

ISSN 2669-0195 ONLINE

<http://doi.org/10.9770/IRD.2019.1.3>

INSIGHTS INTO REGIONAL DEVELOPMENT

**Volume 1 Number 3
September 2019**



ENTREPRENEURSHIP AND
SUSTAINABILITY CENTER

INSIGHTS INTO REGIONAL DEVELOPMENT

ISSN 2669-0195 (online) <http://jssidoi.org/IRD/>

2019 Volume 1 Number 3 (September)

<http://doi.org/10.9770/IRD.2019.1.3>



ENTREPRENEURSHIP AND
SUSTAINABILITY CENTER

Publisher

<http://jssidoi.org/esc/home>

Volume 1 Number 3 September 2019

INSIGHTS INTO REGIONAL DEVELOPMENT*

** The journal was launched as a platform for dissemination of the project results, which has received funding from the European Union's Horizon 2020 research and innovation programme European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme Marie Skłodowska-Curie Research and Innovation Staff Exchanges ES H2020-MSCA-RISE-2014 CLUSDEVMED (2015-2019) Grant Agreement Number 645730730*



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Editorial correspondence including manuscripts and submissions:

Prof. dr. Manuela Tvaronavičienė

Tel.: +37068783944

E-mail: submissions@jssidoi.org or manuela.tvaronaviciene@jssidoi.org

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 <http://orcid.org/0000-0002-6326-5714>

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Author ID: 7005863986

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[Prof. Fan Lü](#), Tongji University, Shanghai, China lvfan.rhodea@tongji.edu.cn

<http://orcid.org/0000-0002-8496-3941>

[Prof. Gilberto de Miranda Rocha](#), Federal University of Pará, Belém, Brazil Brazil_gilrocha@ufpa

Author ID: 55813405600

[Dr. Amr Radwan](#), Academy of Scientific Research and Technology, Egypt amm@sti.sci.eg

 <http://orcid.org/0000-0002-5567-6708>

[Prof. Armenia Androniceanu](#), The Bucharest University of Economic Studies, Faculty of Administration and Public Management, Bucharest, Romania armenia.androniceanu@man.ase.ro

Author ID: 35253283800

Prof. Najiba El Amrani, University Sidi Mohamed bin Abdellah, Faculty of Science and Technology, Fes, Morocco [najiba.elamrani\(at\)usmba.ac.ma](mailto:najiba.elamrani(at)usmba.ac.ma)

Author ID: 56122394900

Prof. Bora Aktan, University of Bahrain, the Kingdom of Bahrain [gbora\(at\)uob.edu.bh](mailto:gbora(at)uob.edu.bh)



<http://orcid.org/0000-0002-1334-3542>

Prof. Gunnar Prause, Tallinn University of Technology, Estonia [gunnar.prause\(at\)ttu.ee](mailto:gunnar.prause(at)ttu.ee)



<http://orcid.org/0000-0002-3293-1331>

Prof. Vera Komarova, Daugavpils University, Latvia [veraboronenko\(at\)inbox.lv](mailto:veraboronenko(at)inbox.lv)



<http://0000-0002-9829-622X>

Prof. Sibylle Heilbrunn, Kinneret College on the Sea of Galilee, Israel [sibylleh\(at\)kinneret.ac.il](mailto:sibylleh(at)kinneret.ac.il)

Author ID: 16642930200

Prof. Fernando García, Department of Economics and Social Sciences, Faculty of Business Administration and Management, Polytechnic university of Valencia, Spain [fergarga\(at\)esp.upv.es](mailto:fergarga(at)esp.upv.es)

Author ID: 57201603529

Dr. Michal Fabus, School of Economics and Management in Public Administration in Bratislava, Slovak Republic [michal.fabus\(at\)vsemvs.sk](mailto:michal.fabus(at)vsemvs.sk)



<http://orcid.org/0000-0002-3792-179X>

Prof. Sulphey, M.M. Prince Sattam Bin Abdulaziz Universtiy, Al-Kharj, Saudi Arabia [s.manakkattil\(at\)psau.edu.sa](mailto:s.manakkattil(at)psau.edu.sa)



<http://orcid.org/0000-0001-6042-2123>

Prof. Mirjana Radović-Marković, Institute of Economic Sciences, Belgrade, Serbia [mirjana.radovic\(at\)ien.bg.ac.rs](mailto:mirjana.radovic(at)ien.bg.ac.rs)

Author ID: 36680528200

Prof. Ronaldo Lopes Rodrigues Mendes, Federal University of Pará, Belém, Brazil [rmendes\(at\)ufpa.br](mailto:rmendes(at)ufpa.br)



<https://orcid.org/0000-0002-5584-8688>

Dr. Andrea Bernardi, Oxford Brookes University, UK [abernardi\(at\)brookes.ac.uk](mailto:abernardi(at)brookes.ac.uk)

Prof. Francesco Vigliarolo, Universidad Católica de La Plata, Argentina [francesco.vigliarolo\(at\)ucalp.edu.ar](mailto:francesco.vigliarolo(at)ucalp.edu.ar)

Dr. Laima Gerlitz, Wismar University of Applied Sciences, Wismar, Germany [laima.gerlitz\(at\)hs-wismar.de](mailto:laima.gerlitz(at)hs-wismar.de)

Author ID: 57015379200

Dr. Federico Tomassi, Agenzia per la Coesione Territoriale, Italy federico.tomassi@uniroma1.it

Dr. Kiran Javaria, University of Lahore, Lahore, Pakistan [Kiranmaryam23\(at\)gmail.com](mailto:Kiranmaryam23(at)gmail.com)



<https://orcid.org/0000-0002-6147-5283>

Prof. Maria da Gloria Gonçalves de Melo, Universidade do Estado do Amazonas, Brazil [mgmelo\(at\)uea.edu.br](mailto:mgmelo(at)uea.edu.br)



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Volume 1 Number 3

September 2019

CONTENTS

Col. Romualdas Petkevičius. FOREWORD

Jurijs Baltgailis.

**THE ISSUES OF INCREASING THE EFFECTIVENESS
OF TEACHING COMPARATIVE ECONOMICS**

190

Ugis Sarma, Girts Karnitis, Janis Zutens, Edvins Karnitis.

**DISTRICT HEATING NETWORKS: ENHANCEMENT OF THE
EFFICIENCY**

200

**Solomon Akpoviroro Kowo, Olusegun Adeleke Oba Adenuga,
Olalekan Owotutu Sabitu.**

**THE ROLE OF SMES DEVELOPMENT ON POVERTY ALLEVIATION
IN NIGERIA**

214

**Abdesselam Ouhajjou, Boumediene Amraoui, Salvatore Monni,
Najiba El Amrani El Idrissi, Manuela Tvaronavičienė.**

**PERFORMANCE OF CLUSTERS IN MOROCCO IN THE SHIFTING
ECONOMIC AND INDUSTRIAL REFORMS**

227

**Raimonda Bublienė, Irina Vinogradova, Manuela Tvaronavičienė,
Salvatore Monni.**

**LEGAL FORM DETERMINATION FOR THE DEVELOPMENT
OF CLUSTERS' ACTIVITIES**

244

**Lahcen El Iysaouy, Najiba El Amrani El Idrissi, Manuela Tvaronavičienė,
Mhammed Lahbabi, Abdelmajid Oumnad.**

TOWARDS ENERGY EFFICIENCY: CASE OF MOROCCO

259



FOREWORD to INSIGHTS INTO REGIONAL
DEVELOPMENT, 2019 Volume 1 Number 3
(September)

Dear readers,

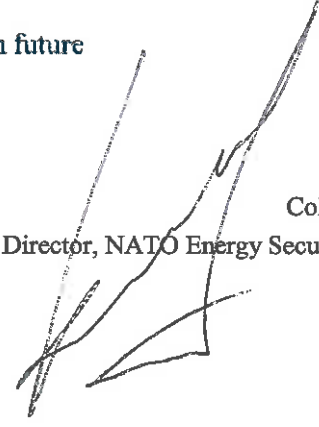
In the contemporary turbulent world all efforts of cooperation and collaboration in such fields as sustainable development via efforts directed to enhancement of energy security, water security and food security cannot be neglected.

NATO Energy Security Centre of Excellence, being open international organization closely networks with wide spectrum of societal stakeholders, including universities, for profit and non-profit public organizations. We are especially keen to work together with international alliances, which are already funded by European Union, and which direct their expertise and efforts towards making our planet safer and more secure in long term prospective.

We support all attempts to build sustainable and secure future, including initiative of the journal launching, under the *European Union's Horizon 2020 research and innovation programme ES H2020-MSCA-RISE-2014 CLUSDEV MED (2015-2019) Grant Agreement Number 645730730*.

Let us all cooperate, collaborate and discuss for our common future

With best regards,


Col. Romualdas Petkevicius
Director, NATO Energy Security Centre of Excellence
Lithuania



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THE ISSUES OF INCREASING THE EFFECTIVENESS OF TEACHING COMPARATIVE ECONOMICS*

Jurijs Baltgailis

Transport and Telecommunication Institute, Lomonosova street 1, Riga, LV-1019, Latvia

E-mail: Baltgailis.J@tsi.lv

Received 18 April 2019; accepted 25 June 2019; published 30 September 2019

Abstract. In the conditions of intensive globalization processes, the problem of international comparisons of countries' development increases. The usual methods of comparisons based on macroeconomic indicators today do not reflect the real reality, so it becomes important in the teaching of economic Sciences to give students a methodology for comparing the economic development of countries on the basis of numerous rating studies. In recent years, the development of rating comparisons has become one of the priorities of many international economic organizations. These rankings make it possible to significantly supplement and specialize international comparisons, to teach students the perfect techniques that allow them to quickly engage in international projects and research, to do business.

Keywords: teaching; comparative economics; globalization; rating; indexes; GDP.

Reference to this paper should be made as follows: Baltgailis, J. 2019. The issues of increasing the effectiveness of teaching comparative economics, *Insights into Regional Development* 1(3): 190-199. [https://doi.org/10.9770/ird.2019.1.3\(1\)](https://doi.org/10.9770/ird.2019.1.3(1))

JEL Classifications: A20, F02

* This research was supported by the project, which has received funding from the European Union's Horizon 2020 research and innovation programme European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme Marie Skłodowska-Curie Research and Innovation Staff Exchanges ES H2020-MSCA-RISE-2014 CLUSDEV MED (2015-2019) Grant Agreement Number 645730730



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1. Introduction

In the educational process of preparing course and diploma papers on a comparative economy, there may be distortions in results and a misunderstanding of reality. To make the educational process more reliable, it is suggested to supplement studies in the field of comparative economics through the use of multiple rating indicators between countries with subsequent deeper analysis. If we use the estimates of several rating agencies in the field of investment sustainability and the order of ten internationally recognized ratings in various aspects of economic development when comparing the economies of different countries, we can get a reasonable picture of the advantages of some countries over others and qualify these advantages in a qualified manner.

The experience of students' performance in coursework in the field of comparative economics showed a clear correlation between all ratings. The most efficient economies occupy a leading position in most ratings. If the rating also carries a wide range of indicators, such as Doing Business, or is largely based on the results of sociological surveys, it helps to identify the problematic aspects in any economy. In addition, the study of the process of formation and calculation of ratings, allows students to become familiar with the deep economic processes and methods for their study. Studying and using rating ratings will be a good school for students to learn about economic processes and can become a good practice for the preparation of diploma papers.

The OECD's monthly publication, Main Economic Indicators (MEI), provides an overall view of short-term economic developments through presentation of an extensive range of specific short-term economic indicators within each of the following subjects: national accounts, domestic demand, production, labour market indicators, business and consumer opinions, prices, composite leading indicators, finance, manufacturing, foreign trade, construction, balance of payments. These indicators are important instruments for the formulation of economic policy at the national level and for use by international organization, such as the OECD, IMF, Eurostat and the European Central Bank (ECB). They are well known, widely collected and used extensively by countries and international organization.

In addition, the methods for their collection and compilation are usually well established and documented within each country and in statistical methodological information compiled by international organization, such as the IMF for their Special Data Dissemination Standard (SDDS). Even so, the methodologies used are not always transparent for a large number of users. In some cases, this may lead to misinterpretation of statistical data and a misunderstanding of economic phenomena, especially when making international comparisons. These shortcomings can be avoided if we do not go into statistics to use ratings, where indicators are often well-founded. This is especially important for entrepreneurs and investors who need quick solutions in a changing market situation.

Our task is to provide an understanding of the ratings that contribute to the expansion of the potential of students in the field of entrepreneurship and international methods in the field of international comparisons. Given the huge number of different ratings and indicators, we have reduced, taking into account the experience of teaching, the most convenient in the study and understanding of the ratings in a single table and reflected their advantages.

2. Methodology

Today in the world there are dozens of new ratings and indexes that have gained popularity among researchers. A number of indexes are developed by companies professionally involved *in insurance risks and advising in the field of investment and lending*. Our task is to identify ratings that can add to and expand comparative studies based on GDP. Below are brief guidelines for country comparisons on the methodology of the World Bank.

Compare countries: income levels. One can use GDP per capita in dollar terms to compare incomes across countries. However, the comparison may be somewhat misleading because consumers face different prices in various countries. One thousand U.S. dollars can buy much more in Mexico compared to the U.S. since prices in Mexico are lower. To account for the differences in prices, one should look at the GDP per capita in Purchasing Power Parity terms. In that way, one compares countries in term of real income (what can be purchased) as opposed to the dollar income.

Compare countries: level of development. The most basic comparison is between GDP per capita levels or the levels of GDP per capita in terms of Purchasing Power Parity. However, GDP can be a misleading measure as it may not capture other aspects of the quality of life such as crime, education, environmental quality, etc. The Human Development Index published by the UN is a composite measure that accounts for a broader set of development factors.

Compare countries: economic structure. One should look at the shares of Agriculture, Industry, and Services in the overall value added of the economy. Generally, lower income countries have a larger share of agriculture and the share of services expands as they develop.

Compare countries: unemployment. The unemployment rate is the standard variable used to compare countries. However, one may want to look at youth and long-term unemployment as well. Both indicators suggest deeper, longer-term problems in the labor market.

Compare countries: corruption. There are two indexes that can be used. One is the Corruption Perceptions Index from Transparency International and the other is the Corruption index from the World Bank. The two institutions apply different methodologies to measure corruption and while the results are similar, they are not the same.

Compare countries: rule of law and governance. The best data to look at are the World Bank governance indicators. They can be used to compare countries in terms of the quality of the bureaucracy, the efficiency of the public administration, and more.

Compare countries: financial development. One can chart the level of private credit as percent of GDP and stock market capitalization as percent of GDP. The first measure shows the development of credit markets while the second one is a measure of stock market development.

Compare countries: economic freedom. The Heritage Foundation publishes several indexes of economic freedom in different areas of economic life: labor market, financial markets, and others. Each of them reflects the degree of government interference and the efficiency of the regulatory and legal system.

Compare countries: globalization. The Globalization Index from the KOF Institute in Switzerland provides well-known and widely used measures of economic, social, and political globalization. Each index reflects the degree of integration of a country with the rest of the world.

Compare countries: internal and external balances. The three most commonly analyzed balances are the Current Account balance, the Trade Balance which is part of the Current Account, and the fiscal balance measured as government revenues minus government spending. If a country has persistent deficits in any one of those balances exceeding 4 percent of GDP, which could suggest the need to rebalance the economy.

Compare countries: infrastructure development. One could look at a number of indicators to compare countries including the spread of mobile phones, the number of passenger cars, the length of railroads, the capacity of ports, etc.

Compare countries: energy production and use. The energy statistics are abundant making it possible to compare countries along many dimensions. Some of the most popular comparisons are the use of energy per capita, the share of green energy used, the retail petrol prices, and the energy used per unit of GDP.

Compare countries: health and education. The country comparison could be multi-dimensional looking at inputs such as health spending per capita and outcomes such as birth/death rates and disease prevalence. Similarly, one can look at the inputs to education including spending and the outputs including literacy rates and school completion rates.

3. Results of the study

The task of the research is to show shortcomings when comparing the economic potentials of countries through GDP and to identify the possibilities for rating research to expand opportunities in the learning process. The general methodology for calculating GDP is based on the reflection primarily of monetary transactions in the process of generating revenues or expenditures of the national product. GDP is the value of goods and services produce in a country during the time period of year. It is a macroeconomics index reflecting the market value of all final goods and services produced over a year's period in all branches of economy in the country, to be consumed, exported, or accumulated, irrespective of the national identity of the used agents of production. The first edition of the UN Guidelines on National Accounts Standards, compulsory for all countries, was published in 1953 and contained less than 50 pages, and the 2008 edition contains 722 pages and 400 pages of commentaries on it (Lequiller F., Blades D. 2016).

However, some countries of developed democracy have doubted whether this index indeed reflects real economy. In February 2008, French President Nicolas Sarkozy invited Nobel laureates in economics Joseph Stiglitz and Amartya Sen, as well as the eminent French economist Jean-Paul Fitoussi to set up a committee of leading economists in order to investigate if GDP was a reliable measure of economic and social progress. The committee was set up and, having worked for several years, came to the main conclusion: the use of market prices in the assessment of economic development is vicious in itself! The Nobel winners discovered suddenly that market production was not a criterion of well-being. Mixing up the two notions can bring about erroneous conclusions on the degree of people's prosperity and can result in wrong political decisions. The material life standard is more closely connected with factors of real income and consumption; production can be expanding while income can be going down, and vice versa, if one takes into account capital amortization and revenues that are repatriated from the country or come into the country in the form of investments or other types of receipts. Latvia can serve an example of the income index distortion. Latvian GDP has been growing steadily over the last five years. If you look at Eurostat data you will see that, with regard to the PPS (purchasing power parity) level, Latvia approximately equals the Czech Republic, being far ahead of Lithuania, Poland and Hungary, let alone Bulgaria and Romania. However, its GDP index makes Latvia a backbencher of the statistics: it lags behind

Czechia by 20 percentage points. To put it simply, incomes in Latvia by no means correspond to the current prices in the country, which limits drastically the consumer purchasing power of the people (Eurostat, 2019).

By the way, the Sarkozy Committee immediately paid attention to the following: the current national accounts show that in some OECD countries the effective revenue of households was growing in quite a different manner than the effective GDP per capita and, as a rule, much slower. Besides, a considerable part of economic activity takes place beyond markets and is seldom reflected in national accounts. The committee has also come to some disappointing conclusions: the manufactured products could appear unwanted at market prices and, hence, distort the actual statistics. There are no methods to measure the cost of people's leisure; for some assets there are no markets where they could be tradable; there is no serious and precise account of services and goods exchange between households, like daily joint commuting to work, baby-sitting or caring for the elderly neighbour. The Nobel winners discovered suddenly that market production was not a criterion of well-being. Mixing up the two notions can bring about erroneous conclusions on the degree of people's prosperity and can result in wrong political decisions. The material life standard is more closely connected with factors of real income and consumption; production can be expanding while income can be going down, and vice versa, if one takes into account capital amortization and revenues that are repatriated from the country or come into the country in the form of investments or other types of receipts (Stiglitz Joseph E., Amartya Sen and Jean-Paul Fitoussi, 2010).

