which knowledge, information, or data flow across different layers of the organization. Small or large, every organization or community (even if self-organizing) needs a structure in order to survive, take actions, and grow. An appropriate organizational structure is an advantage for the organization or community as it, for example, assists better identifying responsibilities and roles, utilizing and controlling resources, binding group members and pointing them common goals, facilitating decision making processes, making easier communication, etc. (Latif et al., 2012).

Basically, the goals and strategies of the organization or community, and the type of members' or customers' needs are the main determinants for selecting a structure. The type of organizational structure implicitly indicates in which ways internal works can be carried out. The organizational structure has profound impact on collaborative networks, and largely constrains the level of autonomy and collaboration with and amongst the members. Evidence shows that as the organizations and communities are more and more evolving from small and medium size to large scale collectives, and from non-computerized to a digital-based model, there is a need for structural adaptability. That is, shifting away from traditional structures (e.g., hierarchical, centralized, etc.) towards unconventional models (e.g., informal, self-directed, etc.).

In the past, the structures of organizations or communities were mostly designed for effectiveness and efficiency although they are nowadays designed for agility, speed, and adaptability to be able to compete and win in today's global competitive environments. As organizations or communities are becoming more and more digital-based and there is a transformation towards performing projects collaboratively, they are forced to redesign their structures which in turn enable them to learn more rapidly, respond to demands properly, and adapt to the characteristics of new workforces and workplaces. While the business environment, customer needs, technology capabilities and the nature of work in organizations and communities are likely to change, the organizational structure needs to reshape as well in a deliberate and strategic way. As such, the design of structures for adaptability is a shift away from traditional organizational structures like the hierarchical, centralized and bureaucratic models, towards unconventional models where projects are fulfilled collectively by network participants.

Although there are vast amounts of literature on organizational structures, there is very little work trying to specifically evaluate the role of organizational structures in large size networked collaborative learning like MCL. Furthermore, there are no clear evidence in the literature that show how mass collaborative projects can define, design, implement, and develop appropriate structures. Therefore, gaining some insight on what kinds of organizational structures have more chances for being adopted in MCL projects is the foremost motivation for investigation around this topic.

In order to gain an understanding of the organizational structure of MC, and propose an appropriate structure for MCL projects, 15 relevant examples of MC in different domains (addressed in Table 2.4) were selected from the literature including, Wikipedia, Digg, Yahoo! Answer, SETI@home, Scratch, Galaxyzoo, Foldit, Applications of the Delphi method, Climate Colab, DonationCoder, Experts Exchange, Waze, Makerspaces, and SAP community network.

In Table 3.2 and Table 3.3, the organizational structure, and main characteristics of two of the above-mentioned examples are summarized as an instance.

Table 3.2. Organizational Structure of Wikipedia.

What is Wikipedia? it is a web-based, free and open content encyclopedia based on a model of openly editable content - a wiki. As a general reference, it has been the most popular on the World Wide Web. It is written collaboratively by the people that use it. Many people from around the world are willingly contributing to Wikipedia development.

Wikipedia Organizational Structure

Wikipedia Membership Method

- Wikipedia is open to public to use, read, write, edit, and make changes in articles.
  - People from any age group, gender, race, culture, and background can participate in.
- Wikipedia community includes all anonymous editors, supporters, current and potential readers.
- Wikipedian consist of two groups, those who create an identity, and those who communicate with other contributors.

Wikipedia Roles

Wikipedians (or editors) are the volunteer who write and edit Wikipedia's articles. Anyone can become a Wikipedian. They do a wide variety of tasks, being free to pick and complete their tasks anytime anywhere.
Wikipedians through collaboration and discussion can gain a sense of collective purpose and connectedness. While there are disagreements about an issue, a consensus can be reached through open and friendly discussion. While unresolved disputes or conflict arise, no matter the reason, it can be pursued in related talk page, either through comprehensive dispute resolution process of Wikipedia or, requesting comments from other Wikipedians.

No	Roles	Descriptions
1	Account creator	Gets access to a tool that allows trusted Wikipedians to create a high number of accounts for other people who request them.
2	Editor (from expert to casual reader)	A volunteer who writes and edits Wikipedia's articles.
3	Bureaucrat	Permitted to perform particular actions on Wikipedians' accounts.
4	Volunteer Response Team	Group of volunteers who answer most email sent to Wikipedia.
5	Event coordinator	For a short time, can add new created accounts to verified user groups, hence such accounts could write new articles.
6	Edit filter manager	Can make, change, enable, disable, and omit edit filters. Moreover, can check private filters and also their related logs.
7	Arbitration Committee	Handles those conflicts which remain unresolved while all the efforts in dispute resolution have failed.
8	Steward	Can give and revoke any authority to or from any Wikipedian on any wiki operated by the Foundation of Wikimedia that permits creating open account.
9	Oversight	Authorized to delete pages and revisions, and block function pages that it makes possible to hide logs or modify pages from any form of usual access by other Wikipedians.
10	CheckUser	Permitted to check the list of all IP addresses, the list of all edits, and all user accounts.
11	Administrator	A volunteer editor who is granted some technical authority to make particular decision and actions about blocking and unblocking user accounts and IP addresses; editing, modifying, and removing the protected pages, deleting and undeleting pages, protecting and unprotecting pages from editing; and etc.
12	Interface administrator	The only local user group who authorized to edit Cascading Style Sheets, JavaScript, and Javascript Object Notation pages.

Relationship Between Roles in Wikipedia

- The community of Wikipedia is divided into large number of “spheres” which categories members based on their area of interest, expertise, background, age, etc.
- The conversations and debates among members will be facilitated by means of Discussion Pages.
- There is possibility for members to nominate each other for awards of Wikipedia.
- Neither the quantity or frequency of contributions can be controlled, nor will members be fired.
- There are additional administrative responsibilities that can be taken to serve the community better.
- It has been attempted to Wikipedians be treated equally with no "power structure" although a hierarchy of positions and permissions is there (from simple editor to Jimmy Wales, the founder of Wikipedia).

Wikipedia Content Management

- Wikipedia is a free online encyclopedia, and its entire contents are written by unpaid volunteers.
- Wikipedia is continually developed and updated. Its articles are intended to be realistic, reliable, and verifiable with cited external sources.
- Wikipedia has variety of procedures (e.g., peer review, good article assessment, and the featured article process) for continual article review and improvement.
- Feedback about articles, in the first instance, raise on the related discussion pages.
- Quality constantly improves via removing or repairing the misinformation and other errors.

Table 3.3. Organizational Structure of Digg.

What is Digg? it is a website that aggregates interesting online news, pictures, and videos through compiling links to the relevant webpages. Users submit stories for promotion, and they are subsequently either voted for (digged) or against (buried). The most popular contents are posted to the front page for making it easier to identify and consume the most important stories, videos, and trends of the day.

Digg Organizational Structure

Digg Membership Method

- Digg is a social networking and user-driven website that anybody can participate.
- In Digg, nothing is written by paid editors. Contents are made by hundreds of thousands of users.
- All users need to create a Digg user account to access the features of the website. They should play active role in both presenting and Digging stories. Log in is mandatory to get to the website. It provides security assurance for each visit.
- After registration, it is possible for users to give comment and vote on others contribution.
- All users' information (e.g., past Diggs, friends, feedbacks) will be stored in their Digg profile.
- Users can submit their stories and also benefit of all provided features on the website. Bad stories will be ignored, and good ones promoted. Thus, the stories that are selected as the best will be cross-pollinated across other channels.
- Users can customize their own news feeds.

Digg Roles

All Digg users are volunteers. The Digg community is made up of users who play different, often overlapping roles.

No	Roles	Descriptions
1	Casual reviewer	Looks for interesting stuff.
2	Reader	Makes up the majority of Digg user who reads and reaps the benefits of provided materials.
3	Submitter	Posts news and stories that s/he finds in different blogs, websites and random postings from around the Web.
4	Dedicated reviewer	Spends several hours each to check the stories, promote good ones, and report those are not good.

Relationship Between Roles in Digg

- Digg provides a place for lively conversation, discussion, inquiry, and debate. Digg community can discuss the topics that they’re passionate about.
- Users can add friends and develop their relationships.
- A user can block another user if doesn't like his submissions or comments. The blocked user may get banned from Digg if he is blocked by enough number of Digg users.
- Users can create or develop a "Digg game" by submitting stories and digging them.

Digg Content Management

- All the content-related decisions are made by site's users.
- When a user submits a story, its validity will be checked by the system.
- When a submitted article is up for promotion to a category homepage or the front page, the system (karma) checks it to make sure the Diggs are valid.
- Digg does not have editorial control on submissions, promotions, or burying.
- Digg manages all things with a proprietary algorithm (de-promotion algorithm). When a story is Digged by certain number of users (at least 40 persons), the Digg system automatically will move it to the front page of the website.
- The most popular stories of Digg are placed in the "Top News" section of the website.
- The top news can be anything (e.g., fun content or serious news).
- Digg is classified into different groups based on topics (e.g., business, technology, videos, and entertainment news).
- Digg has tabs that let users filter or sort contents into news stories, videos, images and podcasts.

Having critically analyzed the organizational structure of the 15 studied examples of MC and also reviewed the related papers, it is concluded that each organizational structure stands upon some building blocks and fundamental elements. In this sense, it is therefore suggested that the organizational structure of MCL (for creating, developing, and serving) should take into account at least four core elements and three supplementary elements. Core elements including, A) the required mechanism for members to join the community, B) the roles that can be taken and played by members, C) the methods of governing the community, and D) the way that possessed knowledge or information can be managed properly and efficiently. Supplementary element consists of, a) the ways and levels that members can engage in different activities, b) the ways that different roles can be built and involved in interrelationships, and c) the power, rights, and responsibilities that members can take. In this structure, the role of supplementary elements is augmenting, clarifying, and facilitating core elements. This organizational structure depends on the specific situations and conditions of application. Therefore, the elements for a typical organizational structure for MCL projects, as derived from the 15 studied examples, are presented in Table 3.4.

Table 3.4. General organizational structure for MCL communities.

General Organizational Structural for MCL Communities			
Joining Mechanisms ➢Applicant: • Sends application for joining ➢Community: • Accepts the application, or • Rejects the application, or • Requests correction *Joining Conditions & Rules* ➢Inclusion & Exclusion: • Easy inclusion and exclusion • Open access for all • Free of charge ➢Accessibility: • Registration is mandatory • Registration with real information • Minimized anonymity *Level of Engagement* ➢Type of Groups: • Group of ordinary members • Group of experts • Group of technical members ➢Type of Members: • Visitors • Active members	*Roles* ➢Managerial Roles: • Identity controllers • Content controllers • Administrators • Moderators ➢Technical Roles: • System managers • IT technicians • Technical operators • Technical support ➢Participatory Roles: • Experts • Ordinary members *Relationships Among Roles* ➢Relationship Rules: • Based on mutual trust • Relies on collaboration • Can build friendship/s • Can create group/s • Can create discussion/s • Can extend to outside ➢Relationship Types: • Short term • Long term • Formal • Informal	*Governance* ➢Governance Focus: • People • Purposes • Policies • Processes & Procedures • Participations • Performances ➢Governance Rules: • Developing transparency • Emphasizing responsiveness • Encouraging accountability • Increasing effectiveness • Reducing risks • Following fairness • Consensus Oriented ➢Type of Governance: • Self governed • Collaborative • Democratic • Non-hierarchical ➢Governance Borders: • Internal interactions • External interactions	*Knowledge Management (KM)* ➢KM Components: • People • Procedures & Methods • Contents • Strategies & Tools ➢KM Processes: • Collecting • Organizing • Summarizing • Analyzing • Synthesizing • Making decision ➢KM Approaches: • Knowledge is continually created, shared, and developed • Knowledge is continually turned from tacit into explicit form • All members are responsible for quality assurance • The quality of knowledge is continually assessed and improved • Well-developed knowledge will be sorted, stored, and used for learning • Learning occurs in both individual and community levels

• Inactive members ➢ Type of Engagement: • Knowledge creation • Knowledge sharing • Knowledge development • Knowledge assessment	• Intimate • Superficial		

3.1.2 Behavioral Structure for Mass Collaborative Learning

The behavioral structure represents a set of related aspects, factors, and features that have a direct or indirect impact on the behavior of the MCL community. The proposed behavioral structure in this thesis work that is presented in Table 3.5, inspired from the behavioral structures and models of 15 examples of MC which embraces two main parts:

- *Behavioral features at the individual level*: that reveal those personal attributes (e.g., personal characteristics, personal skills and background information, and individual capacity) that have a significant effect on individual and community learning.
- *Behavioral features at the community level:* which focus on a set of community features and capabilities that play a key role in the performance and success of the community from the behavioral point of view.

Table 3.5. General behavioral structure for MCL communities.

General Behavioral Structure for MCL Communities	
Individual Level ➢ Personal Characteristics: • Personality • Attribute toward collaboration • Desire to collaboration • Cognitive abilities • Commitment • Motivation • Awareness • Competence fitness • Perceived usefulness • Perceived ease of use ➢ Personal Skills & Information: • Having necessary information • Having necessary skills • Having necessary experience' ➢ Person's Capacity: • Ability to understand information • Ability to use information • Ability to communicate • Ability to make decision • Ability to act under law	*Community Level* ➢ Community Features: • Community strategies • Community rules • Community's behavioral patterns • Community's leadership principles • Community's decision-making principles • Community's brokering principles • Community's value systems • Community's motivation approach • Community's rewarding policies • Community's trustworthiness • Community's preparedness • Community's feedback system • Community's agreements and negotiation approach • Community's partnership strategies • Community's consult system • Community's support system • Community's cultural influences • Community's social influences • Community's conflict resolution approach • Community protocol

It is noteworthy to mention that designing and developing the behavioral structure of complex systems such as MCL communities under an interdisciplinary approach requires a

clear and deep understanding of the concepts (from the disciplines of collaborative network and learning) to capture their complexity. Furthermore, the addressed factors, components, non-tangible features, and characteristics listed in the above organizational and behavioral structures are general and dynamic. In other words, for applying them in a specific case of MCL, they need to be accordingly and appropriately modified based on the objectives, requirements, conditions, and resources of the case.

3.1.3 Reference Model for Mass Collaborative Learning

The implementation and development of MCL communities requires both further progress in understanding the involved processes and addressing the key affecting factors. MCL communities for knowledge construction and sharing require effective collaboration between unlimited number of distributed but interested learners from around the world. The literature, however, is still lacking a comprehensive reference model that can broadly and clearly elaborate the environmental characteristics of MCL communities. Therefore, as a contribution to this context, a reference model for mass collaborative learning is adapted, aiming to facilitate the understanding of related concepts and highlighting the main internal and external components. Given that, by inspiration from the ARCON (A Reference model for Collaborative Networks) (Camarinha-Matos et al., 2008), this work proposes a general reference model for MCL in order to comprehensively and systematically cover different aspects of MCL. Additionally, the proposed reference model helps to better understanding of related concepts, elements, and interactions. This reference model is proposed as the basis to derive the concrete models from which implementations could be developed.

The investigation of relevant studies shows that the ARCON is a promising proposal for the purpose of this work. ARCON can provide a generic abstract framework and representation for understanding of base concepts, involved entities, significant relationships, interfaces, and data flow among the entities of collaborative networks (CNs) in general and MCL communities in particular. As such, it can be used for the development of specifications supporting MCL environments. The positive features that can be mostly attributed to the ARCON include:

- *Simplicity:* it is a simple, easy to understand and explicit model.
- *Comprehensiveness:* it tries to cover and involve the main relevant components of the environment characteristics of CNs.
- *Neutrality:* it tries to address different aspects of CNs from a neutral point of view. That is, "being defined totally independent of the tools or methodologies that can further model or implement different aspects of CNs, and such that any tool or any

methodology can be mapped against it, in order to understand their implicit trade-offs (what they can or cannot do)" (Camarinha-Matos 2008).

In addition to these specific characteristics of ARCON, in comparison with other relevant previous approaches (e.g., Zachman, VERAM, CIMOSA, GERAM (IFIP-IFAC TFAEI, GERAM), FEA, EGA, and SCOR) that contributed to related areas, it has less limitation when a holistic modeling is pursued, being focused on networked organizations (Afsarmanesh 2008). The literature shows that ARCON has potential applications in a wide variety of domains. It has, for example, been applied to the PROVE initiative (a Portuguese network in the agri-food sector that enables small farmers to sell their goods directly to consumers) (Macedo et al., 2012). ARCON has also been applied for different purposes including but not limited to, e-government and e-services (Farooq 2010), trust management (Beckett et al., 2012), decomposing value for the customer (Nicola et al., 2012), and learning in on-line and local University of the Third Age (U3A) in Australia (19).

It is note taking that defining a reference model for a new system like MCL is not an easy task. Since, from one side, the MCL is an emerging paradigm and not all its aspects are well understood and developed yet, and from another side, very few inputs are available in the literature regarding reference models for CNs. Therefore, our findings from reviewing previous studies along with our understanding from ARCON modeling framework are complementarily used in this work as a basis to propose a reference model for MCL. In addition to literature review, the analysis of 15 cases of mass collaboration helped in identifying their relevant characteristics. The ARCON represents the involved environment features and specifications namely, internal aspects and external interactions. Internal aspects mainly concentrate on controllable entities, properties, function, and features of the network and thus address network's endogenous elements, whereas external aspects focus on external interactions between the network and its surrounding area and thus address network's exogenous interactions (Afsarmanesh 2008).

Endogenous elements comprise four dimensions, including:

- *Structural dimension* – refers to participants in the network, and their relationships and roles. This dimension also deals with compositional characteristics of the network (e.g., typology).
- *Componential dimension* – refers to all tangible resources (e.g., technologies) and intangible resources (e.g., knowledge) of the network.
- *Functional dimension* – refers to all those functions, operations, processes, procedures, and methods that are related to the network.
- *Behavioral dimension* – refers to the principles, policies, and governance rules that drive the behavior of the network.

Exogenous interactions also include four dimensions, as follows:

- *Market dimension* – refers to issues that are related to interactions between the network and its customers, competitors, and potential partners. Part of this dimension embraces the mission of the network, its value proposition, joint identity, etc.
- *Support dimension* – refers to interactions with those support services (e.g., financial, technical) that are provided by third-party entities outside the network.
- *Societal dimension* – refers to general interactions between the network and the society (e.g., public and private organizations).
- *Constituency dimension* – refers to interactions between the network and its potential new members (e.g., attracting and recruiting).

Given the above-mentioned environment characteristics of the ARCON and considering the basic requirements of MCL communities, we accordingly adapt a general reference model for MCL (MCL-RM). See Table 3.6, and Table 3.7 for details.

Table 3.6. Endogenous elements for MCL.

Endogenous Elements for MCL			
Structural Dimension	Componential Dimension	Functional Dimension	Behavioral Dimension
Participants • They are volunteer • They have different background • They are autonomous • They are distributed *Roles* • They are taken based on skills • They are taken based on interests • They are taken based on background ➢ Managerial roles: • Identity controllers • Content controllers • Administrators • Supporters • Advisors ➢ Technical roles: • Web designer and developers • Computer engineers • Technical operators • IT technicians ➢ Participatory roles: • Experts • Ordinary members • Partners • Stakeholders *Roles Relationship* • Friendships • Collaboration • Communications	*Resources* ➢ Technological Resources: • Websites • Platforms • Databases • CSCL tools • Internet • Hardware • Software ➢ Human Resources: • Four types of groups: - Ordinary groups - Experts groups - Advisors - Managerial groups - Technical groups • Three types of members: - Top members - Active members - Inactive members ➢ Knowledge Resources: • Knowledge • Information • Data • Repositories • Templates ➢ Financial Resources: • Grants • Funds • Donations & aides ➢ Community outcomes:	*Processes* ➢ Fundamental processes: • Background processes - Community establishment - Community development - Community dissolution • Management processes - Membership management - Profile management - Task management - Knowledge management - Risk management • Execution processes - Resource allocation - Community evaluation - Decision making • Supporting processes - Documentation - Configuration - Verification - Training *Procedures* ➢ Community building: • Goals establishment • Model selection • Resource provision • Rules setting • Foundation building • Facility provision • Member attracting • Contribution managing • Monitoring • Developing	*Governance Model* • Self-governed community • Nonhierarchical • Decentralized • Democratic • Collaborative *Power within the Community* • Power is distributed • There is no obligation • Collaboration creates power *Rules and Policies* • Freely publish the findings • Participants provide reliable materials • Contents are written from neutral viewpoint • Contents are shared throughout the community • Developed contents will be stored in a safe database • Participants take full responsibility of their contributions • Participants keep the community safe and respectful • Participants receive equal opportunities *Culture* • Community orientation • Outcome orientation • Innovation • Stability • Creating value

• Mentor-mentee • Partnership • Peer-to-peer • Transactional • Truste *Community Typology* • Online collaborative learning • Open, but may have access criteria ➢ Type: • Strategic alliances ➢ Size: • Unlimited	• Developed knowledge • Developed skills • Developed competencies • Findings • Gained successes • Public awareness • Training services ➢ Ontologies: • Community ontology • Participants' ontology	➢ Knowledge evolution approaches: • Knowledge creation is emphasized not knowledge acquisition • knowledge turns from tacit into explicit form • Knowledge quality assurance • Continual knowledge assessment • Learning from successful cases ➢ Community operation handling: • Community uses common sense • Community uses voting system • Experts' opinions are highly valued	• Following the rules • Supporting others • Criticizing ideas, not people • Flagging bad behaviors *Constraint & Conditions* • Confidentiality constraints • Internal normative constraints • Ownership of the contents belong to the community

As shown in Table 3.7, three levels of elements are heeded for Exogenous interactions:

- *Community identity level* – that defines the environment in which a MCL is positioned in, shows the position of MCL in the environment, and addresses the way in which a MCL presents itself in the environment.
- *Interaction parties' level* – identify the potential entities that MCL interacts with.
- *Interactions level* – list the type of transactions that a MCL can develop with its interlocutors.

Table 3.7. Exogenous elements for MCL.

Exogenous Elements for MCL			
Market Dimension	**Support Dimension**	**Societal Dimension**	**Constituency Dimension**
Community Identity Level			
Community Mission • External collaboration development • lifelong learning encouragement *Community Profile* • Virtual learning community • Connection building by online platforms (e.g., website, social media, ICT, email) *Market Strategy* • Boundary development • Being served as an innovative library • Being served as a community of practice • Being served as an open knowledge lab	*Community's Social Nature* • MCL is a not-for-profit community • MCL can also provide monetary services • MCL is an informal org • MCL is a decentralized org • MCL is a collaborative org • MCL is a networked org • MCL is an innovative org	*Community legal Status* • MCL is non-governmental community • MCL is a self-governed community • MCL is informal community of learning • MCL is association of collaborators • MCL cultivates deregulated learning • MCL uses grants, charitable and philanthropic funds	*Attracting and Recruiting Strategies* • Increasing community visibility (e.g., by social media) • Using the word-of-mouth recommendations • Developing the partnerships • Keeping the community information up to date • Taking easy approaches to inclusion and exclusion • Using rewarding and ranking system (e.g., giving special access to the platform or information)
Interaction Parties Level			
Potential Customers/Clients • Public/private organizations • Educational centers • Research centers • Libraries • Individuals	*Financial Entities* • Public/private investors • Sponsors/donators *Technical Entities*	*Governmental Organizations* • Educational and scientific org • Intellectual property org • Advisory Councils	*Organizations* • Public/private org • Public/private Institutes • Public/private business • Enterprises • Corporations

• Problem-solving markets • Knowledge intensive business services *Competitors* • Similar MCL projects (e.g., Wikipedia) *Potential Suppliers* • Universities • Massive Open Online Courses (MOOC) • Instructors	• IT companies/experts • Network service provider • Storage service provider *Informational Entities* • Universities • Libraries • Research institutes • Experts/advisers • Professional associations *Social Entities* • Living learning labs • Research hubs	*Private Sectors* • Knowledge intensive business services • Laboratories *NGOs* • Education charities • Advocacy NGOs *Interested Entities* • Businesses • Learning and training services • Consulting services	• Libraries • Laboratories • Research centers • Consult services *Individuals* • Experts • Professionals • Inexpert
Interaction level			
Customer/Client Interactions • Engagement • Collaboration • Consultation *Competitor Interactions* • Knowledge exchanging • Partnering • Joining • Supporting *Supplier Interactions* • Joining • Partnering • Supporting	*Support/Service Acquisition* • Financial support • Technological support • Information service • Consulting service • Training service • Researching service • Donation service • Coaching actions • Alliances *Agreement Establishment* • Contracting • Dealing • Community affiliation	*Political Relations* • Making/developing relationships between community and org *Social Relations* • Developing the collaboration • Sharing the findings *Knowledge sharing* • Face-to-face/directly • Social media • Broadcasting *Seeking Support* • Consultation	*Member Searching* • Advertising • Talking to friends and co-workers • Sending invitation/solicitation • Participants can bring in new faces • Conduct workshops *Joining Process* ➢ Sending application by applicant ➢ Evaluating the application by the community, and: • Accepts the application, or • Rejects the application, or • Requests correction

As shown in Tables above, there are some similarities and overlapping among the elements in the "structure" and "component" parts (shown in Figure in 3.1). Because in practice these parts not only are not separable, but also the related and corresponding elements could develop common tasks and practices.

It should be also added that we considered 5 main common stages of the life cycle for MCL initiatives as the following:

1) *Creation* – this stage deals with incubation, system parameterization, databases creation, generation and definition of ontology, base data or information loading, etc.
2) *Operation* – this stage refers to the operation of MCL initiative and execution of different related tasks / processes towards achieving its goals.
3) *Evolution* – this stage deals with the required changes that should be made during the daily operation of MCL initiative, e.g., to its membership, structural relationships, roles of its members, etc.

4) *Dissolution* – in short-term MCL initiatives, they will dissolve after accomplishing their goals.
5) *Metamorphosis* – in long-term cases, they go through a metamorphosis stage, where their general form and/or purpose can evolve.

Table 3.8 and Table 3.9 show how the identified elements in Table 3.6 and Table 3.7 appear/are used along the life cycle of a typical MCL initiative.

Table 3.8. Endogenous elements along the MCL life-cycle.

Structural Dimension	c	o	e	m	d	**Componential Dimension**	c	o	e	m	d	**Functional Dimension**	c	o	e	m	d	**Behavioral Dimension**	c	o	e	m	d
Active entity						*Active entity*						*Active entity*						*Active entity*					
Actor						---						---						---					
Primary-entity						*Passive entity*						*Passive entity*						*Passive entity*					
Support-entity						**Domain specif. device**						---						---					
						Manufacturing machine						*Action*						*Action*					
Passive entity												**Fundam. Process**						---					
---						**ICT resource**						Main CNO manag process						*Concept*					
						Hardware						- Roles/respons. Mng.						**Prescript. behavior**					
Action						Internet						- Trust management						Cultural principles					
---						Software						- Data/Know. Manag.						- Regional traditions					
						- CNO Manag. System						Particip. operat. proc.-						- Business culture					
Concept												- Roles/resp. Update rq.						- NGO culture					
Role						**Human resource**												Governance principles					
Participant						HR of Network						**Backgr. Process**						- Net. gen. principles					
- Administrator						HR of Actor						Network manag. proc.						- Domain specif. princ.					
- Support provider												- Creation reposit.s						Incent.&reward. policy					
- Broker						**Info/knowl./asset r.**						- Manag. Sys. Setup											
- Planner						Profile/compet.data						- Bulk regist. particip.s						**Obligatory behavior**					
Spot member						- Actor's profiles data						- Net. Inherit. mang.						Network bylaws					
						Inheritance information						- Decis. support man.						- Conflict resol. policy					
Relationship						Ontologies						- Members' rewarding						- Secur. issues policy					
Cooperation/Collaboration						- Network ontology						- Ontology manag.						- Bylaw amend.s pol.					
Trusting						- Domain's ontology						- Ontol. Evolution man.						- Financial policies					
Communication/Info flow						Data/knowl. Reposit.s						- Performance measurement						- Contract enfor. pol.					
Exchanging and sharing						Templates						- IP Management						Internal regulations					
Socializing																		- ICT Use Guideline					
Control/supervision						**Network outcome**						*Concept*						- Sanctions principles					
												Methodo.&Appoach						General law					
Network						*Action*						Network setup handling											
						---						- Govern/valu sys def						**Contract&agreeme.**					
						Concept						Network operation handling						Net adhesion/coal. agr.					
						---						- Members' info quality						Agreement amendm.s					
												- Net's info./policy tr.											
												- Social processes						**Constraint&condit.**					
												- Govern. rules updat.						Confidentiality constr.s					
												- Risk management						Legal constraints					
												- Conflict resolution						Standards constraints					
												- IP management						Internal norm. constr.s					
												- Technology adoption						Physical constraints					
												- Ontol. manag.&updates											
												Net. evolution handling											
												- Rev. gathered knowl.											
												- Trans. to new orga structure											
												Net. Dissolut./inherit.											
												- Knowl.&assets transfer											
												- Re-defining roles											

Table 3.9. Exogenous elements along the MCL life-cycle.

Market Dimension	c	o	e	m	d	Support Dimension	c	o	e	m	d	Societal Dimension	c	o	e	m	d	Constituency Dimension	c	o	e	m	d
Network identity						***Network identity***						***Network identity***						***Network identity***					
Mission						CNO's social nature						Legal status						Attract.&recruit. Strat.					
References/testimonials												Values & principles											
Network profile																							
Market strategy																							
Interaction parties						***Interaction parties***						***Interaction parties***						***Interaction parties***					
												Governmental organ.s						Business entities					
Customers						Certification entities						Associations						Public institutions					
Competitors						Insurance entities						Interest groups											
Suppliers						Logistics entities						Regulatory bodies.											
						Standard registries						Other entities											
						Financial entities																	
						Coaching entities																	
						Training entities																	
						Research entities																	
Interactions						***Interactions***						***Interactions***						***Interactions***					
Advertising						Service acquisition						Political relations						Member searching					
Customer/supplier						Agreement establishment						Seeking support						Receiving applications					
Handling inquiries												Information transfer.											
												Social relations											

	Very Important
	Moderately Important
	Not so Important

c	creation
o	operation
e	evolution
m	metamorphosis
d	dissolution

Toward checking the comprehensiveness of ARCON reference model and its applicability to the MCL projects, the coverage of its elements and their respective dimensions are assessed for the 15 cases of MC, and the results are demonstrated in Table 3.10 and Table 3.11. These results are gained from the evaluation of available information for each case. As it is shown in these two Tables, in some cases, the related information either is not available, or the author could not find it through the investigation. The applicability of ARCON reference model to each specific case, however, should be verified by various empirical experimentations.

Table 3.10. Coverage of endogenous elements for 15 cases of MC.