According to experts, one cannot count the services in an industry branch all of a lump: classes with a freshman student and with an undergraduate are services of different cost; treatment of different diseases also differs in price. The above are examples of investing in human capital assets. The Nobel laureates believe that, in order to know what is happening to economy, one should define precisely the changes in the wealth level. That is why they suggest considering income and consumption jointly with wealth. Wealth measurement should be the primary tool when measuring stability. Things that will last in the future should be represented as reserves of physical, natural, human, or social capital. Besides, computations should be focused on households, and income should also be estimated in non-market spheres.

One should admit that statistics is distanced greatly from real life allowing politicians to justify their unreasoned measures and blunders. The ratings of the most varied orientations can help to expand the picture of the real economic potential of the country and, most importantly, will show the perspective of the movement of the economy, which enables researchers to give concrete recommendations and conclusions on the effectiveness of the actions of the government of comparable countries. International ratings allow expanding the research object, overcoming the shortcomings in the GDP calculations and giving a broader picture of the real economy of the countries being compared. For example Credit Rating Agencies (forthcoming abbreviated as CRAs) fill an important gap in sharing information for both investors and for debt holders. They aim to measure the creditworthiness, in other words companies' ability to meet their debt obligations with a focus on the long-term view. Credit ratings are used for a number of different market participants such as nations, governments and companies for issuing debt (Frost, Carol Ann. 2010), but only reflect the credit risk connected to the product/firm and do not cover other risks such as market – or liquidity risk (Masciandaro, Donato. 2011). The rationality of using CRAs is to reach information economies of scale and to increase the transparency among investors or debt holders. Some of the stronger arguments behind their position in the financial markets are that the ratings are based on information CRAs get from both public and non-public data, their employees and technological framework are highly skilled and they have the right incentives to judge a firm or product without any obligations against the issuer (Tichy, Gunther. 2011).

There are around 150 credit rating agencies in the world but the market is totally dominated by three actors; Standard & Poor's, Moody's and Fitch with a combined market share over 90 percent (De Haan, Jakob and Amtenbrink, Fabian. 2011). The three big agencies (often mentioned as big three) use letters and figures for their ratings, expressed as a scale where, for example, the highest rating for Fitch and S&P is AAA, while the highest

for Moody's is Aaa. The most frequently used international rankings and indexes of students of Latvian universities in the preparation of diploma and home works are presented in Table 1.

Table1. The most frequently used international rankings and indexes of students of Latvian universities in the preparation of diploma and home works

N	Category	Features	Advantage	A source
1	Ease of Doing Business	11 indicators that do not take into account other ratings. Doing Business uses a different approach to measuring the quality of regulation. It focuses on whether an economy has in place the rules and processes that can lead to good outcomes, linked in each case to Doing Business measures of efficiency.	They leave the situation not only in the country, but also in the largest cities.	The World Bank
2	World's Most Competitive Economy	The Global Competitiveness Index (GCI) tracks the performance of close to 140 countries on 12 pillars of competitiveness	It assesses the factors and institutions identified by empirical and theoretical research as determining improvements in productivity, which in turn is the main determinant of long-term growth and an essential factor in economic growth and prosperity.	The World Economic Forum
3	Country Most Open to Trade	The Index covers 12 freedoms – from property rights to financial freedom – in 186 countries.	Reflects and compares the customs and protectionist policies of the world's largest countries.	The World Economic Forum
4	Globalisation Index	It is used in order to monitor changes in the level of globalisation of different countries over extended periods of time. The current KOF Globalisation Index is available for 185 countries and covers the period from 1970 until 2017. A distinction is drawn between de facto and de jure for the Index as a whole, as well as within the economic, social and political components.	Measures the economic, social and political dimension to globalisation. The selection of the variables that go into the KOF Globalisation Index has been reviewed and expanded. Instead of the previous 23 different variables, a total of 42 are now included.	KOF Swiss Economic Institute
5	The Big Mac index	Is a survey that is used to measure the <u>purchasing power parity</u> (PPP) between nations, using the price of a McDonald's Big Mac as the benchmark.	<u>The Big Mac index</u> suggests that, in theory, changes in exchange rates between <u>currencies</u> should affect the price that consumers pay for a Big Mac in a particular nation, replacing the "basket" with the popular hamburger.	<i>The Economist</i> magazine

6	World's Best IP Protection	Report presents trends and changes in levels of physical and intellectual property protection in 129 countries.	One of the main measurements of the index is intellectual property rights protection, or IPR. The IPR score is based on a survey of experts who work in or with the country at hand. Scores are placed on a 10 point scale.	The World Economic Forum
7	The International Tax Competitiveness Index	Businesses will look for countries with lower tax rates on investment in order to maximize their after-tax rate of return. If a country's tax rate is too high, it will drive investment elsewhere, leading to slower economic growth.	The International Tax Competitiveness Index (ITCI) seeks to measure the extent to which a country's tax system adheres to two important aspects of tax policy: competitiveness and neutrality.	Organisation for Economic Co-operation and Development (OECD).
8	Country with Least Corruption Perception	The index covers perceptions of public sector corruption in 168 countries.	Top performers share key characteristics: high levels of press freedom; access to budget information so the public knows where money comes from and how it is spent; high levels of integrity among people in power; and judiciaries that don't differentiate between rich and poor, and that are truly independent from other parts of government.	Transparency International
9	GINI index	Data are based on primary household survey data obtained from government statistical agencies and World Bank country departments	The Gini coefficient measures the inequality among values of a <u>frequency distribution</u> (for example, levels of <u>income</u>). The coefficient ranges from 0 (or 0%) to 1 (or 100%), with 0 representing perfect equality and 1 representing perfect inequality.	The World Bank
10	The Global Human Capital Index	Index ranks 130 countries on how well they are developing their human capital on a scale from 0 (worst) to 100 (best) across four thematic dimensions and five distinct age groups to capture the full human capital potential profile of a country.	The Global Human Capital Report proposes a new benchmark for leaders to build the workforces of the future.	The World Economic Forum

There are interesting examples of corporate indexes. Coface a world leader in credit insurance, provides a comprehensive line of credit insurance to protect companies against potential non-payment by their customers which can be spread across nearly 200 countries. It's the most agile global credit insurance partner in the industry. Updated quarterly, the Coface Country Risk Assessment map (Coface map. 2019) a overview across 160 countries around the world. The Coface country risk assessment aims at evaluating the average credit risk of companies in a given country. The evaluation is based on economic, financial and political data. But it also takes into account Coface experience on the country, under two dimensions: Coface's payment experience on the companies of the country and also its assessment of the business climate.

The Better Life Index (OECD Index. 2019) is designed to let you visualize and compare some of the key factors – like education, housing, environment, and so on – that contribute to well-being in OECD countries. It's an interactive tool that allows you to see how countries perform according to the importance *you* give to each of 11 topics that make for a better life.

The OECD has been keenly involved in the debate on measuring well-being. Based on this experience, these 11 topics reflect what the OECD has identified as essential to well-being in terms of *material living conditions* (housing, income, jobs) and *quality of life* (community, education, environment, governance, health, life satisfaction, safety and work-life balance). Each topic is built on one to four specific indicators: For example, the Jobs topic is based on four separate measures: the employment rate, personal earnings, the long-term unemployment rate and job security. For each indicator you can also compare results for men and women, and see how much your social and economic status affects results. In the future, indicators describing sustainability of well-being over time will complement these indicators reflecting current material living conditions and quality of life.

4. Conclusion

In our opinion, it is necessary to switch from analyzing the GDP of countries to analyzing all available ratings and indexes, which will allow us to get a more accurate picture, as well as to receive students' qualitative knowledge and to learn delicate analysis of the international economy processes while studying the mechanism of rating and index formation. And the main, rating research in different spheres of the economy provides additional information about the level of, for example, corruption or investment opportunities of a country, that does not reflect GDP. The country comparison tool can be used to create interactive charts using over 100 indicators.

Accounting for GDP statistics includes working with large databases made up of primary statistics of different quality and time coverage! But it is unlikely that economists will abandon the GDP figures provided by the World Bank, so the preparation of a real picture of the achievements of any country today is not possible, without clarification with the help of numerous and proven ratings and indexes.

The variables are drawn from major international organizations are updated regularly. One can compare countries over time using the line charts or the rankings of various countries by selecting a specific year.

The comparison charts as well as the source data can be downloaded for free after registering. The most productive use of rating indicators in teaching courses Fundamentals of Risk Management and The Global Economy and International Business Environment, where students are well motivated to study the basics of entrepreneurship.

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Jurijs BALTGAILIS, Dr.oec, is a docent of the Institute of transport and communication in Riga. He teaches at a number of universities in Latvia, has extensive practical experience, led a number of banks in Latvia, Lithuania and Azerbaijan, is a partner in an audit firm. Research interests: international comparisons, tax planning, risk management, globalization and socialization.

ORCID ID: orcid.org/0000-0003-0892-1122

Aknowledgements

This research was supported by the project, which has received funding from the European Union's Horizon 2020 research and innovation programme European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme Marie Skłodowska-Curie Research and Innovation Staff Exchanges ES H2020-MSCA-RISE-2014 CLUSDEV MED (2015-2019) Grant Agreement Number 645730730



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**Publisher**<http://jssidoi.org/esc/home>**DISTRICT HEATING NETWORKS: ENHANCEMENT OF THE EFFICIENCY*****Ugis Sarma¹, Girts Karnitis², Janis Zuters³, Edvins Karnitis⁴**¹*Institute of Energy Systems and Environment, Riga Technical University, Azenes street 12/1, LV1048 Riga, Latvia*^{2,3,4}*Faculty of Computing, University of Latvia, Raina Blvd. 19, LV-1050, Riga, Latvia*¹*Latvenergo AS, Pulkveza Brieva Street 12, LV-1230, Riga, Latvia**E-mails: ²girts.karnitis@lu.lv; janis.zuters@lu.lv; edvins.karnitis@lu.lv; ³ugis.sarma@latvenergo.lv**Received 10 May 2019; accepted 24 June 2019; published 30 September 2019*

Abstract. During the decades the district heating's (DH) advantages (more cost-efficient heat generation and reduced air pollution) overcompensated the additional costs of transmission and distribution of the centrally produced thermal energy to consumers. Rapid increase in the efficiency of low-power heaters, development of separated low heat density areas in cities reduce the competitiveness of the large centralized DH systems in comparison with the distributed cluster-size networks and even local heating. Reduction of transmission costs, enhancement of the network efficiency by optimization of the design of the DH networks become a critical issue. The methodology for determination of the key drivers of the cost-efficiency of the DH networks to implement the most efficient (cost-minimal) thermal energy transmission was developed in this study. An inductive benchmarking modelling was applied; the general causal regularity is based on the observations of specific cases, thus determining the relationships between the network's design and thermal indicators as predictors and transmission costs as the target variable. The key drivers of the network efficiency were disclosed – the network length and the largest inner diameter of the pipes. The methodology is applicable for use by municipalities and heat providers for the heating planning of the new housing developments as well as renovation and/or expansion of the existing DH networks.

Keywords: district heating, network design, data mining, benchmarking methodologies.

Reference to this paper should be made as follows: Sarma, U.; Karnitis, G.; Zuters, J.; Karnitis, E. 2019. District heating networks: enhancement of the efficiency, *Insights into Regional Development* 1(3): 200-213. [https://doi.org/10.9770/ird.2019.1.3\(2\)](https://doi.org/10.9770/ird.2019.1.3(2))

* *The study has been supported by the State Research Program (VPP) project "Development of heat supply and cooling systems in Latvia" (project No. VPP-EM-EE-2018/1-0002), and by the University of Latvia project AAP2016/B032 "Innovative information technologies". The authors would like to thank members of the Latvian Association of Heat Companies for sharing actual data.*

**European Research Council**

Established by the European Commission

JEL Classifications: C24, C45, O13.

Additional disciplines: ecology and environment; energetics and thermoenergetics; informatics.

1. Introduction

During the decades, the advantages of the large district heating (DH) systems were accepted almost as an axiom for the densely populated (urban) areas. Even starting the new millennium the recognized development trend was replacement of isolated small DH systems with an adequate heat sources by a powerful central heat station and main transition line that will carry large volumes of heat over long distances (e.g., King, & Shaw, 2010). The advantages were based on the cost-efficient heat generation (due to higher efficiency factor and cheaper fuel as a result of the effect of scale) as well as on reduced air pollution and carbon emissions (due to a small number of controlled sources and extensive use of the renewable energy). These benefits overcompensated the additional costs of transmission and distribution (further transmission) of the centrally produced thermal energy to consumers.

Recent studies (e.g., Delangle, Lambert, Shah, Acha, & Markides, 2017; Song, Li, & Wallin, 2017) and analyses (e.g., DEA, 2016a; DEA, 2016b), however, show the decreasing competitiveness of the large DH systems in the light of the development of new technologies. There has been a rapid increase in the efficiency of low-power heaters in the last decade. The DH systems using natural gas are losing their advantages of the effect of scale; the effect is only partly remained if biomass is used in both central and local plants. Also the modelling results (Fakhri, Ahlgren, & Ekvall, 2016) show that even with an incredibly large difference in heat costs, already at a very small network length (around 3 km), the urban-size centralized network becomes economically disadvantageous in comparison with the distributed cluster-size local networks.

In addition the modern cluster-based urban planning principles (agglomeration, metropolitan area, peri-urbanisation, etc.) and the heat efficient buildings create the low energy density areas that significantly increase specific transmission costs. But advanced green heat generation technologies (e.g., solar thermal, ground-source heat pumps, geothermal, waste) are well suited for the lower thermal power applications; they become acceptable for use even in the density populated areas. All this reduce the advantages of the large centralized DH systems; actually, only the difference in fuel prices is noteworthy due to the large-scale purchases (which can often be implemented in a distributed system too).

Rapid development of the heat generation technologies directly increases the importance of the design of the DH networks. The network-related costs are not an insignificant component of total heat supply costs, they accounts for up to 40% of the total heating tariff, including distribution losses (10.4% of produced heat in EU28, 12.4% in Latvia in 2016; (Eurostat, 2018)). The reduction of the transmission costs, enhancement of the cost-efficiency of the network become the decisive factor for the DH's competitiveness in the heating sector.

At the same time, the DH currently is well-developed in the Nordic and Eastern European countries as well as in the largest densely populated cities in the EU's countries with mild climate (e.g., ETSAP, 2013; Werner, 2017). Planning and design of the new and renovated networks are long-term projects (for 30-40 years). Evolving over decades, the DH systems have accumulated large amounts of investments; therefore, it is not possible to imagine a rapid dismantling of the DH sector, which would mean colossal sunken investments.

Like in other network industries, heating network operators are the natural monopolists in specific areas. So there is neither direct competition, nor commercially open market; operators have a little motivation to enhance efficiency of the network and business. Therefore the DH transmission segment and its pricing structure are fully regulated. In practice the consumers' choice is limited by administrative and/or fiscal instruments; it is not the

cost-based approach, of course. Nevertheless, consumers would opt for a local heat source, especially in the case of a new building connection. Their benefit (value-in-behaviour) will be based on the rationality and economic self-interest (Butler, Gordon, Roggeveen, Waitt, & Cooper, 2016). Consequently, economic values are becoming the core message in DH marketing (Smaliukiene, 2019); the decreased environmental effect would be an inadequate motivator for choice of the DH.

The European Commission has established a single, detailed and strict legal framework for the electricity and gas sectors, which has been developed for several decades. The DH is very fragmented even within one country, it is a distinct sub-regional issue; there is lack of substantial EU-level regulatory framework devoted to it. The development and functioning of the DH has traditionally been under the responsibility and control of municipalities. Exactly the local government (mostly city municipality) is a planner, normative and financial facilitator and supervisor of the modern heating networks (Saeima, 1994; UNEP, 2015); it is a supplier and large consumer of the thermal energy at the same time. In Latvia as in Estonia and Lithuania, the DH sector is dominated by companies owned by local governments, although there are also some private equity companies. A similar situation can also be seen in the Nordic countries, where municipal enterprises continue to be relatively strong (e.g., Aberg, Falting, & Forssell, 2016).

There is also a government support for further deployment of the heat networks on the national scale and political willingness on European and global scale (e.g., UNEP, 2015; UN, 2017; Euroheat & Power, 2019), taking care on national interests (e.g., energy policy, social policy, climate targets), and recognizing national benefits (modern district energy systems as a key solution to integrate energy efficiency and renewables in cities).

The various factors of increasing the efficiency of the DH systems have been the drivers of further strengthening the competitiveness of the systems over many years. The rapidly growing amount of academic research (e.g., on the search term “district heating” database *ScienceDirect* provided 13 times more issues published in 2017 in comparison with the number of publications in 2008, while the total number of annual records during this period has increased by only 46%) also shows the topicality of the DH related issues. The research has been focused mostly on various aspects of the heat generation (CHP, renewables, thermal storage, heat pumps, etc.) as well as the regulatory issues (e.g., Sarma, & Bazbauers, 2017); the heat transmission temperature is the single practical network issue as well as the hydrodynamic issues as more theoretical topic (see, e.g., Sayegh, Danielewicz, Nannou, Miniewicz, Jadviszczak, Piekarska, & Jouhara, 2017). Currently the studies are linked to development of the fourth generation DH (e.g., Lund, Werner, Wiltshire, Svendsen, Thorsen, Hvelplund, & Mathiesen, 2014).

Each case and each DH network is unique in terms of differences in the amount of the heat transported, operating area, consumers and other factors. The aim of current research is development of the methodology for determination of the key drivers of the cost-efficiency of DH networks to implement the most efficient (cost-minimal) thermal energy transmission. The methodology will be applicable for the heating planning of the new housing developments as well as renovation and/or expansion of the existing DH networks, increasing the degree of heating centralisation by merging smaller and remote DH systems into a larger one, or, on the contrary, routinely fragmenting or even dismantling existing DH systems. The methodology was developed by analysis of various performance aspects and creation of the general causative regularity using the advanced benchmarking modelling procedures on the basis of practical cases (Latvian DH utilities).

2. Basic principles of the methodology

A direct theoretical calculation of transmission costs is an extremely difficult and even practically unachievable task. There are several multivariate analytic methods that are appropriate in principle for the study of cause and effect relationships between the input (network parameters) and output (costs) variables without investigation of

internal aspects of the network (a *black box* principle). The intelligent data mining methods are among them, they are well suited to discover existing regularities in the network's data set; particularly it relates to the benchmarking data mining algorithms.

On the other hand, the mathematical modelling procedures are generally accepted instruments for the prediction of the scenarios in the wide variety of fields. To achieve the set goal we applied an inductive benchmarking modelling, using the declared design, thermal and financial indicators of networks, which are functioning in homogenous conditions (in particular geographical area with the similar environment, climate and business factors). The benchmarking modelling means search of the mathematical model that is based on observations of specific cases (e.g., Moriarty, 2011), thus determining the relationships between the network's design and thermal indicators as independent variables (predictors) and some cost indicator as the dependent (target) variable; its reduction should reflect the efficiency progress in the corresponding network. Due to the analogous impact of external factors, the benchmarking provides comparative assessment of transmission costs; this way we will disclose the impact of network indicators on costs and extract the most significant ones (key drivers), reducing a large number of predictors.