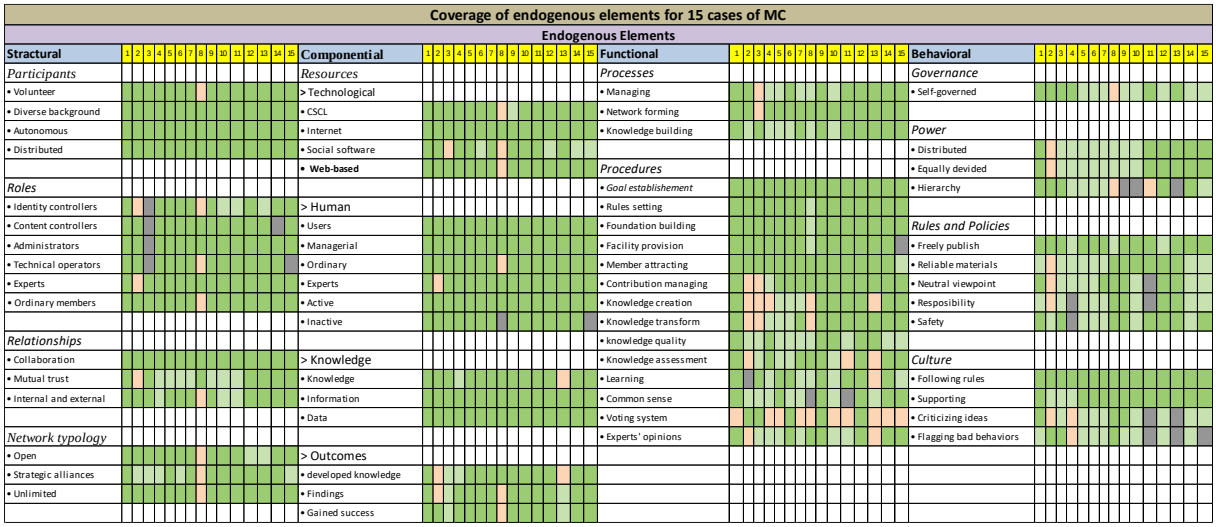
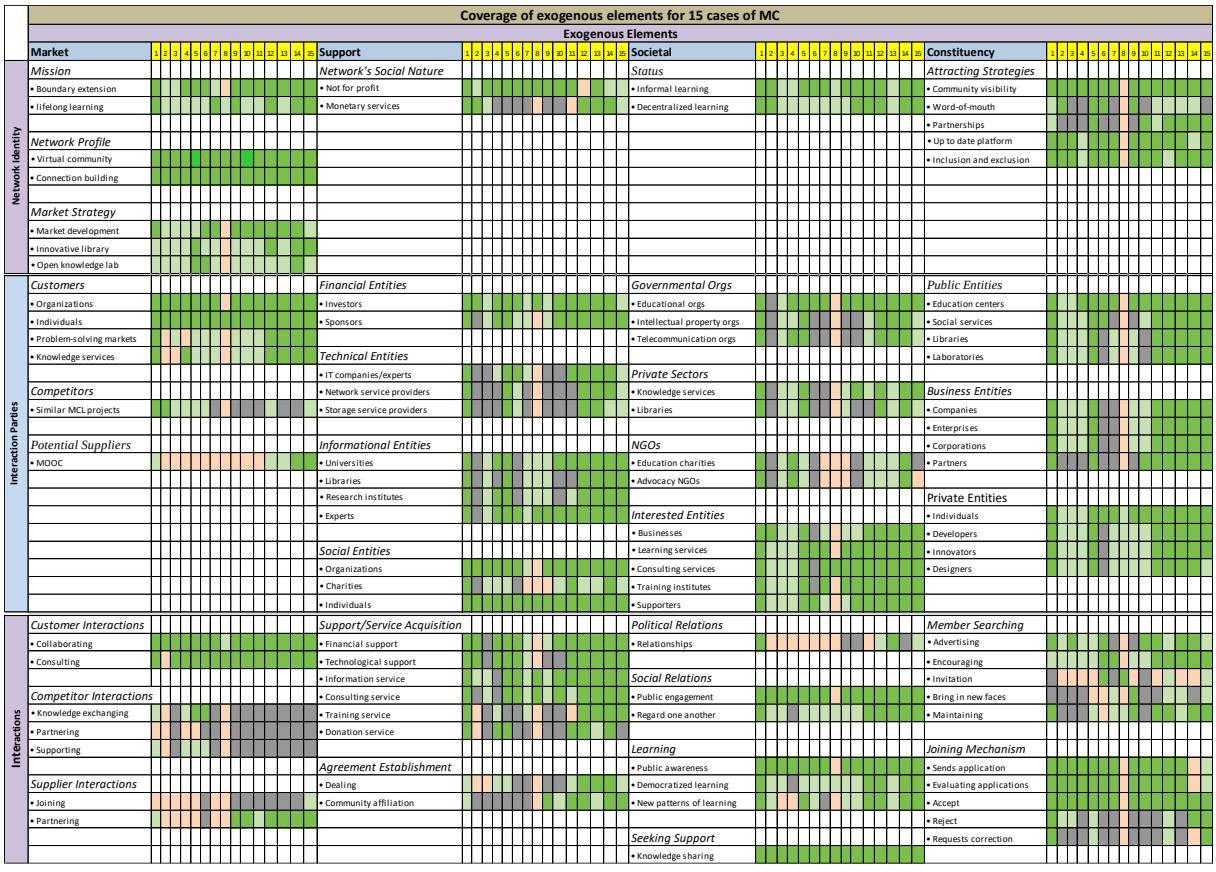


Table 3.11. Coverage of exogenous elements for 15 cases of MC.



	Fully Covered
	Partially Covered
	Not Covered
	Not Found

1	Wikipedia	5	Scratch	9	Climate Colab	13	Waze
2	Digg	6	Galaxyzoo	10	Assignment Zero	14	Makerspaces
3	Yahoo! Answers	7	Foldit	11	DonationCoder	15	SAP Community Network
4	SETI@home	8	Applying Delphi Method	12	Experts Exchange		

3.1.4 Assessment Approaches

3.1.4.1 Assessment Indicators

Good assessment should make use of an appropriate balance between different types of indicators that can establish the link between means or methods used for assessment and in achieving the objective of community learning. Assessment of learning outcomes provides some indicators of learners' learning-related strengths and weaknesses. These outcomes also provide information on learning levels that learners need to attain to achieve targeted learning objectives. The usefulness of any set of indicators will be determined by the information needs for the analysis and diagnosis of the existing situation, the preparation of policy decisions, and the monitoring and evaluation of policy interventions.

Given that and by considering the MGF-MCL, when the objectives are defined, the structural and behavioral models are adapted, and the specific internal and external components are identified and customized, the MCL community can then proceed to the operation phase. In this phase the community needs to assess its organizational changes in relation to (a) the quality of knowledge and skills that learners gained, and (b) the quality of community operation/performance. In that account, the assessment helps the community to monitor its success over time, drive instruction and learning, control learning progress, and boost motivation. The assessment can take place at two levels namely individual level (to assess learners' achievements) and community level (to assess community performance):

- *Assessment at the individual level* – an approach to teaching and learning that creates feedback about the learners' performance, progress, and/or achievements. It also indicates that whether or not the learners have met learning outcomes or the goals of the programs that they participated in.
- *Assessment at the community level* – a systematic process for analyzing the strengths and weaknesses of the community in relation to its performance and the factors that affect performance. Additionally, assessment at this level can obtain valid information about the community's processes, work environment, and organizational structure.

There is a long list of various types of indicators in the literature to choose from. Additionally, there are as many indicators as ways in which they can be constructed. Finding or determining the key and right indicators, however, is not always easy. As choosing the

proper indicators is the first step toward quantifiable improvement for every organization (in general) and for MCL community (in specific), the author took into consideration the following points in selecting the most appropriate indicators for performance assessment at both individual and community levels:

- Being relevant to and consistent with the specific community's vision, strategies, and objectives,
- Having mandatory characteristic requirements (must be actionable, measurable, achievable, realistic),
- Being quantitative and qualitative,
- Being aligned with community growth stage, and
- Being clear and understandable.

The proposed indicators for individual and community performance assessment are listed in Table 3.12.

Table 3.12. Proposed assessment indicators.

Assessment Indicators for MCL Communities	
Indicators for individual performance assessment	**Indicators for community performance assessment**
Input Indicators • Having good socio-economic conditions • Having equipped environment • Enough training courses • Matches of mentors and mentees • Enough related contents • Useful contents • Reliable contents • Learner's prior knowledge • Learner's aptitude • Learner's readiness • Trainer's quality and impacts • Consultation hours *Activity Indicators* • Enough motivation factors • Active contribution • Active collaboration • Effective collaboration • Enough time for doing tasks • Minimized barriers to learning *Outcome Indicators* • Improved knowledge • Increased learning skills • Improved collaboration skills • Developed relationships *Impact Indicators* • Increased civic awareness • Promoted collaborative learning • Being able to solve related problems	*Organizational* - Having enough capacity to deliver services - Having effective coordination techniques • Environmental - Having safe and healthy atmosphere - Enough resources for collaboration • Admission - Active recruitment/employment rate - Enough influential stakeholders • Social - Effective communication - Active contribution • Functional - Enough network productivity - Matches of training courses to future career plans/needs - Internal promotions Vs. external hire • Technological - Equipped environment - Enough technical administrators • Economical - Increase in revenues/profits - Enough financial supports • Structural - Enough application of learning standards - Clarity in the division of responsibilities • Behavioral - Adequate user commitment and retention - Enough coaching

As it is shown in Table 3.12, for the sake of better understanding the type and specifications of the proposed indicators for individual performance assessment, they are placed under four main classes:

- *Input indicators* – focusing on needed resources for creating the learning program.
- *Activity indicators* – focusing on the main activities and operations of the learning program.
- *Output indicators* – focusing on the expected outcome/results that can be achieved by the learning program in the long and the short run.
- *Impact indicators* – focusing on learning program contribution to higher-level strategic plans.

At the Community level, the performance assessment indicators are grouped under 9 considered dimensions of collaboration namely, organizational, environmental, admission, social, functional, technological, economical structural, and behavioral. It should be noted that each MCL community needs to define the specific performance indicators based on its objectives and conditions. A well-developed set of performance indicators (at both levels) can make appropriate links among strategy, operation, and ultimate value creation.

3.1.4.2 A Mixed Method for Assessing the Reliability of Shared Knowledge or Information in a MCL Community

Despite the positive and promising features of MCL, and the opportunities that it can open for the societies, communities, and learners, MCL (as a type of social network) also faces with a huge number of problems, challenges, and limitations. For example, MCL must deal with the challenge of determining and controlling the quality (reliability) of shared content (e.g., knowledge) within the community. In fact, MC is regarded as a double-edged sword when it comes to learning. From one side, it is relatively low cost, accessible, and it can potentially facilitate knowledge sharing and increase public awareness. On the other hand, the (large) size and environment (online) of the community can potentially put it at risk of encountering, involving, abusing, and damaging with unreliable knowledge. On top of that, the anonymity of community participants can likely intensify the problem. Since MCL is typically supported by a public platform, any participant can post any content with various degrees of truthfulness. The dissemination of unhealthy knowledge throughout the community, without doubt, can negatively influence its members (e.g., to be misinformed or misled). Thus, it is left to community members to recognize whether the knowledge is true or not. Unfortunately, this is a dark side of MCL. To successfully deal with the issue of knowledge unreliability, one possible alternative for MCL is focusing on the prevention and reducing the risk of creating

and sharing unreliable knowledge within the community, before involving with reliability assessment. In this respect, MCL could for example adapt the Failure Mode and Effects Analysis (FMEA). FMEA as a structured approach helps identifying and ranking potential unreliable content and their major causes and effects on the community. The major causes could be related to human errors, procedural problems, management oversight, training deficiency, etc. In this process, the community can take needed actions to reduce the chance of potential unreliability occurrence. Unreliable contents can be also prioritized according to how easily they can be detected, how serious their consequences are, and how frequently they occur. Furthermore, a list of recommendations for reliability improvement can be then provided. The aim of applying FMEA is to take actions to eliminate or reduce unreliable contents. In case a piece of unreliable content is created and shared, despite utilizing FMEA, the community can then proceed to utilizing an appropriate content assessment method.

Even though there are several references in the literature for evaluating the validity of shared knowledge, there is relatively little comprehensive discussion about the reliability of shared knowledge in the MCL communities. The existing literature, furthermore, lacks sufficient evidence and results on the way according to which the learners can assess the reliability of shared knowledge in MCL communities at mass level. In MCL, a huge amount of knowledge can be shared within the community. It is note taking that not all shared knowledge need reliability assessment because a number of them can be readily, logically, and/or reasonably realized as a true knowledge (e.g., facts, verified contents). However, there might be some knowledge that give the impression of being untrue or suspicious (e.g., completely false knowledge, fabricated knowledge, manipulated knowledge, misleading knowledge). On that account, it has raised MCL community's concerns about not only the accuracy of the shared knowledge, but also in which way the community can properly gauge the reliability of those materials. To contribute to solving this problem, this thesis work proposes a potential mechanism that can assist MCL community members to assess the reliability and trustworthiness of shared knowledge in a systematic way. The proposed method is a kind of mixed method for assessing the reliability of shared knowledge in a MCL community (MAM-MCL) that comprises of 4 main steps (see Figure 3.2).

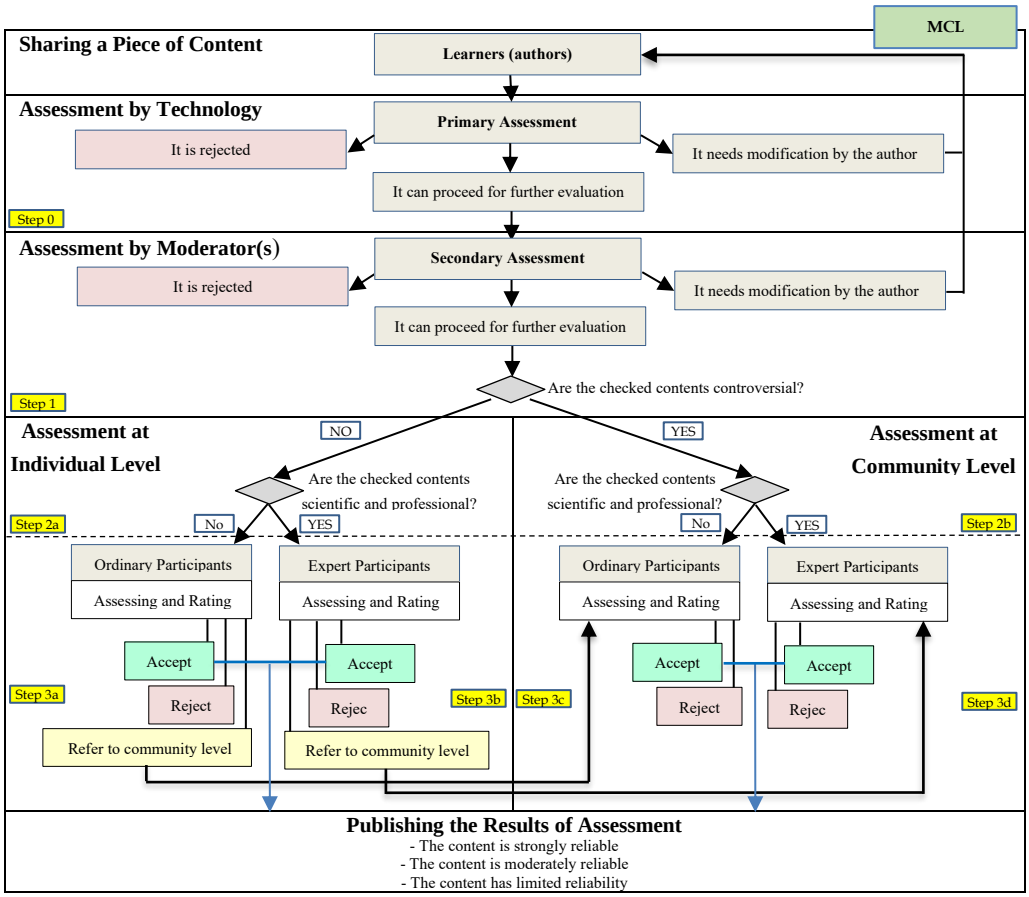


Figure 3.2. Proposed MAM-MCL for assessing the reliability of shared knowledge in a MCL community.

These steps are briefly explained in following.

- *Step 0 – preliminary assessment (by technology)*: in this step the shared piece of knowledge by learners/authors (that are marked for assessment by community contributors) will be initially checked and then filtered by means of technology (e.g., AI software filtering system). In case, the knowledge need modification, it will be sent back to the learner/author. If the knowledge detected (by technology) as unhealthy material, it will be rejected. The knowledge that is not rejected in this step (those that the technology marks for further evaluation), will be referred to the next step.
- *Step 1 – assessment by moderator(s)*: in this step the received knowledge (e.g., suspicious contents, controversial cases) from step 0 will be checked by moderator(s) to make sure it is in line with the community rules and conditions. The checked knowledge will then be classified based on the pre-defined fields, classes, and topics. Then after, it will be sent to the respective assessment level (Step 2). If the checked knowledge "is not controversial", it will be sent to the individual level.

If the checked knowledge "is controversial" (e.g., ethical, cultural, critical issues), it will be sent to the community level. The assumption here is that compared with individuals, the community can better assess and make decisions about the controversial knowledge.

- *Step 2 – referring to individual or community level*: in this step the checked knowledge will be referred by moderator(s) either to individual or community level:
  - *2a – Individual level*: indicates that the reliability of "not controversial knowledge" should be evaluated individually. If the considered knowledge "is scientific and professional", it will be sent to expert participants (at individual level). If the considered knowledge "is not scientific and professional", it will be sent to ordinary participants (at individual level).
  - *2b – Community level*: shows that the reliability of "controversial knowledge" should be evaluated collaboratively. If the considered knowledge "is scientific and professional", it will be sent to expert participants (at community level). If the considered knowledge "is not scientific and professional", it will be sent to ordinary participants (at community level).
- *Step 3 – Assessment by ordinary members and expert participants (in individual and/or community levels)*: the last stage of assessment. In this step the considered knowledge will be assessed either by ordinary or expert participants in both levels, individual and community:
  - *3a – Ordinary participants (at individual level):* they assess the knowledge that "is not controversial, scientific, and professional". There are 5 proposed questions (addressed in Table 3.13) to which the ordinary participants will give a rate (based on 5-point Likert Scale) to determine the reliability of the considered knowledge. In this personal evaluation, if the sum of given rates to all 5 questions is lower than the considered threshold (3.5), the evaluator marks the knowledge as "rejected" or "unreliable". If the sum of the given rates to all 5 questions is above the threshold, the participant marks the knowledge as "accepted" or "reliable". The considered threshold (3.5) is above the mid-point (2.5), and it might sound relatively high. But this level of threshold can increase the knowledge quality assurance. In cases that the knowledge seems needing further/deeper evaluation, the evaluator marks it. When the number of marked knowledge reaches a certain percentage, the moderator(s) will send it to "ordinary participants at the community level".
  - *3b – Expert participants (at individual level)*: they assess the knowledge that "is not controversial, but it is scientific and professional". Similarly, by responding to 5 questions, they will give a rate (based on 5-point Likert Scale) in order to individually and professionally determine the reliability of the considered knowledge. In this personal evaluation, if the sum of given rates to all 5

questions is lower than the threshold (3.5 point), the evaluator marks the knowledge as "rejected" or "unreliable". If the sum of the given rates to all 5 questions is above the threshold, the evaluator marks the knowledge as "accepted" or "reliable". In cases that the knowledge seems needing further/deeper evaluation, the expert participant marks it. When the number of marked knowledges reaches a certain percentage, the moderators will send them to "expert participants at the community level".

- *3c – Ordinary participants (at community level)*: the process of assessment and rating by ordinary participants at the community level follows the same process as for ordinary participants at individual level. Even though, in this step and level, the ordinary participants first by collaborative efforts (e.g., group discussion, sharing ideas and viewpoints) exchange their opinion and findings about the considered knowledge that "is controversial, but not scientific, and professional". Considering the raised points in the community, the ordinary participants then go through a personal rating.
- *3d – Expert participants (at community level)*: the process of assessment and rating by expert participants in community level is similar to the process for expert participants at individual level. Although, in this step and level, the expert participants first by collaborative efforts (e.g., group discussion, sharing ideas and viewpoints, peer review, Delphi method) exchange their opinions and findings about the considered knowledge that "is controversial, scientific, and professional". Taking into account the raised points in the community, the expert participants then go through a personal rating.

The recorded notes that are mentioned above are useful for personal consideration and decision making. Albeit it is suggested that the participants rely more on the results of assessment by the community. Therefore, collecting the results of all assessments in both levels, and also determining (by some technological tool) the final rate (by calculation of all given rates) for the considered knowledge, the community participants can judge the reliability of assessed knowledge.

The 5 defined questions (based on 5-point Likert Scale), and proposed formula for calculation of the given rates (in both levels) are presented in Table 3.13 and Table 3.14.

Table 3.13. Examples of questions and 5-point Likert Scale for assessing the reliability of shared knowledge in MCL community.

Questions (checklist approach)	**5-point Likert Scale**				
1. How much the knowledge is worthy for consideration?	1	2	3	4	5
2. How well the knowledge is written and understandable?	1	2	3	4	5
3. How much the knowledge is accurate and factual?	1	2	3	4	5
4. How much the knowledge is verifiable?	1	2	3	4	5
5. How much is the expertise and reputation of the author/publisher (of knowledge)?	1	2	3	4	5

Table 3.14. Proposed formula for calculation of given rates at individual and community levels.

Proposed formula for calculation of given rates in both levels (individual and community)
$\mathbf{Z} = \frac{\sum_{i=1}^{n} \boldsymbol{E_i} \times \boldsymbol{R_i}}{\boldsymbol{n}} \times \boldsymbol{L}$ $\mathbf{Z} > \mathbf{Mid} \longrightarrow \quad \forall_{accept}: (\sum_{i=1}^{n} \boldsymbol{E_i} \times \boldsymbol{R_i}) > (\sum_{i=1}^{n} \mathbf{12.5} \times \boldsymbol{R_i})$
• $\mathbf{Z}$ = content quality/value • $\boldsymbol{E_i}$ = evaluation result (is an integer in a Likert Scale between 1 to 5 which shows the final opinion of the evaluator) • $\boldsymbol{R_i}$ = personal ranking* • $\boldsymbol{L}$ = rate of acceptance (in individual level = $(\mathbf{1})$, and in community level = $(\mathbf{2})$ • $\boldsymbol{n}$ = number of evaluators
*** E.g. Personal rankings:** - Diploma = **1** - PhD = **6** - Degree student = **2** - Post-doc = **7** - Degree graduated = **3** - Assistant, Prof = **8** - Master student = **4** - Associate, Prof = **9** - Master graduate = **5** - Full, Prof = **10**

At the end it should be mentioned that despite the potential advantages of MAM-MCL presented in this work, its implementation in practice is an extremely challenging task. That is, MAM-MCL needs coping with its limitation and dealing with problematic situations that it faces in the work including but not limited to:

- *High level of complexity of the evaluation process* **-** refers to different levels of evaluation (individual and community), different types of knowledge (controversial and professional), different group of evaluators (ordinary and experts), and human-technology interaction,
- *High level of contributions* **-** refers to a large number of participants who might contribute to the task simultaneously,
- *Explaining and clarifying (for users) the process of evaluat*ion **-** refers to a comprehensive related information or even training that should be provided for participants to appropriately clarify how, when, and what should be evaluated,

- *Explaining and clarifying (for users) the related concepts* **-** refers to a group of concepts and terms (e.g., reliability assessment, primary assessment, secondary assessment, voting, rating) that the participants need to be informed before involving with content assessment,
- *Explaining and clarifying (for users) the needed actions* **-** refers to a set of actions (e.g., critical thinking, noting the untrue contents, collaboration, sharing, learning) that the participants should make before, during, or after knowledge assessment, and
- *Motivating and encouraging participation* **-** refers to providing motivating environment and policies that induce the participants to evaluate, vote, remain active, and etc.

In this chapter the identified and adapted components (organizational part of MGF-MCL) for supporting the implementation, operation, and development of MCL communities are presented at a conceptual level. Before applying these components to any concrete case of MCL, they should be first evaluated by the governance part of MGF-MCL. This task is practically performed (in two case studies) through a customized governance process depicted in Figure 4.5 and presented in Section 4 toward providing some evidence of MGF-MCL validation and applications.

4

VALIDATION AND CASE STUDIES

This chapter presents the validation methodology used for the MGF-MCL framework that consists of practical and theoretical perspectives. Practical aspects involved the evaluation of adequacy, feasibility, and effectiveness of MGF-MCL, proposing a three-step evaluation process that assesses the applicability of the framework for supporting the implementation, operation, and management of MCL initiatives. Theoretical aspects of the MGF-MCL are evaluated by the research community through contributions to panels (professional group), presentations, and publications. The chapter ends with validation findings, and their discussion.

4.1 Validation Approach

Validation is commonly defined as a process which ensures (or gives confidence) that the creation of a new system, model, or framework has captured all the important aspects of a stated problem. Validation also deals with justification of knowledge claimed. Validation in design science is performed by building one or more artefacts that solve a domain problem, in order to create knowledge on how the problem can be solved and show how the solution is new or better than the previous ones. In this work, validation deals with the process of building confidence about the appropriateness of proposed MGF-MCL for its intended purposes, and also addressing its applicability and success in supporting and steering the creation, development, and implementation of MCL communities. The appropriateness and applicability of MGF-MCL is evaluated using two case studies in EU projects, an illustration of a MCL community, and peer validation.

The MGF-MCL is evaluated by considering an adaptation of the Technology Acceptance Model (TAM) methodology (Davis et al., 1989). TAM is one of the most frequently employed models for research into new information technology acceptance. TAM is focused on the intention to use a new technology or innovation. TAM was specifically developed to explain and predict the acceptance of information and communication technologies by potential users.

Figure 4.1 depicts the main steps of the validation approach followed in this work. It comprises four main parts: (a) three formulated research questions, (b) respective hypotheses,

(c) proposed solutions (framework), and (d) three cases used for validation of the proposed solutions.

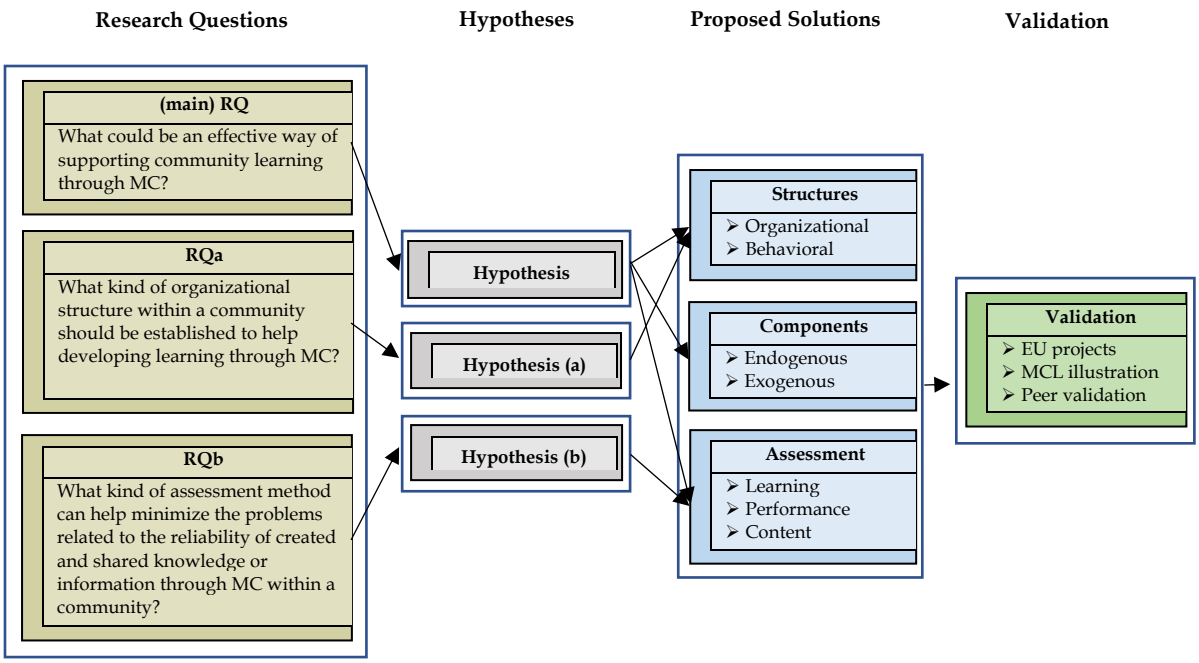


Figure 4.1. Validation approach.

As mentioned above, the following three cases are used to validate the appropriateness and applicability of the MGF-MCL:

- *EU projects:* integrating this thesis work on two European research projects provides very good opportunity to practically assess and observe to what extend the application of MGF-MCL is successful in real cases,
- *Mass collaborative learning illustration:* the application of MGF-MCL in a community of cooks that was introduced and developed in a master thesis allowed to assess the validation of the framework in another related context, and
- *Peer validation:* assessing the MGF-MCL through publications in relevant peer-reviewed international workshops, conferences, and journals.

In addition to the above, as the author is a member of the Center of Technology and Systems (CTS) the development of this research work also benefited from continuous interaction with various experts and researchers in CTS - UNINOVA. These interactions were valuable for the positive feedback on the acceptance of the underlying concepts and the contributions for the collaborative networks area.

4.1.1 Validation Through Case Studies in EU Projects

To evaluate and demonstrate the appropriateness and applicability of MGF-MCL in supporting the establishment, operation, and development of MCL communities, the framework was first instantiated in scenarios defined in the context of two EU projects (case studies), where some important validation results were obtained.

4.1.1.1 Case study 1

The MGF-MCL is used in ED-EN HUB (https://edenhub.eu/), an Erasmus + project co-financed by the European Union and developed by a consortium of 8 institutions from 5 different European countries. The ED-EN HUB project is aimed at improving the quality of education (focusing but not limiting itself to vocational education and training) through the consolidation and systematization of the notion of education-enterprise. This international cooperation alliance aims to allow the development of tools and methodologies towards the creation of synergies between educational institutions and enterprises.

ED-EN HUB uses a collaborative and knowledge-oriented platform (EDENCP) that provides a supportive environment for a training and learning hub where a large number of scattered but enthusiastic trainers and learners from different backgrounds come together to promote their knowledge and competences. The participants in the hub attempt to adopt new ways and develop scenarios for sharing their knowledge, experiences, and ideas which leads to higher-level of understanding, qualification, and performance.

In this project, the MGF-MCL is used to support and guide the creation, operation, and implementation of EDENCP. Hereupon, the validation of MGF-MCL began by evaluating its appropriateness.

Validation of MGF-MCL in this project is performed by taking the following steps:

1. Determining the objectives of framework validation,
2. Determining the needed tools for evaluation (questionnaires and interviews),
3. Determining the suitable criteria/parameters for evaluation of the framework appropriateness (completeness, purposefulness, perceived usefulness, perceived ease of use, cost-effectiveness, and reasonability),
4. Developing related questionnaires,
5. Identifying the potential evaluators (experts, partners, and stakeholders in the projects),
6. Preparing and conducting required interviews,
7. Performing validation tests,
8. Analyzing the collected feedback, and
9. Reporting the results of validation.

The developed questionnaire for this purpose contains the considered validation criteria and parameters namely completeness, purposefulness, perceived usefulness, perceived ease of use, cost-effectiveness, and reasonability, and their respective questions (see Table 4.1).