The authors already have successfully used several benchmarking modelling tools for the cost assessment in a related industry – water supply (Zuters, Valainis, Karnitis, G., & Karnitis, E., 2016; Karnitis E., Karnitis G., Zuters, & Bobinaite, 2017). The results obtained have shown the suitability of the method to solve the similar tasks.

The necessary performance of the network k is determined (fig. 1a) by the requested heat capacity $Ph(k)$, and the thermal energy $Qcon(k)$ that really is supplied through $N(k)$ connection points to consumers. Due to the losses, a higher amount of heat $Qpr(k)$ should be produced and delivered into the network; the price of the $Qpr(k)$ is determined by the regulated heat production tariff $Tpr(k)$. The network consists of different size pipes (inner diameter changes from $Dmin(k)$ to $Dmax(k)$; $Dmed(k)$ is the most frequently used size), their total length is $L(k)$. The total costs $Ctr(k)$ for heat transmission includes all capital expenditures and operational expenses for the network development, maintenance and functioning; the reduction of costs directly characterizes enhancement of network's efficiency. The regulated transmission tariff $Ttr(k)$ could be determined as $Ttr(k) = Ctr(k) / Qcon(k)$; actually it don't provide a new information in our case. All these indicators are clearly and unambiguously defined, they are quantitatively measurable and controllable that is important for modelling quality.

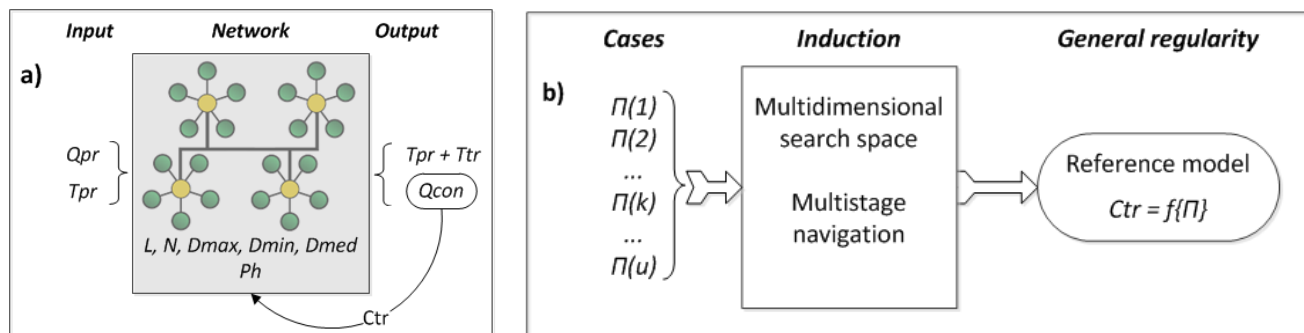


Fig. 1. Indicators of the network (a), and functionality of the benchmark modelling (b)

Developed by authors

For the development of the benchmark model, the DH network k is formalized as a multiple-input single-output determined search space (fig. 1b); its input data set of predictors $\Pi(k)$ defines some output (dependent) cost

variable $C(k)$. Then the creation of the model means search of the multi-functional regularity (1); the internal structure and operation of the network are irrelevant for performing this task.

$$C(k) = f_k(\Pi(k)) \quad (1)$$

There are u different functions $f_1, f_2, \dots, f_k, \dots, f_u$ for u networks; they form a factual basis for the modelling – set of the specific cases that can be used for search of the general regularity. Then the benchmark modelling means an inductive process – search of the general modelled regularity $C(m) = f(\Pi)$ on the basis of u specific cases $C(k) = f_k(\Pi(k))$ by navigation in the multidimensional search space.

The total transmission costs Ctr consist of number of components – heat loss costs, labour costs, depreciation costs, payments for electricity and chemicals, etc. An analysis of the structure of declared basic cost components has been made; it identified a great variety in these components. There are several objective (e.g., various business models, wide but uneven investments) and subjective (e.g. accuracy and uniformity of the data on cost components) reasons for it. The Ctr data can be evaluated as more qualitative (accurate, reliable) ones in comparison with the separate cost components, since the latter very depend on the cost allocation. In addition, exactly total costs are the efficiency criterion as well as the basic regulatory focus as the determinant of transmission tariff Ttr . Therefore, the Ctr were chosen as the dependent variable:

$$(C(k) = Ctr(k)).$$

Other mentioned network's design and performance indicators form the set of independent input indicators $\Pi(k)$:

$$Ctr(k) = f_k(\Pi(k)) = f_k\{Ph(k), Qpr(k), Tpr(k), Qcon(k), Dmin(k), Dmed(k), Dmax(k), L(k), N(k)\} \quad (2)$$

It can be predicted that it will not be achievable model, which is completely adequate to all real networks. The leading motive for practical purposes is to create the function f with the best possible quality. To achieve the maximum conformity of the found regularity, correlation of the particular modelled values with corresponding declared specific costs (correl ($Ctr(m)$: Ctr)) is used as the quality criterion during the creation of the model. We have applied also the Average Normalized Squared Deviation from the Mean value (ANSDM) for assessment of the quality of the models; the normalization was used because of large range of networks size:

$$ANSDM = \frac{1}{u} * \sum_1^u ((Ctr - Ctr(m))/Ctr)^2$$

Number of input data sets u and consequently the output data is finite (number of networks u ; in our case data on 23 DH networks were available). Nevertheless, in order to have the possibility to evaluate the new and/or modified undertakings, it is necessary to create the regularity that is continuous and monotonous for any predictor (the economic logic does not indicate any reason for some extremum) against any $\Pi(k)$ in the determined ranges of input data.

3. First stage of modelling: determination of key drivers

The regression analysis, as the method at the crossroads of data mining and modelling, was chosen as the most preferable statistical modelling tool, which is directly focused on the relationships between the dependent variable and several predictors. For modelling we chose the well-developed, powerful and at the same time user-friendly R statistics environment that provides the flexible modelling algorithms; the modelling was started by using the simpler linear regression algorithm. The post-modelling analysis of residuals will show the purposefulness of continuation of modelling by usage of more complicated nonlinear regression algorithms to obtain the stronger cause-effect relationship.

For the linear modelling we used the built-in linear regression model, implemented in R as a function *lm*, which is called by command *lm*. The target was to detail the general regularity (2) and to create the benchmarking model as the linear mathematical expression:

$$Ctr(lin) = \alpha + \beta_1 * i_1 + \beta_2 * i_2 + \dots + \beta_n * i_n \quad (3)$$

where:

- α – constant;
- β_i – estimated optimal weight of corresponding predictor i .

Identification of outliers (data sets which are too far away from the central data cluster) was made before the modelling by means of standard outlier detecting procedure; the outliers may have a different essence and therefore cannot be used to create the general regularity. After outliers' rejection from the total data set data samples of remaining 20 DH networks had been used for the modelling ($n = 20$).

Checking indicators' cross-independence level was another preparatory activity; the usage of strongly correlated predictors would lead to the so-called multicollinearity problem, i. e., the possibility of obtaining unreliable results by usage of interdependent predictors. To examine the potential problem the typical tool was used – the Variance Inflation Factors (VIF), which characterise the mutual correlation between any pair of predictors. A strong reliability criterion was chosen:

$$VIF = 1/(1-R^2) < 2.5, \text{ or } R^2 < 0.6$$

where: R^2 – coefficient of determination.

The VIFs were calculated for full matrix of input indicators; the mutual correlations of five variables (*Ph*, *Qpr*, *Qcon*, *L*, *N*) were found as being well above the critical threshold). So only one of the five strongly correlated indicators can be used for modelling, the others should be excluded from the data sets. At the same time it is an approval that the structure and specific load of all networks is similar, that significantly increases trust in the results of benchmarked modelling.

To define the most preferable predictor among the strongly interconnected five indicators and so avoid the potential multicollinearity, we made the prior modelling by using the same linear regression algorithm, using all nine independent variables as predictors. The regularity (3) in this case becomes:

$$Ctr(lin\ 9) = \alpha + \beta_1 * Ph + \beta_2 * Qcon + \beta_3 * Qpr + \beta_4 * Tpr + \beta_5 * L + \beta_6 * N + \beta_7 * Dmax + \beta_8 * Dmin + \beta_9 * Dmed \quad (4)$$

Although the correlations between any of interconnected five predictors and *Ctr* are very strong (> 0.8), their impact on *Ctr(lin9)* is different (their mutual correlation is one of the basic reasons). A perusal of p-values shows that the network length *L* is the most significant predictor among the five mentioned mutually-correlating ones (tab. 1); there is only 3.8% probability on random impact of the *L* on *Ctr(lin9)*. Chances of other indicators to be accidental ones are incomparably higher (27% – 85%). Therefore the network length *L* was chosen as the predictor for the basic modelling together with *Tpr*, *Dmax*, *Dmin* and *Dmed*.

Table 1. Statistical characteristics of *Ctr(lin9)* model and its predictors

Variables	Correl with Ctr	<i>Ctr(lin 9)</i> p-value
Ph	0.8739	0.2730
Qcon	0.9063	0.2730
Qpr	0.9285	0.6256
L	0.9200	0.0381
N	0.8138	0.8499

Developed by authors

The modeling process itself was started by creation of linear 5-predictor model in the form:

$$Ctr(lin\ 5) = \alpha + \beta_1 * Tpr + \beta_2 * L + \beta_3 * Dmax + \beta_4 * Dmin + \beta_5 * Dmed \quad (5)$$

The obtained correlation is extremely strong (tab. 2, columns *Ctr(lin5)*); the p-value for the model is very small. At the same time, the excellent correlation is partly misleading because of small amount of data sets in the 30-fold range of the actual *Ctr* values; this is confirmed by the quite large value of ANSDM (7.36%) of the actual costs *Ctr* from those of modelled regularity *Ctr(lin5)*

Table 2. Characteristics of the models and predictors

Indicators	Characteristics of the predictors					
	Linear models				Nonlinear model	
	Ctr(lin 5)		Ctr(lin 2)		Ctr(nolin)	
	p-value	Model parameters	p-value	Model parameters	p-value	Model parameters
L	5.84E-08		3.05E-10		2.11E-13	
Dmax	0.00428		0.000309		7.25E-06	
Dmin	0.70497					
Dmed	0.83559					
Tpr	0.79119					
Statistical characteristics of the models						
	1.071E-09		5.89E-13		7.91E-16	
R ²		0.9651		0.9636		0.9747
ANSDM		0.0736		0.1443		0.0303

Developed by authors

The small p-values of the *Dmax* and *L* show their decisive role in the model's regularity; it clearly means that they are the searched key drivers. The high p-values of other three predictors (*Dmin*, *Dmed* and *Tpr*) show that their impacts on costs are very accidental; these predictors only complicate the model unnecessarily. To evaluate impact of each key driver on costs, in the next modelling stage only variables *L* and *Dmax* were used as the predictors (6) for the creation of the linear 2-predictor model *Ctr(lin 2)*:

$$Ctr(lin\ 2) = \alpha + \beta_1 * L + \beta_2 * Dmax \quad (6)$$

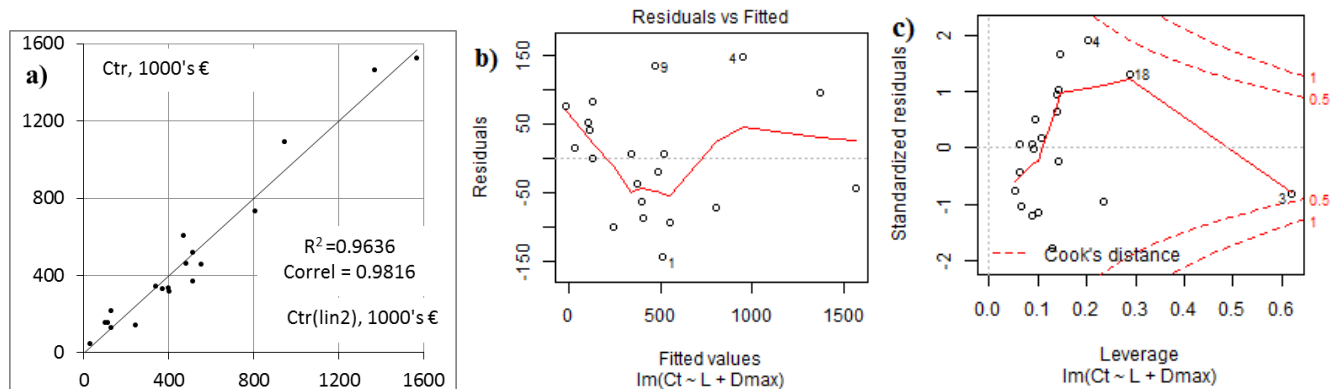


Fig. 2. 2-predictor linear model; scatter plot *Ctr* vs *Ctr(lin2)* (a), diagnostic plots (b, c)

Developed by authors

The final result of the linear modelling (tab. 2, columns *Ctr(lin2)*) shows that the correlation parameters are virtually unchanged in comparison with the *Ctr(lin5)*; extremely small p-value confirms the validity of the predictors' choice. The obtained excellent correlation (Fig. 2a) confirms that L and D are the key drivers of transmission costs, i.e., the efficiency of the network; the abandoned three indicators really have not a significant impact on the searched regularity. The results are consistent with the conclusion of the techno-economic model, developed in (Pusat, & Erdem, 2014): the transmission costs increase with the area size, i.e., with the length of the network. On the other hand, costs for laying out pipes as well as the total cost of piping per meter (ETSAP, 2013; Delangle, Lambert, Shah, Acha, & Markides, 2017) directly depends on the pipes' diameter first of all, therefore the significance of the largest diameter is well explained.

Nevertheless, R diagnostic plots point the incomplete compliance of the actual data with the linear model *Ctr(lin2)*. The plot 2b shows that residuals are not equally spread around a horizontal line (especially at small fitted values). It is an indication that the linear model doesn't fully capture the existing non-linear relationship between the predictors and the target variable. The plot 2c identifies the data point that lies very near to the threshold, so called Cook's distance. This point is not an outlier; nevertheless it can become influential against a general regularity. In addition the ANSDM even increased, its reduction is necessary for more accurate evaluation of the key drivers' impact on the network's efficiency. In general the model needs to be further developed to assess the impact of the key drivers on the efficiency of transmission network.

4. The second stage of modelling: evaluation of the impact of the key drivers

Using the traditional method of the least squares, it was found that the nonlinear trend line in the scatter plot of the created linear model (fig. 2a) provides a slightly higher coefficient of determination R^2 in comparison with the standard linear one. It approves a necessity to add some nonlinearity in the model. To find the correct way, we checked the scatter plots (*Ctr* vs *L*) and (*Ctr* vs *Dmax*) (fig. 3). The impact of each individual predictor on the result of the total mining is, of course, different from the individual correlation (e.g., due to some mutual impact of predictors). Nevertheless, the qualitative differences between both scatter plots provide some comparative indication. The optimum trend line on the scatter plot (fig. 3a) is linear, while on the scatter plot (fig. 3b) one can observe a moderate non-linearity as well as can indicate that the inclusion of power function is preferable.

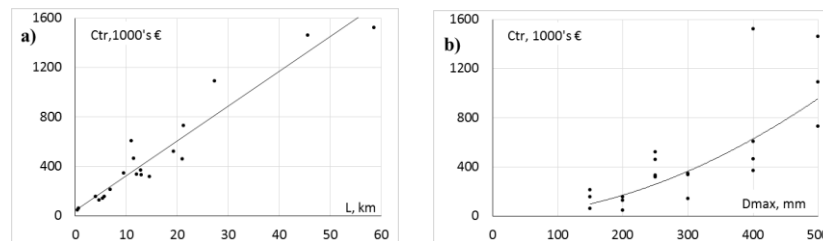


Fig. 3. Scatter plots *Ctr* vs *L* (a) and *Ctr* vs *Dmax* (b)

Developed by authors

Two mutually non-related modelling procedures have been applied to reduce the mentioned inconsistencies, to increase the coincidence of the searched regularity with the declared transmission costs, and to ensure the cross-check of results, thus improving the quality of the model.

To define the non-linearity, which best matches the regularities of the actual costs *Ctr*, as the first step of the nonlinear regression process we used the NLS function, which determines the nonlinear (weighted) least-squares estimates of the parameters of the nonlinear model:

$$\text{mod}(1) \leftarrow \text{nls}(\text{Ctr} \sim \beta_1 * L + \beta_2 * (Dmax)^\gamma, \text{start} = \text{list}(\beta_1 = 23, \beta_2 = 1)) \quad (7)$$

where:

- the start values of the β_1 and β_2 were determined according to the linear model (5);
- the optimum values of the coefficients β_1 and β_2 were calculated by NLS function for number of picked γ values using the correlation $\text{correl}(\text{Ctr}:\text{Ctr}(\text{nolin}))$ as the quality criterion.

As the second step we used the linear modelling to find the free term of the final model $\text{Ctr}(\text{nolin})$ by processing function (7) that was found in the first step:

$$\text{Ctr}(\text{nolin}) \leftarrow \text{lm}(\text{Ctr} \sim \text{predict}(\text{mod}(1))) \quad (8)$$

Slightly improved formal correlation and p-value (tab. 2, columns $\text{Ctr}(\text{nolin})$) in comparison with the linear model $\text{Ctr}(\text{lin2})$ is not the main achievement. The ANSDM is significantly reduced (3.03%), the deviation of actual costs Ctr from the modelled $\text{Ctr}(\text{nolin})$ has decreased for 14 of 20 networks, while it has insignificantly increased only for 4 networks. The highlighted confidence interval (at showed 95% confidence level) is satisfactorily narrow. One can see that the nonlinear model (fig. 4a) is much more coinciding with the actual costs of the utilities in comparison with the linear one.

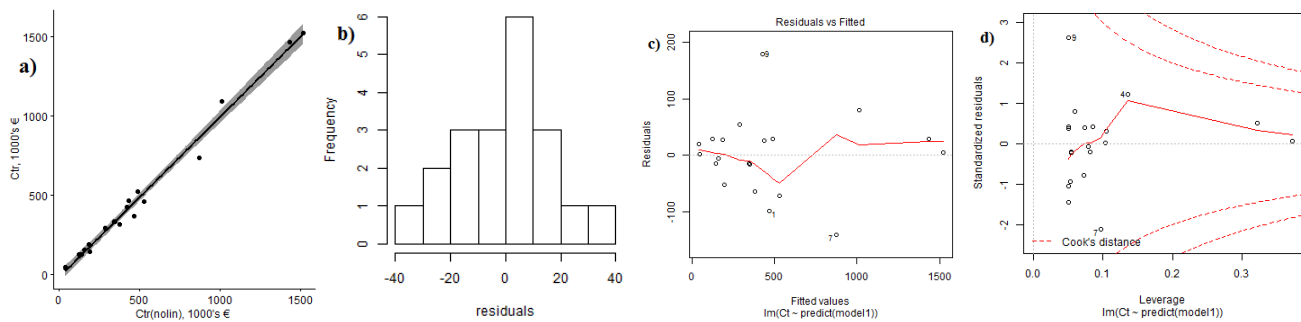


Fig. 4. Nonlinear model $\text{Ctr}(\text{nolin})$; scatter plot Ctr vs $\text{Ctr}(\text{nolin})$ (a), histogram of residuals (b), diagnostic plots (c, d)

Developed by authors

R diagnostic plots show better behaviour of the residuals in comparison with the linear model. The residuals are more equally spread around the horizontal zero line (fig. 4c). There are no patterns between the residuals and fitted values, thus the independence assumption might hold as well. No data point is near the Cook's distance (fig. 4d). The histogram on fig. 4b suggests the normality of the residuals around the zero value that is sign of a good model.

Another modelling procedure that was applied – a classical version of multi-layer perceptron with the error back-propagation training algorithm. The multi-layer perceptrons have proven themselves in a variety of data mining tasks (e.g., Daranda, 2016; Jan, & Ali, 2018; Briedis, & Freivalds, 2018). To obtain the neural model for our case, in addition to standard procedures we introduced techniques to cope with the task-specific conditions: (a) small amount of training data; (b) the monotony requirements for the resulting function with regard to each of the input parameters.

It was realized in the pre-processing phase that it is enough to have just three neurons (computing units) in the *hidden* layer of the network to achieve approximately maximum possible accuracy; input data normalization was made by the S-type function because of very diverse scales of data values. It was also experimentally confirmed that it's enough with just 2 input parameters out of 5 to achieve almost the same quality of the model – $Dmax$ and

L. In addition to correlation between modelled specific costs and declared ones, the accuracy of the modelling was controlled by the stopping criterion – the continuation of the training process until the modelling error falls below the some predetermined threshold ε ; the best possible correlation obtained was 0.995 with ε value of 0.00001.

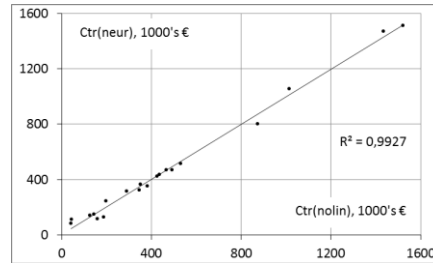


Fig. 5. The mutual coincidence of the neuron network model $Ctr(neur)$ and the nonlinear regression model $Ctr(nolin)$

Developed by authors

Nevertheless, the models obtained with the maximum possible accuracy/correlation too much adapt to the concrete data points used for training and thus they are invalid to model the overall process (so called *overfitting*). Therefore tuning of the model parameters was accomplished to obtain the maximum quality of the searched regularity while avoiding the undesirable overfitting and thus preserving its monotony. To overcome the effect of the overfitting, we used a qualitative method by defining several specific monotony tests with regard to each of the input parameters and applying them against the trained model. After each training episode, the obtained formula was tested to have the monotone cross-relations. E.g., to achieve the monotony, the final value of the threshold ε was increased until 0.0001, the obtained correlation – 0.987.

The excellent coincidence of the both nonlinear regression and neural network models (fig. 5), created by the two mutually independent modelling tools approves that modelling results are very near to the true causal regularity.

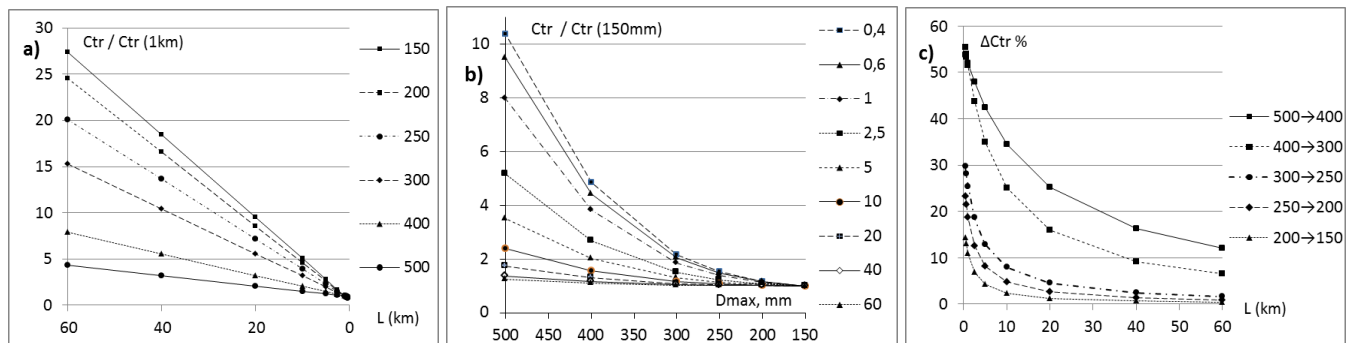


Fig. 6. Impact of key drivers on network cost-efficiency;

(a): the relative transmission costs compared to $Ctr = f(Lkm; Dmax)$;

(b): the relative transmission costs compared to $Ctr = f(150\text{ mm}; L)$;

(c): percentage reduction of the transmission costs (ΔCtr), reducing $Dmax$ by one standardized size

Developed by authors

As it would be predicted, reduction of the length of the network L reduces costs Ctr proportionally (fig. 6a), while the reduction of the $Dmax$ leads to a much faster enhancement of the network efficiency (fig. 6b). The percentage reduction of the transmission costs (ΔCtr), reducing $Dmax$ by one standardized size, is shown in the fig. 6c. It is understandable, that reduction of $Dmed$ and even $Dmin$ also will provide some effect. With larger pipes, the effect

is greater; also, as the total network length decreases, the effect increases as the D_{max} -sized pipes make up a larger part of the total network length.

Conclusions

The created methodology and developed benchmarking models well indicate the total network length and the largest inner diameter of pipes as the key drivers of the heat transmission costs, so the network efficiency. Very high coefficient of determination and low ANSDM approve that the modelled causal regularity is very near to the true one in the full range of combination of predictors. The correlation between models, which are created by mutually absolutely independent modelling tools, is excellent. Hence, the trustworthiness in the results is high; it confirms the quality and credibility of the developed methodology as well as its appropriateness for evaluation and optimization of the network design. The methodology is a reasonable compromise between the accuracy and simplicity, which is its strong advantage for the practical applications.

Results of the current study clearly indicates that an optimum planning of the pipe routes, the choice of adequate pipes' sizes, first of all size of large diameter transmission pipes, are the key drivers designing the modern efficient transition and distribution heating networks for the development, expansion and/or renovation of the DH systems. The still used D_{max} pipes only in 3 of the 20 networks would match the volume of actual P_{con} (see, e.g., ETSAP 2013), even taking into account the reasonable reserve for the potential future growth of the consumption. In other networks, the D_{max} exploited for up to 4 standardized sizes exceeds the D_{max} optimal. Replace of existing D_{max} size pipes with the matching size pipes during the network renovation would significantly increase the network's efficiency, dropping the C_{tr} by up to 35% and thus the overall heat supply tariff ($T_{pr} + T_{tr}$) by up to 12%.

In practice, of course, the actual DH systems are not as homogeneous as the theoretical cases discussed above. However, similar principles should be observed when planning their optimal development. An example is the DH system of Riga, which according to its efficiency and other performance indicators ranks among the best city energy systems in the Baltic Sea region. Its structure consists of two large DH systems and more than ten small and very small systems with the boiler houses of adequate capacity (RS, 2018), which supply remote clusters, to which it was not economically justified to build the long poorly loaded transit pipelines, or even such pipes have been liquidated during the reconstruction.

The complete rebuilding of the existing DH systems is, of course, very expensive and therefore practically impossible. Another option would be to intensify the transition to the fourth generation DH networks with a low heat carrier temperature that will require pipes of larger size. But the heating systems of the buildings currently are not yet prepared for this transition. So the analysis of various DH system models, possible re-planning of the network design and selection of adequate pipe's size is a single real option to enhance the efficiency of the network.

Nevertheless, the current study has to be evaluated as the first stage of the research; it demonstrates the correctness of the working hypothesis and perspective of the research. There is a strong basis for continuation of research to further enhance the methodology, to increase its quality and to narrow the standard segment; further improvement of the methodology certainly is possible and necessary.

Currently data on only 23 of 56 functioning networks were available for modelling; in addition three of them were classified as outliers. Increase of the number of data sets would be highly desirable to reflect better the large range of networks' sizes; mentioned differences between the correlation and ANSDM is a direct sign. Our previous experience shows that the availability of data over several consecutive years is a substantial positive factor. It will become possible to identify and to remove from the full data pack several unreliable and/or even contradictory

bad data sets, which distort the regularity of the declared data on the networks. Modelling will be made on the basis of the most qualitative and reliable (*good*) data sets; the obtained general regularity will be applicable to the *bad* networks of low confidence too. Fig. 5 clearly shows that some data of several networks seems being too far from the general regularity; it is known that operators of these small networks performs a number of other municipal functions too, obviously the cost accounting is far from perfect in the utility. The consequences of the model's attempts to include such data as much as possible in the common model are the deterioration of the quality of the model. E.g., in our case the exclusion of only two *bad* data sets reduces the ANSDM by one third.

Overall, the results of the study emphasize the municipalities' duty to be proactive in fulfilling their heating supply obligations, ensuring the most efficient functioning of the DH networks and thus minimizing the heat tariffs for their area's population and other consumers. It is time to revise approach of local governments to heat supply; each municipality needs to consider carefully whether to give the preference to a centralized energy model with long, inefficient large-sized pipes, or to several local heat generation stations and an efficient distribution networks. Each individual DH project must be carefully analysed by reviewing the stagnant habits and finding the optimal solution; the work and resources invested will pay off by the most effective network design and implementation for specific area.

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Aknowledgements

The study has been supported by the State Research Program (VPP) project "Development of heat supply and cooling systems in Latvia" (project No. VPP-EM-EE-2018/1-0002), and by the University of Latvia project AAP2016/B032 "Innovative information technologies". The authors would like to thank members of the Latvian Association of Heat Companies for sharing actual data.



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Short biographical note about the contributors at the end of the article (name, surname, academic title and scientific degree, duties, research interests):

Ugis SARMA, PhD student at Riga Technical University, is the Corporate Strategy Director of the Latvenergo AS. He has been employed in the energy sector for more than 20 years. His research interests focus on DH optimisation and regulation issues. Author of more than 20 publications.

<https://orcid.org/0000-0003-4654-4647>

Prof. Girts KARNITIS, Dr.sc.comp., is a Professor at the Faculty of Computing, University of Latvia. He is interested in data analysis and big data. During last years he has modeled number of issues – innovative and digital development, water supply, district heating.

<https://orcid.org/0000-0002-7563-6383>

Prof. Janis ZUTERS, Dr.sc.comp., is a Professor at the Faculty of Computing, University of Latvia. His research interests include machine learning and natural language processing.

<https://orcid.org/0000-0002-3194-9142>

Prof. Edvins KARNITIS, Dr.sc.eng., is the Leading Researcher at the Faculty of Computing, University of Latvia. His research interests focus on data analysis and strategic planning. Author of more than 200 research and analytical publications.

<https://orcid.org/0000-0001-6784-7327>

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THE ROLE OF SMES DEVELOPMENT ON POVERTY ALLEVIATION IN NIGERIA*

Solomon Akpoviroro Kowo¹, Olusegun Adeleke Oba Adenuga², Olalekan Owotutu Sabitu³

¹ Kwara State University Nigeria, Department of Business Administration and Entrepreneurship, Nigeria

² National Open University of Nigeria, Department of Educational Foundations, Nigeria

³ Ogun State Institute of Technology Igbesa Nigeria, Department of Business Administration, Nigeria

E-mails: ¹ Kowosolomon@gmail.com ; ² oadenuga@noun.edu.ng; ³ olatoyosim@gmail.com

Received 10 March 2019; accepted 20 June 2019; published 30 September 2019

Abstract. The role of SMEs development on poverty alleviation has been a core element of the current report. This study examined the role of small and medium enterprises on poverty eradication in Nigeria. Two research questions were posed for the study and two hypotheses formulated in line with the objectives. One hundred and forty two (142) questionnaires were administered randomly to the entire employee population of the SME companies that are registered with SMEDAN in Lagos Nigeria. The sample size was determined using Yamane formula. The data was analysed using manual and electronic based methods with the aid of data preparation grid and statistical package for the social sciences, (SPSS) statistical package version 21.0. The study made use of statistical tools which include: analysis of variance (ANOVA), correlation efficient and regression analysis in testing hypotheses where applicable. Therefore, the study found out that SME development affects poverty alleviation and also Training organized by SMEDAN affects SMEs employment creation. It was discovered that the small and medium enterprises provided employment opportunities, training ground, harnesses utilization of local resources and also acts as a pillar hold of a nation, Nigeria inclusive. The study concluded that a good development strategy if employed by these SMEs will grow to large-scale capital intensive. The study recommends that SMEs should source their loans from the financial institutions where interest rates are low.

Keywords: SMEs; poverty eradication; employment creation; training; SMEDAN

Reference to this paper should be made as follows: Kowo, S. A.; Adenuga, O. A. O.; Sabitu, O.O. 2019. The role of SMEs development on poverty alleviation in Nigeria, *Insights into Regional Development* 1(3): 214-226. [https://doi.org/10.9770/ird.2019.1.3\(3\)](https://doi.org/10.9770/ird.2019.1.3(3))

* *Parts of this text are spinoffs from research in the framework of the project European Union's Horizon 2020 Research and Innovation Programme projects European Cohort Development Project (ECDP) Grant Agreement No.777449 (2018-2019)*



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1. Introduction

In this period of globalization, through world trade it is well recognized that private sector development has an important role to play in poverty alleviation (Bagetic & Sanogo, 2005; Tavis, 2016; Volchik et al., 2018; Mayorova et al., 2018; Bužavaitė et al. 2019).

Micro, small and medium enterprises is a very important sector in Nigeria economy and it is stipulated in the Nigeria strategy for Growth and Poverty Reduction as a crucial towards addressing the concerns and aspiration of the Nigeria vision 2020 (Nwaba, 2011). Nigeria has been the center of trade for many centuries. Nigeria depends on commercial activities for economic growth and most of them are engaged in the small scale business as the major means of earning their income particularly on agricultural sector, fishing sector and other business. These sectors contribute significant towards the reduction of poverty and unemployment. In Nigeria before revolution people were more engaged in micro, small and medium enterprises as artisans and other activities in urban areas. In rural areas SMEs engaged people in agricultural activities and business involving agriculture products and other consumable. After the 1964 revolution, the Government initiated a number of SMEs enterprises for the manufacture of nails, garment, cooking utensils, electrical wires, soaps and other products.

The SMEs in Nigeria create job opportunities among the low skilled people and therefore hold the key to employment creation and income generation (Maina, 2014; Iorun, 2014; Udoko-Aka, 2015). In the mid-1970s SMEs were engaged in cooperative activities especially for women groups (Ogundele, 2012). In 1984 the business started to build its root after the announcement of Free Trade (Trade Liberalization policy) and this was the initiation for small Scale Enterprises. Various investments have been approved and a large number of Small Scale Enterprise (SMEs), commercial farming and even manufacturing firms were established by natives and foreigners (Sule, 2014).

Consequently, the need for this research work is very important. The majority of enterprises in Nigeria fall within this category. SMEs accounts for over 70 percent of employment in Nigeria, with the potential of employing more and also has a large potential of reducing poverty in our economy (Sule, 2014; Otokiti 2002).

The small and medium enterprises (SMEs) are supervised by various ministries in depending on its nature of operation. Those ministries are: Ministry of Trade, Industry and marketing, Ministry of community, woman and children, Ministry of Labour, Economic empowerment and cooperatives and Nigeria chamber of commerce and industries. SMEs activities are in the form of batik making, antiques, handcraft works, medicine soap making, oil milling and other tourism articles involved in trades which include purchasing and sales of goods and agricultures. Long chains of this type of business are located at many places in South west Nigeria. Most of them are owned by individual and other by family or groups. These enterprises create many job opportunities to the people of Nigeria especially the youth from different gender. The main objective of small enterprises is profit making and enabling people to improve their income through this kind of business (Anyanwu, 2004).

1.1 Statement of the Problem

Generally, the Small and Medium Enterprises (SMEs) has become very popular entity in Nigeria due to their important role they play in terms of reducing unemployment rate among people. Concern with employment creation and with the welfare of the least advantaged can therefore lead to policies to raise labor standards and employment levels and stability in this sector on microeconomics and distributional grounds (Anyanwu, 2004). This has been reinforced in the past by the not always sustainable notion that these firms are in general, efficient

users of labor inputs at a micro economic level. CBN (2007) provide a useful critical review of this line of reasoning. Another set of argument hinges upon notions of market failure. The government of Nigeria has undertaken various measures and programmes to establish and sustain the SMEs in order to contribute towards poverty reduction. This action has caused many people to formulate and engage in SMEs. To address the problems aforementioned, the study will answer the following question: (i) To what extent does SME development affect Poverty Alleviation? (ii) To what extent does training organized by SMEDAN affect SMEs Employment creation? The Research Objectives are: (i) To determine the role of SMEs development on poverty alleviation. (ii) To determine the effect of training organized by SMEDAN on SMEs Employment creation

1.2 Operationalization of Research Variables

Examining the Role of SME development on poverty alleviation as the topic has the following constructs:

Dependent construct as – Poverty alleviation and Independent as SME development.

The above is mathematically expressed as $Y = f(X)$

Where Y – Dependent Variable

X – Independent Variable.

Y – Poverty alleviation

X – SME development

Therefore from this equation, the alleviation of poverty would depend on the development of SME

This is expressed as:

Poverty alleviation = f (SMED)

That is $PA = f(SMED)$

Where $PA = Y$ and $SMED = X$

The X and Y are broken down as follows:

$Y = (y1, y2,)$

y1 – Poverty alleviation

y2 – Employment generation

Similarly $X = (x1, x2)$

Where

x1 – SME development

x2 – Training

2. Literature Review

2.1 The Roles of Small and Medium Enterprises in Eradicating Poverty in Nigeria

Small and medium scale industries facilitate the creation and use of non-existing or unused products and materials. It is also the main stream of economic activities in a nation and provides the stages for industrial revolution and economic growth (Abosede, 2000). In a contribution of Abugu (2007) on the place of small scale enterprises in the economy, he states that “the role of small & medium scale enterprises in the development of the country has been summarized in the Nigeria Third National Development Plan of 1975-80 which dwells on generating employment opportunities, stimulating indigenous entrepreneurs, improvement in per capita income, balanced regional development, education, empowerment of citizens, Stimulation of indigenous companies and providing self-sufficiency.

Improvement in Per Capital Income

SMEs locate and exploit opportunities. They convert idle resources like land, labour and capital into national income and wealth in the form of goods and service. They help to increase Net National Product (GNP) and per capital income in the country, which are important yardstick for reducing poverty and measuring economic growth (Adelaja, 2003).

Generation of Employment

Anyanwu (2003) Opined that SMEs enhance employment generation in a place since unemployed youths and graduates can easily engage in skills on their own. Small and medium enterprises generate more employment opportunities on the aggregate than giant industries. Many people in this country depend on self-employment for sustenance. Many others including their relations are provided employment in these enterprises directly and indirectly.