Table 4.1. Questionnaire for evaluating the appropriateness of MGF-MCL.

Criteria / Parameters	Questions	SDA	DA	A	SA	IDK	IANS
Completeness	1. The MGF-MCL encompasses the necessary parts for the proper evaluation of the identified components, features, and factors that might be used in (creation, development, and implementation) of EDENCP.						
	2. The MGF-MCL comprises the necessary steps for the proper evaluation of the considered functions of EDENCP.						
Purposefulness	3. The MGF-MCL can provide satisfactory results.						
	4. The MGF-MCL can create the expected value.						
Perceived usefulness	5. The MGF-MCL is useful for evaluating the identified components, features, and factors that might be used in (creation, development, and implementation) of EDENCP.						
	6. The MGF-MCL is useful for evaluating the considered functions of EDENCP.						
Perceived ease of use	7. The MGF-MCL is clear and easy to understand.						
	8. The MGF-MCL is clear and easy to follow.						
Cost-effective	9. The MGF-MCL helps us to save resources (e.g., time, effort, and costs) in identifying the required features and capabilities for EDENCP.						
Reasonability	10. The MGF-MCL can meet the expectations in identifying the required features that might be used in the creation, development, and implementation of EDENCP.						
	11. The MGF-MCL has a reasonable chance of success in the evaluation of the considered functions of EDENCP.						

It is notetaking that in line with the core constructs used for the TAM, the validation criteria and parameters are set by a group of partners and stakeholders of the project (who are expert in this area) with respect to the proposed criteria and parameters in the literature, the strategic objectives of the project, and their expectations for EDENCP. Figure 4.2 shows an image of various online meetings that the partners and stakeholders of the project and the author of the thesis had for this purpose. The questionnaire contains 6 criteria and parameters and 11 questions. Each question should be rated on a 6-point Likert scale (Likert, 1932) including strongly disagree (SDA), disagree (DA), agree (A), strongly agree (SA), I don't know (IDK), and I am not sure (IANS). The Likert scale questions are formulated to understand the level of agreement of respondents (project partners and stakeholders, i.e., a kind of "focus

group") with the appropriateness of MGF-MCL. The questionnaire was sent to 8 groups of focused partners/experts, and they are asked to respond to the questions with collaboration of their internal team members who contribute to the project. The results of analyzing their answers/opinions are presented in Table 4.2.

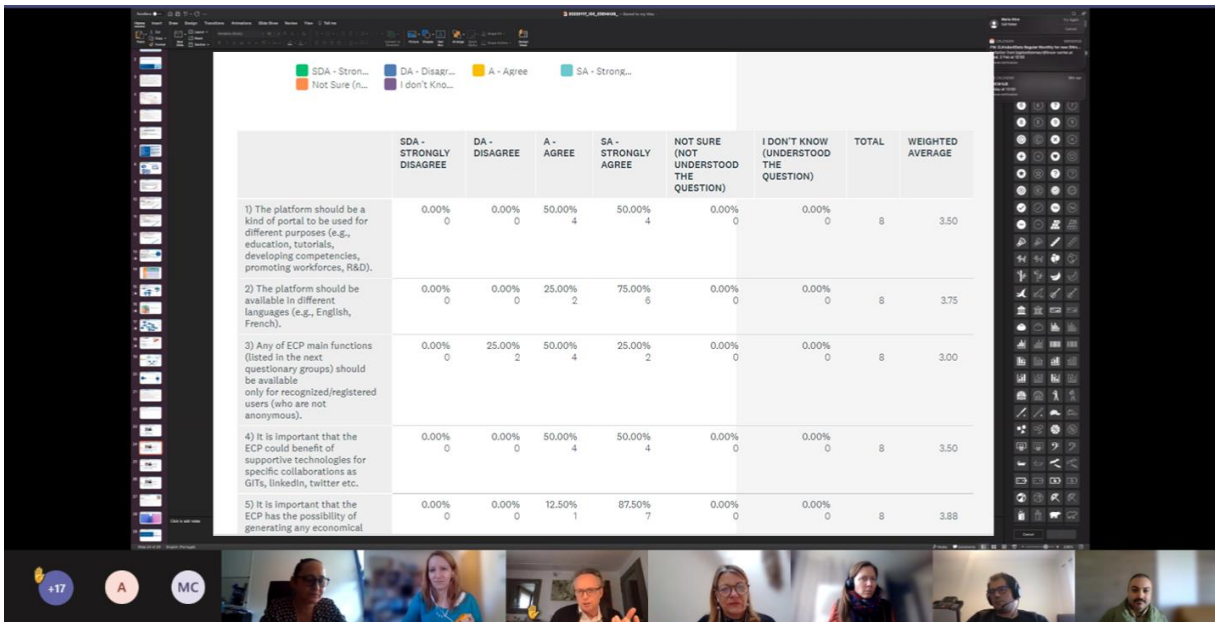
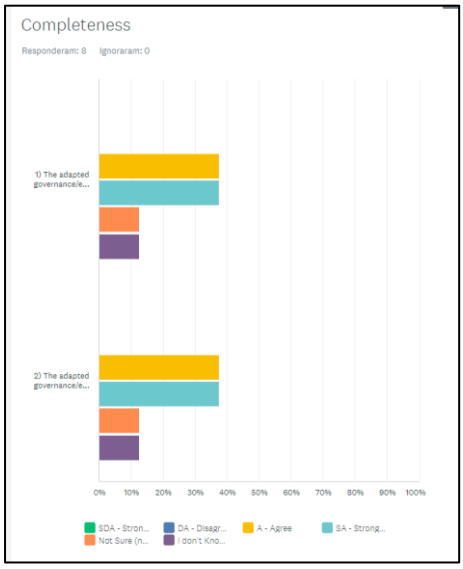


Figure 4.2. ED-EN HUB online group meeting.

Table 4.2. Results of evaluating MGF-MCL appropriateness for EDENCP.

Criteria / Parameters	Feedback Number	Questions	Weighted average	Percentages	SDA	DA	A	SA	IANS	IDK
Completeness	8	Q1	3	75%	0	0	3	3	1	1
	8	Q2	3	75%	0	0	3	3	1	1
Purposefulness	8	Q3	3.25	81.25%	0	1	4	3	0	0
	8	Q4	2.75	68.75%	0	1	4	2	1	0
Perceived usefulness	8	Q5	3.28	82%	0	0	5	3	0	0
	8	Q6	3.13	78.25%	0	1	5	2	0	0
Perceived ease of use	8	Q7	2.38	59.50%	0	1	3	2	2	0
	8	Q8	2.25	56.25%	0	1	4	1	2	0
Cost-effective	8	Q9	2.50	62.50%	0	2	1	2	1	2
Reasonability	8	Q10	3.14	78.50%	0	0	3	4	1	0
	8	Q11	3	75%	0	0	4	3	1	0
Average	-	-	2.88	72%	0	7	39	28	10	4
Max	-	-	4.00	100	55	55	55	55	55	55

The questionnaire was made and analyzed by SurveyMonkey (which is a well-known online application/tool used for creating and running professional online surveys). In this project, the other stages of MGF-MCL evaluation are also performed by using this tool. As an illustration, the results of analyzing the criteria of "completeness" performed by SurveyMonkey are displayed in Figure 4.3.



	SDA - STRONGLY DISAGREE	DA - DISAGREE	A - AGREE	SA - STRONGLY AGREE	NOT SURE (NOT UNDERSTOOD THE QUESTION)	I DON'T KNOW (UNDERSTOOD THE QUESTION)	TOTAL	MÉDIA PONDERADA
1) The adapted governance/evaluation process encompasses the necessary parts for the proper evaluation of the identified components, features, and factors that might be used in (creation, development, and implementation) of the learning framework/platform.	0.00% 0	0.00% 0	37.50% 3	37.50% 3	12.50% 1	12.50% 1	8	3.00
2) The adapted governance/evaluation process comprises the necessary steps for the proper evaluation of the considered functions for the framework/platform.	0.00% 0	0.00% 0	37.50% 3	37.50% 3	12.50% 1	12.50% 1	8	3.00

Figure 4.3. A Screenshot of the analysis made with the SurveyMonkey.

Taking Table 4.2 into account, it can be stated that:

- All considered criteria and parameters for evaluating the appropriateness (validity) of MGF-MCL got the (acceptance) percentage over 50, a reasonable indicator of general acceptance.
- Among the 11 questions addressed in this survey, only the three questions that are related to the criteria "perceived ease of use" and "cost effective" had the percentage between 56% to 63%. The other 8 questions had a percentage ≥ 72. The average percentage given to all the criteria and parameters is also 72. It shows a convincing indicator of framework compliance.
- The given answers show that there are not any strongly disagreement for the addressed points (questions). In fact, there are only 7 disagreements in total which is not high.
- Totally, there are 39 "agreement" and 28 "strong agreement" which is a considerable positive reaction.
- As a whole, there are only 10 answers which claim that "I am not sure", and 4 answers that said, "I don't know". Indeed, this rate is not high at all. Due to the fact

that the MGF-MCL is evaluated theoretically and conceptually at this stage, thus a percentage of ambiguity and uncertainty is understandable.

Given the convincing results and positive feedback achieved through the above-mentioned evaluation and after several rounds of discussion, at the end the ED-EN HUB partners and stakeholders accepted MGF-MCL as an appropriate framework to be used in the project for supporting and directing the creation, development, and implementation of EDENCP (a reasonable indicator for framework validation). This experiment raised the first green flag for the proposed framework.

Having found the MGF-MCL as an appropriate framework to be considered, the partners and stakeholders proceed with its applicability evaluation. In this regard, the framework was first customized collaboratively by partners and stakeholders based on objectives, requirements, and conditions of the project. Afterward, the partners and stakeholders through three rounds of (developed) questionnaires tried to evaluate the applicability of the MGF-MCL, relying on the considered criteria and parameters for this purpose namely, adequacy, feasibility, and effectiveness.

It should be noted that the MGF-MCL can be applied to a specific MCL case either fully or partially. This decision should be made by the decision makers in the target case. In ED-EN HUB project, all parts addressed in the framework are considered potential for application on EDENCP.

Figure 4.4 illustrates the approach used for applying the MGF-MCL to EDENCP. This application has mutual benefits for both sides (that is a kind of co-evolution).

Benefits for EDENCP:

- Driving and supporting the process of implementation, operation, and management of EDENCP,
- Modifying and developing the specified EDENCP (system) functions.

Benefits for MGF-MCL:

- Improving and developing the MGF-MCL based on the feedback provided by the partners, stakeholders, and developers of EDENCP,
- Moving toward MGF-MCL (framework) validation.

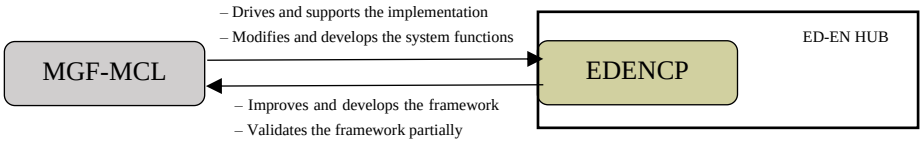


Figure 4.4. Application of MGF-MCL to the EDENCP context.

To start the practical experiment with the demonstration of MGF-MCL as well as to evaluate its applicability to the EDENCP, a specific governance process was adopted by taking into account the proposed governance process (that is presented as "part 2" in Figure 3.1). The governance process evaluates and then orchestrates the identified factors, relationships, transactions, and other influences on EDENCP. The governance process emphasizes a series of steps, tasks, and decisions that are fundamental in assuring the appropriateness of MGF-MCL for implementation on EDENCP. The proposed governance process is dynamic and flexible to change and development. That is, based on the objectives, circumstances, and requirements of a concreate case, its parameters can be changed accordingly. The adapted governance process for EDENCP is illustrated in Figure 4.5.

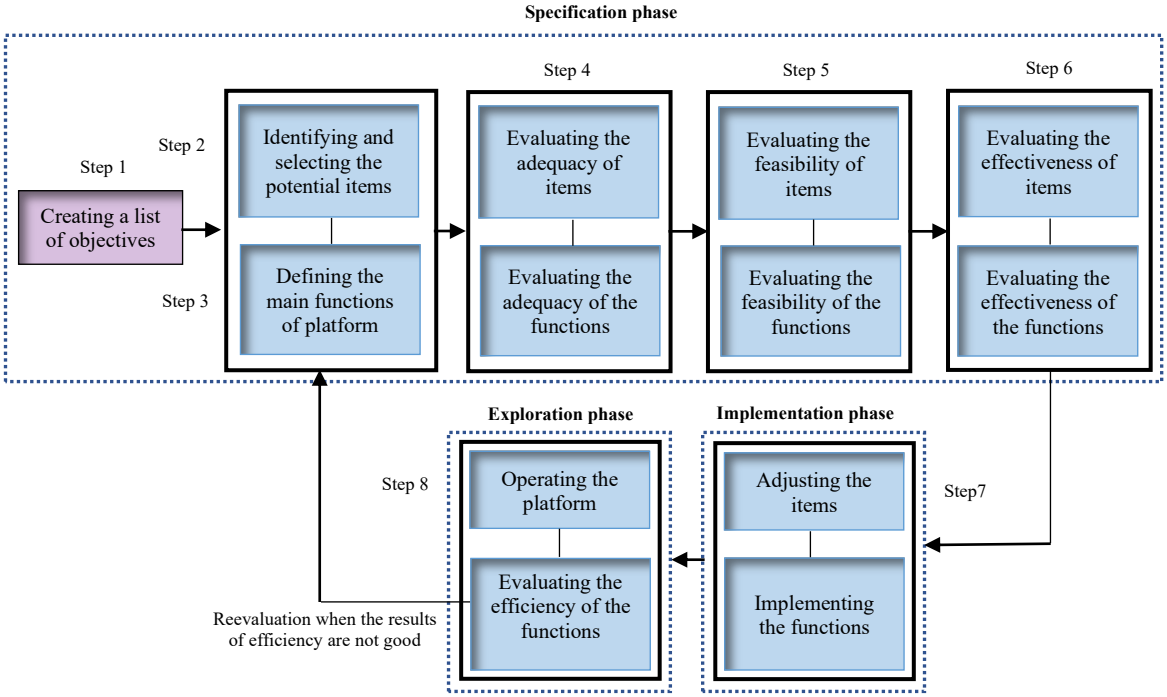


Figure 4.5. Governance process to apply the MGF-MCL.

As illustrated in Figure 4.5, in the governance/evaluation process (used for ED-EN HUB) consists of 3 phases (specification, implementation, and exploration) and 8 steps that are briefly explained in the following:

- *Step 1 - Creating a list of the required EDENCP's objectives and outcomes*: these objectives indicate what the ED-ED HUB project wants to achieve by using the EDENCP. Thus, the objectives were collaboratively defined by the project's partners and stakeholders.
- *Step 2 - Selecting the potential factors, features, and elements from MGF-MCL that can be considered for implementation on EDENCP:* the addressed factors, features, and elements in MGF-MCL (Figure 3.1) were inspired from (a) the related models and framework in the literature, (b) the background knowledge of the author, and (c) from 15 cases of MC that are presented in Table 2.4 and analyzed in Table 4.3. Taking into account Figure 3.1 and Table 4.3, the potential factors, features, and elements were selected for consideration in EDENCP. These items were then customized based on EDENCP's objectives, requirements, and specified functions. These items are presented in the questionnaire which is addressed in Appendix 1.
- *Step 3 - Determining the main functions of EDENCP*: these functions refer to action executions and transactions in the system. Considering the objectives and requirements of ED-EN Hub, 8 functions were collaboratively proposed (by partners) to provide a clear vision of the activities that should be performed in the MCL system against the proposed EDENCP objectives. These functions are listed in Table 4.4.
- *Step 4 - Evaluating the adequacy of the (a) selected factors, features, and elements as well as (b) determined functions*: this step first evaluates whether or not the selected factors, features, and elements are reasonable enough and adequate to be used in the EDENCP. This task was performed by using an instrument (questionnaire) shown in Appendix 1. Next, the 8 system functions were collaboratively evaluated to find the ones that can adequately meet the EDENCP objectives. These relationships are marked with (X) in Table 4.4.
- *Step 5- Evaluating the feasibility of the (a) selected factors, features, and elements as well as (b) determined functions*: the first part of this step of evaluation aims to rationally and objectively uncover the strengths and weaknesses of the selected factors and features in the real environment. The feasibility was benchmarked against technical capabilities and the budget available. This step was performed by means of the questionnaire shown in Appendix 2. The second part of the evaluation deals with

developing the explanation of the functions, adjusting the number of functions, and also reflecting the functions in the questionnaire used in this step.

- *Step 6 - Evaluating the effectiveness of the (a) selected factors, features, and elements as well as (b) determined functions*: this step first evaluated the effectiveness of selected factors, features, and elements aiming at reducing the number of wasted resources that are used to develop the MGF-MCL and reach the desired results. This task was performed by using the questionnaire shown in Appendix 3. Then after, through a group discussion the partners made a decision about the effectiveness of functions. All the first 6 steps of evaluation in the governance process are considered as "specification phase".
- *Step 7 – Adjusting MGF-MCL and implementing MCL system (functions)*: having made the last changes that lead to framework improvement, the system functions should then be implemented to make the services available for users.
- *Step 8 – Operating MCL system and evaluating the efficiency of MCL system (functions)*: when the MCL system starts operating for a certain period, its efficiency should be then evaluated against its objectives.

In the following, the steps taken, and the approaches and instruments (questionnaires) used in the project for the evaluation of adequacy, feasibility, and effectiveness of MGF-MCL are presented.

Creating a List of the EDENCP's Objectives (Step 1)

The following 5 objectives are collaboratively created to help in setting the goals in a way that all project activities lead to one single direction:

- *Determining skills requirements*: which addresses the main general and specific skills as well as transversal and transferable competences that are applicable to both initial and continuing education (based on the principle of education industry cooperation).
- *Co-designing, developing, and training*: which provides guidelines and resources that can be used in training events for either people from the educational side who wants to implement education enterprise actions or for people from the business side who needs to reinforce their links with the educational system.
- *Detecting, assessing, and clarifying (policy recommendations)*: which represents the synthesis of the experiences developed during the project in the five regions targeted by EDENHUBs. The recommendations will be drafted by classifying and comparing the main policy objectives to which the creation of the joint structure is associated, the range of developed functions and concrete results achieved,

difficulties in the start-up, funding and collaboration models, solutions found in consolidating collaboration, models of public-private collaboration and governance developed.

- *Creating career guidance:* which presents a complete and secured accompanied pathway for people, from their first choice of orientation (at the age of 14, when compulsory education positions the pupil with regard to choose), to professional reorientation, through the question of guidance and training in collaboration between the stakeholders in education/training and the company.
- *Organizational benchmarking (benchmarking process description*): which clarifies what collaboration activities are expected to take place through the collaboration platform.

Selecting the Potential Factors, Features, and Elements (Step 2)

As mentioned above, in order to identify and select the potential factors, features, and elements (which could be implemented on EDENCP), the structures, models, and methods used in 15 cases of MC (presented in Table 2.4) are reviewed, analyzed, and then summarized in Table 4.3. Afterward, the selected items are accommodated in MGF-MCL and then customized for application to the EDENCP. Through the process of MGF-MCL customization for EDENCP, the partners and stakeholders attempt to use the proposed items or alter them (if needed) to suit platform's preferences or requirements. For example, instead of supporting the open access to the platform for all people, some access restrictions are considered for EDENCP.

Table 4.3. 15 Representative examples of mass collaboration and their positive and negative features.

15 Examples of MC and their features	
1. Wikipedia	
➢ ***Positive Factors***	➢ ***Negative Factors***
• Free, contributed by volunteers • Open access • Easy inclusion, anyone can participate • Users can play different roles and do different tasks • No power hierarchy, users are treated (almost) equally • Articles are continuously developed, updated and checked • Consensus can be reached through friendly and open discussion	• Wikipedia editors are anonymous • Quantity or frequency of contributions is not controlled • Not all contents are accurate; the scientific level of articles varies • Contents are not free from bias • Anyone can vandalize the articles • Some users might have fake credentials
2. Digg	
➢ ***Positive Factors***	➢ ***Negative Factors***
• A user-driven website, open to anybody • Easy inclusion • Log in is mandatory, users need to create a Digg user account	• There is no editorial control on submissions

• Users are volunteers and can play different roles and participate in different tasks • Users can add friends and develop their relationships • Users' information and contributions are associated to their Digg profile • Stories are classified into different groups based on topics • Good stories will be promoted • Contents are checked by the system • Digg raises capital from investors	• Influential group of users can affect the information credibility, promotions, burying, and votes • Users cannot share their opinions because Digg lacks commenting features on the website
3. Yahoo! Answers	
➢ ***Positive Factors*** • Yahoo! Answers was an open learning community, available in 12 languages, and open to all • Users could connect, share info, add comments, ask questions, answer others' questions and/or vote • There were some categories with multiple sub-categories for organizing the questions • There were a "Point System" (scoring) and a "Voting System", • Users could receive a "badge" under their name, e.g., naming them as a "Top Contributor" • Staff could reach different levels of authority and site access • Supportive users were featured on the Yahoo! Answers Blog • The "user moderation system" handled its misuses • Posts could be detached if they received a sufficient negative weight • Supported by funds and financial aides • Provided diverse supportive services	➢ ***Negative Factors*** • Users could use any name and photo for opening the account • There was no system to filter the incorrect answers • There were improper grammar and incorrect spelling in answers • Once the "best answer" was chosen, there was no chance to add more answers nor improvement
4. SETI@home	
➢ ***Positive Factors*** • Open to anybody • Easy inclusion • Participants are volunteers and can build a team and make competitions • Has a "Voting System" to determine the validity of the results • The "Credit System" can monitor how much work is done • It can raise financial donations	➢ ***Negative Factors*** • The risk of cheating (for gaining credit) is high • Some participants might misuse the resources of the projects to gain work-unit results • The projects cannot share their resources
5. Scratch	
➢ ***Positive Factors*** • Open to anybody and available in 70+ languages • It can be used in different settings: schools, libraries, community centers, museums, and homes • Users can ask questions, share their creative ideas, stories, and projects, get feedback, and collaborate with others • If something breaks the community's rules, Scratch will take respective action (e.g., sends a warning to the account, removes it, or blocks the account)	➢ ***Negative Factors*** • Without creating an account, users can contribute (e.g., create their own projects, read and put comments) • Users can create several accounts
6. Galaxy Zoo	
➢ ***Positive Factors*** • Easy inclusion	➢ ***Negative Factors***

• Users are volunteer • Creating user account is necessary • Username is associated to user's contributions • It uses computer technologies and human intelligence for classification of galaxies • It monitors and analyses some of the contributions and transactions • Information is stored in a secured database • It uses "Amazon Web Services" to rapidly serve the website to a large number of people • It raises funds	• Using the real name is not a must for registration • Personal information cannot be completely removed from the system • The classification system cannot provide feedback about the process of classification
7. Foldit	
➢ ***Positive Factors*** • Open to all • Easy inclusion, engaging the general public and scientific teams in online research • Players can use Foldit forum for collaborations e.g., train new players • It relies on human-computer interaction • It has a "Ranking" and "Awarding System" • The website records, monitors, and stores the posts and interactions • It publishes all important scientific discoveries • The results can be used in scientific publications • It benefits from grants	➢ ***Negative Factors*** • Players can play without an account, so there are many anonymous identifiers in the community • It is not easy to learn and play Foldit • Playing Foldit needs a reasonably powerful computer
8. Applications of the Delphi method	
➢ ***Positive Factors*** • There are different types of Delphi • Each panel will be selected and invited • The experts can discuss about or comment on others' forecasts • All the experts and their forecasts are giving equal weight • It can be applied in the several different fields of science • It can raise funds	➢ ***Negative Factors*** • The potential experts might not agree or be available for participation • The method is not able to make complex forecasts with multiple factors • The response times might take several days or weeks
9. Climate Colab	
➢ ***Positive Factors*** • Benefits from contribution of experts and crowds • Easy inclusion • Users are volunteers and can play different roles and perform different tasks • Users can collaborate on the platform with whoever is interested in similar topics • Users can comment on others' proposals • It has a "Voting System", "Rewarding System", "Messaging System", and "expert advisory board" • In the website, there is a list of community members, their points, roles, activities, and membership date • It raises funds and financial supports	➢ ***Negative Factors*** • It must continuously identify, invite, and maintain a large number of different expertise • It uses top-down approach in the community
10. Assignment Zero	
➢ ***Positive Factors*** • Open to all • Users are volunteers	➢ ***Negative Factors*** • Users might produce and share stories recognized as useless

• Users must create a user account by providing the real full name and a valid e-mail address • There is a list of tasks that users can perform • Users can contribute to different topics • Users are encouraged to make themselves known to the public by providing their biography • It gives credit to the contributions, and it is supported by founds	• Interviews often take place face-to-face, so the candidates have to live close to the interviewee
11. DonationCoder	
➢ ***Positive Factors*** • It provides free tools and services • Registration needs a valid email address • There are different forms of communication • All users are considered equal • It benefits from grants and donations	➢ ***Negative Factors*** • Users can sign up at the website by using a different email and name • Some sections of the website are available only to donators • For participation in the forum, participants require first donating, and then receiving the license key, registering a forum account, and lastly upgrading their forum account • The contracting and consulting services are not cheap
12. Experts Exchange	
➢ ***Positive Factors*** • Users must register with accurate email address • Users are not allowed to have more than one account, • Users are volunteers • EE covers over 230 tech topics, and prioritizes the contents based on usefulness • Users can receive recognition and secure credentials with "Credly" (a digital badge platform that provides digital credentials to individuals through working with credible organizations) • EE provides a variety of professional training courses in a wide variety of topics, and it produces various video tutorials	➢ ***Negative Factors*** • EE provides answers only via paid mode • If a user account is past due, EE might cancel the account for non-payment
13. Waze	
➢ ***Positive Factors*** • User-generated community • It is free to download and can be used anywhere • It relies on crowd sourced information • Users need registration • Users can connect and work together • It offers points to users • Advertising is the main source of generating revenue	➢ ***Negative Factors*** • Using Waze needs enough initial and active users to collectively create the local maps and continuously update data to make it useful • Very limited number of countries (13) have a full base map, in others either the map is incomplete, or not yet used • Waze currently supports only private cars, not public transportation, bicycle, or trucks
14. Makerspaces	

➢ ***Positive Factors***	➢ ***Negative Factors***
• It is member-driven • It can take different forms (physical, virtual), shapes, sizes, and for different purposes • Most of Makerspaces need registration • Users are people with common interests • Users can meet, socialize, and collaborate (on projects), co-create, learn new skills, share, research, explore and invent, prototype, solve problems, play, and even boost self-confidence • It benefits from funds and financial support	• Some Makerspaces have membership fees • Physical Makerspaces have been criticized for their high costs associated with tools and materials
15. SAP Community Network	
➢ ***Positive Factors*** SAP community network serves as a resource repository and a platform for SAP users to collaborate with each other • Software users, developers, consultants, mentors and students use the SAP Community Network to get help, share ideas, learn, innovate and connect with others • Open to all • Users are volunteers • It offers/hosts discussion forums, tutorials, expert blogs, sap code sharing gallery, utilities, technical library, wiki, article downloads, e-learning catalogs, and other facilities through which its users contribute their knowledge • It has its own channel on YouTube • Its users' knowledge contribution to the community can be quantified • It has a contributor recognition program (CRP) that awards points to community users for each technical article, code sample, video, wiki contribution, forum post, and weblog authored. • SAP publicly recognizes its most active contributors • It has over 430 spaces (sub-groups)	➢ ***Negative Factors*** • Knowledge flows are not measurable • The questions asked before are not easy accessible • It is impossible to read the list of problems in the scope of the theme • There is no control to navigate to the blogs section directly • It is difficult to find the important and most liked blogs

Determining the Main Functions of EDENCP (Step 3)

The following 8 functions are collaboratively defined for EDENCP by the project partners and stakeholders:

- Developing an appropriate search engine.
- Determining the aspects, components, and features of collaboration.
- Managing training process.
- Providing training execution support.
- Designing curriculum.
- Inserting new competence demands.
- Providing suitable tools to evaluate the performances.
- Providing proper database/service that introduce and offer promising, validated, and trusted tools.

These functions refer to EDENCP functionality and its ability, capabilities, and features that all together will provide the defined services in accordance with the specifications as set out in the project.

Evaluating the Adequacy of Selected Factors, Features, and Elements (Step 4)

To evaluate the adequacy of MGF-MCL for usage in EDENCP, a number of positive factors and specific features (selected from Table 4.3) that have potential applicability are picked out. To evaluated and benchmark the adequacy and importance of the nominated factors, features, and elements, they are addressed in 100 questions, forming the adequacy questionnaire (see Appendix A).

Each question in the questionnaire represents a potential factor, feature, or elements that might be used on the platform. The questions - based on the specifications and characteristics that they present- are classified under 9 considered dimensions of collaboration namely, organizational, environmental, admission, behavioral, social, structural, functional, technological, and economical. This classification facilitates the presentation, analysis, and interpretation of the results of evaluation.

The adequacy and importance of the selected factors, features, and elements (to be considered for EDENCP) are asked and assessed by a checklist in the questionnaire. There are six possible answers in the checklist for each question namely, strongly disagree, disagree (SDA), agree (A), strongly agree (SA), I don't know, and I'm not sure (now). The evaluators (partners, constituting a kind of "focus group" in terms of the Design Science method) not only can choose one of these possible answers, but they can also put comments and feedback (if needed) about each addressed item in each question. It is noteworthy to mention that this questionnaire provides a kind of global evaluation of the considered dimensions and their respective factors, features, and elements.

The questionnaire was sent to each partner of the ED-EN HUB consortium, and they were asked to respond to the questions collaboratively (with their internal involved members who are experienced in this field of study and work). Therefore, the questions in each questionnaire were answered via the collaboration and confluence of different minds rather than a single partner. This strategy not only helped to reduce the number of questionnaires that were sent out, answered, and evaluated, but also increased the quality and accuracy of the given answers.

The main results of adequacy evaluation (average of popularity of adapted factors, features and elements for implementation on EDENCP) achieved from analyzing the 5 received questionnaires are summarized in Table 4.4. In this step of evaluation, the received responses are analyzed manually.

Table 4.4. Average of popularity given to the dimensions in adequacy evaluation.

Considered Dimensions	Number of questions per dimension	Average of popularity gained from adequacy evaluation
- Organizational	7	83.57%
- Environmental	7	69.28%
- Admission	12	82.91%
- Behavioral	8	63.75%
- Structural	15	71%
- Social	7	70.71%
- Functional	25	66%
- Economical	10	58.50%
- Technological	9	76.66%

To have a better view of the results of this step of evaluation, they are also displayed as a radar chart in Figure 4.6.

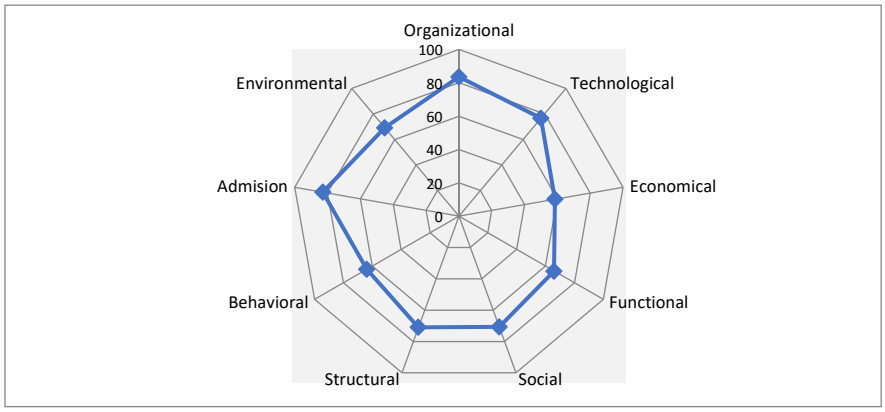


Figure 4.6. Average popularity of 9 dimensions obtained from adequacy evaluation.

Taking into account the given responses to the questions of the adequacy questionnaire, and from the performed analysis it can be concluded that:

- The 9 considered dimensions are generally accepted by all evaluators (partners), because the average popularity given to all dimensions is above 50% (an indicator of acceptance).
- Among the considered dimensions, the organizational dimension and its respective features, factors, and elements received the highest average of popularity (83.57%), whereas the economical dimension received the lowest average of popularity (58.50%) from the respondents' point of view.
- Analyzing all responses given to every single question (in all dimensions) shows that some of the selected and adapted factors, features, and elements (that the average of their popularity is lower than 50%) need to be revised, improved, changed, or omitted (in some cases), before moving to the next phase of evaluations.

In this direction, the provided feedbacks by the partners offered very good ideas of what other important points need to be addressed in further developments.

Evaluating the Adequacy of Functions (Step 4)

After evaluating the adequacy of selected factors, features, and elements, the defined functions for the EDENCP were also evaluated. This evaluation focuses on judging whether or not the functions can adequately meet the objectives of EDENCP. Thus, in a theoretical and conceptual evaluation, the functions that show signs of adequacy for meeting one or some objectives are marked with (X) in Table 4.5. This Table addresses the 8 defined functions and the 5 considered objectives for EDENCP. This step of evaluation also gives a view of the potential interactions among the EDENCP functions and objectives.

Table 4.5. Evaluating the adequacy of system functions.

ED-EN HUB Main Processes					
EDENCP Functions	EDENCP Objectives				
	Determine Skills Requirements	Co-Design, Develop and Training	Detect, Assess and Certify	Career Guidance	Organizational Benchmarking
1. Search Engine	x	x	x	x	x
2. Collaboration	x	x	x	x	x
3. Managing training		x			
4. Training Execution Support		x			
5. Design Curriculum	x	x			
6. Insertion of new Competences demands	x	x		x	
7. Tools to evaluate Performance (benchmarking)			x	x	x
8. Database/service offering different tools	x	x	x	x	x

The results of function evaluation give direction to function creation, development, and implementation. The results of the adequacy evaluation in this step are used as a base for feasibility evaluation.

Evaluating the Feasibility of Selected Factors, Features, and Elements (Step 5)

In this step of evaluation, the technical team of the project (from NOVA University Lisbon) attempted to judge the possibility, ability, and feasibility of selected factors, features, and elements in supporting the EDENCP with the least amount of wasted time, money, and effort. In this way, they tried to provide a fact-based understanding of the current level of the framework's feasibility and maturity. The gained insight was enriched by employing both knowledge-based questions and application-based techniques. In this process, not only the technical feasibility of MGF-MCL is evaluated based on available budget and technical capabilities, but also the technical risks of MGF-MCL application are identified, quantified,

and reported. In this step, evidence-based evaluations and data-driven decisions are also helpful strategies that were taken into consideration.

Then, the technical team proceeded to further assessment of the selected factors, features, and elements according to the EDENCP functional requirements. Hence, the second questionnaire is collaboratively developed to collect the opinion of partners in this regard. In this questionnaire, 9 related questions are designed for each function, addressing the most important technical aspects (factors, features, and elements) that should be evaluated for feasibility assurance. The formulated questions are polar question (Yes or No questions). This questionnaire is illustrated in Appendix B.

The results gained from the primary round of questionnaire (used for evaluating the adequacy of developed and adapted factors, features, and elements) are used in the project as a base for feasibility evaluation. That is, those addressed factors, features, and elements (in the questions) that received high popularity and their threshold is ≥ 80%, are selected for consideration, further evaluation, and probable implementation on EDENCP.

Table 4.6 summarizes the results of adequacy evaluation (shown in Table 4.4), plus the number of questions (used in the questionnaire) per dimension, and the number of questions per dimension whose threshold is ≥ 80. The threshold 80 was specifically suggested for the selection of potential items as it could make a balance between the number of factors, features, and elements addressed in the questionnaire and the sum of items needed for feasibility evaluation in the next stage. In other words, in adequacy evaluation (step 4), 100 factors, features, and elements are addressed in the questionnaire (one item per question). The number of addressed items for application to the EDENCP are relatively high, aiming to provide reasonable number of potential items for selection and also giving this chance to the evaluators to select the items from the list that they think are the best. Because, from feasibility point of view, it is not cost effective to implement all those items in the EDENCP. It is note taking that the considered threshold (≥ 80, which is relatively high) caused a significant reduction in the number of considered factors, features, and elements (that should be used in the next steps of evaluation). This level of threshold and high percentages of popularity, however, give a certain degree of assurance for feasibility consideration.

Table 4.6. Results of adequacy evaluation and considered threshold that were used for feasibility evaluation.

Considered dimensions	Results of adequacy evaluation	Number of questions per dimension	Number of questions per dimension that their threshold is ≥ 80		Base for consideration in feasibility evaluation
- Organizational	**83.57%**	7	5		71.42%
- Environmental	69.28%	7	3		42.85%
- Admission	82.91%	12	9		**75%**
- Behavioral	63.75%	8	3		37.50%
- Structural	71%	15	7		46.66%
- Social	70.71%	7	4		57.14%
- Functional	66%	25	7		28%
- Economical	**58.50%**	10	2		**20%**
- Technological	76.66%	9	6		66.66%

The graph illustrated in Figure 4.7 provides a better view of the results presented in Table 4.6.

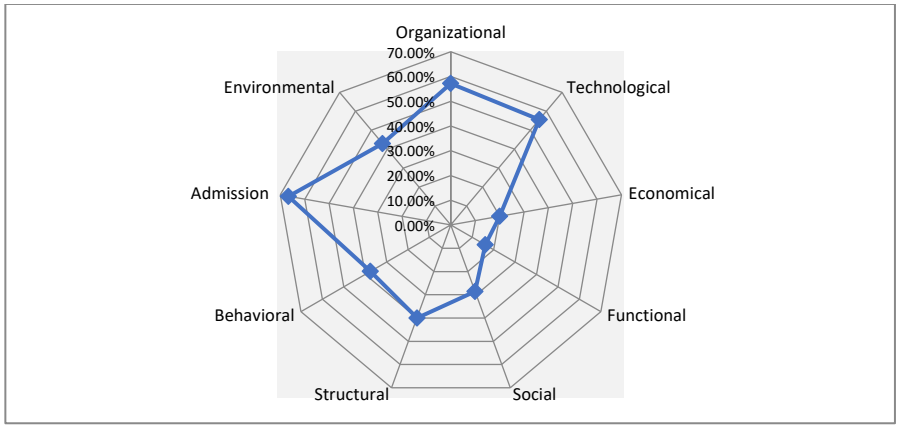


Figure 4.7. Results of adequacy evaluation and considered threshold that were used for feasibility evaluation.

Taking into account the considered threshold, it should be highlighted that:

- The dimension of admission has the highest percentage of popularity with (75%), followed by the organizational dimension with (71.42%). However, the lowest percentage of popularity (given by the evaluators) belongs to the economical dimension with (20%).
- The low percentage of popularity of some dimensions (in both situations, before and after considering the threshold) namely, economical, functional, and behavioral shows that these dimensions did not receive high attention (in comparison with other considered dimensions) from the evaluators point of view.
- Those dimensions that gained higher percentages of popularity namely, admission, organizational, and technological, indicate that they have high potential of

feasibility (from the evaluators' perspective) to be implemented in EDENCP. Thus, the focus of attention should be given to these dimensions.

In the second stage of feasibility evaluation, the questionnaire was sent to the same group of partners (who participated in the adequacy evaluation), but at this time 18 evaluators individually responded the questions, because the partners and stakeholders decided to come up with a mix of group and individual evaluation. The results achieved from the feasibility questionnaire are presented in Table 4.7. Those factors, features, and elements (that are highlighted with green color) received a popularity over 60%. They are selected as potential items for the next step of evaluation (effectiveness). At this time the threshold 60 was suggested by the partners and stakeholders, as it is believed that it can reasonably adjust the number of considered items for effectiveness evaluation. It means that we attempt to narrow down with different steps of evaluation (as it is shown in Figure 4.8) and minimize the number of considered items as much as reaching a logic number of possible and feasible items to be integrated to the platform.

Table 4.7. Results of second step of feasibility evaluation.

Functions	Average of Popularity of Functions	Organizational	Environmental	Admission	Behavioral	Structural	Social	Functional	Economical	Technological
F 1	55.55%	83.33%	55.56%	66.67%	50.00%	66.67%	66.67%	33.33%	16.67%	61.11%
F2	53.08%	72.22%	83.33%	66.67%	11.11%	72.22%	44.44%	44.44%	33.33%	50.00%
F 3	50.61%	72.22%	94.44%	22.22%	66.67%	61.11%	38.89%	72.22%	11.11%	16.67%
F 4	52.46%	50.00%	83.33%	50.00%	66.67%	50.00%	61.11%	55.56%	11.11%	44.44%
F 5	53.70%	72.22%	38.89%	83.33%	55.56%	38.89%	100.00%	61.11%	5.56%	27.78%
F 6	52.46%	50.00%	61.11%	50.00%	83.33%	61.11%	61.11%	38.89%	22.22%	44.44%
F 7	51.85%	55.56%	61.11%	61.11%	66.67%	61.11%	44.44%	55.56%	16.67%	44.44%
Av	52.81%	65.07%	68.25%	57.14%	57.14%	58.73%	59.52%	50.58%	16.66%	41.26%

Taking into account the results shown in Table 4.7, it should be underlined that:

- The low average of popularity given to the economical dimension (16.66%) and technological dimension (41.26%) shows that the majority of addressed factors, features, and elements in these two dimensions do not have much chance to be implemented in the EDENCP from the feasibility point of view.
- The selected factors, features, and elements should be prioritized in the process of implementation on EDENCP. That is, those that received a higher percentage of popularity (e.g., factors, features, and elements in social dimension used for function 5, with 100%) need to be given more attention and emphasis.

- The dimensions also should be prioritized in the process of implementation in EDENCP. For example, among the addressed dimensions, the environmental dimension received a higher percentage of popularity (68.25%). In this way, the developers and decision-makers can manage the resources for implementation according to dimensions' feasibility and popularity.

Evaluating the Feasibility of Functions (Step 5)

Evaluation of the proposed functions led to developing (collaboratively) their description. In addition, further function evaluation caused to merging the first function (search engine) with the last function (database/service offering different tools). So that the first function is eventually changed to "search engine for finding information and tools". Therefore, the number of functions reduced to 7, as addressed in Appendix B and explained in the following:

- *Function 1 (Search engine for finding available information and tools on EDENCP):* provides a software system that is designed to carry out specific searches related to particular competences (of members), courses, activities, and supporting tools.
- *Function 2 (Collaboration):* deals with collaborative practices whereby some members work together to complete a task, solve a problem, and/or achieve a shared goal.
- *Function 3 (Managing Training)*: focuses on flexible strategies that can properly manage different aspects of training from program creation to evaluation and prioritizing learning needs.
- *Function 4 (Training Execution Support)*: provides the needed support for (a) training execution, (b) learning engagement strategies, and (c) implementation of performance-based assessment for training proficiency.
- *Function 5 (Design Curriculum)*: is a cyclical, and analytical process that helps to create a training framework which is able to facilitate and guide the creation of training programs in a particular domain. It integrates different training elements such as learning strategies, processes, materials, and experiences that may help to design and develop such training program instructions.
- *Function 6 (Insertion of New Competences Demands)*: is the process of identifying and adding the key competences and basic skills (e.g., cognitive skills of critical thinking, problem-solving, and interpersonal skills) required to perform the teaching and training with success. This function supports the identification of competences demands for the companies. It is designed for three main situations: (a) when an employer recognizes that his company needs new workers, but the new workers just arrived from the university and do not have the specific needed competences, (b) when the employer recognizes that the existing workers need to improve their competences or gain new ones for the specific tasks, or (c) when the worker recognizes (by himself/herself) that he/she needs to gain a particular competence. The main consequences of this function are to improve the existing curriculum or add new ones based on the demands of the companies.

- *Function 7 (Tools to Evaluate Performance (Benchmarking))*: is the function to evaluate the performance of (a) EDENCP in relation to its functions and (b) the workers of the companies against the transversal competencies that they have already gained. For doing so, first it needs defining some specific key performance indicators (KPIs) related to each particular performance.

Evaluating the Effectiveness of Selected Factors, Features, and elements (Step 6)

In this step of evaluation, the technical partners of the project proceeded to assessing the effectiveness of the selected factors, features, and elements, aiming to judge the degree of their success in achieving the goals of EDENCP (mentioned in Table 4.5). This task is concerned with comparing (at this stage theoretically) the inputs of MGF-MCL with the desired outputs that it can make. Therefore, to find out whether or not the selected factors, features, and elements, from feasibility point of view, are effective in obtaining the expected results, a third questionnaire was created by technical team (see Appendix C). The author of this thesis, as a member of the technical group, has played different roles in this project, for example, contributed to:

- Literature review,
- Planning, and performing experiments and surveys,
- Carrying out fieldwork, e.g., collecting samples
- Collecting, recording, and analyzing data,
- Designing and developing required questionnaires,
- Providing reports and presentations,
- Writing research papers, reviews, and summaries,
- Participating in various group meeting and discussions, and
- Anticipating what kinds of risk might observe during the task fulfilment.

Considering the above, those factors, features, and element (addressed in Table 4.7) whose popularity is over 60% were selected for effectiveness evaluation, meaning that these items were evaluated at this time from effectiveness perspective. In this step, the evaluators (partners and stakeholders), by giving a rate to each item from not at all effective (0) to extremely effective (4), tried to determine how much the MGF-MCL is effective for implementation on EDENCP. Table 4.8 presents the results of this step of evaluation from 5 received questionnaires.

Table 4.8. Results of effectiveness evaluation.

Functions	Organizational	Environmental	Admission	Behavioral	Structural	Social	Functional	Economical	Technological
F 1	95%		90%		95%	80%			75%
F2	90%	95%	75%		90%				
F 3	95%	95%		80%	75%		90%		
F 4		90%		80%		80%			
F 5	80%		95%			95%	75%		
F 6		80%		90%	80%	75%			
F 7		75%	80%	90%	80%				
Sum	90%	87%	85%	85%	84%	82.5%	82.5%		75%

As it can be seen in Table 4.8, except for the economical dimension, the other dimensions have at least one factor, feature, or elements for effectiveness evaluation. From the results of this evaluation, it can be said that:

- Among the addressed dimensions, the organizational dimension got the highest percentage of popularity (90%), whereas the technological dimension received the lowest percentage of popularity (75%). In general, it shows how much effective the dimensions are from the evaluators' perspective.
- Those dimensions and their related factors, features, and elements whose percentage of popularity (gained from this evaluation) is lower than 80% (the considered threshold for this step), were not regarded as enough effective items to be implemented on the EDENCP. Meaning that those factors, features, and elements that their percentage of popularity is 75 (highlighted with yellow color), were all taken out from the list.
- In function implementation (step 7), those dimensions that have higher percentage of popularity should be prioritized. As an example, in implementation of function 1, the priority (based on available resources and capabilities) should be given to organizational and structural, admission, and social dimensions respectively.

Evaluating the Effectiveness of Functions (Step 6)

In some online and face-to-face plenary group meetings that the focus group had with together they made several discussion and argumentation about the effectiveness of EDENCP functions. In these meetings, they shared their views and opinions around the following related questions:

- Can the function(s) achieve the desired/targeted goals?
- Can the function(s) gain a certain degree of success?
- Can the function(s) produce the desired effect?

- Can the function(s) be operated according to the project plan?

By critically assessing different aspects of functions' effectiveness, the partners finally came to the conclusion that the existing (theoretical) evidence makes a convincing impression of the effectiveness of the functions. That is, they decided to keep the functions as they are until reaching the results of efficiency evaluation. Then after, they can make the needed decisions and actions if needed.

It should be added that in the specification phase (from step 1 to step 6), some strategies are taken into consideration namely, engaging the partners in different stages of evaluation, clarifying the evaluation process, collaboratively designing the process of evaluation and developing the questionnaires, gathering credible evidence, justifying the conclusions, and using and sharing lessons learned.

The other two phases of evaluation (implementation and exploration) are still in progress in ED-EN HUB project at the stage of concluding this thesis. But the results of their evaluation will be reported in future publications.

Figure 4.8 clarifies the process of MGF-MCL validation and applicability evaluation in the ED-EN HUB project.

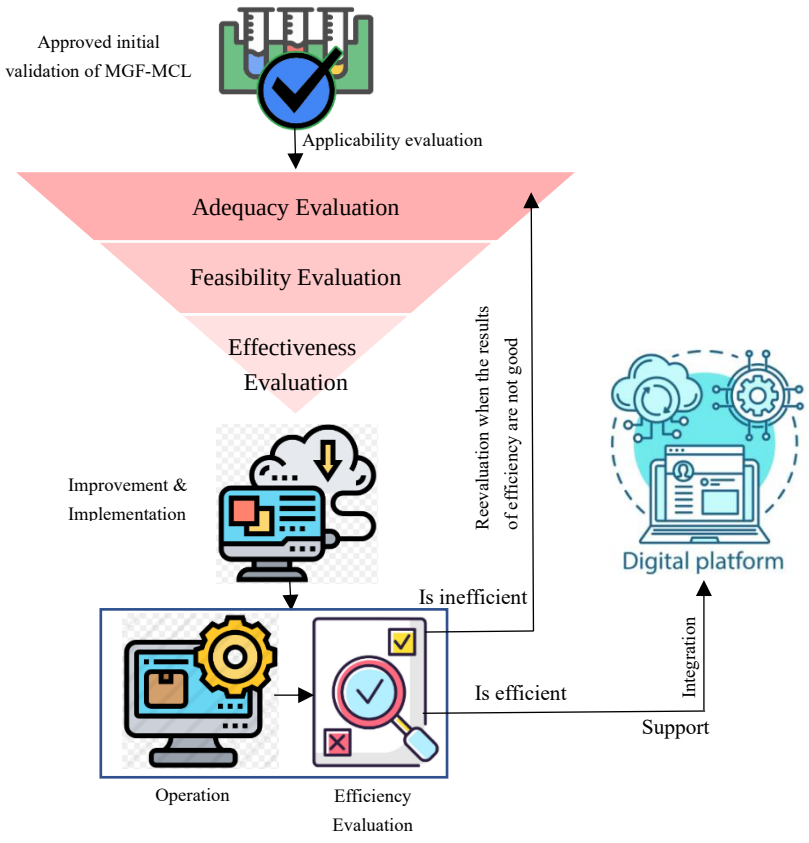


Figure 4.8. Sketch of MGF-MCL validation, adaptation, evaluation, and application in the ED-EN HUB project.

As it is shown in the Figure 4.8, initially the validation of the MGF-MCL was checked to ensure that it is enough appropriate to be applied to the EDENCP. The three first steps of applicability evaluation (adequacy, feasibility, and effectiveness) are then fulfilled. In this phase of evaluation, the identified factors, features, and elements were evaluated and customized step by step, offering a shrunken number of items with high potential of application on EDENCP. After completing the other two phases of evaluation (implementation and exploration) the efficiency (which is the last considered criterion and parameter for applicability) of MGF-MCL will be evaluated. In this step, if a factor, feature, or element is found inefficient, it should be then reevaluated by the governance evaluation process. In case a factor, feature, or element is recognized as an efficient item, it can be used for integration into the EDENCP.

The primary results gained from the evaluation of specification phase show that the MGF-MCL is fairly adequate, feasible, and effective to be applied to EDENCP. As a results, the positive results obtained in this case (up to this stage) through the evaluation of the MGF-MCL appropriateness and applicability could bring the framework one step closer to full validation.

4.1.1.2 Case Study 2

The MGF-MCL is also used in the ENHANCE project (http://eplus-enhance.eu/). ENHANCE is co-funded by the Erasmus + Programme of the European Union. The project contributes to strengthening the skills and training expertise of Tunisian and Moroccan universities in three targeted topics namely, maintenance engineering, production engineering, and quality engineering (which refer to MPQ) for inciting and assisting both partner countries transition to Industry 4.0 era. The project focuses on developing a knowledge transfer framework and Lifelong eLearning Platform (LeLP).

In the ENHANCE project we applied the same strategy and approach for MGF-MCL validation and evaluation that were employed for the ED-EN HUB project. That is, the validation of MGF-MCL is first measured by evaluating its appropriateness for LeLP. The MGF-MCL is then adapted according to the goals, requirements, and circumstances of the ENHANCE project. Thereafter, the applicability of MGF-MCL to the LeLP is evaluated through the governance process exhibited in Figure 4.5. In that account, the actions that are performed in this project are briefly presented in the following sub sections.

***Evaluating the Appropriateness of MGF-MCL for Using in LeLP*:**

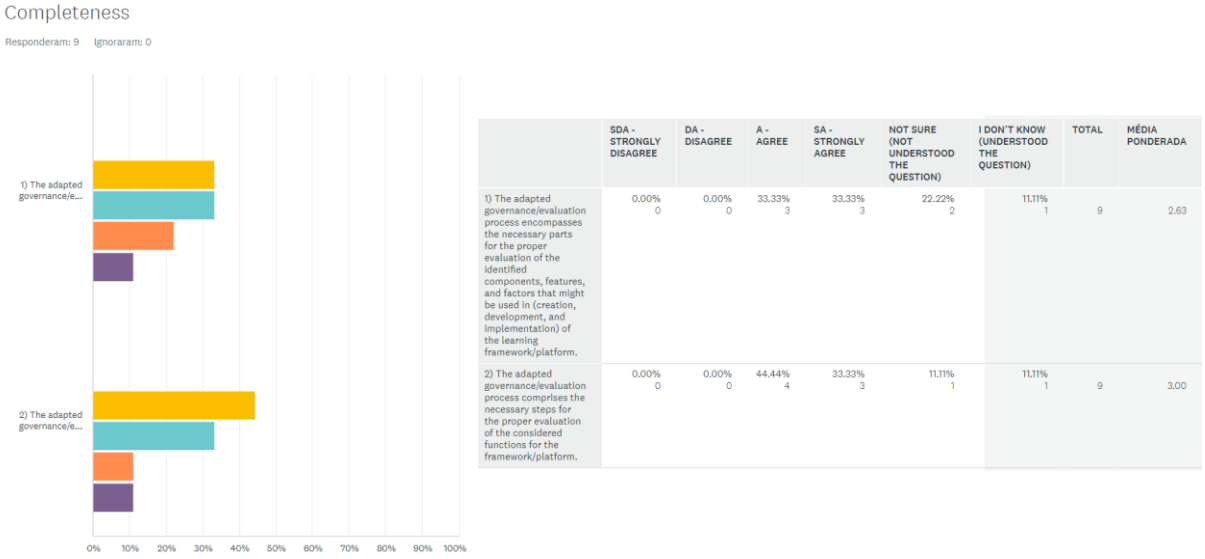
A series of useful experiences and valuable insights achieved from MGF-MCL appraisal and experimentation in ED-EN HUB project (mentioned above) that in turn facilitated for us the process of framework evaluation in ENHANCE project. As proof of this, the developed

questionnaire for the evaluation of MGF-MCL appropriateness (presented in Table 4.1) is also used in this case (by the agreement of ENHANCE partners and stakeholders). This agreement is made following several rounds of group discussion about the suitability of this questionnaire and the included points for the purpose of this case. Consequently, following this agreement, the questionnaire was sent to 9 group of partners and stakeholders toward collecting their feedback as an essential source for ongoing evaluation and improvement. The focus group of evaluators answered the questions with the collaboration of their internal colleagues who have contribution to the project. Thus, on the one side they can benefit from the advantages of collective decision making, and on the other side they can deliver better outputs. Table 4.9 presents the results of analyzing this survey questionnaire. This Table addresses the considered criteria and parameters for framework validation, number of evaluators/feedbacks, number of questions, weighted average given (by evaluators) to each criterion, percentage of popularity of each criterion (from the evaluators point of view), and the considered rates. The rates include, strongly disagree (SDA), disagree (DA), agree (A), strongly agree (SA), I am not sure (IANS), and I do not know (IDK).

Table 4.9. Results of evaluating MGF-MCL appropriateness for LeLP.

Criteria / Parameters	Feedback Number	Questions	Weighted average	Percentages	SDA	DA	A	SA	IANS	IDK
Completeness	9	Q1	2.63	65.75%	0	0	3	3	2	1
	9	Q2	3	75%	0	0	4	3	1	1
Purposefulness	9	Q3	3.22	80.05%	0	1	5	3	0	0
	9	Q4	2.78	69.05%	0	1	5	2	1	0
Perceived usefulness	9	Q5	3.44	86%	0	0	5	4	0	0
	9	Q6	3.22	80.05%	0	1	5	3	0	0
Perceived ease of use	9	Q7	3.13	78.25%	0	1	4	3	1	0
	9	Q8	2.44	61%	0	1	4	2	2	0
Cost-effective	9	Q9	2.57	64.25%	0	2	2	2	1	2
Reasonability	9	Q10	3.13	78.25%	0	0	3	4	1	1
	9	Q11	3.22	80.50%	0	1	5	3	0	0
Average	-	-	2.98	74.50%	0	8	45	32	9	5
Max	-	-	4.00	100	55	55	55	55	55	55

As an illustration, the analysis that was made with SurveyMonky for the criteria "completeness" is illustrated in Figure 4.9. It should be added that this tool is also used for other steps of evaluation in this project.



	SDA - STRONGLY DISAGREE	DA - DISAGREE	A - AGREE	SA - STRONGLY AGREE	NOT SURE (NOT UNDERSTOOD THE QUESTION)	I DON'T KNOW (UNDERSTOOD THE QUESTION)	TOTAL	MÉDIA PONDERADA
1) The adapted governance/evaluation process encompasses the necessary parts for the proper evaluation of the identified components, features, and factors that might be used in (creation, development, and implementation) of the learning framework/platform.	0.00% 0	0.00% 0	33.33% 3	33.33% 3	22.22% 2	11.11% 1	9	2.63
2) The adapted governance/evaluation process comprises the necessary steps for the proper evaluation of the considered functions for the framework/platform.	0.00% 0	0.00% 0	44.44% 4	33.33% 3	11.11% 1	11.11% 1	9	3.00

Figure 4.9. A Screen dump of the analyze made with the SurveyMonkey.

The results of the evaluation of MGF-MCL appropriateness show that:

- All the considered criteria and parameters for evaluating the appropriateness (validity) of MGF-MCL got the (acceptance) percentage over 50 which is a reasonable indicator of general acceptance.
- The average percentage given to all the criteria and parameters is 74.50. Among the 11 questions addressed in this survey, only 4 questions had the percentage lower than the average. These questions include the first question of completeness with 65.75%, the second question of purposefulness with 69.05%, the second question of perceived ease of use with 61%, and the question of cost effectiveness with 64.25%. The other addressed questions had a percentage above the average.
- The number of disagreements is relatively low (8), and there is not any evidence of strong disagreement.
- There are only 9 answers which claim that "I am not sure", and 5 answers that said, "I don't know". In essence, this is viewed as a normal consequence of theoretical evaluation.
- The number of acceptances is nearly high, agree 45 and strongly agree 32.

Given the above it can be concluded that from the results of this evaluation and also after several related group discussions there are a great number of positive feedbacks and convincible indicators of framework compliance. In a nutshell, the MGF-MCL is accepted (by the partners and stakeholders) as an appropriate framework to be used for further evaluation. Therefore, this is regarded as another evidence for MGF-MCL validation.

In the following, the steps taken (in ENHANCE) for evaluating the MGF-MCL applicability are explained. Based on the agreement made by the partners and stakeholders, these steps follow the governance process illustrated in Figure 4.5. In this project, all parts of the MGF-MCL are taken into consideration.

***Creating a List of Objectives for the ENHANCE Project (Step 1)*:**

The following 8 specific objectives are collaboratively defined by partners and stakeholders which provide guidance and direction to meet the overall goals of the project:

1) Analyzing the gap between skills acquired by students and the required MPQ4.0 (maintenance engineering, production engineering, and quality engineering Industry 4.0) skills by industry of the future.
2) Training the project partners, using Train the Trainer Approach (Sandres et al., 2015).
3) Developing innovative teaching materials using a learner-centered learning methodology.
4) Defining a quality assurance plan for the learning programs.
5) Developing a successful exploitation and dissemination strategy.
6) Creating a Lifelong eLearning (LeL) platform for practitioners.
7) Developing a learning and knowledge transfer framework addressing MPQ skills for Industry 4.0.
8) Creating Digital Innovation Hubs (DIH) in each target country.

For the purpose of this thesis work, only the last three objectives (objectives number 6, 7 and 8) are taken into account because it is assumed that the MGF-MCL can expectedly support these three objectives (among the others). For the other objectives (objectives numbers 1 - 5) another framework is considered.

Selecting the Potential Factors, Features, and Elements (Step 2)

Similar to the ED-EN HUB project, to identify the potential factors, features, and elements for implementation on ENHANCE Lifelong eLearning platform (LeLP), the information addressed in Table 4.3 is taken into account. The selected factors, features, and elements from this Table are then customized. They are then addressed in 90 questions, forming the first questionnaire for evaluating the applicability of MGF-MCL to the LeLP. (See Appendix D).

Determining the Main Functions of LeLP (Step 3)

Concerning the three considered objectives, several sub functions are needed to be considered for each main function, aiming at providing the appropriate services for users of the system. These objectives and associated functions are briefly explained in the following:

- Objective A – creating LeLP for practitioners which should support collaboration and learning in large networks of participants:
  - *Function 1* – the platform (that is usually video-based in some way) provides an online collaborative environment where users (e.g., universities, teachers, students, workers) can share their content and experiences. This function could be supported by several parts of the MGF-MCL such as organizational and behavioral structures, endogenous elements, and content assessment method.
  - *Function 2* – teachers can perform class activities such as, construct classes, deliver courses, upload videos, assign and grade quizzes and homework assignments. This function could receive support from learning and performance assessment.
  - *Function 3* – students can collaborate on finding the courses that are suitable for them and the way that they can consuming the content of courses properly. This function can be directed by organizational and behavioral structures, and endogenous elements.
  - *Function 4* – the LeLP has a built-in way for students to practice their new skills and get teachers' feedback. This function could be guided by behavioral model.
  - *Function 5* – the classes on the LeLP are self-paced, either in part or in full. This function could be supported by organizational structure.
- Objective B – developing a learning and knowledge transfer framework addressing MPQ skills for Industry 4.0:
  - *Function 1* (in maintenance engineering) – data acquisition from equipment, technologies, and functions. This function could be supported by exogenous elements and content assessment method.
  - *Function 2* (in production engineering) – creating a decision support system for continuous production plans evaluation. This function could be derived by performance assessment.
  - *Function 3 (in production engineering)* – data analytics (analyzing raw data to make conclusions) for business intelligence and value creation out of production data. This function could be steered by content assessment method.
  - *Function 4* (in quality engineering) – real-time or near-real time quality control in manufacturing. This function could be supported by performance assessment.
- Objective C – creating Digital Innovation Hubs (DIH) in each target country:
  - *Function 1* – researchers in the hubs can collaborate with university in some ways (e.g., in designing and developing learning materials), share their findings (e.g., new knowledge and information). This function can be supported by endogenous elements and content assessment method.