Education

Towards the end of the sixties, two significant contributors were made in the field of small and medium enterprises. One was that, there is a positive linkage between entrepreneurship and economic development and the other was regarding and emergence of a strong hypothesis that small and medium enterprises can be developed through planned efforts (Capenter, 2001; Otokiti, 2002).

Provide Self Sufficiency

The small and medium enterprises not only become self-sufficient but also provide great standards of living to its employees and the public. It provides opportunity to a number of people working in the organization. The basic factors which become a cause of happiness may be liberty, monetary rewards and the feeling of contentment that one gets after doing a job (Uzoma & Uzoma, 2012).

2.2 Characteristics of Small and Medium Scale Enterprises

A major feature of SMEs in Nigeria relates to the ownership structure, which primarily revolves around one-man or a family. Nigerian SMEs are predominantly owned by a sole proprietor or partners (Adeniji, 1981). Owualah (1999) states that in Nigeria SMEs, it is difficult for owners or managers to obtain short or long term capital from the organized capital market, but instead relies on loans from friends, relatives or money lenders, and also from personal saving (Udoko- Akaka, 2015). Adegbite (1995) refer to Nigerian SMEs as the cornerstones in which Nigeria economic growth and stability rests. Similarly, Adeniji (1981) states that SMEs are known to be labour intensive, and SMEs in Nigeria account for over half of the total share of employment. According to CBN (2007) SMEs have contributed significantly to Nigeria development by the provision of employment opportunities, marketing of goods and services, and the growth and development of the rural areas. SMEs have also contributed immensely to the growth of indigenous entrepreneurship in Nigeria. From this point in time it has been agree that SMEs are generally regarded as the locomotive that drive the economic engines of growth and poverty eradication in developing countries like that of Nigeria(Tavis,2016;Alenxander, 2005;Onyemere,2013;Cares & Porter 1997).

2.3 Constraints to Small and Medium Scale Enterprises Development

The challenges faced by SMEs globally are very worrisome which hinder its operation towards alleviating or reducing poverty in the country (Chasten and Mangles, 1997; Sule, 2014; Caleman, 2002; Brain& Ostenyeng, 2001; Ogundele, 2012; Afrane, 2002; Adizes, 1979).The following are the constraints faced by SMEs: Osuagu (2016) opined that lack of access to finance or loan has been one of the most pervasive obstacles faced by SMEs in both developed and developing countries. It represents the major challenges which can significantly affect the ability of a firm to grow, upgrade its technology, expand its market, and promote its management skills, increase productivity simply to grow and survival in the business environment (Berger, 2000; Kao, 1982; Hall, 1987; Williamson, 1985; Wiles, 1977; Ogundele & Olayemi, 2015; Cheston & Reed, 1999). Onyemere (2013) posit that inadequate financial services have been figure out as the primary inhibitors to SMEs development and production in Nigeria. Barry (1978) noted that insufficient start-up capital from the personal savings of an individual and the contribution from friends and relatives still constrained access to institutional finance from the capital market and banks. The genesis behind the limitation or constraint includes; wrong and unacceptable feasibility report, inability to raise the required equity contribution, lapses to provide collateral securities and incomplete financial

documentation (Yavlinsky et al, 1994; starodubrovskaya, 1995; Anyanwu, 2004; Churchill 1983; Chan et al 2006; Ogundele & Opeifa, 2014b).

Infrastructural Facilities

Inadequate infrastructural facilities or deplorable conditions of the available once and it has posed a formidable obstacle to SMEs operations, and hence call for urgent attention by the government (Otokiti, 2002). The obstacle of infrastructure involves inadequate transportation system, shortage of water supply, poor telecommunication system, and lack of electricity to solid waste management. These make businesses to provide expensive parallel infrastructure. These have been a hindrance to the success of SMEs performance in Nigeria (Adelaja, 2003).

Strategic Planning Problem

SMEs do not carry out strategic planning in their operations properly. Previous study conducted by Wedel (1998) claimed that SMEs lack strategic planning system because well active and sound planning serve as a necessary input for sound decision making for new ventures or existing enterprise to succeed in terms of profits maximization and the rest.

Multiple Taxation

Abugu (2007) discovered that the manifold and high taxes are considered to be significant factors that cause SMEs' failure in Nigeria. This is the major obstacle faced by given it to tax consultants and agents hired by the governments at all level. There are not honest in their operations, excessive in their assessment and broken heart in their relationship to the production process.

Unfavourable Fiscal Policy

It has been recognized that Government policies and programmes regarding SMEs are inappropriate, inadequate or inconsistent, which inhibit the growth and development of SMEs (Otokiti, 2002). Anyanwu (2003) also state that the SMEs sector in Nigeria has not been thriving mostly due to poor implementation of several government policies as well as frequent policy changes or what they call policy inconsistencies.

Sources of Finance to Small and Medium Enterprises

Small scale business could be financed through the following ways: Saving: Individuals save money for various motives. Individuals can directly set aside unexpended earning and save indirectly when they pay life assurance premiums or purchase amenities (Bamberger, 1983).

External Borrowing

An individual who wishes to start a business can borrow money from people or external sources to expand his business. A sole proprietor or partnership may obtain funds by borrowing from a private individual or from micro credit institution (Carland et al, 1994).

Trade Credit

The basic trade credit transaction involves the supplies handling over goods or performing a service without receiving immediate payment in exchange. The customer is expected to pay by some agreed issues.

- a. The seller would be unwise to part with goods or perform the service, unless he is satisfied that the customer will indeed pay.
- b. The terms of the transaction will include some credit period which is accepted to both parties and to which it would be to the customer advantage to adhere.
- c. There must be some sanction, which the supplier can impose on the customer if he fails to meet the agreed terms. There are three reasons for the existence of trade credit. They are convenience, cost, and loyalty. Trade credit service as a permanent source of loans to worth customers.

2.4 Problem of Small and Medium Enterprises in Nigeria

Lack of Access to Funding/Credits

When an idea is conceived, there must be fund to actualize such idea (Ogundele, 2012). A business opportunity in the course of planning must first consider capital as a basis for the establishment. This is because deficiency of fund in procuring fixed and current assets as required by the enterprises jeopardizes the operation of the business (Osuagu, 2016; Uwandu, 2012). Lack of capital therefore is a disability to the industrialist in the actualization of their objective which sometimes is attributed to the rigorous bureaucratic red-tapism involved in procuring funds from the banks and financial institution (Ogundele & Olayemi, 2015).

Government Unstable Policies

Uzoma & Uzoma (2012) Opined that there has been an instability and inconsistency in the Nation's government and policy formulations. Government policies and social attitudes affect business operation considerably. Nwaba, (2011) noted that "in a nation of relaxed economic policies and stable political system, the business community is seen to flourish more than one that lacks these qualities" He further added that government policies and laws could have such an overwhelming impact on the business arena leading to economic boom or depression. The regulation of the Central Bank of Nigeria (CBN) over banks on both fiscal and monetary policies coupled with inconsistencies of these policies determines the credit extension to the small and medium enterprises (Ogundele & Opeifa, 2014b).

Lack of Suitable Training and Leadership Development

Sule (2014) emphasized that Training institution abounds in Nigeria, but they rarely address the relevant needs of SMEs especially in the areas of accounting, marketing, information technology, technological processes and development. SMEs are left most often on their own to survive amidst the avalanche of operational difficulty inherent in the Nigeria environment as well as the operational shortcoming, which characterize institution set up to facilitate small scale enterprises businesses. Some of this organization lacks appropriate skills to operate (Nwaba, 2011)

3. Methodology

In this study, SMEs that are registered with SMEDAN in Lagos are used in determining the role of SMEs on poverty alleviation and the survey method is adopted for collection of relevant data. The study employed the ex-post facto method. For the purpose of this research, the study population refers to the entire number of employees in SMEs that are registered with SMEDAN in Lagos. For this study, the sample size is determined using Yard's formula. This formula is concerned with applying a normal approximation with a confidence level of 95% and a limit of tolerance level (error level) of 5% (Harrel, 2001).

To this extent the sample size is determined by $n = N/1 + N * e^2$

Where: n – the sample size

N – population

e – the limit of tolerance

Therefore, $n = 220/1 + 220 * 0.05^2 = 220/1 + 220 * 0.0025 = 220/1.55 = 142$ respondents

A sample size of one hundred and forty two (142) SME out of the two hundred and twenty (220) SME population of the selected SME that are registered with SMEDAN in Lagos as calculated above. All members of the population had equal chances to be chosen as part of the sample because one hundred and forty two (142) questionnaires were administered randomly to the entire employee population of the SME companies that are registered with SMEDAN in Lagos. The data was analysed using manual and electronic based methods with the

aid of data preparation grid and statistical package for the social sciences, (SPSS) statistical package version 21.0. The study made use of statistical tools which include: analysis of variance (ANOVA), correlation efficient and regression analysis in testing hypotheses where applicable (Table 1, Table 2).

Table 1. Distribution of respondents and response rate

Respondents Occupation	Questionnaire administered (sampled)	Percentage of total response (%)
Top Level	29	24.00
Middle Level	48	39.60
Lower Level	44	36.40
Total	121	100.00
Gender/Category	Questionnaire administered (sampled)	Percentage of total response (%)
Male	76	62.80
Female	45	37.20
No of Returned	121	85.21
No of not Returned	21	14.79
Total no of Questionnaires	142	100.00

Source: Field Survey 2018

Table 2. The Descriptive statistics of SMEs Development and Poverty Alleviation

Responses	Total (N)	Mean
SMEs Development And poverty alleviation		
Development of SME is hindered by competition.	121	4.66
Stock market fluctuations and economic sentiment affect development of SME	121	3.98
SME development contributes to the growth of the economy.	121	3.89
Poverty alleviation programmes has a positive effect on the current state of the nation	121	3.89
The allocation of funds to the victims of poverty eradicates poverty.	121	3.98
Training organized by SWEDAN and SMEs employment creation	Total	Mean
Convenience in attending vocational training organized by SMEDAN determines your attendance.	121	3.87
You have benefited from training organized by SMEDAN.	121	3.79
Vocational training put in place by SMEDAN empowers youth for employment	121	3.86
Employment creation is boosted by SMEDAN organized training.	121	3.88
Employment creation reduces the level of Unemployment.	121	3.89
The rate at which Employment is created reflects the rate of empowerment programmes organized by SMEDAN	121	3.90

Source: Field Survey 2018

4. Results

Hypothesis 1

H_{01} SMEs development does not affect poverty alleviation

H_{a1} SMEs development affects poverty alleviation

Table 3. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.979 ^a	0.957	0.957	0.24561

a. Predictors: (Constant), SME DEVELOPMENT

Source: Authors Computation, 2018

Table 4. ANOVA^a

	Model	Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	161.678	1	161.678	2680.186	0.000 ^b
	Residual	7.178	119	0.060	-	-
	Total	168.856	120	-	-	-

a. Dependent Variable: POVERTY ALLEVIATION

b. Predictors: (Constant), SME DEVELOPMENT

Source: Authors Computation, 2018

The results from the model summary tables above (Table 3, Table 4) revealed that the extent to which the variance in poverty alleviation can be explained by SMEs development is 95.7% i.e (R square = 0.957). The ANOVA table shows the Fcal 2680.186 at 0.0001 significance level. SME development affects poverty alleviation.

Table 5. Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.049	0.084		0.589	0.557
	SMEDEVELOPMENT	0.979	0.019	0.979	51.771	0.000

a. Dependent Variable: POVERTY ALLEVIATION

Source: Authors Computation, 2018

The coefficient table (Table 5) above shows the simple model that expresses how SMEs development affects poverty alleviation. The model is shown mathematically as follows;

$Y = a + bx$, where y is reduction in cost and x is SMEs development, a is a constant factor and b is the value of coefficient. From this table therefore, POVERTY ALLEVIATION = 0.049 + 0.979 SMEs development. This means that for every 100% change in poverty alleviation, SMEs development contributed 97.9%. The significance level below 0.01 implies a statistical confidence of above 99%. This implies that SMEs development affects poverty alleviation. Thus, the decision would be to reject the null hypothesis (H_0), and accept the alternative hypothesis (H_a).

Hypothesis 2

H_{02} Training organized by SMEDAN does not affect SMEs employment creation

H_{a2} Training organized by SMEDAN affects SMEs employment creation

Table 6. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.979 ^a	0.958	0.958	0.24385

a. Predictors: (Constant), TRAINING

Source: Authors Computation, 2018

Table 7. ANOVA^a

	Model	Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	161.674	1	161.674	2718.968	0.000 ^b
	Residual	7.076	119	0.059	-	-
	Total	168.750	120	-	-	-

a. Dependent Variable: EMPLOYMENT CREATION

b. Predictors: (Constant), TRAINING

Source: Authors Computation, 2018

The results from the model summary tables above (Table 6, Table 7) revealed that the extent to which the variance in SMEs employment creation can be explained by SMEDAN training is 95.8% i.e (R square = 0.958). The ANOVA table shows the Fcal 2718.968 at 0.0001 significance level. Training organized by SMEDAN affects SMEs employment creation.

Table 8. Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
1	(Constant)	0.144	0.082	1.747	0.083
	TRAINING	0.973	0.019	52.144	0.000

a. Dependent Variable: EMPLOYMENTCREATION

Source: Authors Computation, 2018

The coefficient table above (Table 8) shows the simple model that expresses how training organized by SMEDAN affect SMEs employment creation. The model is shown mathematically as follows;

$Y = a + bx$ where y is SMEs employment creation and x is SMEDAN training, a is a constant factor and b is the value of coefficient. From this table therefore, SMEs employment creation = $0.144 + 0.973$ SMEDAN training. This means that for every 100% change in SMEs employment creation, SMEDAN training contributed 97.3%. The significance level below 0.01 implies a statistical confidence of above 99%. This implies that training organized by SMEDAN affect SMEs employment creation. Thus, the decision would be to reject the null hypothesis (H_0), and accept the alternative hypothesis (H_a).

4.1 Empirical Findings

The general finding of this research study centered on the achievement and role of SMEs in eradicating poverty in the state.

- (1) It was discovered that the small and medium enterprises provided employment opportunities, training ground, harnesses utilization of local resources but also acts as a pillar hold of a nation, Nigeria inclusive.
- (2) More so, the problems of the industry were also identified as; managerial /technical problem ,inadequate and improper utilization of funds, commercials and infrastructural problems and instability in government policy as envisage by the various authors whose works were cited in chapter two (2)of the research studies.
- (3) Further analysis in reflected these problems as major causes of failure in the industry and more importantly in the areas of managerial capability, which encompasses the general ideality, resources and motivation within the reach of the entrepreneurs. In other words low productivity and inefficiency were attributed to poor managerial function existing in small and medium enterprises.

5. Conclusions

From the information supplied by the various related literature, regarding problem, nature, capacity and prospect of small and medium enterprises including oral interviews and information gotten from the analyzed questionnaire, it becomes clear that many variables needs the attention of the small and medium enterprises and government alike such include the provision of incentives, credit and loan facilities, provision of infrastructural facilities, promotional campaign support programme etc the impact made by these SMEs cannot be underestimated especially in the areas of providing employment opportunities and utilization of local resources. Its immense contributions in providing for the general public and basic needs of the society cannot be quantified. A good development strategy if employed by these SMEs will grow to large-scale capital intensive.

6. Recommendations

In line with the above premise of findings and conclusions drawn by the study, the following recommendation if applied effectively will serve as a means of achieving economic growth and eradicating poverty in Nigeria.

1. Firstly small and medium enterprises should source their loans from the financial institutions where interest rates are low. Entrepreneurs should insist on revolving loan scheme from government which should be interest free.
2. Secondly, government should introduce a revolving loan scheme for small and medium enterprises; she can equally set up a team to monitor the use of such loan so as to avoid its diversion. To this and Nigeria Industrial Development Bank (NIDB), Nigeria Bank of Industry (NBI) and Nigeria Agricultural and Cooperatives Bank (NACB) should gear up towards assisting the small and medium enterprises in satisfying their capital needs.
3. Thirdly, the government can jointly open a data bank with small and medium enterprises. The duty of this bank will be to furnish potentials and prospective investors with information concerning the availability of factors of production and the existing market potentials in the economy.
4. Finally, an improvement and reliability by the government on the infrastructural facilities such as accessible road and regular power supply will facilitate efficient operation of the industry; moreover, a positives thinking, concern and implementation in the development plan and policies of the government over small and medium enterprises will yield positively to the promotion of the industry.
5. The government therefore should protect the manufacturing industries by way of banning and increasing tariff on import of similar goods so as to promote our indigenous entrepreneurs. Besides, recognition of the small scale industries as a base to industrialization will assist in achieving a maximum productivity, efficiency and total independence in the near future.

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Aknowledgements

Parts of this text are spinoffs from research in the framework of the project European Union's Horizon 2020 Research and Innovation Programme projects European Cohort Development Project (ECDP) Grant Agreement No.777449 (2018-2019)



Solomon Akpoviroro KOWO

ORCID ID: <https://orcid.org/0000-0002-0504-2248>

Olusegun Adeleke Oba ADENUGA

ORCID ID: <https://orcid.org/0000-0001-5390-0318>

Olalekan Owotutu SABITU

ORCID ID: <https://orcid.org/0000-0001-9928-9534>

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PERFORMANCE OF CLUSTERS IN MOROCCO IN THE SHIFTING ECONOMIC AND INDUSTRIAL REFORMS*

Boumediene Amraoui¹, Abdesselam Ouahajjou², Salvatore Monni³, Najiba El Amrani El Idrissi⁴, Manuela Tvaronavičienė⁵

^{1,2}*Faculty of Juridical, Economic and Social Sciences of Fez, University Sidi Mohammed Ben Abdallah, Fes, Morocco*

³*Department of Economics, Roma Tre University, Via Silvio D'amico 77, Rome 00145, Italy*

⁴*Faculty of Science and Technology, University Sidi Mohamed Ben Abdellah, Fez, Morocco*

⁵*Vilnius Gediminas Technical University, Saulėtekio 11, Lt-10223 Vilnius, Lithuania*

E-mail: Corresponding author: Boumediene Amraoui, boumediene.amraoui@usmba.ac.ma

Received 3 May 2019; accepted 20 June 2019; published 30 September 2019

Abstract. The emergence of cluster policy around the world is inspired by the models of the Silicon Valley. Territorial and local development productive systems depend on the new integrated management models that are clusters. Morocco has adopted economic and industrial reforms aimed at accelerating the structural transformation of its production system by strengthening its territorial development model while adopting a cluster development policy through the National Pact for Industrial Emergence, but the performance of these clusters is questionable because they are in the genesis stage and must overcome social, managerial, financial and administrative obstacles and lack of public and private sector partnerships and insufficient innovative collaborative projects. This raises the question of measuring the dynamics and performance of a clusters and the problem of evaluating the economic development of a region. In this study, we intend to conduct review of Moroccan clusters and diagnose their performance in the context economic and industrial moving.