Evaluating the Adequacy of Selected Factors, Features, and Elements (Step 4)

In this case, in order to evaluate the adequacy of selected factors, features, and elements, they are addressed in 90 questions (as mentioned in step 2) under 11 dimensions of collaboration namely, organizational, environmental, admission, social, functional, economical, technological, structural, behavioral, learning assessment, and performance assessment dimensions. 13 evaluators (partners and stakeholders) participated in this step of evaluation as focused group. Similar to other prior developed questionnaires, the alternative choices/answers include, strongly disagree (SD), disagree (DA), agree (A), strongly agree (SA), I don't know, and I'm not sure. The evaluators are encouraged to leave their feedbacks, remarks, and recommendations about the addressed points in the questionnaire due to their constructive comments are very important for the improvement of MGF-MCL. The results of adequacy evaluation (average of popularity given to the dimensions and their related items) are presented in Table 4.10. This Table addresses the considered dimensions, number of questions per dimension, weighted average, and percentage of popularity gained from adequacy evaluation.

Table 4.10. Average of popularity given to the dimensions in adequacy evaluation.

Considered Dimensions	Number of questions per dimension	Weighted average	Percentage of popularity gained from adequacy evaluation
1- Organizational	7	3.50	87.50%
2- Environmental	7	3.41	85.32%
3- Admission	11	3.15	78.86%
4- Social	7	3.49	87.35%
5- Functional	17	3.51	87.83%
6- Economical	5	3.48	87.20%
7- Technological	4	3.63	90.87%
8- Structural	12	3.18	79.64%
9- Behavioral	8	3.43	85.93%
10- Learning assessment	6	3.68	92.16%
11- Performance assessment	6	3.13	78.29%

In order to have better view of the results gained in this step of evaluation, they are demonstrated by a Radar graph in Figure 4.10.

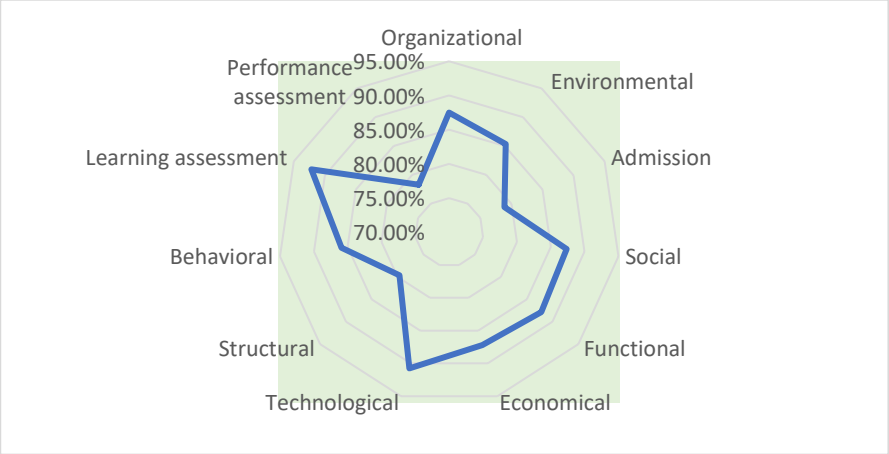


Figure 4.10. Average of popularity given to the dimensions in adequacy evaluation.

Considering the results of adequacy evaluation, it can be stated that:

- In general, the entire considered dimensions are accepted by all evaluators (focus group), because the average popularity given to all dimensions is above 60% (a reasonable indicator for acceptance).
- Among the considered dimensions, the learning assessment dimension and its related features, factors, and elements received the highest average of popularity (92.16%). While the performance assessment dimension received the lowest average of popularity (78.29%) from the evaluators' point of view.
- Analyzing all responses given to the questions shows that the majority of the addressed factors, features, and elements are considered as an important and adequate item to be used in LeLP. Even though, there are some items that received a relatively lower level of attention, for example, participation of general users in decision making. In such cases, the addressed factors, features, and elements either are excluded from the list, or replaced with other potential items.

In this step of evaluation, the evaluators by providing useful feedback and comments also helped in better adapting and developing the selected factors, features, and elements.

Evaluating the Adequacy of Functions (Step 4)

Having evaluated the adequacy of the selected factors, features, and elements, the determined functions for the LeLP are then evaluated by the focus group. In this step of evaluation, the partners and stakeholders theoretically checked out the adequacy of functions in meeting the objectives of LeLP (addressed in prior step). Given that, as it is addressed in Table 4.11, the functions that show signs of adequacy for one or some objectives are marked with (X), showing the potential relationships and interactions among the objectives and functions of LeLP.

Table 4.11. Evaluating the adequacy of system functions.

Part of ENHANCE Main Processes			
Some Functions of LeLP	Three Objectives of LeLP		
	Supporting collaboration and learning by LeLP	Developing a learning and knowledge transfer framework	Creating Digital Innovation Hubs
1. Providing an online collaborative environment	x		x
2. Performing class activities	x		
3. Finding courses and using the materials	x	x	
4. Practicing new skills and getting feedback	x		
5. Creating self-paced classes	x		
6. Acquiring data from equipment		x	x
7. Creating decision support system	x	x	x
8. Analyzing raw data to make conclusions	x	x	x
9. Controlling quality in manufacturing		x	x
10. Creating collaboration with DIHs	x	x	x

Evaluating the Feasibility of Selected Factors, Features, and Elements (Step 5)

In this step of evaluation, the technical partners of the project (from NOVA University Lisbon) focused on those factors, features, and elements in each dimension that got the popularity over (80%) in adequacy evaluation. The threshold 80 enabled the technical team to select the items with high popularity. This threshold was suggested by considering (a) the highest percentage and lowest percentage of popularity in Table 4.12, (b) distribution of percentages, and (c) range of percentages, aiming at making a balance between the number of items addressed in this step and the number of items that should be presented in the next stages of evaluation. In this project, the author of this thesis given the same responsibilities that he has taken in ED-EN HUB project.

Table 4.12. Considered factors, features, and elements for feasibility evaluation.

Organizational	Environmental	Admission	Behavioral	Structural	Social	Functional	Economical	Technological	Learning Assessment	Performance Assessment
80.50%	77.75%	75%	94.50%	81.25%	83.25%	77.50%	86%	91.75%	91.75%	80.50%
91.75%	89%	61%	91.75%	50%	87.50%	91.75%	94.50%	89%	97.25%	75%
89%	89%	91.75%	69.50%	86%	87.50%	97.25%	89%	97%	94.50%	77.75%
91.75%	83.25%	66.75%	83.25%	85.75%	90.75%	97.25%	83.25%	85.75%	86%	77.75%
94.50%	91.75%	91.75%	97.25%	89%	91.75%	87.50%	83.25%		94.50%	80.50%
80.50%	86%	77.75%	78.25%	89%	87.50%	83.25%			89%	78.25%
84.50%	80.50%	89%	91.75%	77.75%	83.25%	87.50%				
		90.75%	81.25%	80.50%		89%				
		87.50%		75%		94.50%				
		66.75%		89%		87.50%				

		69.50%		80.50%		91.75%				
				72%		89%				
						89%				
						83.50%				
						81.25%				
						78.25%				
						84.50%				
Av 87.50%	Av 85.32%	Av 78.86%	Av 85.93%	Av 79.64%	Av 87.35%	Av 87.83%	Av 87.20%	Av 90.87%	Av 92.16%	Av 78.29%

The technical team by taking into consideration the selected items (shown by green color) from Table 4.12 and also the available resources (e.g., budget, time, capabilities) attempted to:

- Assess the possibility, workability, and expediency of the selected factors, features, and elements to be used in LeLP, and
- Assess the association, connection, and relevancy of the selected factors, features, and elements to the addressed LeLP functions. Thus, in feasibility evaluation the selected factors, features, and elements are presented under related LeLP functions.

On that basis, the second questionnaire is developed, concentrating on technical aspects of selected items that should be evaluated for feasibility assurance. In this questionnaire, 34 Likert scale questions are formulated to collect the opinion of partners and stakeholders of the project and check the extent to which they agree or disagree with the addressed points. This questionnaire is illustrated in Appendix E. The questionnaire sent to 8 group of partners and stakeholders, and they asked to react duly in collaboration with their involved colleagues (in the project). The results of this step of evaluation are presented in Table 4.13.

Table 4.13. Average of popularity given to the dimensions in feasibility evaluation.

Functions	Number of questions per dimension	Weighted average	Percentage of popularity gained from adequacy evaluation
Global Function	7	3.60	90%
Function 1	4	3.15	78.75%
Function 2	2	3.10	77.50%
Function 3	3	3.57	89.25%
Function 4	3	3.63	90.75%
Function 5	5	3.26	81.50%
General Function 1	5	3.57	89.25%
General Function 2	5	3.35	83.75%

To gain a better view about the results of this step of evaluation, the summary of outcome analysis is also displayed by a graph in Figure 4.11.

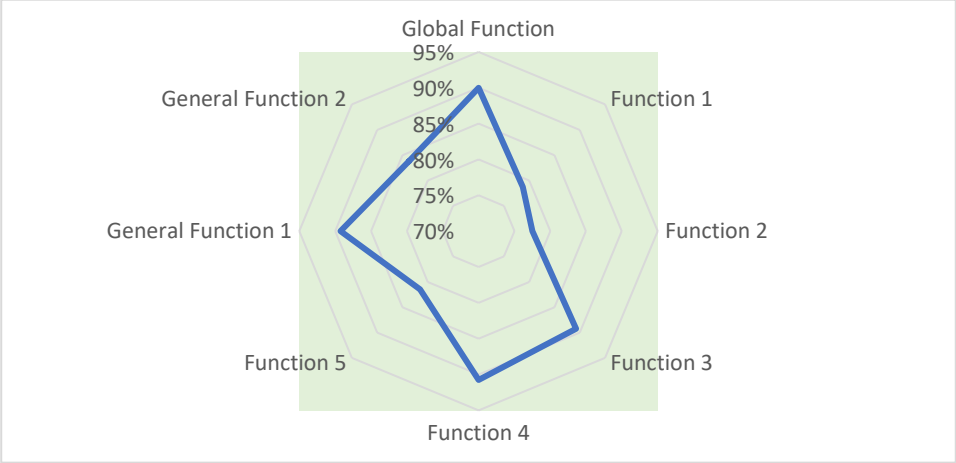


Figure 4.11. Average of popularity given to the dimensions in feasibility evaluation.

From the results of this step of evaluation, it can be said that:

- Almost all the addressed factors, features, and elements are viewed (by evaluators) as feasible items (with high percentage of acceptance), except two items that their given popularity is lower than 66%.
- Among the associated functions, the highest percentage of attention is given (by partner evaluators) to Function 4 with 90.75%, while the lowest percentage of popularity is given to Function 2 with 77.50%.
- Those factors, features, and elements that acquired higher percentage of popularity would be in the focus of attention (of the partners and stakeholder) in the next steps of evaluation and even in integration to the LeLP (if they are selected as an essential item, at the end).

Evaluating the Feasibility of LeLP Functions (Step 5)

In parallel with evaluating the feasibility of selected factors, features, and elements, the technical team proceeded with assessing the feasibility of LeLP (system) functions. In this respect, they critically appraised the function specification, adjustment, and improvement. For doing so, by taking into account the (a) results of adequacy evaluation (presented in Table 4.10 and Table 4.11), (b) objectives of the project, and (c) requirements of the LeLP. The technical team thus came up with a new list of functions. The new introduced functions evolved from altering, modifying, and developing the functions addressed in Table 4.14 toward optimization them. The new functions include one global function, five main functions, and two general functions for LeLP. The results of evaluating and developing the LeLP functions are presented in Table 4.14.

Table 4.14. Evaluating the feasibility of LeLP functions.

Evaluating the Feasibility of LeLP Functions
Global Function
• *Global function* – refers to primary functions of every platform that enable the system to facilitate its core transaction.
Main Functions
• *Dynamic training design* – refers to creating and developing new training and educational courses and lessons for the existing students/employees. This function needs taking into consideration the assessment of students' learning quality that would invoke changes in the programme and help students better fulfil the learning objectives.
• *Training programme generator* – refers to generating the training programme according to students' profile.
• *Improving training course contents* – refers to identifying distinctive research results (potentially results of DIH activities) that may be used to improve courses contents.
• *Training execution support* – refers to providing the needed support for (a) training execution and training planning, and (b) learning engagement strategies.
• *Training quality assessment* – refers to providing the needed support for design the overall training (performance-based) assessment and reporting.
General Functions
• *Managing user's account* – refers to management of user's account by providing different access rights or profiles and to facilitate activation/deactivation of their accounts.
• *Managing internal interactions and transactions* – refers to managing various interactions and transactions between users e.g., sharing the resources and training/learning materials.

The fact of the matter is that in ENHANCE project the process of MGF-MCL validation, evaluation, and application is lately commenced. Therefore, the other remaining steps of evaluation can only be accomplished in a phase after this thesis work. However, the positive results gained from (a) framework validation, (b) primary phases of its applicability evaluation, and (c) several critical discussions with the focus group prove that the MGF-MCL (after making the needed modification and development according to the project goals and circumstances) has high potential to be used for supporting and directing the creation, operation, and implementation of LeLP. All the satisfactory results gained in this project bring the MGF-MCL one step closer to full validation. Further practical validation, however, is needed that should be done by future work.

At the end it should be noted that both the ED-EN HUB and ENHANCE projects faced some limitation in the evaluation of MGF-MCL, for example:

- Almost the same approach, process, and tool used for the evaluation of the framework. However, using a different approach, process, and tool might lead to different outcomes.

- We identified that some concepts (e.g., MC, MCL, MetaGovernance framework, governance process) are often vague and confusing for the partners and stakeholders of the projects.
- Theoretically and conceptually evaluating different aspects of the MGF-MCL framework is an arduous and daunting task.

4.1.2 Validation in Mass Collaborative Learning Illustration

The MGF-MCL was also used in an illustration of the MCL community. This illustration was developed in a master thesis (Alves 2021) and co-supervised by the author of this work. The illustration presents a MCL community called GloFood. Indeed, GloFood is a community of (professional and non-professional) cooks who come together from around the world to learn new things about cooking. GloFood introduces a supportive and social learning environment where the cooks by providing different self-created video clips from their own dishes and sharing them within the community try to:

- Create an unique and comprehensive list (video collection) of the local, national, and international dishes,
- Share their related (culinary) knowledge and (cooking) experiences with the peers,
- Increase the level of information about the quality and quantity of ingredients, and
- Raise the level of knowledge about healthy diet, balanced diet, and nutrition.

For this purpose, a digital platform is developed, aiming to facilitate the collaboration and interactions among users. As it is illustrated in Figure 4.12, the platform is implemented using the Django framework, a web framework that uses a Model View Template (MVT) architecture. The "Model" manages the application data, the "View" receives the data from the user, and the "Template" acts as the presentation layer and describes the way that the content is presented to the user.

The flow work of the platform is very simple. For using the platform and joining to the GloFood community, users must initially register on the platform (with real personal information), login to the platform, create a personal profile, and keep it updated. When the user accesses to the platform through a web browser, it sends an URL request to Django. This URL path is linked to a particular View which interacts with the Model and retrieves the data from the database. Then, the Template renders the view with the retrieved data to the user.

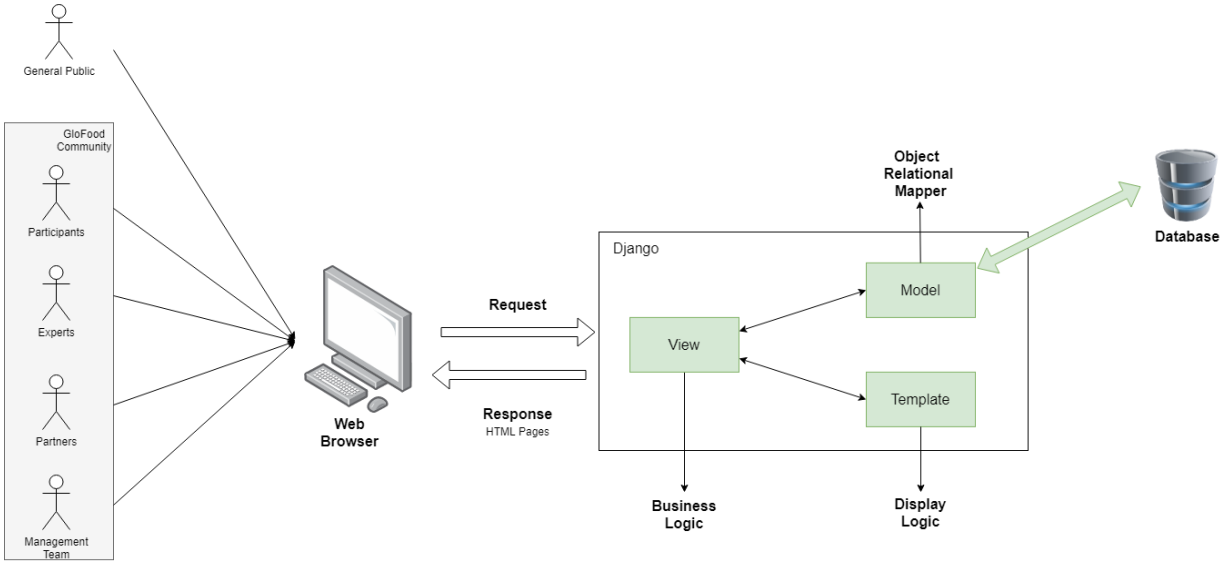


Figure 4.12. GloFood platform (Alves 2021).

The platform that reaps the advantages of advanced technologies (e.g., online discussion forums and voting systems) is used to, for example:

- Simplify the collaborative learning for community members,
- Facilitate the communications and connections for members,
- Support the members in creating, uploading, downloading, and watching the video clips from the list,
- Support the members in sharing their knowledge, ideas, experiences, tips, recipes, and comments,
- Enable the evaluation of others' contributions, and
- ETC.

To gain a better insight into the user-platform functions, the Unified Modeling Language (UML) use case diagram is presented in Figure 4.13. UML is a standardized modeling language consisting of an integrated set of diagrams, developed to help system and software developers for specifying, visualizing, constructing, and documenting the artifacts of software systems, as well as for business modeling and other non-software systems. UML is not a programming language but there are tools that can be used to generate code in various languages using UML diagrams. UML has a direct relation with object-oriented analysis and design (Siau et al., 2001). Figure 4.13 also shows the different ways in which a user might interact with a platform.

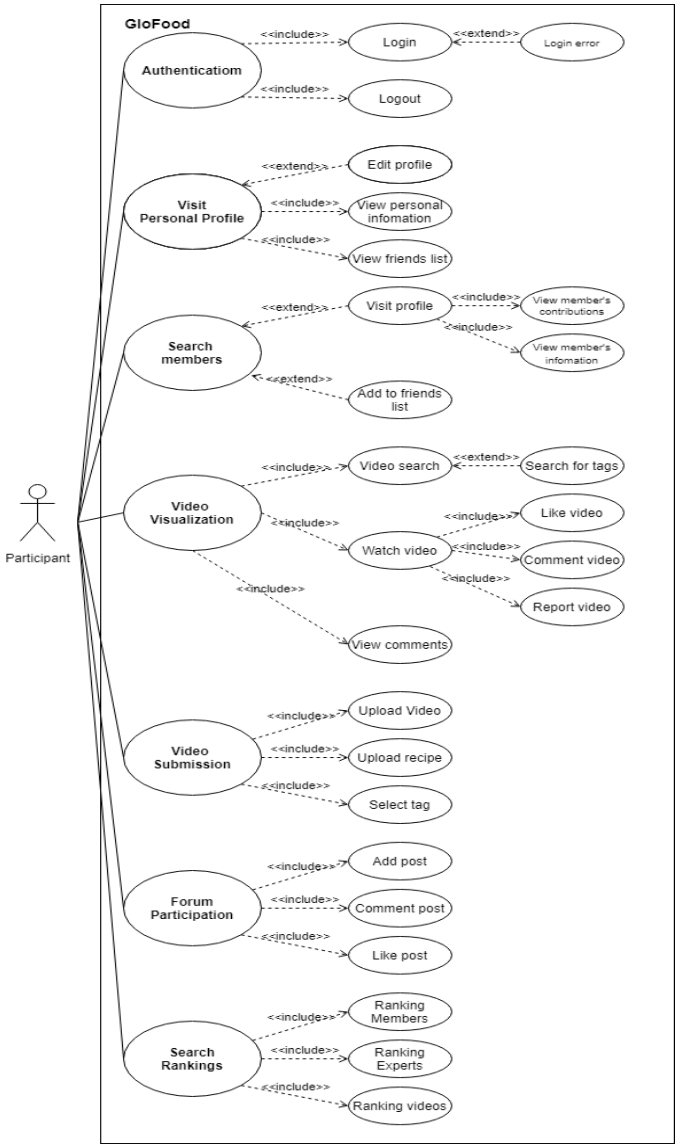


Figure 4.13. User-platform functions / use cases (Alves 2021).

In GloFood community, the users (based on their interest and capabilities) can take different roles such as ordinary member (simple user), expert (in culinary and cooking, nutrition, and health), technical member (e.g., technical operator, web developer), and managerial member (e.g., moderator, administrator, account manager, content controller). There is a possibility for the members to take some roles at the same time although they are encouraged to be committed to the taken roles. The users could receive rewards/credit (e.g., more access to different pages and information, higher rank, badge) when actively and positively take part in defined functions (shown in Figure 4.13). Furthermore, sharing the useful knowledge is highly recommended. Because knowledge sharing can, for example:

- Help cooks to find the better and new techniques, recipes, and ingredients for cooking,

- Make the community's best problem-solving experiences reusable,
- Stimulating innovation and growth,
- Reducing loss of knowledge and know-how (keep knowledge and expertise in the community), and
- Impact on (individual and community) learning.

In order to improve the outputs of the community (e.g., increasing the quantity and quality of the provided dishes/video clips) and generate a positive impact on the community, the members are asked to vote others' contributions (e.g., dishes/video clips). The voting system enables the members to judge the observable features of the dishes (e.g., techniques of cooking, nutritional value of ingredients, creativity), aiming to find the positive and negative points in dishes, and ideally improve the quality of cook by providing useful recommendations particularly by experts. Voting system stands on rating scale. The video clips that receive the highest rate will move to the top of the list. The ones that gain certain amount of negative feedback should be put away.

The creation, development, and implementation of GloFood platform was guided by MGF-MCL in different ways including but not limited to:

- Addressing the main features of a MCL community and the influential factors,
- Guiding the presentation, specification, and characterization of the cooking community,
- Helping to define the main concepts (e.g., learning community), structures (organizational and behavioral), components (internal and external), functions (e.g., collaboration, interactions), roles (e.g., organizer, executive, and content controller), and participants (e.g., managerial, expert, ordinary),
- Supporting the collaboration and interaction among members, and
- Underlining the key aspects of content and performance assessment.

The successful application of MGF-MCL to GloFood (learning community) provided another evidence of validation of the framework.

4.1.3 Validation by Peer Review and Publication

In addition to above-mentioned channels of validation, a number of publications in recognized conference proceedings and scientific journals was also performed with the aim to obtaining qualitative peer validation and to disseminate the thesis results. Table 4.15 presents the list of publications and the corresponding contributions for this work that include: two publications in international journals and five publications in international conferences proceedings with peer reviewing. In Table 4.15, there is one manuscript that has not been published yet, but it is decided to be published in a recognized journal.

Table 4.15. List of publications related to MGF-MCL.

List of Related Publications
Publications in International Journals
Zamiri M., Camarinha-Matos L.M. (2019). **Mass Collaboration and Learning: Opportunities, Challenges, and Influential Factors.** *Applied Sciences* 2019, 9(13), 2620; DOI: 10.3390/app9132620
Zamiri M., Camarinha-Matos L.M., Sarraipa J. (2022). **Meta-Governance Framework to Guide the Establishment of Mass Collaborative Learning Communities**. *Computers*. 2022, 11, 12. https://doi.org/10.3390/computers11010012
Zamiri M., Camarinha-Matos L.M., Sarraipa J., Goncalves R.J. (2022). **An Organizational and Governance Model to Support Mass Collaborative Learning Initiatives**. (Not published yet)
Publications in International Conferences Proceedings
Zamiri M., Camarinha-Matos L.M. (2018). **Learning Through Mass Collaboration - Issues and Challenges**. In: Camarinha-Matos L., Adu-Kankam K., Julashokri M. (eds) Technological Innovation for Resilient Systems. DoCEIS 2018. IFIP Advances in Information and Communication Technology, vol 521. Springer, Cham. https://doi.org/10.1007/978-3-319-78574-5_1
Zamiri M., Camarinha-Matos L.M. (2019). **Organizational Structure for Mass Collaboration and Learning**. In: Technological Innovation for Industry and Service Systems. DoCEIS 2019. IFIP Advances in Information and Communication Technology, vol 553, p 14-23. Springer, Cham. DOI:10.1007/978-3-030-17771-3_2
Zamiri M., Camarinha-Matos L.M. (2020). **Towards a Reference Model for Mass Collaborative Learning**. In: Camarinha-Matos L., Farhadi N., Lopes F., Pereira H. (eds) Technological Innovation for Life Improvement. DoCEIS 2020. IFIP Advances in Information and Communication Technology, vol 577. Springer, Cham
Zamiri M., Sarraipa J., Goncalves R.J. (2020). **A Reference Model for Interoperable Living Labs Towards Establishing Productive Networks.** In proceeding: 10th International Conference on Interoperability for Enterprise Systems and Applications, November 17-20, 2020, Tarbes, France.
Zamiri M., Camarinha-Matos L.M. (2021). **A Mixed Method for Assessing the Reliability of Shared Knowledge in Mass Collaborative Learning Community**. In: Technological Innovation for Applied AI Systems. DoCEIS 2021. IFIP Advances in Information and Communication Technology, vol 626.Springer, Cham. https://doi.org/10.1007/978 -3- 030-78288-7_3

To clarify the focus and contribution of above-mentioned publications, Table 4.16 addresses the association of these publications with the main issues considered in the thesis and the related research question (RQ).

Table 4.16. Association of related publications with thesis issues and research questions.

Association of related publications with thesis issues and research questions	
Mass Collaboration and Learning: Opportunities, Challenges, and Influential Factors	
Issues	RQs
- Background knowledge - Organizational structures - Adopted methods/mechanisms - Adopted technologies - Performance assessment	- What could be an effective way of supporting community learning through mass collaboration (MC)? - What kind of organizational structure within a community should be established to help developing learning through MC?

- Content assessment	- What kind of assessment mechanism can help minimize the problems related to the reliability of created and shared knowledge or information through MC within a community?
Meta-Governance Framework to Guide the Establishment of Mass Collaborative Learning Communities	
Issues - Background knowledge - Organizational structures - Adopted methods/mechanisms - Performance assessment - Content assessment - Validation	RQs - What could be an effective way of supporting community learning through mass collaboration (MC)? - What kind of organizational structure within a community should be established to help developing learning through MC? - What kind of assessment mechanism can help minimize the problems related to the reliability of created and shared knowledge or information through MC within a community?
An Organizational and Governance Model to Support Mass Collaborative Learning Initiatives (not published yet)	
Issues - Background knowledge - Organizational structures - Adopted methods/mechanisms - Performance assessment - Content assessment - Validation	RQs - What could be an effective way of supporting community learning through mass collaboration (MC)? - What kind of organizational structure within a community should be established to help developing learning through MC? - What kind of assessment mechanism can help minimize the problems related to the reliability of created and shared knowledge or information through MC within a community?
Learning Through Mass Collaboration - Issues and Challenges	
Issues - Background knowledge - Organizational structures - Adopted methods/mechanisms - Adopted technologies - Content assessment	RQs - What could be an effective way of supporting community learning through mass collaboration (MC)? - What kind of organizational structure within a community should be established to help developing learning through MC? - What kind of assessment mechanism can help minimize the problems related to the reliability of created and shared knowledge or information through MC within a community?
Organizational Structure for Mass Collaboration and Learning	
Issues - Background knowledge - Organizational structures	RQs - What could be an effective way of supporting community learning through mass collaboration (MC)? - What kind of organizational structure within a community should be established to help developing learning through MC?
Towards a Reference Model for Mass Collaborative Learning	
Issues - Background knowledge - Elements and components	RQs - What could be an effective way of supporting community learning through mass collaboration (MC)?
A Reference Model for Interoperable Living Labs Towards Establishing Productive Networks	
Issues - Background knowledge - Elements and components	RQs - What could be an effective way of supporting community learning through mass collaboration (MC)?
A Mixed Method for Assessing the Reliability of Shared Knowledge in Mass Collaborative Learning Community	
Issues - Background knowledge - Content assessment	RQs - What kind of assessment mechanism can help minimize the problems related to the reliability of created and shared knowledge or information through MC within a community?

As mentioned in Table 4.15 and Table 4.16, different parts and considered issues of the thesis were published in recognized conferences proceedings and scientific journals. The results prove that various aspects of the thesis were evaluated and accepted by peers. Therefore, the research work not only was disseminated, but also obtained qualitative peer validation.

4.1.4 Concluding Remarks

In summary, in section 1.4, the main research question and two sub-questions were defined with the corresponding hypotheses. Considering the followed validation methodology presented in this chapter, it can be concluded that all the hypotheses are positively validated.

The contribution to the European research projects provided reasonable validation and positive assessment. Each of the considered projects/case studies has applied the MGF-MCL to support the creation, operation, management, and implementation of their digital collaboration platform. In each project, by employing the governance process, different aspects of MGF-MCL have been assessed through (a) taking some phases and steps of evaluation, (b) using some developed questionnaires, (c) continuous interaction and discussion with various partners and stakeholders of the projects ("focus group"), and (c) in collaboration with several expert evaluators. The proposed framework was globally accepted by the two EU projects, highlighting the validation of the MGF-MCL and its potential application to other related cases. In addition, a close interaction with the experts, researchers, and stakeholders in these projects was very valuable for the author, as their useful feedback provided some direction for improving different parts of the MGF-MCL.

The validation of the MGF-MCL is also made through its successful application to the creation and development of the collaborative learning platform used in mass collaborative learning illustration (master thesis).

The validation in the scientific community provided an overall peer assessment of the global work since several publications have been evaluated and accepted during the PhD work. The helpful feedback received from the reviewers helped to better design and develop the MGF-MCL.