**This research was supported by the projects, which have received funding from the European Union: International Research Staff Exchange Scheme (IRSES) FP7-PEOPLE-2012-IRSES, Grant Agreement Number 319017 SHuMED and ES H2020-MSCA-RISE-2014 CLUSDEV MED Grant Agreement Number 645730730*



European Research Council

Established by the European Commission

Keywords: The Moroccan industrial strategies; economic reforms and industrial development; development of clusters; the performance of clusters

Reference to this paper should be made as follows: Amraoui, B.; Ouhajjou, A.; Monni, S.; El Amrani El Idrissi, N.; Tvaronavičienė, M. 2019. Performance of clusters in Morocco in the shifting economic and industrial reforms, *Insights into Regional Development* 1(3): 227-243. [https://doi.org/10.9770/ird.2019.1.3\(4\)](https://doi.org/10.9770/ird.2019.1.3(4))

JEL Classification: O55

1. Introduction

Conventional factors of territorial development such as proximity to natural resources, production units and skilled population are not currently able to ensure sustainable industrial growth (Porter, 1990). This is due to the fact that the mechanisms of local development do not correspond to territorial productive systems, which are considered by the majority of researchers and decision-makers to be self-evident (Torre, Zimmermann, 2015). To achieve an advantageous competitive capacity there is currently a trend towards integrated management systems, namely clusters. The latter group companies into more innovative and competitive “clusters” (Porter, 1998). The countries of the North quickly placed these clusters in their industrial policies (Pommier, 2014).

Porter (1990) firstly has defined the cluster as a geographic concentration of interconnected firms, suppliers, service providers, related industry firms and associated institutions (universities, standardization agencies or professional organizations) that compete and cooperate. In a second time Porter (1998) emphasized the capacity of creation and innovation of clusters via the division of labour between companies having regional proximity. According to Delgado et al. (2014) clusters are geographical concentrations of industries linked by knowledge, skills, inputs, demand and/or other links. According to E. Gallié et al. (2014), the emergence of cluster policy around the world is inspired by the models of the Silicon Valley cited by Porter (1990, 1998) and other researches show their beneficial effects on economic efficiency of the firms and territories on which they are located. Industrial clusters act as instruments to reinforce the innovation capacities of companies (Tvaronavičienė et al., 2015; Monni et al., 2017; Zemlickiene et al., 2017; Žižka et al., 2018; Petrenko et al., 2019).

According to P. Parto (2008) a cluster is a group of interdependent companies that innovate and generate economic growth. A fundamental element of clustering is the synergy created by complementarities and the dissemination of knowledge among cluster members. These synergies can be called collective efficiency (Carpinetti et al., 2007; Yang, Černevičiūtė, 2017; Tvaronavičienė, Razminienė, 2017).

The success of a cluster is positively influenced by the variety and complementarity of the activities of the firms (Staber, 2001). For E. Callegati, S. Grandi (2007), the dynamics of cluster require a combination of competition and cooperation between companies, on the one hand competition as a powerful incentive for innovation and increased efficiency, and on the other hand cooperation that promotes the spread of knowledge and the overall attractiveness of the system.

Before integrating cluster structures as a means of territorial development, Morocco has established economic social reforms: National Initiative for Human Development (NIHD), Green Morocco Plan, National Pact for Industrial Emergence Industrial Acceleration Plan (IAP) aimed at accelerating the structural transformation of its productive system and making it more competitive. (Ministry of Economy and Finance of Morocco, 2018)

In addition, the competitiveness of the Moroccan industrial sector is confronted with several entrepreneurial and technological constraints, particularly in the case of SMEs (eng. Small and medium-sized enterprises) which represent 94% of the Moroccan industrial fabric, the measures envisaged in the framework of the Industrial

Acceleration Plan should nevertheless, unleashing the potential of the Moroccan industrial sector and turning it into a real lever for structural transformation of the Moroccan economy. The Industrial Acceleration Plan (IAP) and the “clusters”, expressions of a spatial anatomy testifying to the new dynamism of this cosmopolitan country (Eddellani et al., 2019). In this respect, as early as the 2000s, Morocco entered for the first time into cluster development policy through the National Pact for Industrial Emergence (fr. Pacte National pour l’Emergence Industrielle). Today, Morocco's cluster program includes the “Morocco Innovation Strategy”, which aims to improve R&D and promote innovation. The aim was to develop 15 national clusters from 2009. The objective is to reinforce the coherence of its development model and make it more inclusive, especially at the territorial level by placing the regions of the Kingdom in the rank of development actors and prepare a space for wealth creation and emergence of competitive specialization profiles. Additionally, Morocco actively pursues an industrial policy plan (fr. Plan d’Accélération Industrielle) until 2020 which includes the development of cluster organisations and cluster policy. The program clustering combines a top-down and bottom-up approach: public support and at the same time launching a competition between clusters. Other cluster organizations are promoted by other stakeholders such as the solar cluster or the industrial sector of environmental services (CISE). The development of the attractiveness of the twelve regions of Morocco for industrial investments should promote a distribution more equitable and sustainable wealth at the national level (Ministry of Economy and Finance of Morocco, 2018).

The question about the effectiveness of clusters was discussed in a context of comparative study in Europe the existence of two ideal-typical models Gallié et al. (2014). Cluster approaches and methods of analysis (Tvaronavičienė et al., 2015). Cluster effectiveness through comparative analysis (Tvaronavičienė et al., 2015) and clusters to local industrial ecosystems (Torre, Zimmermann, 2015).

In Morocco, the emergence of clusters created new forms of regionalised production as a special Moroccan model in the gestation (Eddellani et al., 2019), which tends towards a specific Maghrebian model (Pommier, 2014) and is characterized by the emergence of a new territorial industrial policy (Rajae A, 2016), a tourism cluster in Morocco (Porter et al., 2008) and to what extent these Moroccan clusters are performing well (El Waatmani, Makhtari, 2019).

This study aims to detect indicators for evaluation performance of Moroccan clusters and highlight the economic impact on their host territories. This raises the question of measuring the dynamics and performance of a cluster in innovation and the problem of evaluating the economic development of a region. In this study, we intend to conduct an environmental scan of Moroccan clusters and diagnose their performance in the moving of economic and industrial context. This article is divided into four sections: 1) economic reforms and industrial development; 2) elaboration of the three Moroccan industrial strategies; 3) cluster development in Morocco; 4) the performance of clusters and their impacts on regional development.

2. Economic reforms and industrial development

Morocco undertook economic and industrial reforms through the privatization program in 1993 followed by structural reforms in 1995 with the aim of strengthening the economy, guiding industrial development and boosting the country's competitiveness. According to the Office of the High Commission for Planning (HCP) (2009) the reforms have mainly affected the liberalization of foreign trade, the deregulation of prices, the opening of the national economy to foreign investors, the modernization of the tax system, the restructuring of state-owned enterprises and modernization of the capital market. It was signed more than 30 sectoral program contracts at the national level, 16 regional plan contracts under the Green Morocco Plan, more than 15 delegated management contracts and 28 cities contracted delegated management contracts. In addition to the creation of institutions of mixed economy and institutions with a funding role such as the Hassan II Fund for Economic and Social Development (2000). In the role of promoting investment in the economic and social sectors, the Agency of Agricultural Development (ADA), public institution, its role implementing the Green Morocco Plan, Deposit

Caisse and Management of Morocco (Caisse de Dépôt et de gestion du Maroc) (CDG), the National Company of Motorways of Morocco (ADM), Holding Company Al Omrane and subsidiaries, National Agency for the Promotion of Small and Medium Enterprise (ANPME): Instituted to contribute to the development and upgrading of the company. Regarding the regional development poles, three development agencies have been created: the Agency for the Development of the Southern Provinces (2002), the Agency for the Development of the Provinces of the Oriental (2006) and the Agency for the Development of Northern Provinces (1996) plus 16 Regional Investment Centre's (RICs). In addition, the Moroccan economy has undergone a structural change, with economic growth rising from 3,8% between 1999-2003 to 4,8% between 2004 and 2008. This new level of growth was due to the structural transformation of the productive fabric (service activities), the share of tertiary activities in total real value added increased from 52,1% to 56,4% between 1998 and 2008, while secondary activities experienced a virtual stagnation of their weight in the total real value added to 27,5% in 2008 after 27,7% in 1998. The value added of the primary sector (agriculture and fisheries), it decreased by 20,2% of the GDP in 1998 to 16,1% in 2008. This economic growth is due to reforms affecting all sectors, industry, agriculture, PTB and trade and each sector has its part of GDP contribution as shown in Table 1 below.

Table 1. The distribution of GDP by sectors.

Distribution of GDP by sector of activity (in%)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Agriculture and fishing	17,5	15,5	13,3	14,7	14,7	15,5	14,7	13,2	15,2	12,2	13,2	13,5	14,0	13,0	13,5	13,0	14,8	14,0	14,5
Industry, Energy and Mines	20,8	21,3	21,3	19,6	19,4	19,9	19,9	19,4	18,7	18,1	21,7	20,5	19	19,5	20	20,5	19	19,5	19,5
Construction (BTP)	3,8	3,7	4,5	4,9	4,9	5,1	5,7	6,0	5,7	6,0	5,6	5,8	5,6	5,5	5,5	5,5	5,4	5,2	5,0
Services	50,4	52,5	54,2	54,0	54,1	53,2	53,8	55,6	54,6	53,5	51,2	51,5	51,0	52,4	53,5	51,59	51,7	49,7	50,1

Source: High Commission for Planning (HCP) (2009)

Indeed, we analyse both (Table 1) Note that, during the period 2002-2016 the share of the industry to the contribution in GDP is on average of 18%. The agriculture was 13,4%, a regression of 3,2% compared to the decade previous, the share of trade in GDP, it amounted to 9,85% and the share of the construction sector in GDP, it reached 5,77% with an increase of 1,8%. The 2000s were marked by a gradual transformation of the Moroccan industry into traditional sectors, new emerging specializations in this case the automotive and aerospace industries.

This structural change is perceptible on the basis of three important variables namely exports, decent employment and foreign direct investment (FDI): Exports of the world trades in Morocco (WTM) reached, in fact, nearly 119 billion dirhams (11 010 571 925,50 Euro) in 2014 against nearly 75.5 billion dirhams (6 987 181 052,20 Euro) in 2008, which corresponds to an additional of more than 44 billion dirhams (4 071 999 553,60 Euro). This dynamic was mainly driven by the outstanding performance of the automotive sector (an average annual growth of 22% between 2008 and 2014), aeronautics (an average annual growth of 13% against + 5% for and + 4,5% for electronics). Positive evolution of the technological content of exports of manufactured products with high and medium high technology. Their part has significantly increased in recent years to 47% in 2013 against 31% in 2003 converging gradually to the global average of 56,8% over the period 2009-2012. This trend is mainly due to the increase in exports of vehicles, electrical appliances.

Similarly, the contribution to skilled employment marks this modernization, with average annual growth rates of 16%, 14% and 9% respectively for the automotive, aeronautics and electronics sectors between 2008 and 2012. These performances, however, contrast with the structural decline in formal employment in the textile and clothing industry. The analysis of the structure of the FDI shows a shift towards the industrial activities which occupied during the 2012-2014 period the first place with an average share of 30% to the detriment of the traditionally dominant activities like the real estate and the tourism (Ministry of Economy and Finance of Morocco, 2015).

In this movement of sectoral and structural reforms, whose public authorities are committed to ensuring a strong, sustainable and wealth-generating economic growth, have emerged the strategy of public-private partnership and the three industrial strategies: The (Morocco 2020 emergence plan) in 2005, the (national pact for industrial emergence) in 2009, and the (industrial acceleration plan) in 2014 (Ministry of Industry, Trade, Investment and Digital Economy of Morocco, 2016).

3. Elaboration of the three Moroccan industrial strategies

3.1. Morocco 2020 Industrial Emergence Plan

The Morocco 2020 Industrial Emergence Plan is a program to amplify Morocco's industrial development strategy through a public-private partnership (Ministry of Foreign Affairs and International Cooperation, 2019). This program, launched on December 21, 2005, creates a development framework encompassing all industrial activities, including business activities. Offshoring, this plan aims to create 440000 jobs, thereby increasing gross domestic product (GDP) by 1.6 points per year.

The objective is to strengthen the competitiveness of the industrial sector, the Emergence plan was based on three main ideas: focus industrial recovery efforts on the sectors for which Morocco has competitive advantages designated “World Trades of Morocco”, in particular, Offshoring, automotive, aeronautics and space, textiles and leather, electronics and food processing, through dedicated development programs; four major Transversal Works, divided into a project to strengthen the competitiveness of SMEs, an improvement of the business climate, a training project and a development plan for new generation industrial parks, called “P2I - Integrated Industrial Platforms”; The establishment of an institutional organization capable of allowing the effective and efficient implementation of programs.

3.2. The National Pact for Industrial Emergence (PNEI)

The National Pesticide for Industrial Emergence (PNEI) is a program contract spanning the period 2009-2015. The program aimed to create 220,000 jobs by increasing industrial GDP by DH 50 billion and generating an additional export volume of DH 95 billion. This pact also provided for 50 billion private investments in industrial activity. It required funds in the order of 12.4 billion DH, of which 34% were dedicated to training and human resources and 24% to investment incentives. The National Pact for Industrial Emergence aims to build a competitive and productive industry, it focuses on the World Trades of Morocco (MMM): automotive, aeronautics, electronics, Offshoring, textile and agribusiness. The latter are divided into two categories: Foreign Direct Investments (FDI) oriented trades This category includes Offshoring, Automotive, Aeronautics and Electronics. These businesses will benefit, as part of this program, from the creation of 22 integrated industrial platforms (P2I) which are reception sites for investors. Regarding the second category of MMM, it is represented by the traditional trades namely: the textile-leather and agro-food sector. For the textile-leather sector, the state provides support for international marketing. At the same time, dedicated logistics areas will be created and tariff reforms will be put in place. Agribusiness is not left out, since the State will encourage investment in value-added

sectors (citrus fruits and olive oil for example) and will support the best players in consumer products (confectionery, biscuits among others). The State will also promote integrated projects in basic commodities such as milk and meat for example. In 2012, the industry drained nearly 8 billion dirhams of foreign direct investment (FDI), or 26 percent of total FDI, which puts the sector at the forefront. Industrial GDP, meanwhile, increased by 28.4 billion dirhams between 2008 and 2011. More than 100,000 jobs were created in the global businesses of Morocco between 2009 and 2012. During the same period, the exports of the automotive sector increased by more than 125% while those of the aeronautical industry recorded an increase of 60% (MEF, 2013).

3.3. Industrial acceleration plan

The regression of the part of industrial GDP in the national GDP from 16.62% in 2003 to 14.57% in 2012 a decline accompanied, of course, a loss of industrial jobs as well as a decline in industrial exports, symptomatic of a loss speed in terms of competitiveness and an alarming deindustrialisation. The Industrial Acceleration Plan aims to increase the share of industrial GDP in the national GDP from 14% to 23% by 2020 as well as the creation of 500,000 jobs over the next ten years. This plan was accompanied by the creation of an Industrial Investment Fund (FDI) with a budget envelope of 20 billion dirhams (approximately 1.835.000.000,00 Eur) over 7 years. FDI grants and subsidies will be conditional on employment generated, value creation and export volumes. The plan also plans to support the productive actors who move in the dark to the formal, by creating the status of the self-entrepreneur and the support to VSEs through an appropriate tax and other measures to facilitate its integration in the economic fabric. Another measure put in place by the Industrial Acceleration Plan is the development of industrial ecosystems following the logic of "industrial development-territorial competitiveness" which was introduced with the first P2I. The aim is to reduce the fragmentation of the industrial sector, build a more integrated and less fragmented industrial fabric, while allowing SMEs to benefit from strategic alliances with large companies through economic interest groups. Economic interest groupings are gatherings of companies, particularly SMEs, around a large company (national business leaders, professional associations or foreign investors) which will serve as a driving force in a given sector.

3.4. The context of creation of Integrated Industrial Platforms (P2I)

The country's farming and industrial policies are designed to target the European market. In terms of cooperation, four strategic sectors have been identified: agro-food, textile, ICT and electronics, as well as renewable energies (Šimelytė, A. Et al, 2016). Integrated Industrial Platforms (P2I) are the result of a desire to develop the World Trade of Morocco (WTM) is an integrated vision of territorial development and the national economy, the P2I allows the industrial upgrading of the country by the involvement of the public and private sector, as is the case for the PNEI in general. The value proposition of P2I to investors revolves around the following dimensions: 1) real estate offer: rental / sale of raw surfaces or ready-to-use buildings at competitive prices; 2) offer of service on area: meeting the main needs of investors and their employees (general services, operating, business, etc.); 3) one-stop administrative: grouping the key services of the State for investors; 4) zone training offer creation of a specialized institute of training or a public training center, adapted logistics offer. Optimal logistic connectivity of the area to the main national transport axes and offer of logistics services on an integrated zone, living environment and integration to the city, selection of well positioned and connected land public transport networks.

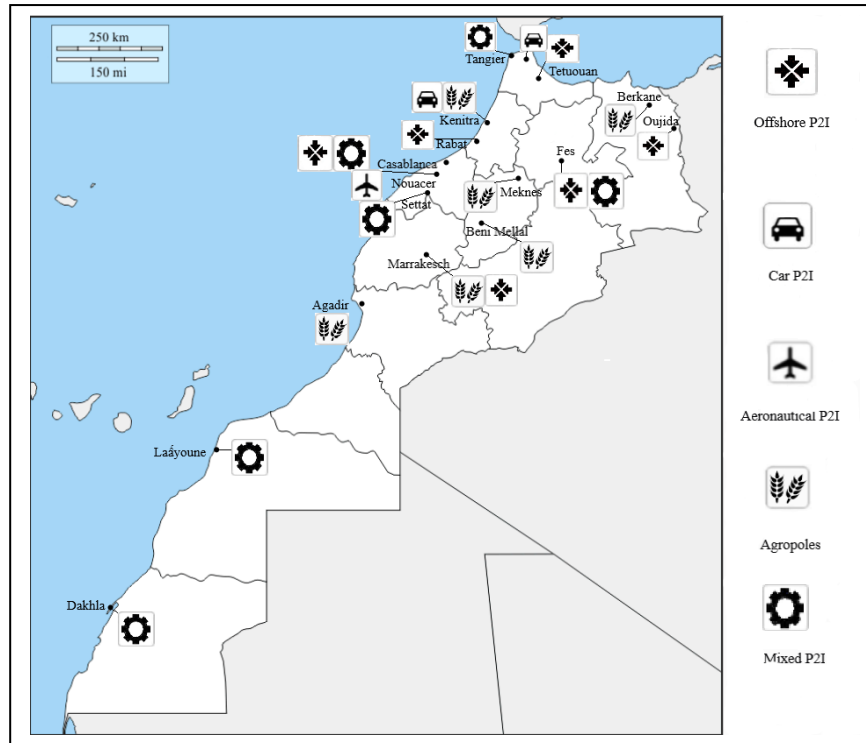


Figure 1. Integrated industrial platforms for geographical distribution
Source: The Ministry of Industry, Trade, Investment and Digital Economy (2016)

Technopole of Oujda: the project of the Oujda Technopole, the first P2I launched under the program-contract, is a project specifically dedicated to the activities of manufacturing renewable energy equipment and aimed at developing a Morocco offer for solar-related activities, wind energy and energy efficiency. MEDZ, pursuing its mission of privileged partner of the public authorities for the territorial development, is in charge of the realization of this project within the framework of a partnership with the Ministry of Finance, the Ministry of Industry, the Ministry of the Energy, the Ministry of National Education, the Wilaya, the Oriental Region, the Agency of Oriental and ONDA.