It should be added that during this research, the author of this dissertation has joined and contributed with research work and publications in another research project (CARELINK). This project research is also in the context of collaborative networks, providing supportive services for people living with dementia. With the participation in this project the accumulated knowledge comprising CNs and also the interaction with the project partners'

views also contributed for the validation of the base concepts of collaborative networks used in this thesis work (Zamiri et al., 2020).

Given the above, it can be concluded that the hypotheses are positively validated to a reasonable extent. Therefore, the proposed MGF-MCL that is qualitatively validated can potentially support and guide the creation, operation, and implementation of MCL initiatives. As a concluding remark, this validation showed that MGF-MCL is promising and represents a first step in this novel area of research. Nevertheless, we are conscious of the limits of the validation process, constrained by practical limitations and time limits. Further developments in this area will certainly require deeper and more comprehensive validation.

5

CONCLUSIONS AND FUTURE WORK

This chapter presents the final considerations stating the novelty of this research and also concludes the thesis. It presents the main topics and conclusions of the performed research work. It includes an overview of the developed work, a summary of achieved results, and finalizes with some directions for future research.

5.1 Overview of the Work

Learning occurs since the earliest civilizations were formed. Reviewing the practices used for learning throughout history to present days shows that the learning methods have evolved gradually but surely. Even though learning methods have come a long way, looking at the future of learning requires making changes in such methods to keep them up to date with the context and growing demands of the 21st century. In this direction, MCL as an emerging method is showing to be beneficial and supportive for autonomous learning. MCL unlocks new opportunities for an unlimited number of scattered learners to build up a self-directed community and also achieve an entirely new level of flexibility, efficiency, and customization. The design of this flexible learning space goes beyond the physical context to include the virtual or mixed reality. So, it is leaping into the digital age to be supported and enriched by ICT technologies. In the informal process of learning implicit in MCL, cross-functional collaboration, peer-to-peer learning, and crowdsourcing, are the predominant strategies. As this new trend of learning will continue to grow, it requires preparation for changing the nature of learning practices.

MCL opens the possibility for the general public and adults to go back to learning habits, anytime and anywhere. That is MCL fosters lifelong learning after formal education and throughout life. It foresees a learning-friendly environment, where learners are encouraged to join a community and actively contribute to a vast range of defined activities and topics.

As an illustration, MCL can provide an innovative and suitable environment with specific features (e.g., safe, customizable, affordable, conventional, flexible, and accessible), equipped with modern technologies (e.g., video conferencing, blogs, discussion forums, or

platforms) through which a large number of interested people (e.g., teachers, students, and even general public) at regional, national, or international level can engage in collaborative learning practices (e.g., sharing learning materials, discussion) throughout the COVID-19 crisis and even after.

MCL not only enables the participants to engage in collaborative knowledge acquisition, creation, sharing, retention, and development, but also allows them to be curators of knowledge. Hence, participants become independent learners who are leaders of their own education. There are many potential benefits from the application of this complementary method of learning. For instance, it creates a specific network of enthusiastic participants - from pupils and nonscientists to professionals and experts, who may come from different backgrounds, and when it comes to solving complex problems (which are mainly out of one's ability), strategies such as critical thinking, group discussion, voting, collective intelligence, and outsourcing will help the learners.

The success that MC has gained over the last years in the learning domain is in fact noticeable. The literature shows that MC has morphed and expanded the physical, virtual, and intellectual boundaries of the learning environments (Zamiri et al. 2019). As such, MC has had successful applications (at different levels and to different degrees) in diverse learning contexts, for example:

- Massive Open Online Courses (MOOCs), which are free online courses where the learning contents are delivered to any person who wants to take a course. In this model of learning that is designed for large numbers of geographically dispersed students, they can practice learning individually (in personal tasks, thus not really mass collaboration) and through community interactions (in interactive courses, featuring a form of mass collaboration).
- World of Warcraft (WoW), which is a massively multiplayer online role-playing game that facilitates learning through gamification. WoW creates a community of players where they can play with others in temporary groups. In this collaborative space, learning occurs when the learner needs and wants it. Therefore, in the context of problem-solving, there are opportunities to receive the answers (from other players or more experienced peers) to a question or obtain advice quickly.
- Scratch, which is a free programming language and online community where scratchers/learners can create their own interactive stories, games, and animations. Scratch promotes problem-solving skills, self-expression, collaboration, and creative teaching and learning. There is a discussion page with multiple forums mainly used for chatting, helping (with coding), creating, sharing, and learning together (Shapiro et al. 2016).

- SAP Community Network (SCN), which is a community of software users, developers, consultants, mentors, and students who use the network to get help, share ideas, learn, innovate, and collaborate (Fischer et al. 2016).
- Community of Inquiry (Col) framework is a community of learners and instructors who share a virtual space, technology-reliant environment, rule-based interaction, and course-dependent learning objectives that resulted from the interaction of the perceptions of social, cognitive, and teaching presences (Garrison et al. 2009).
- ePals global community, which is an example of social online learning that provides the needed tools (platform) and meeting places to build a worldwide community of learners, global citizens who can share ideas, practice communication, and offer help and guidance (Bernadette et al. 2016).

It should be added that MCL as a kind of open-source community and flexible learning environment can potentially take place in diverse environments such as mixed reality, virtual reality (Mystakidis et al. 2021), social virtual reality environments (immersive virtual worlds or multi-user virtual environments) (Mystakidis et al. 2021), multi-user 3D interactive environments, and 3D multi-user virtual worlds (e.g., social virtual worlds, open-source virtual worlds, collaborative virtual learning worlds) (Pellas et al. 2017).

Despite the tremendous progress in these areas, notable achievements, and positive results that MCL has obtained over the years for learners, communities, and societies, this body of knowledge is still faced with several limitations and challenges which derive from, for example:

- The novelty of the MCL concept,
- The complexity of its underlying processes,
- The interdisciplinary nature of the method,
- The fact that the organizational structure, and associated mechanism of MCL are still evolving,
- The fact that there is insufficient evidence about the successful application of MCL in various fields,
- The process of MC in the learning community not being clearly formalized and documented yet, and
- The fact that there are some difficulties about the process of stimulating people to join the community and keep them motivated to contribute.

Furthermore, this approach of collective learning, which is addressed by people of different areas, is viewed and presented from different perspectives by the researchers of each discipline. As a result, this promising complementary approach of learning and amazing experience has not yet been revealed in an integrated perspective to all people around the world. It should be also added that although design science research enables researchers to develop novel solutions towards solving ever changing social and business needs, the resulting output is subject to the creativity, intuition, and problem-solving capabilities of the

researcher (Hevner et al. 2004). Whilst we have demonstrated that the results of our research are practically applicable and generate utility in the context of MCL.

This dissertation contributes to respond to the above-mentioned challenges and limitations. It raises the importance of a comprehensive governance structure for MCL that provides a clear understanding and oversight about, for example, how a learning community can be directed and supported, and how its objectives could be set and achieved through MC. The proposed MGF-MCL has three main building blocks (structures, components, and assessment method and indicators), addressing the significant parts of a MCL community that need special attention in both research and development.

The MGF-MCL consolidates the integration of ideas from different governance styles (some organizational, behavioral, and governance structures, and also a set of assessment methods) to achieve an effective outcome. The MGF-MCL proposed in this work is a general framework that needs to be adapted before application to specific MCL cases. It was applied to two case study projects in which the vocational education and training respond to the needs of collaborative education-enterprise approaches. It was also used in an illustration of a MCL community called "community of cooks", where the interested cooks by sharing their knowledge, experiences, and also self-created video clips, come together to practice collaborative learning. The application of the MGF-MCL in these three case studies showed its potential when designing new learning communities. In addition, different solutions addressed in the MGF-MCL are also accepted by peer-reviewed journals and conference publications. At the end, after validation gained through the above-mentioned three-level approaches, some conclusions on the results of the proposed work may be drawn and followed.

5.2 Main Contributions

The main contributions of this thesis work appear at five different levels: providing an overview of background work, a set of concepts, structures, method, and framework, aiming at driving and supporting the implementation, operation, and management of MCL initiatives. The novel contributions of this work include:

- **Background work -** helped to (a) have a good overview about the current state of research on the topic, (b) summarize and synthesize the arguments and ideas of existing knowledge in this field of study, and (c) identify the key questions about the topic that need further research.
- **Concepts -** a set of concepts related to MC, CI, and MCL are discussed and formally defined. By giving a formal description of these concepts, we provide a base support for MCL practices and initiatives.

- **Structures -** two structures are proposed: (a) an organizational structure, which provides an insight about the certain activities, roles, functions, responsibilities, and relationship between roles, and (b) a behavioral structure, which provides an indication of behavior of community and individual members, social factors, and hierarchy of authority in the MCL community.
- **Method -** the proposed content assessment method highlights the importance of quality and reliability assessment, advantages of human and computer contributions in assessment, and the power of collaboration in detecting unhealthy materials.
- **Framework -** the proposed MGF-MCL framework provides a summary overview of the important, required, and unique elements and features of a typical MCL initiative that should be considered by researchers and developers when developing a new MCL community.

Figure 5.1 depicts the main contributions of this work.

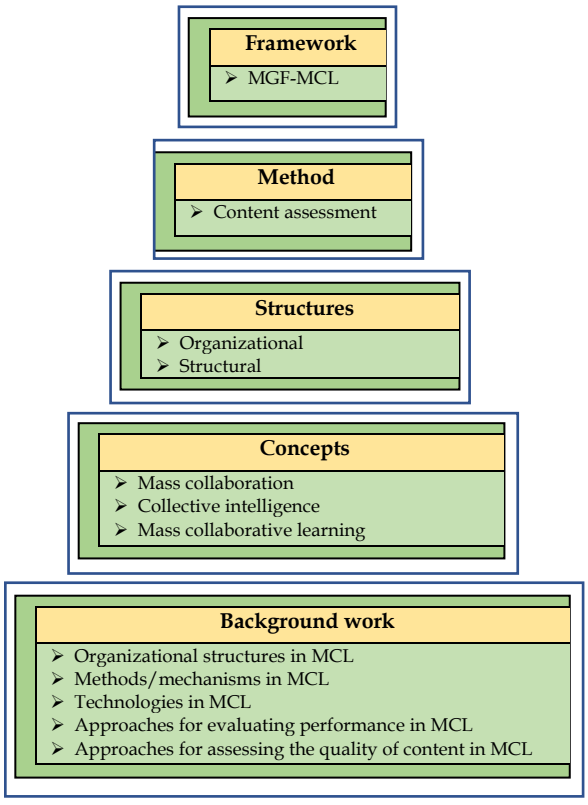


Figure 5.1. Original contributions of thesis.

5.2.1 Results

Considering the main research question and the two decomposed sub-questions, the corresponding hypotheses are elaborated resulting on a main hypothesis. Through the development and validation of the proposed framework and related solutions, all hypotheses are validated to a reasonable extent. Therefore, it can be concluded that:

- Community learning could be effectively supported through MC when three streams of work are appropriately rooted in the foundation of a community namely, through (I) identifying the positive and negative factors in existing and emerging successful examples of MC; (II) adopting contributions from collaborative networks in terms of structural and behavioral models; and (III) establishing adequate learning assessment indicators and metrics.
- Community learning through MC could be helped when existing models of organizational structures for long-term strategic networks are extended to allow more fluid borders and new roles, incentives and internal subgroups are defined to focus on learning and knowledge generation.
- The problems related to the reliability of created and shared knowledge or information through MC could be minimized when the community benefits not only from the combination and application of a set of appraisal rules, criteria, and methods, but also the contributed content materials are critically assessed through a collective effort.

Table 5.1 exhibits the followed research schema, including the main topics which contributed to the validation.

Table 5.1. Research scheme.

Research contribution relationship with the research questions and hypotheses
RQ ? What could be an effective way of supporting community learning through mass collaboration (MC)?
H ➢ Community learning could be effectively supported through MC if three streams of work are appropriately rooted in the foundation of a community namely, through (I) identifying the positive and negative factors in existing and emerging successful examples of MC; (II) adopting contributions from collaborative networks in terms of structural and behavioral models; and (III) establishing adequate learning assessment indicators and metrics.
Proposed solution MGF-MCL (see figure 3.1)
RQa ? What kind of organizational structure within a community should be established to help developing learning through MC?
Ha

➢ Community learning through MC could be helped if existing models of organizational structures for long-term strategic networks are extended to allow more fluid borders and new roles, incentives and internal subgroups are defined to focus on learning and knowledge generation.
Proposed solutions ✍ ARCON (see Table 3.6 and Table 3.7) & MGF-MCL (see Figure 3.1)
RQb ? What kind of assessment mechanism can help minimize the problems related to the reliability of created and shared knowledge or information through MC within a community?
Hb ➢ The problems related to the reliability of created and shared knowledge or information through MC could be minimized if the community benefits not only from the combination and application of a set of appraisal rules, criteria, and methods, but also the contributed content materials are critically assessed through a collective effort.
Proposed solutions ✍ MAM-MCL (see Figure 3.2) & MGF-MCL (see Figure 3.1)

The work presented in this thesis tries to from one side add value to the field by highlighting the importance of addressed topic and its related issues, requirements, and limitations. From the other side, it proposes an innovative and practical solution (MGF-MCL) to the increasing demand for collaborative learning in different contexts. The MGF-MCL is a dynamic and adaptable framework that can enhance its success in this fast-changing learning environment. Organizations and communities supporting global education as well as collaborative and lifelong learning can thus benefit from the outputs of this work.

5.3 Future Work

Having into consideration the pioneering nature of this research work, it becomes clear that many doors are open for future research. The first impression is that the MCL, as an interdisciplinary approach, is a promising and demanding subject with multiple areas of application. Therefore, some aspects are identified to be improved and others need to be explored. Some of these future work and research issues are summarized below:

- **Further evaluation of MGF-MCL -** the first and foremost task to turn the framework in a practical usable tool is completing the process of evaluation for the two case studies presented above withing an extended time frame.
- **Development of MGF-MCL -** further evaluation of MGF-MCL and identifying its strengths and weaknesses could help to improve and adjust different parts of the framework, increase its sustainability, and rectify its limitations.
- **Further validation of MGF-MCL -** the validation, reliability, and usefulness of MGF-MCL can be tested by further application to other related and potential case studies.

- **Applying MCL in multiple contexts -** despite the challenging circumstances, MCL has shown high potential to be applied to different contexts, toward a better understanding of the concepts, relations, and influential factors. By doing so, certainly new challenges and needs for improvement will emerge.

BIBLIOGRAPHY

Afsarmanesh, H. & Camarinha-Matos L.M., 2008. The ARCON modeling framework: In: Collaborative Networks: Reference Modeling, L.M. Camarinha-Matos, H. Afsarmanesh, Springer: New York. ISBN 978-0-387-79425-9. DOI: https://doi.org/10.1007/978-0-387-79426-6_7

Aggarwal, A., Sundar, G. & Thakur, M., 2013. Techniques of Performance Appraisal - A Review. *International Journal of Engineering and Advanced Technology*, 2(3).

Agichtein, E., Castillo, C., Donato, D., Gionis. A. & Mishne. G., 2008. Finding high-quality content in social media. In *Proceedings of the international conference on Web search and web data mining - WSDM '08*. pp. 183–194. Available at: http://portal.acm.org/citation.cfm?doid=1341531.1341557. DOI: 10.1145/1341531.1341557

Alexander, J.E. & Tate, M.A., 2000. Web Wisdom: How to Evaluate and Create Information Quality on the Web. *IEEE Transactions on Professional Communication*, 43(3), pp. 341–342. Available at: https://www.researchgate.net/publication/31737548_Web_Wisdom_How_to_Evaluate_and_Create_Information_Quality_on_the_Web_JE_Alexander_MA_Tate.

Alkhattabi, M., Neagu, D. & Cullen, A., 2010. Information quality framework for e-learning systems. *Knowledge Management & E-Learning: An International Journal*, 2(4), pp. 340–362. Available at: http://www.kmel-journal.org/ojs/index.php/online-publication/article/view/21/62. DOI:10.34105/j.kmel.2010.02.025

Allen, W., Fenemor, A., Kilvington, M., Harmsworth, G, Young, R.G., Deans, N., Horn, C., Phillips, C., Montes de Oca, O., Ataria, J. & Smith, R., 2011. Building collaboration and learning in integrated catchment management: The importance of social process and multiple engagement approaches. *New Zealand Journal of Marine and Freshwater Research*, 45(3), pp. 525–539. DOI:10.1080/00288330.2011.592197

Alves, P.M.S., 2021. Glofood – Knowledge Sharing in a Community. Master thesis, Department of Electrical and Computer Engi-neering, NOVA University Lisbon, September 2021.

Anne, L.B., 2011. Exploring Network Organization in Military Contexts: Effects of Flatter Structure and More Decentralized Processes. *Military Psychology*, 23(3), pp. 315–331. Available at: https://www.researchgate.net/publication/239796118_Exploring_Network_Organization_in_Military_Contexts_Effects_of_Flatter_Structure_and_More_Decentralized_Processes. DOI:10.1080/08995605.2011.570595

Aperjis, C., Huberman, B.A. & Wu, F., 2010. Harvesting Collective Intelligence: Temporal Behavior in Yahoo Answers. *arXiv preprint arXiv:1001.2320 (2010)*. Available at: http://arxiv.org/abs/1001.2320.

Aritajati, C. & Narayanan, N.H., 2013. Facilitating Students' Collaboration and Learning in a Question and Answer System. *Proceedings of the 2013 conference on Computer supported cooperative work companion*, pp. 101–105. DOI: 10.1145/2441955.2441983

Awal, G.K. & Bharadwaj, K.K., 2014. Team formation in social networks based on collective intelligence - An evolutionary approach. *Applied Intelligence*, 41(2), pp. 627–648. DOI: 10.1007/s10489-014-0528-y

Azua, M., 2010. *The social factor: Innovate, ignite, and win through mass collaboration and social networking.* 1st Editio., Available at: https://www.amazon.com/Social-Factor-Innovate-Collaboration-Networking/dp/0137018908.

Barkley, E.F., Cross, K.P. & Major, C.H., 2004. *Collaborative Learning Techniques: A Handbook for College Faculty.* 1st Editio., San Francisco: Jossey-Bass.

Baumeister, R.F. & Leary, M.R., 1997. Writing narrative literature reviews. *Review of General Psychology*, 1(3), pp. 311–320. DOI: 10.1037//1089-2680.1.3.311

Beckett, R, C. & Jone, M., 2012. Collaborative network success and the variable nature of trust. *Production Planning & Control*, 23(4), pp. 240-251, DOI: 10.1080/09537287.2011.62765.

Beckett, R. C. & Jones, M., 2011. Active Ageing: Using an ARCON framework to study U3A (University of the Third Age) in Australia. In L. Camarinha-Matos, A. Pereira-Klen & H. Afsarmanesh (Eds.), 12th IFIP Working Conference on VIRTUAL ENTERPRISES, pp. 189-196, Amsterdan: IFIP. DOI: 10.1007/978-3-642-23330-2_21

BerG-Weger, M. & Schneider, F.D., 1998. Interdisciplinary collaboration in social work education. *Journal of social work education*, 34(1), pp. 97-107.

Bernadette Dwyer B., 2016. Teaching and Learning in the Global Village: Connect, Create, Collaborate, and Communicate. The Reading Teacher, 70(1), pp. 131–136. DIO:10.1002/trtr.1500

Bernardo, T., 2007. Employing mass collaboration information technologies to protect human lives and to reduce mass destruction of animals. *Veterinaria italiana*, 43(2), pp. 273–284.

Blagojević, M. & Milošević, M., 2013. Collaboration and learning styles in pure online courses: An action research. *Journal of Universal Computer Science*, 19(7), pp. 984–1002.

Blohm, I., Riedl, Ch., Leimeister, J.M. & Krcmar, H., 2011. Idea Evaluation Mechanisms for Collective Intelligence in Open Innovation Communities: Do Traders Outperform Raters? In *Proceedings of the International Conference on Information Systems*. pp. 1–24. Available at SSRN: https://ssrn.com/abstract=1936590

Bonabeau, E., 2009. Decisions 2.0: The power of collective intelligence. *MIT Sloan Management Review; Cambridge*, 50(2), pp. 45–52.

Bosch-Sijtsema, P. & Sivunen, A., 2013. Professional Virtual Worlds Supporting Computer-Mediated Communication, Collaboration, and Learning in Geographically Distributed Contexts. *IEEE Transactions on Professional Communication*, 56(2), pp. 160–175. DOI: 10.1109/TPC.2012.2237256

Bothos, E., Apostolou, D. & Mentzas, G., 2009. Collective intelligence for idea management with Internet-based information aggregation markets. *Internet Research*, 19(1), pp. 26–41. DOI:10.1108/10662240910927803

Bothos, E., Apostolou, D. & Mentzas, G., 2012. Collective intelligence with web-based information aggregation markets: The role of market facilitation in idea management. *Expert Systems with Applications*, 39(1), pp. 1333–1345. Available at: http://dx.doi.org/10.1016/j.eswa.2011.08.014.

Bradley, L., Lindström, B. & Rystedt, H., 2010. Rationalities of collaboration for language learning in a wiki. *European Association for Computer Assisted Language Learning, ReCALL*, 22(2), pp. 247–265. DOI: 10.1017/S0958344010000108

Brocke J.V., Hevner A. & Maedche A., 2020. Introduction to Design Science Research. In: vom Brocke J., Hevner A., Maedche A. (eds) *Design Science Research*. Cases, Cham. DOI: 10.1007/978-3-030-46781-4_1

Camarinha-Matos, L.M., Afsarmanesh, H., Galeano, N. & Molina, H., 2009. Collaborative networked organizations - Concepts and practice in manufacturing enterprises. *Computers and Industrial Engineering*, 57(1), pp. 46–60. DOI:10.1016/j.cie.2008.11.024

Camarinha-Matos, L.M., Afsarmanesh, H., Ermilova, E., Ferrada, F., Klen, A. & Jarimo, T., 2008. ARCON reference models for collaborativ networks. In Collaborative Network: Reference Modeling. Springer: Berlin/Heidelberg, Germany, 2008; pp. 83–112. DOI:10.1007/978-0-387-79426-6_8

Camarinha-Matos, L.M. & Afsarmanesh, H., 2008. The ARCON modeling framework. In: Collaborative Networks: Reference Modeling. L.M. Camarinha-Matos, H. Afsarmanesh, Springer: New York, 2008. DOI:https://doi.org/10.1007/978-0-387-79426-6_7

Campbell, A., Hurry, J. & Zidov, M., 2011. Designing an organisation to activate cross-sectoral mass collaboration towards sustainability. *Netlearning2002.Org*, pp. 97. Available at: https://www.diva-portal.org/smash/get/diva2:829353/FULLTEXT01.pdf

Caspi, A. & Blau, I., 2011. Collaboration and psychological ownership: How does the tension between the two influence perceived learning? *Social Psychology of Education*, 14(2), pp. 283–298. DOI 10.1007/s11218-010-9141-z

Chan, T., Roschelle, J., His, Sh., Kinshuk, D., Sharples, M., Brown, T.H., Patton, Ch., Cherniavsky, J., Pea, R.D., Norris, C., Soloway, E., Balacheff, N., Scardamalia, M., Dillenbourg, P., Looi, Ch.K. & Milrad, M., 2006. One-To-One Technology-Enhanced Learning: An Opportunity For Global Research Collaboration. *Research and Practice in Technology Enhanced Learning*, 1(1), pp. 3–29. Available at: https://www.researchgate.net/publication/32231162_One-to-one_technology-enhanced_learning_An_opportunity_for_global_research_collaboration.

Chand, S., 2016. 8 Types of Organisational Structures: their Advantages and Disadvantages. *Advertisements*. Available at: http://www.yourarticlelibrary.com/organization/8-types-of-organisational-structures-their-advantages-and-disadvantages/22143.

Chen Z., Jiang, Y. & Zhao, Y Yu, Y., 2010. A Collaborative Filtering Recommendation Algorithm Based on User Interest Change and Trust Evaluation. *International Journal of Digital Content Technology and its Applications*, 4(9), pp. 106–113. DOI: 10.4156/jdcta.vol4.issue9.13

Cheng, X., Li, Y., Sun, J. & Huang, J., 2016. Application of a novel collaboration engineering method for learning design: A case study. *British Journal of Educational Technology*, 47(4), pp. 803–818. DOI: 10.1111/bjet.12382

Clint, P., Liddle, S., Chan, P., Doxey, A. & Isom, B., 2007. WEB 2.0 learning platform: Harnessing collective intelligence. *Turkish Online Journal of Distance Education*, 8(3), pp. 16–33.

Corell-Almuzara, A., López-Belmonte, J., Marín-Marín, J.-A. & Moreno-Guerrero, A.-J., 2021. COVID-19 in the Field of Education: State of the Art. *Sustainability 2021*,

13(10), 5452. https://doi.org/10.3390/su13105452.

Cress, U., Moskaliuk, J. & Jeong, H., 2016. *Mass Collaboration and Education*, Computer-Supported Collaborative Learning Series. DOI: 10.1007/978-3-319-13536-6

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. J. M. s., 1989. User acceptance of computer technology: a comparison of two theoretical models. *Management Science*, 35(8), pp. 982-1003. DOI:10.1287/mnsc.35.8.982.

Daxenberger, J., 2016. *The Writing Process in Online Mass Collaboration NLP-Supported Approaches to Analyzing Collaborative Revision and User Interaction*. Technische Universität, Darmstadt. Available at: http://tuprints.ulb.tu-darmstadt.de/id/eprint/5225.

Deal, A., 2009. *A Teaching with Technology White Paper: collaboration tools*, Available at: https://www.cmu.edu/teaching/technology/whitepapers/CollaborationTools_Jan09.pdf.

De Liddo, A., Sándor, Á. & Shum, S.B., 2012. Contested collective intelligence: Rationale, technologies, and a human-machine annotation study. *Computer Supported Cooperative Work*, 21(4–5), pp. 417–448. DOI:10.1007/s10606-011-9155-x

DeLiddo, A. & Shum, S.B., 2013. The Evidence Hub: harnessing the collective intelligence of communities to build evidence-based knowledge. *Large Scale Ideation and Deliberation Workshop,* 29 June - 02 July 2013, pp.8.

De Moor, A., 2013. Creativity Meets Rationale: Collaboration Patterns for Social Innovation. *Creativity and Rationale*, 20, pp. 377–404. DOI: 10.1007/978-1-4471-4111-2_18

DeNisi, A.S. & Pritchard, R.D., 2006. Performance Appraisal, Performance Management and Improving Individual Performance: A Motivational Framework. *Management and Organization Review*, 2(2), pp. 253–277. DOI: https://doi.org/10.1111/j.1740-8784.2006.00042.x

Diki, D., 2013. International Collaboration of Distance Learning Universities for Online Learning in Indonesia. *Lux*, 2(1), pp. 1–8. DOI: 10.5642/lux.201301.12

Dillenbourg, P. & Baker, M., 1995. The evolution of research on collaborative learning. In *Learning in Humans and Machine: Towards an interdisciplinary learning science*. Elsevier, Oxford, pp. 189–211. Available at: http://telearn.archives-ouvertes.fr/hal-00190626/.

Doan, A., Ramakrishnan, R. & Halevy, A.Y., 2010. Mass Collaboration Systems on the World-Wide Web. *Comm ACM*. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.154.444&rep=rep1&type=pdf.

Domik, G. & Fischer, G., 2011. Transdisciplinary collaboration and lifelong learning: Fostering and supporting new learning opportunities. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 6570, pp. 129–143. DOI: 10.1007/978-3-642-19391-0_10

Dondio, P. & Longo, L., 2011. Trust-Based Techniques for Collective Intelligence in Social Search Systems. In. *Next Generation Data Technologies for Collective Computational Intelligence*. pp. 113–135. DOI:10.1007/978-3-642-20344-2_5

Du, Z., Fu, X., Zhao, C., Liu, Q. & Liu, T., 2013. Interactive and Collaborative E-Learning Platform with Integrated Social Software and Learning Management System. In *Proceedings of the 2012 International Conference on Information Technology and Software Engineering: Software Engineering & Digital Media Technology*. DOI: 10.1007/978-3-642-34531-9_2 Duque, R., Gomez-Perez, D., Reyes, A.N. & Bravo, C., 2015. Analyzing collaboration and interaction in learning environments to form learner groups. *Computers in Human Behavior*, 47, pp. 42–49. DOI: 10.1016/j.chb.2014.07.012

Elliott, M.A., 2007. Stigmergic Collaboration A Theoretical Framework for Mass Collaboration. *Center for Ideas Victorian College of the Arts*, Ph.D. (October), pp. 1–264. Available at: http://dlc.dlib.indiana.edu/dlc/bitstream/handle/10535/3574/elliott_phd_pub_08.10.07.pdf.txt?sequenc..

Espitia, M.I. & Olarte, A.C., 2011. Virtual Forums: A Pedagogical Tool for Collaboration and Learning in Teacher Education. *Colombian Applied Linguistics Journal*, 13(2), pp. 29–42. DOI: https://doi.org/10.14483/22487085.3763

Fallis, D., 2009. Introduction: The epistemology of mass collaboration. *Episteme*, 6(1), pp. 1–7. DOI: 10.3366/E1742360008000506

Farooq, M, K., 2010. Capability Maturity Model for ARCON Implementation for e-Government Services. Proceedings of the 4th International Conference on Theory and Practice of Electronic Governance (ICEGOV), Beijing, China, October 25-28, pp. 379–380. https://doi.org/10.1145/1930321.1930405

Fischer, G., 2016. Exploring, Understanding, and Designing Innovative Socio-Technical Environments for Fostering and Supporting Mass Collaboration. *Mass Collaboration and Education*, pp. 43–63. DOI: 10.1007/978-3-319-13536-6_3

Franks, P.C. & Oliver, G.C., 2012. Experiential learning and international collaboration opportunities: virtual internships. *Library Review*, 61(4), pp. 272–285. DOI: 10.1108/00242531211267572

Franks, P.C. & Oliver, G.C., 2011. Virtual Internships: Opportunities for Experiential Learning and International Collaboration in Digital Curation Curricula. In *77th*

IFLA General Conference and Assembly. San Juan, Puerto Rico. Available at: https://www.ifla.org/past-wlic/2011/217-franks-en.pdf.

Fritch, J.W. & Cromwell, R.L., 2001. Evaluating internet resources: Identity, affiliation, and cognitive authority in a networked world. *Journal of the American Society for Information Science and Technology*, 52(6), pp. 499–507. DOI: 10.1002/asi.1081

Galbraith, J.R., 1987. Organization design. In J. W. Lorsch (Ed.). In *Handbook of organizational behavior*, pp. 343-357. Englewood Cliffs, NJ: Prentice Hall.

Gao, F., 2013. A case study of using a social annotation tool to support collaboratively learning. *Internet and Higher Education*, 17(1), pp. 76–83. Available at: http://dx.doi.org/10.1016/j.iheduc.2012.11.002.

Garrison, D.R., Anderson, T. & Archer, W., 2010. The first decade of the community of inquiry framework: A retrospective. *The Internet and Higher Education*, 13(1–2), pp. 5-9. DOI:10.1016/j.iheduc.2009.10.003

Gea, M., Soldado, R.M. & Gamiz, V., 2011. Collective Intelligence and Online Learning Communities. *Information Society (i-Society), 2011 International Conference*, pp. 319–323.

Ghazawneh, A., 2008. *Managing Mass Collaboration: Toward a Process Framework*. Lund University. Available at: https://lup.lub.lu.se/student-papers/search/publication/1336594.

Gholami, B. & Safavi, R., 2010. Harnessing collective intelligence: Wiki and social network from end-user perspective. In *IC4E 2010 - 2010 International Conference on e-Education, e-Business, e-Management and e-Learning*. pp. 242–246. DOI: 10.1109/IC4E.2010.49

Görs, J., Horton, G. & Kempe, N., 2012. A collaborative algorithm for computer-supported idea selection in the front end of innovation. *Proceedings of the Annual Hawaii International Conference on System Sciences*, (May), pp. 217–226. DOI: 10.1109/HICSS.2012.48

Gray, C. & Smyth, K., 2012. Collaboration creation: Lessons learned from establishing an online professional learning community. *Electronic Journal of e-Learning*, 10(1), pp. 60–75.

Grigore, M. & Rosenkranz, C., 2011. Increasing the Willingness To Collaborate Online: an Analysis of Sentiment-Driven Interactions in Peer Content Production. *Icis*, pp. 1–18.

Hairon, S. & Tan, C., 2017. Professional learning communities in Singapore and Shanghai: implications for teacher collaboration. *Compare: A Journal of Comparative and International Education*, 47(1), pp. 91–104. DOI: 10.1080/03057925.2016.1153408

Halatchliyski, I., Johannes, M., Joachim, K. & Ulrike, C., 2014. Explaining authors' contribution to pivotal artifacts during mass collaboration in the Wikipedia's knowledge base. *International Journal of Computer-Supported Collaborative Learning*, 9(1), pp. 97–115. DOI: 10.1007/s11412-013-9182-3

Halatchliyski, I., 2015. *Networked Knowledge: Approaches to Analyzing Dynamic Networks of Knowledge in Wikis for Mass Collaboration*. Universitat Tubingen. Available at: http://hdl.handle.net/10900/64355.

Heifetz, R.A., Linsky, M. & Grashow, A., 2010. The practice of adaptive leadership. Tools and tactics for changing your organization and the world. *Personnel Psychology*, 63(1), pp. 243–264.

Hevner, A., March, S., Park, J. & Ram S., 2004. Design science in information systems research. MIS Quarterly 28(1), pp. 75–105.

Heylighen, F., 1999. Collective Intelligence and its Implementation on the Web: algorithms to develop a collective mental map. *Computational & Mathematical Organization Theory*, 3, pp. 1–26. DOI: 10.1023/A:1009690407292

Hovland, C.I., Janis, I.L. & Kelley, H.H., 1953. *Communication and persuasion: psychological studies of opinion change*, New Haven, CT: Yale University Press.

Hoyle, D., ISO 9000 Quality Systems Handbook: Using the Standards as a Framework for Business Improvement, Sixth Edition,Taylor and Francis, 2009.

Huang, L., Deng, Sh., Li, Y., Wu, J., Yin, J. & Li, G., 2013. A trust evaluation mechanism for collaboration of data-intensive services in cloud. *Applied Mathematics and Information Sciences*, 7(1 L), pp. 121–129.

Hughes, J.E. & Narayan, R., 2009. Collaboration and Learning with Wikis in Post-Secondary Classrooms. *Journal of Interactive Online Learning*, 8(1), pp. 63–82.

Hwang, N.R., Lui, G. & Tong, M.Y.J.W., 2008. Cooperative Learning in a Passive Learning Environment. *Issues in Accounting Education*, 23(1), pp. 67–75. DOI: 10.2308/iace.2008.23.1.67

Jafari, M., Bourouni, A. & Amiri, R.H., 2009. A new framework for selection of the best performance appraisal method. *European Journal of Social Sciences –*, 7(3), pp. 92–100.

Jehn, K. a. & Bezroukova, K., 2004. A field study of group diversity, work group context, and performance. *Journal of Organizational Behaviour*, 25(6), pp. 703–729. DOI: 10.1002/job.257

Johnson, D.W., Maruyama, G., Johnson, R., Nelson, D., & Skon, L., 1981. Effects of cooperative, competitive, and individualistic goal structures on achievement: A meta-analysis. *Psychological Bulletin*, 89(1), pp. 47–62. DOI: 10.1037/0033-

2909.89.1.47

Jones, P., 2010. Collaboration at a distance: Using a wiki to create a collaborative learning environment for distance education and on-campus students in a social work course. *Journal of Teaching in Social Work*, 30(2), pp. 225–236. DOI: 10.1080/08841231003705396

Joyce, E., Pike, J.C. & Butler, B.S., 2013. Rules and Roles vs. Consensus: Self-Governed Deliberative Mass Collaboration Bureaucracies. *American Behavioral Scientist*, 57(5), pp. 576–594.

Kane, G.C., 2011. A multimethod study of information quality in wiki collaboration. *ACM Transactions on Management Information Systems*, 2(1), pp. 1–16. DOI: 10.1145/1929916.1929920

Kapoun, J., 1998. Teaching undergrads WEB evaluation: A guide for library instruction. *College & research libraries news*, 59(7), pp. 522–523.

Kates, A. & Erickson, P.J., 2008. Virtual Collaboration in a Matrix Organisation. *The Handbook of High Performance Virtual Teams*, pp. 1–24.

Kaushik, A., 2012. Evaluation of Internet Resources: A Review of Selected Literature. *Brazilian Journal of Information Science*, 6(2), pp. 61–83. DOI: http://dx.doi.org/10.36311/1981-1640.2012.v6n2.05.p61

Kawalek, P., 2010. Benefit-Driven Participation in Open Organizational Social Media Platforms: The Case of The Sap Community Network. *Issues in Information Systems*, 9(1), pp. 601–611.

Lambropoulos, N., Faulkner, X. & Culwin, F., 2011. Supporting social awareness in collaborative e-learning. *British Journal of Educational Technology*, 43(2), pp. 295–306. DOI: 10.1111/j.1467-8535.2011.01184.x

Latif, K.I., Baloch, Q.B. & Naser Khan, M., 2012. Structure, Corporate Strategy and the Overall Effectiveness of the Organization. *Social Sciences*, Vol. 5(2). pp. 1-13.

Lee, C.B., Chai, C.S., Tsai, C.C. & Hong, H.Y., 2016. Using Knowledge Building to Foster Conceptual Change. *Journal of Education and Training Studies*, 4(8), pp.116–125. DOI: 10.11114/jets.v4i8.1661

Li, Z., Shen, H. & Grant, J., 2012. Collective intelligence in the online social network of yahoo! answers and its implications. *Proceedings of the 21st ACM international conference on Information and knowledge management*, pp. 455–464. DOI: 10.1145/2396761.2396821

Lichtenstein, S. & Parker, C.M., 2009. Wikipedia model for collective intelligence: a review of information quality. *International Journal of Knowledge and Learning*, 5(3/4), pp. 254. DOI: 10.1504/IJKL.2009.031199

Lih, A., 2004. Wikipedia as Participatory Journalism: Reliable Sources? Metrics for evaluating collaborative media as a news resource. In. *5th International Symposium on Online Journalism*. pp. 31.

Likert, R., 1932. A technique for the measurement of attitudes. *Archives of Psychology*, 22 140, 55 pages.

Liu, B., Jiang, Y., Sha, F. & Govindan, R., 2012. Cloud-enabled privacy-preserving collaborative learning for mobile sensing. In. *Proceedings of the 10th ACM Conference on Embedded Network Sensor Systems - SenSys '12*. pp. 57–70. DOI: 10.1145/2426656.2426663

Liu, Y. & Wu, Y., 2010. A survey on trust and trustworthy e-learning system. *Proceedings - 2010 International Conference on Web Information Systems and Mining, WISM 2010*, 1, pp. 118–122. DOI: 10.1109/WISM.2010.62

Lloyd, J., Amigo, M. & Hettitantri, N., 2016. Learning through participation as a mass collaboration. *Asia-Pacific Journal of Cooperative Education*, 17(2), pp. 163–174.

Louder, J.R., 2011. *Distance Learning Environments at One Emerging Research Institution in Texas: The Relationship between Instructor Support, Student Interaction and Collaboration, and Learning*. Texas Tech University. Available at: http://hdl.handle.net/2346/ETD-TTU-2011-08-1821.

Luo, S., Xia, H., Yoshida, T. & Wang, Z., 2009. Toward collective intelligence of online communities: A primitive conceptual model. *Journal of Systems Science and Systems Engineering*, 18(2), pp. 203–221. DOI: 10.1007/s11518-009-5095-0

Macedo, P., Abreu, A. & Camarinha-Matos, L.M., 2012. Modelling a Collaborative Network in the Agri-Food Sector Using ARCON Framework: The PROVE Case Study. 13th Working Conference on Virtual Enterprises (PROVE), Bournemouth, United Kingdom, pp.329–339, ff10.1007/978- 3-642-32775-9_34ff. ffhal-01520428.

Madnick, S.E., Wang, R.Y., Lee, Y.W. & Zhu, H., 2009. Overview and Framework for Data and Information Quality Research. *ACM Journal of Data and Information Quality*, 1(1), pp. 1–22. DOI: 10.1145/1515693.1516680

Maleewong, K., Anutariya, C. & Wuwongse, V., 2008. A Collective Intelligence Approach to Collaborative Knowledge Creation. In *2008 Fourth International Conference on Semantics, Knowledge and Grid*. pp. 64–70. DOI: 10.1109/SKG.2008.80.

Manouselis, N., Vuorikari, R. & Van Assche, F., 2010. Collaborative recommendation of e-learning resources: An experimental investigation. *Journal of Computer Assisted Learning*, 26(4), pp. 227–242. DOI: 10.1111/j.1365-2729.2010.00362.x

Maries, I. & Scarlat, E., 2011. Enhancing the computational collective intelligence within communities of practice using trust and reputation models. *Lecture Notes*

in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 6560, pp. 74–95. DOI: 10.1007/978-3-642-19968-4_4

Mason, W. & Watts, D.J., 2012. Collaborative learning in networks. *Proceedings of the National Academy of Sciences*, 109(3), pp. 764–769. DOI: 10.1073/pnas.1110069108

McCann, R., Doan, A. & Vanitha Varadarajan, A.K., 2003. Building Data Integration Systems: A Mass Collaboration Approach. In *International Workshop on Web and Databases*. San Diego, California.

Meola, M., 2004. Chucking the Checklist: A Contextual Approach to Teaching Undergraduates Web-Site Evaluation. *portal Libraries and the Academy*, 4(3), pp. 331–344. Available at: https://www.researchgate.net/publication/228777906_Chucking_the_Checklist_A_Contextual_Approach_to_Teaching_Undergraduates_Web-Site_Evaluation.

Metzger, M.J., 2007. Making sense of credibility on the web: Models for evaluating online information and recommendations for future research. *Journal of the American Society for Information Science and Technology*, 58(13), pp. 2078–2091. DOI: 10.1002/asi.20672

Meunier-FitzHugh, K.L. & Piercy, N.F., 2008. The Importance of Organizational Structure for Collaboration Between Sales and Marketing. *Journal of General Management*, 34(1). DOI: 10.1177/030630700803400102

Miguel, J., Caballé, S., Xhafa, F., Prieto, J. & Barolli, L., 2014. A collective intelligence approach for building student's trustworthiness profile in online learning. In *Ninth International Conference on P2P, Parallel, Grid, Cloud and Internet Computing, 3PGCIC 2014, 8-10 November 2014, Guangzhou, Xina: proceedings. IEEE.* pp. 46–53. DOI: 10.1109/3PGCIC.2014.132

Mintzberg, H., 1980. The Structuring of Organizations: A Synthesis of Research. *Administrative Science Quarterly*, 25(3). Available at: https://www.researchgate.net/publication/228270959_The_Structuring_of_Organizations_A_Synthesis_of_Research.

MIT Center for Collective Intelligence., 2011. Examples of collective intelligence. Available at: https://scripts.mit.edu/~cci/HCI/index.php?title=Examples_of_collective_intelligence.

MIT Management SLOAN., 2014. Climate Colab Crowdsources Solutions For Global Problems. Available at: http://mitsloan.mit.edu/newsroom/articles/climate-colab-crowdsources-solutions-for-global-problems/.

Morten, E., 2013. How Bureaucratic Structure Matters: An Organizational Perspective. In The SAGE Handbook of Public Administration, eds. B.G. Peters, and J. Pierre. Los Angeles, CA: SAGE Publications, pp. 157–168. DOI:

10.4135/9780857020970.n7

Mystakidis, S., 2021. Motivation Enhancement Methods for Community Building in Extended Reality. In Augmented and Mixed Reality for Communities; Fisher, J.A., Ed.; CRC Press: Boca Raton, pp. 265–282. DOI: 10.1201/9781003052838-17

Mystakidis, S., Berki, E. & Valtanen, J.-P., 2021. Deep and Meaningful E-Learning with Social Virtual Reality Environments in Higher Education: A Systematic Literature Review. *Appl. Sci*, 11, 2412, DOI:10.3390/app11052412.

Nathaniel, T., 2010. Wikipedia and the politics of mass collaboration. *Platform: journal of media and communication*, 2(2), pp. 40–53. Available at: http://wrap.warwick.ac.uk/54111/.

Nations, U., 2015. The 2030 Agenda for Sustainable Development. Available at: https://sustainabledevelopment.un.org/.

Naumann, F., 2002. Quality-driven Query Answering for Integrated Information Systems. In *Lecture Notes in Computer Science*, 2261. DOI: 10.1007/3-540-45921-9

Nerantzi, C., 2013. A case of problem based learning for cross-institutional collaboration. *Electronic Journal of e-Learning*, 10(3), pp. 306–314. Available at: https://www.researchgate.net/publication/286558267_A_case_of_problem_based_learning_for_cross-institutional_collaboration.

Neumann, T. & Carrington, A., 2007. A mass collaboration approach to e-learning: Multiple venue production. *Association for Learning Technology Newsletter*. Available at: http://archive.alt.ac.uk/alt.newsweaver.co.uk/newsweaver.co.uk/alt/e_article00078377064e4.html?x=b11,0,w.

Nickel, M., Tresp, V. & Kriegel, H.-P., 2011. A Three-Way Model for Collective Learning on Multi-Relational Data. In *Proceedings of the 28th International Conference on Machine Learning, ICML 2011*. Washington.

Nicola, S. & Ferreira, E.P. 2012. A Novel Framework for Modeling Value for the Customer, an Essay on Negotiation. *International Journal of Information Technology & Decision Making*, 1(3), pp. 661-703. DOI: 10.1142/S0219622012500162

Nielsen, W., Chan, E.K. & Jahng, N., 2010. Collaborative learning in an online course: A comparison of communication patterns in small and whole group activities. *Journal of Distance Education*, 24(2), pp. 39–58. Available at: http://ro.uow.edu.au/cgi/viewcontent.cgi?article=2319&context=edupapers.

Nitti, M. & Girau, R., 2012. A subjective model for trustworthiness evaluation in the social Internet of Things. In *IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, PIMRC*. DOI: 10.1109/PIMRC.2012.6362662

Oh, J., Jeong, O.R., Lee, E. & Kim, W., 2011. A framework for collective intelligence from internet Q&A documents. *International Journal of Web and Grid Services*, 7(2). DOI: 10.1504/IJWGS.2011.040445

Pallot, M., Martínez-Carreras, M.A. & Prinz, W., 2010. Collaborative Distance: A Framework for Distance Factors Affecting the Performance of Distributed Collaboration. *International Journal of e-Collaboration*, 6(2), pp. 1–32. DOI: 10.4018/jec.2010040101

Paleri P., 2018. Organised Human. In: Human Investment Management. *Springer*, Singapore. https://doi.org/10.1007/978-981-10-6024-3_4

Panchal, J.H. & Fathianathan, M., 2008. Product Realization in the Age of Mass Collaboration. In *Proceedings of IDETC/CIE 2008 ASME 2008 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference August 3-6*. DOI: 10.1115/DETC2008-49865

Peffers K., Tuunanen T., Gengler C.E., Rossi M., Hui W., Virtanen V. & Bragge J., 2006. The Design Science Research Process: A Model for Producing and Presenting Information Systems Research. *Proceedings of the First International Conference on Design Science Research in Information Systems and Technology*, 24-25 February, 2006, Claremont, California, USA, pp. 83-16.

Pellas, N., Kazanidis, I., Konstantinou, N. & Georgiou, G., 2017. Exploring the educational potential of three-dimensional multi-user virtual worlds for STEM education: A mixed-method systematic literature review. *Education and Information Technologies*, 22(5), pp. 2235–2279, DOI:10.1007/s10639-016-9537-2.

Persico, D. & Pozzi, F., 2011. Task, Team and Time to structure online collaboration in learning environments. *World Journal on Educational Technology*, 3(1), pp. 1–15. Available at: http://ezproxy.lib.ucf.edu/login?URL=http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2012-24263-001&site=ehost-live%5Cnpersico@itd.cnr.it.

Pombo, L., Loureiro, M.J. & Moreira, A., 2010. Assessing collaborative work in a higher education blended learning context: strategies and students' perceptions. *Educational Media International*, 47(3), pp. 217–229.

Potter, A., McClure, M. & Sellers, K., 2010. Mass collaboration problem solving: A new approach to wicked problems. *2010 International Symposium on Collaborative Technologies and Systems, CTS 2010*, pp. 398–407. DOI: 10.1109/CTS.2010.5478486

Poston, R.S. & Speier, C., 2005. Effective use of knowledge management systems: a process model of content ratings and credibility indicators. *MIS Quarterly*, 29(2), pp. 221- 244. DOI:10.2307/25148678

Qi, G.J., Aggarwal, C.C., Han, J. & Huang, T., 2013. Mining Collective Intelligence in

Diverse Groups. In *Proceedings of the 22Nd International Conference on World Wide Web*. pp. 1041–1052. DOI: 10.1145/2488388.2488479

Rabbany, R., Elatia, S., Takaffoli, M. & Zaïane O.R., 2013. Collaborative Learning of Students in Online Discussion Forums: A Social Network Analysis Perspective. In *Chapter, Educational Data Mining, Volume 524 of the series Studies in Computational Intelligence,* pp. 441-466. DOI: 10.1007/978-3-319-02738-8-16

Ramaley, J., 2016. Collaboration in an Era of Change: New Forms of Community Problem-Solving. *Metropolitan Universities*, 27(1), pp. 3–24.

Rao, L. & Bryson, K.M.O., 2007. Towards defining dimensions of knowledge systems quality, *Expert Systems with Applications*, 33(2), pp. 368-378.

Richardson, M. & Domingos, P., 2003. Building Large Knowledge Bases by Mass Collaboration. *Proceedings of the international conference on Knowledge capture - K-CAP '03*, pp. 129–137. DOI: 10.1145/945645.945665 Riedl, C., Blohm, I., Leimeister, J.M. & Krcmar, H., 2010. Rating scales for collective intelligence in innovation communities: Why quick and easy decision making does not get it right. In *Thirty First International Conference on Information Systems (ICIS)*. pp. 1–21.

Robertson, B., 2007. Organization at the Leading Edge: Introducing Holacracy™. *Integral Leadership Review*. Available at: http://www.holacracy.org/sites/default/files/resources/HolacracyIntro2007-06.pdf.

Rodriguez-Artacho, M., Mayorga, J.I., Read, T., Vélez, J., Ros, S., Rodrigo, C., Lorenzo, E., Delgado, J.L., Bárcena, E., Castro-Gil, M., Martín, S. & Molina, C. P., 2010. Enhancing authoring, modelling and collaboration in E-learning environments: UNED research outline in the context of e-Madrid excellence network. *2010 IEEE Education Engineering Conference, EDUCON 2010*, pp. 1137–1144. DOI:10.1109/EDUCON.2010.5492449

Šalková, A., 2013. The use of cost management techniques as a strategic weapon in SME's. *Scientific Papers of the University of Pardubice, Series D*, 20(28), pp.91. Available at: http://hdl.handle.net/10195/54036.

Sancho, J., 2016. Learning Opportunities for Mass Collaboration Projects Through Learning Analytics: A Case Study. *Revista Iberoamericana de Tecnologias del Aprendizaje*, 11(3), pp. 148–158. DOI: 10.1109/RITA.2016.2589482.

Sanders, M.J., Reynolds, J., Bagatell, N., Treu, J.A., O'Connor, E. & Katz, D.L., 2015. Promoting Healthy Lifestyles to Children at School: Using a Multidisciplinary Train-the-Trainer Approach. *Public Health Manag Pract*, 21(4), pp. 27-35. DOI: 10.1097/PHH.0000000000000141.

Schumann, J., Shih, P.T., Redmiles, D. & Horton. G., 2012. Supporting initial trust in

distributed idea generation and idea evaluation. In *Proceedings of the 17th ACM international conference on Supporting group work - GROUP '12*. pp. 199–208. DOI: 10.1145/2389176.2389207

Shaout, A. & Yousif, M.K., 2014. Performance Evaluation – Methods and Techniques Survey. *International Journal of Computer and Information Technology*, 3(5). Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.650.5598&rep=rep1&type=pdf

Shapiro R.B., 2016. *Toward Participatory Discovery Networks: A Critique of Current Mass Collaboration Environments and a Possible Learning-Rich Future*. In: Cress U., Moskaliuk J., Jeong H. (eds) Mass Collaboration and Education. Computer-Supported Collaborative Learning Series, vol 16. Springer, Cham. DOI:10.1007/978-3-319-13536-6_10

Shen, X.L., Lee, M.K.O. & Cheung, C.M.K., 2012. Harnessing collective intelligence of Web 2.0: Group adoption and use of Internet-based collaboration technologies. *Knowledge Management Research and Practice*, 10(4), pp. 301–311. DOI: 10.1057/kmrp.2012.30

Short, B.J., 2012. *21st Century Skills Development: Learning in Digital Communities: Technology and Collaboration*. University of Oregon. Available at: https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/12407/Short_oregon_0171A_10397.pdf?sequence=1&isAllowed=y.

Siau, K. & Cao, Q., 2001. Unified Modeling Language: A Complexity Analysis. *Journal of Database Management (JDM)*, 12(1). pp. 26-34. DOI: 10.4018/jdm.2001010103.

Silva, T.H., Vaz de Melo, P.O.S., Viana, A.C., Almeida, J.M., Salles, J. & Loureiro, A., 2013. Traffic condition is more than colored lines on a map: Characterization of Waze alerts. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 8238 LNCS, pp. 309–318. DOI: 10.1007/978-3-319-03260-3_27

Spielman, S.E., 2014. Spatial collective intelligence? credibility, accuracy, and volunteered geographic information. *Cartography and Geographic Information Science*, 41(2), pp. 115–124. doi: 10.1080/15230406.2013.874200

Stvilia, B., Twidale, M., Gasser, L. & Smith, L.C., 2008. Information Quality Discussions in Wikipedia. *Journal of the American Society for Information Science and Technology*, 59(6), pp. 983-1001.

Sun, G. & Shen, J., 2014. Facilitating social collaboration in mobile cloud-based learning: A team workas a service (TaaS) approach. *IEEE Transactions on Learning Technologies*, 7(3), pp. 207–220. DOI: 10.1109/TLT.2014.2340402

Tapscott., D. & Williams, A.D., 2008. Wikinomics: How Mass Collaboration Changes

Everythingtle. *International Journal of Communication 2*, pp. 1–11. DOI:10.5860/choice.44-6933

Todoran, I.G., Lecornu, L., Khenchaf, A. & Caillec, J.M.L., 2013. Information quality evaluation in fusion systems. In *2013 16th International Conference on Information Fusion (FUSION)* Istanbul , pp. 906-913. DOI: 10.13140/2.1.4147.8085

Toprak, E. & Genc-Kumtepe, E., 2014. Cross-Cultural Communication and Collaboration: Case of an International E-Learning Project. *European Journal of Open, Distance and E-Learning*, 17(1), pp. 134–146. DOI: 10.2478/eurodl-2014-0009

Tsai, W., Li, W. & Elston, J., 2011. Collaborative Learning Using Wiki Web Sites for Computer Science Undergraduate Education: A Case Study. *IEEE Transactions On Education*, 54(1), pp. 114–124. DOI: 10.1109/TE.2010.2046491

Turban, E., Liang, T.P. & Wu, S.P.J., 2011. A Framework for Adopting Collaboration 2.0 Tools for Virtual Group Decision Making. *Group Decision and Negotiation*, 20(2), pp. 137–154. DOI: 10.1007/s10726-010-9215-5

United Nations., 2015. The 2030 Agenda for Sustainable development. Retrieved from: https://sustainabledevelopment.un.org/.

Urquhart, R., Cornelissen, E., Lal, S., Colquhoun, H., Klein, G., Richmond, S. & Witteman, H.O., 2013. A Community of Practice for Knowledge Translation Trainees: An Innovative Approach for Learning and Collaboration. *Journal of Continuing Education In The Health Professions*, 33(4), pp. 274–281. DOI: 10.1002/chp.21190

Venclova, K., Salkova, A. & Kolackova, G., 2013. Identification of Employee Performance Appraisal Methods in Agricultural Organizations. *Journal of Competitiveness*, 5(2), pp. 20–36. DOI: 10.7441/joc.2013.02.02

Viégas, F.B., Wattenberg, M. & Dave, K., 2004. Studying cooperation and conflict between authors with history flow visualizations. *Proceedings of the 2004 conference on Human factors in computing systems - CHI '04*, 6(1), pp. 575–582. DOI: 10.1145/985692.985765

Wang, H., Wang, N. & Yeung, D.-Y., 2015. Collaborative Deep Learning for Recommender Systems. In *Proceedings of the 21th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*. pp. 1235–1244. DOI: http://dx.doi.org/10.1145/2783258.2783273.

Wang, Q. & Tunzelmann, N.V., 2000. Complexity and the functions of the firm: Breadth and depth. *Research Policy*, 29(7–8), pp. 805–818. DOI:10.1016/S0048-7333(00)00106-2

Wang, S., Zhu, X. & Zhang, H., 2011. Web service selection in trustworthy

collaboration network. *Proceedings - 2011 8th IEEE International Conference on e-Business Engineering, ICEBE 2011*, (May), pp. 153–160. DOI: 10.1109/ICEBE.2011.71

Weitzel, L., Quaresma, P. & Oliveira, J.P.M., 2012. Evaluating Quality of Health Information Sources. *2012 IEEE 26th International Conference on Advanced Information Networking and Applications*, pp. 655–662. DOI: 10.1109/AINA.2012.41

Wöhner, T. & Peters, R., 2009. Assessing the quality of Wikipedia articles with lifecycle based metrics. *Proceedings of the 5th International Symposium on Wikis and Open Collaboration WikiSym 09*, pp.1. DOI: 10.1145/1641309.1641333

Wolf, M.M., Wolf, M.J., Frawley, T., Torres, A. & Wolf, S., 2012. Using social media to enhance learning through collaboration in higher education: a case study. *Applied and Agricultural Economics Association's 2012 AAEA Annual Conference: Seattle, WA*, pp. 1–13. Available at: http://digitalcommons.calpoly.edu/agb_fac/131/.

Yaragarla, R., 2016. Scenarios of collaborative approach in mass collaboration. *Open sourse framework for enterprise application*. Available at: http://www.workmonkeylabs.com/scenarios-of-collaborative-approach-in-mass-collaboration/.

Yaragarla, R., 2016. Scenarios of collaborative approach in mass collaboration. Available at: http://www.workmonkeylabs.com/scenarios-of-collaborative-approach-in-mass-collaboration/.

Zaffar, F.O. & Ghazawneh, A., 2012. Knowledge sharing and collaboration through social media - the case of IBM. In *MCIS 2012 Proceedings. 28*. pp. 1–11. Available at: https://www.researchgate.net/publication/230767036_KNOWLEDGE_SHARING_AND_COLLABORATION_THROUGH_SOCIAL_MEDIA_-THE_CASE_OF_IBM.

Zamiri M. & Camarinha-Matos L.M., 2019. Organizational Structure for Mass Collaboration and Learning. In: Technological Innovation for Industry and Service Systems. DoCEIS 2019. IFIP Advances in Information and Communication Technology, vol 553, pp. 14-23. Springer, Cham. DOI:10.1007/978-3-030-17771-3_2

Zamiri, M., Sarraipa, J., & Gonçalves, R.J., 2020. A Reference Model for Interoperable Living Labs Towards Establishing Productive Networks. In Proceedings of the 10th International Conference On interoperability for Enterprise Systems and Applications, Tarbes, France, November 17th to 19th, 2020, pp. 17-29.

Zhang, J. & Baden-Fuller, C., 2010. The influence of technological knowledge base and organizational structure on technology collaboration. *Journal of Management Studies*, 47(4), pp. 679–704. DOI: 10.1111/j.1467-6486.2009.00885.x

Zhu, C., 2008. Quantitative models for performance evaluation and benchmarking:

data envelopment analysis with spreadsheets. In *International Series in Operations Research & Management Science*. Available at: http://www.ifets.info/journals/15_1/12.pdf.