Atlantic Free Zone (AFZ): AFZ, the first sectoral P2I targeting mainly the automotive sector, enjoys a strategic position, between two important economic centers, Casablanca and Tangiers. Indeed, the project spread over 345 hectares, is located 12 km east of the city of Kenitra (Gharb Chrarda Bni Hssen) and enjoys excellent connectivity (rail, air and highway). The figure 1 shown the integrated industrial platforms.

The industrial sector, the second largest employer at the national level as shown in figure 2 below, employs 12.7% of the labor force. Trade and "general administration and social services provided to the community" occupy respectively 12.5% and 10.2% of this population. This sectoral distribution, maintained since 2000, reflects the sectoral stability of employment at national level (Ministry of Economy and Finance in Morocco DEPF, 2009). In addition, the agriculture, fishing and forestry sector is the main source of activity with 42.1% of the labor force. In the industrial sector, the dominant sectors are textile-clothing (Tangier, Casablanca, Guercif and Taza), mechanical and electrical subcontracting (Casablanca) and information and communication technologies. The textile-clothing industry has some advantages.

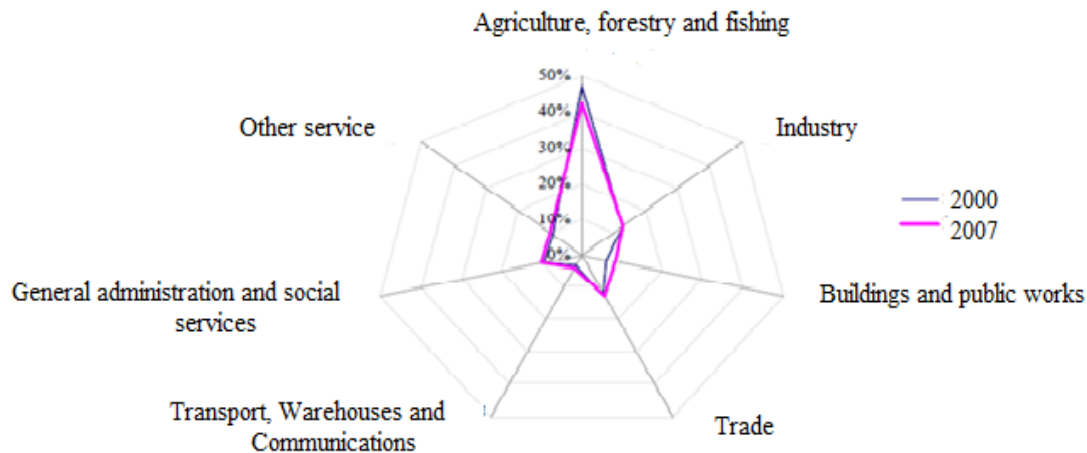


Figure 2. Evolution of the employment structure by branch of economic activity.

Source: The Ministry of Economy and Finance of Morocco (2008)

In fact, SMEs and SMIs represent more than 85% of the industrial fabric of the sector (Bakala, 2017). In the Fez-Meknes region, it is the leather, brassware and tourism sectors in the Ziz valley. A study by the Directorate of Studies and Financial Forecasts (DEPF) converged on the same observation, namely a high concentration of industrial employment in labor-intensive industries such as the clothing industry (32%) and the food industries (16%) (Pommier, 2014).

4. Emergence and development of clusters in Morocco

The globalization of economies and the restructuring of the industrial sector have made it possible to strengthen the presence of SMEs / SMIs internationally as a guarantee of competitiveness, innovation and flexibility-flexibility. A requirement also for Morocco especially that its productive fabric is 93% of the SME / SMI, in addition the application of the networking between the intelligent territories, such a process generates the inter connectivity between local productive system SPL and clusters sheltering clusters of flexible entities pooling the risks and costs of strategic operations (Bouayad et al, 2008). Cluster-type organizations are well-rooted in the Moroccan economy, with many small-scale enterprises and small farms having joined together in the form of cooperatives from 1937 to bring together production and joint processing of products. The form, purpose and level of support of the state have varied over time. Although they cannot be considered as “innovation clusters”, cooperatives are an ever-active and relevant traditional form of clusters, which constitute high-value chains. The first analyses made on clusters go back to the beginning of the 2000s by the Directorate of Spatial Planning, which is responsible for the National Spatial Planning Scheme. Conducted by French and Moroccan academics,

statistical work and field surveys on Localized Production Systems or SPL have identified about fifty agglomerations of specialized institutions totalling 35% of Moroccan manufacturing employment (P. Pommier, 2014). Since the 2000s, Morocco has adopted a policy of creating clusters, the state of which engages with local actors through consultation. The policy pursued by the government aims, in fact, to encourage projects to promote the agglomeration and the cooperation of the companies in several sectors and the reinforcement of the links with the local institutions as well private as public in particular, in the fields of formation and research, etc. This policy of local synergies and exchange of knowledge is at the heart of the policy of clusters proposed by the public authorities. The objective is to provide cluster companies with assistance for their joint activities and to create a global environment conducive to their development and competitiveness. Cluster development policy, which Morocco is committed to through the National Pact for Industrial emergence aimed to develop 15 national cluster initiatives in 2009.

The Moroccan cluster program (2009) now includes the “Morocco Innovation Strategy” program, which aims to improve research and development (R&D) and promote innovation by targeting triple helix agents. Since 2009, the Maroc Innovation initiative has been aiming to create more than 200 innovative start-ups until 2014, and to register a thousand Moroccan patents. The Cluster program combines a top-down and bottom-up approach: public support and at the same time launching a competition between Clusters. Other cluster organizations are promoted by other stakeholders such as the Solar Cluster or the Industrial Services Industry Cluster (CISE). In addition, Morocco is actively pursuing an industrial policy plan (“Industrial Acceleration Plan”) until 2020, which includes the development of cluster organizations and their policies. In this respect, Morocco has developed the strategy for the installation of Integrated Industrial Platforms (P2I) and Techno poles, as well as a strategy to support and label Clusters in order to create ecosystems. This economic recovery aims to develop modes of cooperation within the territories and in sectors with high potential for innovation, allow the diffusion of positive externalities and technological overflows (Ministry of Industry, Trade, Investment and Digital Economy, 2016).

4.1 Characteristics of clusters in Morocco

Clusters in Morocco is defined as an association constituted in accordance with Dahir No. 1-58-376 dated (November 15, 1958) as it has been completed and amended, whose members are enterprises, institutions and research center or training and institutions, operating in the industrial and technological sectors, with a common development strategy and whose statutory purpose is to stimulate the emergence of innovative collaborative projects. In addition to these traditional clusters, the Moroccan state has allowed the emergence of clusters in industrial value chains. Moroccan clusters have recently emerged on the basis of a double impulse. On the one hand, the impetus for industrial policy of grouping companies from the same sector in the same territory, either through the development of technology parks or designated free zones, has enabled Moroccan industries to same sector to regroup. This impetus was complemented by a policy led by the Ministry of Finance and titled “Moroccan Innovation” in 2009 (European cluster collaboration platform.eu, 2019). This strategy, which aimed to stimulate innovation and competitiveness, aimed specifically at creating clusters and providing public funding for this effect.

As a result, clusters in Morocco come in three different forms:

1) Agricultural / craft cooperatives: cluster initiatives, built on a model comparable to certain European clusters, an association of companies, the public sector and academics who join forces to collaborate and innovate;

2) Agropoles and Technoparc bring together industries from the same sectors in the same territory, as well as research institutes in order to foster innovation and increase the region's specialization for increased competitiveness and attractiveness:

- Agro-pôle Olivier - olives and olive oil cluster. Technology transfer and providing accessibility of international achievements for contributing to the upgrade and development of the olive sector;
- Agrinnov is a cluster gathering the agro-food stakeholder of Morocco;

- Agrotech SMD is platform for exchange and cooperation between regional and national institutions regarding agriculture;
 - Agadir Haliopôle located in a fishing area, the cluster encourage R&D to improve to products and boosts exports. The cluster has received a Bronze ECSA label in 2014;
 - Casa Technopark was launched in 2001 on the city of Casablanca. Rabat duplicated the model in 2012. Technopark Casa is a community of innovation constantly hosting more than 230 companies (Casablanca & Rabat) in the sectors ICT and “green tech” with more than 60 new starts-up every year;
 - CasaNearShore Park is a service offering office spaces and other infrastructure and assistance services to companies specialising in software development, infrastructure management, back office banking, insurance services, and customer relationship management; supporting offshoring of international enterprises;
 - Parc Technopolis with an area of 300 hectares, addressing investments and projects related to new technology sectors;
 - Fès Shore is dedicated to developing new economic potential of the region in the field of offshoring.
- 3) CleanTech cluster benefiting from the status of free zone, focused on the development mainly in the solar, wind and energy efficiency sectors.

The National Pact for Industrial emergence aimed to develop 15 national cluster initiatives in 2009, but the number of clusters labeled at the end of 2016 are 11 clusters whose target for 2020 is 20 clusters. In the table 2 regrouping different Moroccan clusters operating in different sectors and specialization (Table 2).

Table 2. Grouping different Moroccan clusters

Cluster/ year of creation	Sector	Specialisation	Members of clusters	Region
Mechanical Mechatronic Electronics of Mohammedia (CE3M) / December 2010	Electronics and Mechatronics	On-board electronic systems, energy conversion systems, mechatronic systems.	CE3M is the result of the evolution of enterprise group GE3M which was formed in 2006 on the initiative of companies such as A2S Industries, SOFMAG and some other French companies from the Valley of the Arve, Lyon or Besançon. 40 members: 32 SMEs; college of multinationals companies: Thales, ST Microelectronics, ADETEL Morocco, Moroccan Railways, sub-contracting SMEs; research centres; five engineering schools, a technical center (CETIM).	Mohammedia-Casablanca
Morocco Numeric Cluster / November 2010	ICT	Mobile services, security, electronic banking, digital rights; multimedia packages.	Ministry of Industry Trade and New Technologies: ASTEC; AUSIM; APEBI; CGEM; SoftCenter; Al Jisr, MITC; GreenTic, Technopolis; University Mohammed V of Rabat; Hassan II University of Casablanca; University Ibn Tofail of Kenitra; University Hassan 1 st in Settat; University Sidi Mohamed Ben Abdellah of Fes; CNRST; ENSA; EMSI; ENSEM; INPT.	TechnoPark in Casablanca
Morocco Microelectronics Cluster (MMC) 2010	Microelectronic	Embedded systems, integrated circuit and optoelectronic design	Companies: ST-Ericsson; Mentor Graphics; Nemotek; Mascir-Micro; Mu Electronics; Valtronic; ADETEL Group; ATC and Lear Corporation; Training and research organizations: Mascir, INPT, EMI, FSR-UM5A, UIR, EMSI, ENSIAS and USMBA; Institutions: Technopolis; Ministry of Industry and CNRST.	Technology park, Rabat

Cluster/ year of creation	Sector	Specialisation	Members of clusters	Region
Ocean Opole Tan-Tan 2010	Seafood products	Marine Resource Development: fisheries, aquaculture, renewable energy, shipyard	Large companies: SOVAPEC – flour, fish, oil; OUCHARRA group – industries: ASAT- canneries, Moroccan Omnium Fishing Fleet- deep-sea fishing; Moroccan Omnium of Fishing. Industries: PHIASUD - offshore fishing, African Shipyard. SME: a dozen in the fish product processing business. Training and research organisations: IBN ZOHR University, National Institute of Fisheries Research; Institute of Marine Fishing Technologies. Institutional: local authorities (Guelmim Es-Smara Region and Tan Tan/El Ouatia Municipalities). Trade unions involved in fishing and port activities.	Tan-Tan region
Pôle Agadir Haliopôle 2012	Seafood products	Fishing and seafood processing	37 companies and Study and Research Laboratories, Institutions and Communities and Professional Associations and Federations.	Agadir region, Souss Massa Drâa region
“Menara” Marrakech Exclusivity Network for Advanced Research in Art’s Living 2012	Food-processing and cosmetic	Luxury Products, Food and Cosmetics	Total 32 members: 24 enterprises, more than 1300 researchers represented by cluster; Marrakech Private University, Centre Traditional Arts.	Marrakech
Construction Materials Energy Efficiency Cluster (EMC) 2014	Eco - constructions	energy efficiency of building materials	The Board of Directors of the cluster includes public and private operators, including the Al Omrane group, Hassan I University, Orobrique, Lafarge Calnicor Maroc, Bureau Veritas and Multicerame etc.	Casablanca
Moroccan Technical Textiles Cluster (C2TM) 2013	Textile	Textile technique	A dozen founding members (ALIALEX, BLANCATEX, HIKMATEX, ICOMA, MAFACO, MAZAFIL, MODALINE, PIF, SOMAFI, TEXTCOM, WAKLIM ENGINEERING ...); it also remains open to other companies. AMITH, ESITH, Casa Moda Academy, CTTH and Hassan II University are the support, research and training organizations.	Casablanca
Moroccan Denim Cluster (MDC) 2014	Textile	Textile, jeans, casual wear	Created by seven companies in the sector that will be joined by other members. Open to the rest of the professionals. In addition to these companies, the administrators are the Higher School of Textile and Clothing Industries (ESITH), the Technical Center for Textiles and Clothing (CTTH) and the AMITH.	Casablanca
Casablanca Home Textile Cluster (CHTS) 2016	Textile	House textile	120 companies, accounting for 70% of the national production and employing 22,000 people. The cluster is supported by the European Union, the Italian Agency for Development Cooperation, the Union for the Mediterranean and the United Nations Industrial Development Organisation (UNIDO). On the Moroccan side, the cluster is supported by powerful corporations, including the AMITH as well as public institutions (Maroc PME, Maroc Export), and training institutions.	Casablanca
Industrial Cluster for Environmental Services (CISE) 2016	Industry	Development of the industrial sector of environmental services	35 members: 6 SME (5 start-ups among SME); 6 larger companies; 7 research organisations, universities, technology centres.	Casablanca
Solar cluster 2017	Solar Energy	Industrial activities related to solar energy; solar technologies	25 founding members: MASEN; ONEE; ADEREE; SIE; Mascir; MedZ; FENELEC; FIMME; FMCI; FMC; FNBTP; Centrelec; Temasol; Cleanergy; Nrj International; AIC Métallurgie; DLM; Morocco	Casablanca

Cluster/ year of creation	Sector	Specialisation	Members of clusters	Region
			Workshop; LSA Industries; ADI; Cegelec; Ciments du Maroc; Cadi Ayad University; Rabat International University and CERIMME and fourteen other members of the Board of Directors including FENELEC and FIMME, five business colleges and two colleges of educational organizations, higher education, vocational training and research.	
Aerospace Moroccan Cluster (AMC) 2011	Aerospace	Aerospace industry	105 international companies: Anchor companies; Safran; EADS; Bombardier & Boeing; Aerotechnic industries; UTC Aerospace systems; Royal Air Maroc; Air France AIRBUS, Snecma Morocco Engine services.	Casablanca

Source: prepared by authors

Four strategic sectors, presenting attractive clusters, in the context of EU-Morocco cluster cooperation were identified: the agro-food industry; textile; ICT and electronics; renewable energies.

The agro-food sector is the sector in which the most diverse types of clusters can be found: small-scale farming cooperatives; two clusters; two acropoles.

5. Innovation performance of clusters and their impacts on regional development.

Cluster performance in innovation is a fundamental part of their existence in the literature. Several authors have shown the importance of performance measurement systems. According to L. C. R Carpinetti et al. (2007), the system for measuring the performance of a cluster is composed of the following four categories:

- 1) economic and social outcomes: economic growth, gross product and employment as the main indicator of the size of the cluster (Smith et al., 2006);
- 2) business performance: growth and competitiveness (productivity, costs, benefits ...), triggered by easier access to valuable resources and services;
- 3) collective efficiency: cooperation actions, including innovations and spin-offs;
- 4) social capital: cultural values such as trust and cooperation.

The indicators for measuring the performance of a cluster according S. Chalaye, N. Massard (2009) are: the position of firms in the cluster vis-à-vis global competition (global market penetration capacity, market share), the number of common projects, the replacement rate of failing firms, the level of exports of members. Cluster performance measures can also be performed across the number of firms in a given location (Krugman, 2012). According to S. Chalaye, N. Massard (2009), the determinants of the clusters are a structural nature of the functioning of the cluster (economic, geographical or governance order), the determinants linked to the potential of R&D, the capacity of the cluster to transform these resources into innovations, the positioning of the cluster in terms of sectors and markets, the level of cluster connectivity, and the cluster environment.

Moreover, some authors argue, the life cycle of clusters depends on four phases of development in the emergence of the cluster: diffusion; commercialization and decline of a technology; the development cycle of the industry (Favoreu et al., 2008).

The Morocco Microelectronics Cluster (MMC) uses the following indicators: networking and partnerships: number of partnerships signed, number of cooperation protocols signed, number of network events, number of joint R&D, innovation and technology transfer activities (El malki, 2012). In this respect, according to a study carried out on six Moroccan clusters, with different activities, the number of labelled cluster companies is 252 companies, or an average of 39 enterprises per cluster. SMEs represent 66.37% of these companies: large

companies = 2 SMEs. In cluster 2, SMEs account for 91.48%. Half of the six clusters are home to fewer than 30 companies the other three clusters have more than 70% of the business population of all clusters (El Waatmani, Makhtari, 2019), see Table 3.

Table 3. Number of companies by cluster.

Number of companies by cluster	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
SMEs	30	43	10	45	17	9
Large companies	20	4	10	20	10	14
Total companies	50	47	20	65	27	23

Source: author based on A. El Waatmani, M. Makhtari (2019).

The entrepreneurial performance of clusters is measured by the number of start-ups created within the clusters, the total number of start-ups amounts to 60 start-ups on average 10 start-ups per cluster, which proves that the development of start-ups depends on the investment cost. In addition, innovative collaborative projects are an important indicator, since the presence of educational and research institutions is the cornerstone of innovation, there are 127 innovative collaborative projects on average of 21 projects per cluster. As a consequence, there are 25 patents filed by the six clusters studied an average of 4 patents per cluster (El Waatmani, Makhtari, 2019).

In addition, public authorities launch calls for projects from clusters, operating in the industrial and / or technological sectors, carrying a significant development strategy for their sectors and for which innovation is a central factor in competitiveness. Innovation and R&D, which puts the clusters into question, the difficulties they face vis-à-vis the objectives drawn by the public authorities at the level of the policy of support for clusters and the strategies traced "Maroc innovation" the creation of start-ups and patent filings. The performance of clusters depends on several factors: the sector in which it operates (ICT) or textile, the degree of dynamism of the cluster's leadership team, the governance within the cluster, the human resources in charge of management of clusters and their managerial capacities. The Moroccan Court of Auditors (2014) conducted an evaluation of the "Maroc Numeric 2013: MN2013" strategy concerning its governance and management and the assessment of the achievement of the objectives of the strategy through the analysis of its indicators and indicators. International ICTs. The report was organized around different themes: social transformation, implementation of user-oriented public services, computerization of SMEs, development of the ICT industry. Strategies accompanied by actions for the development of human capital and digital trust. According to the Court, most of the objectives have not been met and far from it with achievement rates ranging from only 10% to 50%. Among other things, only 10% of the 3,000 pilot SMEs that need to be computerized in the context of the Moussanada IT program have actually been computerized (Moroccan Court of Auditors, 2014).