A

QUESTIONNAIRE FOR EVALUATING THE ADEQUACY OF MGF-MCL IN ED-EN HUB PROJECT

Appendix A shows the questionnaire used in the ED-EN HUB project for evaluating the adequacy of considered dimensions of collaboration and their related factors, features, and elements that have the potential to be implemented on EDENCP. The answer that best represents the evaluator's opinion should be chosen from the addressed multiple choices. The alternative answers are:

- *SDA = strongly disagree*
- *DA = disagree*
- *A = agree*
- *SA = strongly agree*
- *I don't know*
- *I'm not sure*

Questionnaire for evaluating the adequacy of considered dimension of collaboration and their related factors, features, and elements that have potential to be implemented on EDENCP		
Considered Dimensions	Main factors, features, and elements that might be integrated into EDENCP	Checklist
Organizational Dimension (Relates to the organization of hub or the way it is set up. It is also related to the action of organizing something)	**1)** It is important that even general users could help (the partners and administrators) to develop the EDENCP.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	2) It is important that the EDENCP engages diverse groups (e.g., general public, experts, and professionals) in the process of learning.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	3) It is important that the EDENCP provides opportunities for collective learning.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	4) It is important that the EDENCP be used for different purposes (e.g., education, tutorials, developing competencies, promoting workforces, R&D).	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	5) It is important that the EDENCP facilitates the process of knowledge building, sharing, and developing.	SDA / DA / A / SA / I don't know / I'm not sure

	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	6) It is important that the EDENCP be used for different fields of study and work.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	7) It is important that the EDENCP be a user-driven service (it means putting the users in charge, in some way)	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Environmental Dimension (Relates to the hub's surroundings and also the impact of participants' activities on its condition)	**8)** It is important that the EDENCP be open for all people to contribute.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	9) It is important that the EDENCP provides three levels of access (for three groups of users: partners, administrators, and general users).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	10) It is important that the EDENCP could be available in different languages.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	11) It is important that the EDENCP facilitates different forms of communication (virtual, physical, or mixed).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	12) It is important that the EDENCP provides a common collaboration space to be used by different settings such as educational, industrial, services, and labs.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	13) It is important that the EDENCP provides a supportive environment in which users can help each other.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	14) It is important that the EDENCP simulates the ways users collaborate toward building a dynamic hub.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Behavioral Dimension (Relates to the principles, policies, and governance rules that drive the behavior of the hub)	**15)** The partners and administrators have the authority to bring about structural changes in the EDENCP.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	16) The general users do not have the authority to make technical changes in the EDENCP.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	17) The general users can contribute to decision-making processes.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	18) It is important that the governance rules for the original hub are defined in a collaborative and democratic way.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	19) To build trust, the EDENCP must make transparency as a part of hub policy.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	20) It is important that the EDENCP provides a "rewarding system".	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	21) It is important that the EDENCP supports developing transversal skills.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	22) It is important that the EDENCP provides a "conflict resolution system".	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Admission Dimension (Relates to the process or fact of entering or being	*Inclusion*				
	23) It is important that the EDENCP facilitates the process of joining (inclusion) to the groups, communities, and hub.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
		SDA	DA	A	SA

allowed to enter the hub)	**24)** It is important that the EDENCP provides free access for all users.	I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	25) It is important that the EDENCP provides a service for identifying and inviting a specific group of participants such as, trainers, experts, technical, and managerial.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	26) It is important that all the users actively take part in introducing the hub to potential and interested persons.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	27) It is important that the EDENCP suspends or even deactivates a user's account who does not follow the community/hub rules.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	28) Users can stop their contribution at any time.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	29) It is important that the users make notifications before stopping their contributions.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	Accessibility and Proximity				
	30) To promote the quality of contributions and develop transparency, it is important that the EDENCP reduces the anonymity.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	31) To reduce anonymity, it is important that the users create a user account and register by providing the real personal information (e.g., full name, profession, and e-mail address, and photo).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	32) It is important that the EDENCP incentives the user to keep contributing.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	33) It is important that the EDENCP tracks the time-outs (to check if there a problem with the user or the service).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	34) It is important that the username be associated with the user's contributions (to facilitate the monitoring of contributions).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Structural Dimension (Relates to the network structure such as participants, relationships, roles, and network typology)	*Participants*				
	35) It is important that the users from any age, background, culture, and gender can use the EDENCP.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	36) Users will not be paid and they will contribute on the volunteer base.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	37) It is important that the EDENCP provides different services for different group of users (e.g., learners, trainers, experts, researchers, academics, managers, and entrepreneurs).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	38) It is important that the EDENCP can deliver services for even people outside the community/hub.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	39) It is important that the EDENCP provides some services for people with special needs (e.g., people with disabilities).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	40) It is important that the users could participate in the activities that they are interested in and have related background.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
		SDA	DA	A	SA

	41) It is important that the users could make a list of useful things that they can bring to the hub.	I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	42) It is important that the EDENCP makes a list of the services that delivers.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	Roles and Tasks				
	43) It is important that the users could play different roles (e.g., expert, advisor, trainer, trainee, editorial, researcher, technical, managerial) based on their qualifications.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	44) It is important that the users could engage in multiple tasks (e.g., training execution, providing learning contents, delivering the contents, exchanging the contents, executing, providing supports, commenting, reporting) based on their interests and capabilities.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	45) It is important that the users could simultaneously contribute in different domains, courses, majors, practices, issues, and events.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	46) It is important that the users could support the process of developing curricula.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	47) It is important that the users could support the process of training.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	48) It is important that the users could support the process of competency development.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	49) It is important that the users could support the contributions from different people.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Social Dimension (Relates to the collaborative activities and interactions between the participants and hubs)	*Collaboration*				
	50) It is important that the EDENCP builds a network for career development.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	51) It is important that the users could learn new things collaboratively.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	52) It is important that the users could solve the problems collaboratively.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	53) It is important that the EDENCP could provide computer-supported collaborative tools for collaboration.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	54) It is important that the EDENCP could provide a "discussion forum" for collaboration.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	55) It is important that the users could build interdisciplinary collaboration (a collaboration that involves individuals from different teams, disciplines, and backgrounds).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	56) It is important that the EDENCP could support building strategic partnerships and alliances with potential external parties (to share the resources and expertise).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Functional Dimension (Relates to the base functions, operations, running, and	*Content Management*				
	57) It is important that the EDENCP could make accessible the created and developed content for all users.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
		SDA	DA	A	SA

procedures in the hub)	**58)** It is important that the users could support the process of creating, sharing, and developing the contents.	I don't know	I'm not sure		
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	59) It is important that the EDENCP could provide a "voting system" for evaluating the quality of created contents.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	60) It is important that the EDENCP could continually develop and update the contents.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	61) It is important that the EDENCP could classify the developed contents into specific courses and majors (based on predefined topics).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	62) It is important that the EDENCP could save the developed contents in a secured database.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	63) It is important that the EDENCP could publish some of the important discoveries, developments, and outcomes.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	Operation Management				
	64) It is important that the EDENCP could continuously promote its operational processes (set of activities or tasks that produces a specific service).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	65) It is important that the EDENCP could save users' personal information and contributions in their profile.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	66) It is important that the EDENCP could provide a "monitoring system" to constantly monitor the transactions.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	67) It is important that the EDENCP could provide a "benchmarking system" to regularly evaluate the performances.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	68) It is important that when someone breaks the rules, EDENCP could take the needed actions (e.g., sends a warning message to the account, removes it, or blocks the account).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	69) It is important that the EDENCP could unblock the owner of the blocked account if he promises to follow the rules in the future.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	Interaction Management				
	70) It is important that the EDENCP could provide an appropriate service for internal interactions such as sharing the resources, training, and learning materials.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	71) It is important that the EDENCP could provide an appropriate service for external interactions such as exchanging the expertise and findings.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	72) It is important that the EDENCP could provide multiple communication channels (e.g., email, live chat, message board, wiki, and social networks).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	73) It is important that the EDENCP could occasionally evaluate communication activities.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	74) It is important that the EDENCP could provide a Real-Time Interaction Management (that generates contextually relevant and personalized messages and offers, within the context of the user interaction).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
		SDA	DA	A	SA

	75) It is important that the EDENCP could provide opportunities for external interactions with similar communities and hubs.	I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	Human Resource Management				
	76) The users should be treated equally.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	77) It is important that the EDENCP could encourage users to make themselves known to the public (by providing their background knowledge and expertise).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	78) It is important that the EDENCP could provide an advisory board (for each field of study, major, or course).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	79) It is important that the EDENCP could retain effective users (for example by giving rank, badge, and more access).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	80) It is important that the EDENCP could provide a question and answer board for the users' issues and inquiries.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	81) It is important that the EDENCP could use outsourced talents.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Economical Dimension (Relates to the supportive services that could be provided internally and/or externally)	*Supports and Services*				
	How important do you think the following services could be for the economic sustainability of the platform:				
	82) Benefiting from private and public funding, grants, financial aids and donations, capital from investors and sponsors, and advertising.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	83) Providing supportive training and learning services for schools, organizations, institutions, businesses, and companies.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	84) Providing supportive training and learning services for social media markets.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	85) Providing consulting services.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	86) Providing supportive services for research practices and publications.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	87) Providing supportive services for conferences and workshops.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	88) Providing material and financial supports for innovators.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	89) Developing a program that assists and guides users in making occupational choices.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	90) Provide a support service that facilitates learning for people with disabilities.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	91) Providing needed service for companies that look for persons who have specific skills and competences.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Technological Dimension	**92)** It is important that the EDENCP could provide web-based communication.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				

(Relates to using technical means and interconnected components)	**93)** It is important that the EDENCP could use ICT technologies to facilitate communications processes.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	94) It is important that the EDENCP could benefit from Computer-Supported Collaborative Learning.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	95) It is important that the EDENCP could make links with social media platforms (to facilitate communications).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	96) It is important that the EDENCP could provide a search engine that helps participants to find particular information and services provided in the hub.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	97) It is important that the EDENCP could use potential tools for assessing the performances.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	98) It is important that the EDENCP could provide sufficient technological services that support collaboration.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	99) It is important that the EDENCP could use external technological supports.	SDA	DA	A	SA
		I don't know		I'm not sure	
	100) It is important that the EDENCP could save the interactions in a secure database.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				

B

QUESTIONNAIRE FOR EVALUATION THE FEASIBILITY OF MGF-MCL IN ED-EN HUB PROJECT

Appendix B shows the questionnaire used in the ED-EN HUB project for evaluating the feasibility of considered factors, features, and elements in connection with the EDENCP functions. There are 7 functions in the questionnaire. For each function, 9 polar questions are formulated, addressing the potential issues that should be evaluated for feasibility assuredness.

Questionnaire for evaluating the feasibility of considered dimension of collaboration and their related factors, features, and elements that have potential to be implemented on EDENCP		
1. Questions for Search Engines for Finding Information and Tools	**Yes**	**No**
1. It feasible to be used for multiple purposes (e.g., searching, sorting info)		
2. It feasible to have different access levels and provide a comprehensive list of available info		
3. It is feasible being flexible to change (e.g., open to add new info or keywords for searching)		
4. It is feasible to be free of charge and be used only by registered users		
5. It is feasible to have cross-functional capabilities (e.g., searching multiple features)		
6. It is feasible to be customizable (e.g., contains searching features to adapt to users' profiles)		
7. It is feasible to show newly inserted data in the real-time		
8. It is feasible to make income from external users using this service		
9. It is feasible to use advanced functions (e.g., search in other external hubs)		
2. Questions for Collaboration		
1. It is feasible to engage a diverse group of people in multiple communication tasks (e.g., chat forum)		
2. It is feasible to create collaboration spaces around different domains/topics		
3. It is feasible to promote the available skills or make a set of needed competences		
4. It is feasible to do limitless collaboration activities		
5. It is feasible to invite users to voluntarily contribute to collaborative activities based on their interest		
6. It is feasible to open the doors to the society for engaging in collective problem solving		
7. It is feasible support continuous collaborative activities to foment an active behavior		
8. It is feasible to create income services (e.g., training-consultancy services)		
9. It is feasible to provide a built-in collaborative solution (e.g., zoom-could-based video communication; ProofHub- a task management app)		
3. Questions for Managing Training		
1. It is feasible to use different characteristics to manage the training planning (e.g., cost, success rate, learning needs)		
2. It is feasible to use different training modes (blended learning) in the training planning		

3. It is feasible to have collective authoring training feature		
4. It should be able to consider inclusive training and learning		
5. It is feasible to give freedom for choosing the courses (help to prioritize learning needs bases on the user's profile)		
6. It is feasible to use analytics over-collected info to improve further training authoring and planning (i.e. knowledge management)		
7. It is feasible to create a training plan such as evaluation of the contents collectively (have a procedure to perform)		
8. It is feasible to generate income by providing different services for external users		
9. It is feasible to have external authoring tool (e.g., iSpring, Articulate)		
4. Questions for Training Execution Support		
1. It is feasible to define learning engagement strategies collaboratively		
2. It should be able to analyze what kind of approach or balance can be best used in training execution for different training modes (virtual vs. traditional classes)		
3. It is feasible to define the required training rules associated with execution modes		
4. It is feasible to define clear inclusive rules for admission		
5. It is feasible to manage the training execution with the trainees' competence level (have different learning engagement strategies accordingly to each group of students' competencies)		
6. It is feasible to use analytics over-collected performance data to improve further training execution and its learning engagement strategies (i.e. knowledge management)		
7. It is feasible to support training execution, learning engagement strategies, and performance assessment definition		
8. It is feasible to generate income by providing training support service for external users		
9. It is feasible to provide Learning Management System (e.g., moodle)		
5. Questions for Design Curriculum		
1. It is feasible to create diverse groups profile for contribution		
2. It is feasible to make open to all the process of curriculum design		
3. It is feasible to design curriculum based on demands of companies		
4. It is feasible to provide free access (to design curriculum) to registered users		
5. It is feasible to develop volunteer and profile-based participation for designing curriculum		
6. It is feasible to share training elements (e.g., learning strategies, processes, materials, and experiences) for collaborative designing curriculum		
7. It is feasible to facilitate the process of continuous curriculum adaption		
8. It is feasible to generate income by providing this function (as a service) for external users		
9. It is feasible to trigger the external devices for notifying the deadlines of the particular contributions (e.g., calendar)		
6. Questions for Insertion of New Competences Demands		
1. It is feasible to use diverse groups in finding competence demands collaboratively		
2. It is feasible to open to all the insertion of new competences demands		
3. It is feasible to suggest concepts for competence demands writing		
4. It is feasible to create easy invitation procedure for the contribution of new companies		
5. It is feasible to encourage volunteer and active participation in finding new competence demands		
6. It is feasible to facilitate open discussion about the new competence demands		
7. It is feasible to facilitate the function of continuous competence demands finding		
8. It is feasible to provide consultation service (to generate income) for finding the competence demands		
9. It is feasible to use tools such as questionnaires to support the finding of competence demands		
7. Questions for Tools to Evaluate Performance		
1. It is feasible to use diverse groups that collaboratively define the KPIs for each specific activity		
2. It is feasible to create different levels of evaluation		
3. It is feasible to authorize users for taking different roles in the evaluation process		
4. It is feasible to have easy and free access to verification of the evaluation results		
5. It is feasible to create different roles for the evaluation procedure (e.g., evaluators, users, programmers)		
6. It is feasible to facilitate the open discussion about the evaluation results or KPIs definition		
7. It is feasible to facilitate the process of KPIs definition and evaluation for each activity		
8. It is feasible to use consultation service (to generate income) for KPIs definition and evaluation process		
9. It is feasible to use tools such as questionnaires to support the KPIs definition and evaluation process		

C

QUESTIONNAIRE FOR EVALUATION THE EFFECTIVENESS OF MGF-MCL IN ED-EN HUB PROJECT

Appendix C demonstrates the questionnaire used in the ED-EN HUB project for evaluating the effectiveness of considered factors, features, and elements concerning the functions of EDENCP. The respondents (partners) by giving a rate to each question show how much the considered items are effective (from their perspective) in reaching the goals of MGF-MCL. The considered rates are as follow:

- *Not at all effective* = 0
- *Slightly effective* = 1
- *Moderately effective* = 2
- *Very effective* = 3
- *Extremely effective* = 4

Questionnaire for evaluating the effectiveness of considered dimension of collaboration and their related factors, features, and elements that have potential to be implemented on EDENCP					
1. Questions for Search Engines for Finding Information and Tools	**0**	**1**	**2**	**3**	**4**
1. It is effective to be used for multiple purposes (e.g., searching, sorting info)					
2. It is effective to be flexible to change (e.g., open to add new info or keywords for searching)					
3. It is effective to have cross-functional capabilities (e.g., searching multiple features)					
4. It is effective to be customizable (e.g., contains searching features to adapt to users' profiles)					
5. It is effective to use advanced functions (e.g., search in other external hubs)					
2. Questions for Collaboration					
1. It is effective to engage a diverse group of people in multiple communication tasks (e.g., chat forum)					
2. It is effective to create collaboration spaces around different domains/topics					
3. It is effective to promote the available skills or make a set of needed competences					
4. It is effective to invite users to voluntarily contribute to collaborative activities based on their interest					
3. Questions for Managing Training					
1. It is effective to use different characteristics to manage the training planning (e.g., cost, success rate, learning needs)					
2. It is effective to use different training modes (blended learning) in the training planning					
3. It is effective to consider inclusive training and learning					
4. It is effective to give freedom to choose the courses (help to prioritize learning needs bases on the user's profile)					

5. It is effective to create a training plan such as evaluation of the contents collectively (have a procedure to perform)					
4. Questions for Training Execution Support					
1. It is effective to analyze what kind of approach or balance can be best used in training execution for different training modes (virtual vs. traditional classes)					
2. It is effective to define clear inclusive rules for admission					
3 It is effective to use analytics over-collected performance data to improve further training execution and its learning engagement strategies (i.e., knowledge management)					
5. Questions for Design Curriculum					
1. It is effective to create diverse groups profile for contribution					
2. It is effective to design curriculum based on demands of companies					
3. It is effective to share training elements (e.g., learning strategies, processes, materials, and experiences) for collaborative designing curriculum					
4. It is effective to facilitate the process of continuous curriculum adaption					
6. Questions for Insertion of New Competences Demands					
1. It is effective to make open to all the insertion of new competences demands					
2. It is effective to create easy invitation procedure for the contribution of new companies					
3. It is effective to encourage volunteer and active participation in finding new competence demands					
4. It is effective to facilitate open discussion about the new competence demands					
7. Questions for Tools to Evaluate Performance					
1. It is effective to create different levels of evaluation					
2. It is effective to authorize users for taking different roles in the evaluation process					
3. It is effective to have easy and free access to verification of the evaluation results					
4. It is effective to create different roles for the evaluation procedure (e.g., evaluators, users, programmers)					

D

QUESTIONNAIRE FOR EVALUATING THE ADEQUACY OF MGF-MCL IN ENHANCE PROJECT

Appendix D demonstrates the questionnaire used in the ENHANCE project for evaluating the adequacy of considered dimensions of collaboration and their related factors, features, and elements with respect to the EDENCP functions. There are 11 dimensions of collaboration and the related questions. The considered rates are as follow:

- *SDA = strongly disagree*
- *DA = disagree*
- *A = agree*
- *SA = strongly agree*
- *I don't know*
- *I'm not sure*

Questionnaire for evaluating the adequacy of considered dimension of collaboration and their related factors, features, and elements that have potential to be implemented on ENHANCE Lifelong eLearning Platform (LeLP)						
Considered Dimensions	Main factors, features, and elements that might be integrated into LeLP	Checklist				
Organizational Dimension - (Relates to the organization of LeLP or the way it is set up. It is also deals with the action to be performed in the LeLP).	**1)** It is important that even general users (e.g., learners) could help (the partners and administrators) to develop the LeLP.					
		SDA	DA	A	SA	
		I don't know		I'm not sure		
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)					
	2) It is important that the LeLP engages diverse groups of learners (e.g., from different background) in the process of learning.	SDA	DA	A	SA	
		I don't know		I'm not sure		
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)					
	3) It is important that the LeLP provides opportunities for collective learning.	SDA	DA	A	SA	
		I don't know		I'm not sure		
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)					
	4) It is important that the LeLP could be used for different purposes (e.g., education, tutorials, developing competencies, promoting workforces, R&D).	SDA	DA	A	SA	
		I don't know		I'm not sure		
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)					
	5) It is important that the LeLP facilitates the process of knowledge building, sharing, and developing.	SDA	DA	A	SA	
		I don't know		I'm not sure		
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)					
	6) It is important that the LeLP could be used for different fields of study and work.	SDA	DA	A	SA	
		I don't know		I'm not sure		

	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	7) It is important that the LeLP be a user-driven service (users/learners are considered as the main component, contributor, and supporter).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Environmental Dimension - (Relates to the LeLP's surroundings and also the impact of participants' activities on its condition).	**8)** It is important that the LeLP be open for all interested learners to contribute.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	9) It is important that the LeLP provides three levels of access (for three groups of users: partners, administrators, and general users/learners).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	10) It is important that the LeLP could be available in different languages (e.g., English, French).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	11) It is important that the LeLP facilitates different forms of communication (virtual, physical, or mixed).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	12) It is important that the LeLP provides a common collaboration space to be used by different settings such as educational, industrial, services, and labs.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	13) It is important that the LeLP provides a supportive environment in which users can help each other.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	14) It is important that the LeLP simulates the ways users collaborate toward building a dynamic and active community.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Admission Dimension - (Relates to the process of joining to the LeLP. It includes two main sub-areas: Inclusion (questions from 15 till 20) and Accessibility & Proximity (questions from 21 till 25)).	*Inclusion*				
	15) It is important that the LeLP facilitates the process of joining (inclusion) to the community.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	16) It is important that the LeLP provides free access for all users.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	17) It is important that the LeLP provides a service for identifying and inviting a specific group of participants such as, trainers, experts, technical, and managerial.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	18) It is important that all the users actively take part in introducing the community to potential and interested persons.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	19) It is important that the LeLP suspends or even deactivates a user's account who does not follow the rules.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	20) Users can stop their contribution at any time.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	Accessibility and Proximity				
	21) To promote the quality and reliability of contributions, it is important that the LeLP reduces the anonymity of users.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	22) To reduce anonymity, it is important that the users create a user account and register by providing the real personal information (e.g., full name, profession, and e-mail address, and photo).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
		SDA	DA	A	SA

	23) It is important that the LeLP incentives the user to actively contribute and keep contribution.	I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	24) It is important that the LeLP tracks the time-outs (to check if there is problem with users or services).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	25) It is important that the username be associated with the user's contributions (to facilitate monitoring of contributions).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Social Dimension - (Relates to the collaborative activities and interactions between the participants of the LeLP).	*Collaboration*				
	26) It is important that the LeLP builds a network for career development.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	27) It is important that the users could learn new things collaboratively.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	28) It is important that the users could solve the problems collaboratively.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	29) It is important that the LeLP could provide computer-supported collaborative tools for collaboration.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	30) It is important that the LeLP could provide a "discussion forum" for collaboration.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	31) It is important that the users could build interdisciplinary collaboration (a collaboration that engages individuals from different teams, disciplines, and backgrounds).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	32) It is important that the LeLP could support building strategic partnerships and alliances with potential external parties (to share the resources and expertise).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Functional Dimension - (Relates to the base functions, operations, running, and procedures in the LeLP. It includes four main sub-areas: Content Management (questions from 33 till 36), Operation Management (questions from 37 till 40), Interaction Management (questions from 41 till 44), and Human Resource Management (questions from 45 till 49)).	*Content Management*				
	33) It is important that the LeLP could make accessible the created and developed content for all users.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	34) It is important that the LeLP could support the process of developing and updating the training contents, when is needed.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	35) It is important that the LeLP could classify the developed contents into specific courses and majors (based on predefined topics).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	36) It is important that the LeLP could save the developed contents in a secured database.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	Operation Management				
	37) It is important that the LeLP could continuously promote/update its operational processes (set of activities or tasks that produces a specific service).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	38) It is important that the LeLP could save users' personal information and contributions in their profile.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
		SDA	DA	A	SA

	39) It is important that the LeLP could provide a "monitoring system" to constantly monitor the transactions and contributions.	I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	40) It is important that when someone breaks the rules, LeLP could take the needed actions (e.g., sends a warning message to the account, removes it, or blocks the account).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	Interaction Management				
	41) It is important that the LeLP could provide an appropriate service for internal interactions such as sharing the resources, training, and learning materials.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	42) It is important that the LeLP could provide an appropriate service for external interactions such as exchanging the expertise and findings.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	43) It is important that the LeLP could provide multiple communication channels (e.g., email, live chat, message board, wiki, and social networks).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	44) It is important that the LeLP could provide opportunities for external interactions and collaboration with similar communities.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	Human Resource Management				
	45) The users should be treated equally.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	46) It is important that the LeLP could encourage the users to make themselves known to the public (by providing their background knowledge and expertise).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	47) It is important that the LeLP could provide a consult and advisory board (for each field of study, major, or course).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	48) It is important that the LeLP could retain effective users (for example by giving rank, badge, and more access).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	49) It is important that the LeLP could use outsourced experts, teachers, and talents.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Economical Dimension - (Relates to the supportive services that could be provided internally and/or externally).	*Supports and Services*				
	How important do you think the following services could be for the economic sustainability of the platform:				
	50) Benefiting from private and public funding, grants, financial aids and donations, capital from investors and sponsors, and advertising.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	51) Providing supportive training and learning services for schools, organizations, institutions, businesses, and companies.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	52) Providing supportive training, learning, and research services for research centers, living labs, innovators, and etc.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	53) Providing supportive services for conferences and workshops.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	54) Developing a program that assists and guides the users in making occupational choices.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Technological Dimension -	**55)** It is important that the LeLP could provide sufficient technologies that support web-based communication and collaboration.				
		SDA	DA	A	SA

(Relates to using technical means and interconnected components of the LeLP).		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	56) It is important that the LeLP could use ICT technologies and Computer-Supported Collaborative Learning to support training.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	57) It is important that the LeLP could use potential tools for assessing the performances.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	58) It is important that the LeLP could benefit of external technological supports.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Structural Dimension - (Relates to the network structure such as participants, relationships, roles, and network typology of the LeLP. It includes two main sub-areas: Participants (questions from 59-65) and Roles & Tasks (questions from 66 till 70)).	*Participants*				
	59) It is important that the users from any age, background, culture, and gender could contribute to LeLP.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	60) Users will not be paid, and they will contribute on the volunteer base.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	61) It is important that the LeLP provides different/specific services for different/specific group of users (e.g., learners, trainers, experts, researchers, academics, managers, and entrepreneurs).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	62) It is important that the LeLP could deliver the services for people outside the community.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	63) It is important that the LeLP provides some special services for people with special needs (e.g., people with disabilities).	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	64) It is important that the users could participate in particular activities that are related to their interests and background.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	65) It is important that the LeLP makes available a list of the services that could deliver.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	Roles and Tasks				
	66) It is important that the users could play different roles (e.g., expert, advisor, trainer, trainee, editorial, researcher, technical, managerial) based on their qualifications.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	67) It is important that the users could engage in multiple tasks (e.g., training execution, providing learning contents, delivering the contents, exchanging the contents, executing, providing supports, commenting, reporting) based on their interests and capabilities.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	68) It is important that the users could simultaneously contribute in different domains, courses, majors, practices, issues, and events.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	69) It is important that the users could support the process of training development.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
	70) It is important that the users could support the contributions from different people.	SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
Behavioral Dimension - (Relates to the principles, policies, and governance	**71)** Only the partners and administrators have the authority to make structural changes in the LeLP.				
		SDA	DA	A	SA
		I don't know		I'm not sure	
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)				
		SDA	DA	A	SA

rules that drive the behavior of the LeLP).	**72)** The general users do not have the authority to make technical changes in the LeLP.	I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	73) The general users can contribute to decision-making processes.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	74) It is important that the governance rules for the community to be defined in a collaborative and democratic way.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	75) To build trust, the LeLP must make transparent policies for the community.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	76) It is important that the LeLP perceived ease of use and perceived usefulness.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	77) It is important that the LeLP provides "feedback system".	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	78) It is important that the LeLP provides a "conflict resolution system".	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
Learning Assessment Dimension - (Relates to learners´ qualification, performance, contribution, and output).	**79)** It is important that the LeLP could provide assessment service for measuring learners´ background knowledge.	 SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	80) It is important that the LeLP could provide assessment service for measuring trainers´ qualification.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	81) It is important that the LeLP could provide assessment service for measuring the quality of training materials.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	82) It is important that the LeLP could provide assessment service for measuring the contributions.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	83) It is important that the LeLP could provide assessment service for measuring the knowledge gained by learners.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	84) It is important that the LeLP could provide assessment service for measuring the success of collaborative learning.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
Performance Assessment Dimension - (Relates to LeLP performance evaluation, namely in relation to its related functions or community activities).	**85)** It is important that the LeLP could provide assessment service for measuring the operation of community.	 SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	86) It is important that the LeLP could provide assessment service for measuring the effectiveness of coordination.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	87) It is important that the LeLP could provide assessment service for measuring the productivity of community.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	88) It is important that the LeLP could provide assessment service for measuring the effectiveness of used technologies.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
	89) It is important that the LeLP could provide assessment service for measuring the outputs of community.	SDA / DA / A / SA / I don't know / I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)	
		SDA / DA / A / SA

	90) It is important that the LeLP could provide assessment service for measuring the profitability of community.	I don't know	I'm not sure
	If you have any suggestions for this issue please feel free to let us know. (you can use this box)		

E

QUESTIONNAIRE FOR EVALUATING THE FEASIBILITY OF MGF-MCL IN ENHANCE PROJECT

Appendix E demonstrates the questionnaire used in the ENHANCE project for evaluating the feasibility of considered dimensions of collaboration and their related factors, features, and elements with respect to the EDENCP functions. The questionnaire addresses some considered functions for LeLP including a global function, main functions, and general functions. There are some related questions for each function. The considered rates are as follow:

- *SDA = strongly disagree*
- *DA = disagree*
- *A = agree*
- *SA = strongly agree*
- *IDK = I don't know*
- *IANS = I'm not sure*

Questionnaire for evaluating the feasibility of considered dimension of collaboration and their related factors, features, and elements that have potential to be implemented on LeLP.						
Global Function	**SDA**	**DA**	**A**	**SA**	**IDK**	**IANS**
1) The platform should be a kind of portal to be used for different purposes (e.g., education, tutorials, developing competencies, promoting workforces, R&D).						
2) The platform should be available in different languages (e.g., English, French).						
3) Any of ECP main functions (listed in the next questionary groups) should be available only for recognized/registered users (who are not anonymous).						
4) It is important that the ECP could benefit of supportive technologies for specific collaborations as GITs, LinkedIn, twitter etc.						
5) It is important that the ECP has the possibility of generating any economic benefit from providing supportive training and learning services for different organizations as schools, companies, research centers, living labs, etc.						
6) The ECP should follow a set or pre-determined trust and transparency principles and policies for the community.						
7) It is important that the ECP has a mechanism of feedback to improve future versions of the system.						
Main Functions						
Function 1 (dynamic training design)						
8) It should create and develop new training and educational courses and lessons for the existing students/employees.						

9) It should take in consideration the learning assessments that invoke changes in the programme (which help students better fulfil the learning objectives).						
10) The training design function may benefit of computer-supported collaborative tools. While people are designing may intend to discuss any particular situation with others.						
11) The training design should be used for creating specific courses and modules based on predefined topics and experiences (this may. uses a particular specification system able to record such experiences e.g., xapi.com.						
Function 2 (training programme generator)						
12) The training programme generator should generate the training programme accordingly to determined profile characteristics of the student.						
13) The training programme generator should be dynamic to actively readjust the programme depending in the students' performance. This means that after the creation of a programme it may readjust the lessons contents to improve the learning of a specific student.						
Function 3 (improving training course contents)						
14) This function should help to collect ideas for testing/research in DIH labs.						
15) It should identify/evaluate distinctive research results from DIH research activities able to be integrated in courses contents.						
16) It is important that this function could use as input the assessment results of measuring the knowledge gained by learners. Such data may help to identify weaknesses and strengths of the course contents.						
Function 4 (training execution support)						
17) This function should support the training execution and training planning.						
18) It should support the learning engagement strategies.						
19) It is important that this function could provide an assessment feature able to measure the knowledge gained by learners.						
Function 5 (training quality assessment)						
20) This function should support the training quality assessment and report the results.						
21) The training quality assessment should benefit of potential tools.						
22) The training quality assessment could be used for measuring trainers' qualification.						
23) The training quality assessment should consider the quality of training materials.						
24) The training quality assessment should consider the quality of community operation and outputs.						
General Functions						
Function 6 (user management)						
25) This function should manage the user's accounts (profiling and identification).						
26) It should support specific users' activation and deactivation.						
27) It should help to identify users that who does not follow the rules.						
28) It should facilitate managing different role users allowing multi features as enabling to contribute to different tasks/domains, courses, issues, and events.						
29) This function should support the identification and invitation of specific/demanding participants.						
Function 7 (Information management)						
30) This function helps managing various interactions and transactions such as sharing the resources, training, and learning materials.						
31) This function helps managing the participation profile in particular activities/events.						
32) This function manages the dissemination of information (interest topic per type of users).						
33) This function should facilitate the asynchronous discussion/collaboration between different users through a discussion forum.						
34) It should be able to manage different discussions (from forum) or events categorization.						