In general, research and innovation in Morocco is poorly structured and lacks homogeneity between the various stakeholders (Universities, National Center for Scientific and Technical Research (CNRST) and specific entities corresponding to a given sector (National Institute of Agronomic Research (INRA), National Institute of Posts and Telecommunication (INPT), etc.) According to the Economic, Social and Environmental Council or (CESE) report (2014), the low budgets allocated to research and innovation, which went from 0.4% of GDP in 1999 to 0.8% of GDP in 2013, show that the system suffers from a weakness in scientific production. With a global share of Morocco of 0.12% in 2010, the national private productive sector considers itself to be self-employed in terms of applied research and innovation and is rarely organized or structured: between 2009 and 2010. In a sample of 300 Moroccan companies, only 23% of them reported having an R&D and innovation activity, and the number of national patents per million inhabitants improved from 152 in 2010 to 353 in 2014. The number of patents filed with foreign participants was 855 in 2010 and 743 in 2014. By region, the figures show the predominance of the

Greater Casablanca region in terms of enterprises created, national industrial production, industrial exports and staff employed during the period 1985-2014, with a rise in Tangier-Tetouan region in recent years.

Conclusion

The recent industrial development experienced by Morocco through the establishment of three plans (Emergence Plan, National Pact of Industrial Emergence, Industrial Acceleration Plan) to make its productive system more competitive and innovative has given birth to clusters by the initiative of the government, as in other countries, the emergence of innovative market-oriented projects and support companies and the most voluntarist actors to build high-level clusters. The effectiveness and performance of Moroccan clusters suffers from governance and adaptation to the regional, national and international context, it is necessary to integrate other competitive factors of Moroccan companies as the human factor whose innovation is closely linked with 'index of human development. Moreover, the managerial, financial and administrative obstacles. Lack of public and private sector partnerships and the lack of innovative collaborative projects. In this respect, Morocco must develop strong "competitive" advantages rather than "comparative" advantages in its industrial branches, through the promotion of research and development in the industrial productive system. To overcome its difficulties, it is essential to have the combination of knowledge to innovation and to develop specializations to be able to capture advanced knowledge produced from a distance, to assimilate and exploit them and to encourage collaboration between EU-Morocco clusters.

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Aknowledgements

This research was supported by the projects, which have received funding from the European Union: International Research Staff Exchange Scheme (IRSES) FP7-PEOPLE-2012-IRSES, Grant Agreement Number 319017 SHuMED and ES H2020-MSCA-RISE-2014 CLUSDEV MED Grant Agreement Number 645730730



European Research Council
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Boumediene AMRAOUI

<https://orcid.org/0000-0001-5461-2721>

Abdesselam OUHAJJOU

<https://orcid.org/0000-0002-9613-8973>

Salvatore MONNI

<http://orcid.org/0000-0002-6326-5714>

Najiba El Amrani EL IDRISSE

<https://orcid.org/0000-0001-5603-1306>

Manuela TVARONAVIČIENĖ

<https://orcid.org/0000-0002-9667-3730>

Register for an ORCID ID:

<https://orcid.org/register>

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LEGAL FORM DETERMINATION FOR THE DEVELOPMENT OF CLUSTERS' ACTIVITIES*

Raimonda Bublienė¹, Irina Vinogradova², Manuela Tvaronavičienė³, Salvatore Monni⁴

¹Department of Law, Vilnius Gediminas Technical University, Saulėtekio 11, Lt-10223, Vilnius, Lithuania

²Department of Information Technologies, Vilnius Gediminas Technical University, Saulėtekio 11, Lt-10223, Vilnius, Lithuania

⁵Department of Entrepreneurship and Business Technologies, Vilnius Gediminas Technical University, Saulėtekio 11, Lt-10223 Vilnius, Lithuania

³Department of Economics, Roma Tre University, Via Silvio D'amico 77, Rome 00145, Italy

E-mails: ¹ raimonda.bubliene@vgtu.lt; ² irina.vinogradova@vgtu.lt; ³ manuela.tvaronaviciene@vgtu.lt; ⁴ salvatore.monni@uniroma3.it

Received 15 May 2019; accepted 26 June, published 30 September 2019

Abstract. In this study, the authors have investigated the determination of the most suitable legal form for the development of the cluster management activities. In each particular case the developers of the cluster have to assess the objectives of the cluster, the principal aspects of the mutual partnership, the risks that could be provoked, and in accordance with the derived decisions. The choice of the cluster legal activity form depends on the objectives and on the branch in which the cluster is operating, on the number of the cluster participants, on the type of the activities of the cluster, on the openness or closeness to new members, type of the contributions of the partners and the other factors. The most reliable solution regarding the choice of the model of the functioning and management of the cluster has to be derived as well legal regulation of the legal form of the activity discussed. The advantages and disadvantages of two models of the cluster formation discussed. During experimental evaluation, the significance of criteria was determined and the expert evaluation on legal form for the

* This research was supported by the project, which has received funding from the European Union's Horizon 2020 research and innovation programme European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme Marie Skłodowska-Curie Research and Innovation Staff Exchanges ES H2020-MSCA-RISE-2014 CLUSDEV MED (2015-2019) Grant Agreement Number 645730730



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development of clusters activities was performed. Foundation and management of the clusters are determined firstly by the fact that in one case a new established legal person performs the functions of the cluster coordinator while in another case one of the cluster participants performs the functions and partners legal cooperation determined by Agreement on Partnership. Article analyses the multi-criteria decisions-making to establish the cluster with the certain type of juridical form of legal person or to develop cluster management activities by the Partnership Agreement. The recommendations presented by application of MCDM calculus methods with aspect of percentage.

Keywords: MCDM, clusters, juridical form, TOPSIS, COPRAS, SAW

Reference to this paper should be made as follows: Bublioni, R.; Vinogradova, I.; Tvaronavičienė, M.; Monni, S. 2019. Legal form determination for the development of clusters' activities, *Insights into Regional Development* 1(3): 244-258. [https://doi.org/10.9770/ird.2019.1.3\(5\)](https://doi.org/10.9770/ird.2019.1.3(5))

JEL Classifications: K2

Additional disciplines: Law

1. Introduction

The aim of the study is to identify the potential and possibilities to choose thoroughly the legal form of the cluster for it to be prosperous in its operational activities and management. The organizational structure of the selected legal form has to satisfy the majority of the requirements of the cluster functioning. However, the mutual requirements have to be considered essential enabling the cluster itself to operate efficiently and transparently. To achieve this is possible, in case the hierarchy level in the cluster is insignificant and the form of the selected activities makes it possible to efficiently provide necessary decisions, accurately and suddenly react to the demand and needs of the customers on the market. Innovation clusters means structures or organised groups of independent parties (such as innovative start-ups, small, medium and large enterprises, as well as research and knowledge dissemination organisations, non-for-profit organisations and other related economic actors) designed to stimulate innovative activity through promotion, sharing of facilities and exchange of knowledge and expertise and by contributing effectively to knowledge transfer, networking, information dissemination and collaboration among the undertakings and other organisations in the cluster (European Commission, 2014).

The clusters are assessed according to their potential regarding the innovations to be developed. They could be considered innovative, if their enterprises apply a high level of the mutual cooperation among the enterprises, what concerns the level of the clients and the suppliers; they provide an intensive partnership and cooperation with the universities, development institutions and the other organizations of education and scientific research. Such particular forms of the cooperation promote the development and expansion of the new innovations.

Regions are the geographical areas in which the local spill-overs that drive cluster evolution have a meaningful influence on economic performance, depending on the specific sector, activity, and externality the scope of the appropriate area, it also refers to the area in which there is a significant likelihood for knowledge to be spread through unplanned meetings or chance observations of what others do (Ketels & Protsiv, 2016). The appropriate selection of the legal form in majority cases depends on the type of the region in which the cluster tends to operate, on the number of the participants of the cluster, on the objectives of the cluster activities as well as on the other factors. It is very important to speed up the mobilization of the resources of all the participants of the cluster, to be able to accept and approve the new members possessing very diverse competencies. Regularly the optimum number of the participants of the cluster greatly depends on the field of the activities or the branch of the industry or innovations.

To determine the optimum number of the participants of the cluster in a particular field of the operation is rather difficult due to the very specific and individual type of the cluster. The optimum number of the participants of the cluster has to be related to the chain that provides the reliable and serviced product, innovation and the development of the chain together with an easy and not complicated way of the partnership communication. The significance of the cluster is the fact that all the members of the cluster are focused on to the activities of the management in the fields requiring the competence as well as the professional experts are delegated. A single participant, especially if it is a small enterprise, is not able to provide a wide number of diverse competencies, when in all the stages of the formation of the values, the priorities against their competitors or in terms of the independent acquisition of such competencies might and would require disproportionally high costs. Therefore, the participation in the cluster with a relatively small amount of the contribution, make it possible to obtain the maximum economic benefit for each participants of the cluster, the partnership competence is transformed into the type of cooperation. In cases of separate enterprises, it is too expensive to invest into the purchase of the expensive scientific equipment directed towards the further scientific investigations or the infrastructure, but the group of the enterprises registered in the cluster could make use of them. However, the participation in the cluster make it possible for the enterprises to share the costs and the risks, when mutually developing and putting to testing the prototypes of the new products. Cluster evolution is viewed as an adaptive process with different possible outcomes based on episodic interactions of nested systems (Martin & Sunley, 2011). The participation of the cluster tends to develop the cooperation in all the chains of the development of the values (Yang, Černevičiūtė, 2017; Žižka et al. 2018; Razminienė, Tvaronavičienė 2018).

The cluster is the dynamically developing virtual business system that has been developed to implement their particular objective. The geographic concentration of activities, the intersectoral and intrasectoral linkages and the assembling of local innovation networks, based upon strong cooperation ties between public and private actors (Monteiro, De Noronha, & Neto, 2013). The planning of the main activities has to be executed when officially formalizing them, development and management of the clusters depends on advantages and disadvantages of models of the cluster formation. However, that type of the hierarchy distribution preserving one level with the majority of the members is considered complicated as well. The most important issue is to describe and agree on the main principals of the management of the cluster, because the clusters themselves depend on the particular individuals employed and their responsibilities provided.

2. Set of Criteria for Evaluation of a Legal Form of Activity

Thus, in particularly, there have to be discussed Model A and Model B of the establishment of cluster, analysing the issues of their founding, managing and operation, the advantages, disadvantages of their operational forms. It is possible to single out two particular models in terms of their operation and management, which in their terms determine the choice of the legal form and the way of their official registration. In the case of Model A in order to coordinate the management of the cluster there is established a new and separate legal person, which is entrusted with the objectives of the functions of the cluster manager. In the case of Model B the functions of the cluster manager are entrusted to one of the participants of the cluster, but a new and separate legal entity is not liable to the responsibility concerning the execution of these functions.

In Lithuania, the Model A prevails; therefore, the participants of the cluster initiate a separate legal entity, which is responsible for carrying out the functions of the cluster manager. The following three forms of the legal persons are applied in the practices of the Republic of Lithuania: Private Limited Liability Company (PLLC), Public Establishment (PE), Association, these legal persons are liable to the responsibility of the newly appointed cluster manager for the functions of the cluster coordinator. According the data from the National Register of Legal Entities of the Republic of Lithuania there are registered 35 clusters as the legal persons in the Republic of Lithuania. As the Associations registered twenty-four clusters, five registered as PE and four legal persons as

PLLC, one cluster registered as Individual Enterprise and one as Small Partnership (Center of Registers, 2019). The first and the most popular way of establishment legal person is Association and it is a separate legal entity, but the objective of the Association is to coordinate the activities of the participants of the Association, to represent the interests of the participants of the Association as well as to protect them (Republic of Lithuania Law on Associations, 2004). The Association consists of the participants which have to be not more than three and they have their own separate managing authorities, or they have the right to hire employees or make agreements. The property of the Association is separated from the property of the participants and the participants are not liable for the obligations of the Association limited civil liability. The issues related to the activities management of the Association problems are delegated and addressed at the Meeting of the Participants, where each member to the Association has one vote unless the regulations of the Association prescribe the other way. The advantages of the Association are considered to be the following: a simple procedure of the acceptance of the new members of the participants and the possibility to have a multi-stage structure of the management. The greatest disadvantage of the Association is the fact that the earned profit of the Association is not allowed to be distributed to its participants, there is no possibility to pay dividends from the part of the profit.

The objective of the Public Establishment is to satisfy the public interests in carrying out the activities in the fields of education, scientific research, cultural events, health care, environmental protection, development of sports activities, social and legal consultancy and the other social activities (Republic of Lithuania Law on Public Establishments, 2017). The number of the founders of the Public Establishment is not limited; they could be considered the entities, not seeking any profit from the operational activities of the companies. The entities becoming stakeholders of the Public Establishment are liable to delegate their contribution to the company; the quantity of it has to be determined by the stakeholders themselves. The law do not prescribe the minimum amount of the contribution. Thus, a single stakeholder in the General Meeting of the Stakeholders has only one vote, if the Articles of the Association do not prescribe the other way. The Public Establishment is obliged to have the Manager and the General Meeting of the Stakeholders; what concerns the other authorities of the company the Board, the participants of the Public Establishment are allowed to make decisions by themselves and decide what managing authorities to be elected. The property of the Public Establishment is separated from the property of participants, limited civil liability and they are not responsible for the obligations of the Public Establishment and the debts.

The advantage of the Public Establishment is the following. The procedure of the acceptance of the participants is not complicated and the equality of the General Meeting of the Participants of the Stakeholders. The greatest disadvantage of the Public Establishment that the law imperatively prescribing the restrictions for the purposes of the activities carried out by the legal person for to satisfy the public interests in carrying out the activities in the specific fields. The functions and activities of the cluster manager are related not to the public interests but to the interests of the participants of the cluster. That could prevent the efficiently exercising the functions the cluster manager within the Public Establishment. In the practices of Lithuania, the cluster managers are also used to be the Public Establishment.

The third form of legal person Private Limited Liability Company (Republic of Lithuania Law on Companies, 2014). PLLC is an independent legal entity, separated from the company owners (shareholders), the authorised capital is divided into the shares. After the establishment of the Private Limited Liability Company, the independent company is able to purchase property in their name the property is separated from the property of the owners, limited civil liability. It is worth mentioning that the cluster manager is able to be entrusted not only with the legal entity but the natural person as well, a person carrying out an individual enterprise and supplying the services despite that, the majority of the cluster managers are considered to be legal entities. An example one cluster is registered as the Individual Enterprise according the data of National Register of Legal Entities.

The founders of the Private Limited Liability Company have the right to own the shares of the company, but do not have the right to hold the particular property of the company, as well. In case, the company is profitable the shareholders have the right to obtain the part of the profit (dividends). Besides that, the shareholders such as the owners of the company altogether determine the objectives of the management and decide on the main issues. As the property of the shareholders is separated from the company property - limited civil liability, the shareholders are not in charge of the commitments of the company, and the debts.

It is possible to distinguish the following principal advantages of the PLLC. As the possibility to influence the management of the Private Limited Liability Company proportionally to the number of the shares owned by the shareholders and the profit of the PLLC is possible to be paid to the shareholders as the dividends. The law clearly regulates and indicates the legal relationship between the shareholders. The disadvantages of the PLLC could be considered more complicated and more formal than the other legal forms regarding the joining and withdrawing of the new members in the company.

According to the Model B the activity forms of the cluster when the cluster manager is appointed to be a participant of the cluster. The scope and legal regulation for the Agreement on Partnership settled by the Civil Code of the Republic of Lithuania (Civil Code of the Republic of Lithuania, 2000). The cluster functioning and management, distinguish that the functions of the cluster manager are delegated to one of the participant of the cluster not to a new legal entity. In majority cases, a certain participant of the cluster, is delegated the performance of the functions of the cluster manager just by signing joint activity the Agreement on Partnership with the other members.

The partnership activity is prescribed what concerns the cooperation of the partners in terms of their resources and knowledge, what concerns the general interests and the objective. The agreement determines and describes the pre-condition for the participants of the cluster to be free to agree on various aspects of cooperation and cluster activities. It prescribes the order the way the contributions to be made, the issues related to the ownership of the contributions, the distribution of the functions and liabilities, representation of the particular cluster, division of the profit from the performed activities. One of the issues that could be discussed in the Agreement on Partnership is the case, when one of the participants is delegated the functions of the performance of the cluster manager. Then the right is delegated to a particular participant to be able to represent the participants and besides that there are determined the limits of the authorities as well as the accountabilities, the order the way the information could be provided to the other partners.

3. The applied MCDM methods

The MCDM methods are used for the calculation to choose a legal form of activities for the cluster establishment. The application of the MCDM methods consist of 2 stages. The first stage it is the determination of the criteria weights and the second – the legal form establishment for the cluster activities evaluation according to the criteria. For obtaining the relative estimates of the courses and demonstrating the application of MCDM methods, such as TOPSIS (The Technique for Order of Preference by Similarity to Ideal Solution), SAW, COPRAS (Complex Proportional Assessment), which reflect the main ideas of MCDM approaches, were used in the work. They include the calculation of the optimal distance from the best and from the worst alternatives, the combination of the values and weights of the criteria for obtaining the qualitative estimate of the method, determination of the degree of influence of the maximizing and minimizing criteria and taking into consideration the optimal distance from the average estimate (Vinogradova, Podvezko, & Zavadskas, 2018).

3.1 The method used for determining the weights of the criteria

The weights of criteria mean one of two component parts in MCDM methods. The effect of criteria on the results of evaluation differ, therefore determination of weights is very important (Trinkūnienė, et al., 2017). The analytical hierarchy process method is a closed logical construction that is realized by applying simple rules for organizing and analyzing complex decisions, in order to find the best possible solution (Vinogradova & Kliukas, 2015). The principle of the pairwise comparison method is that an expert simultaneously compares only two criteria out of the total number of criteria. Pairwise comparison determines how much one criterion is more important than the other one. Saaty (Saaty, 1980) proposed a five score 1-3-5-7-9 evaluation system (Turskis, Keršulienė, & Vinogradova, 2017). If criteria have the same importance, the result of evaluation is equal to one. If the difference between the weights of criteria is the biggest, the result of evaluation is equal to nine. Once evaluation is completed, an inverse unknown weight ratio symmetric pairwise comparison matrix P is formed. Reciprocals are automatically assigned in each pair-wise comparison (Kurilov & Vinogradova, 2016)

Matrix elements $p_{ij} = \frac{w_i}{w_j}$, $(i, j = 1, 2, \dots, m)$, $p_{ij} = \frac{1}{p_{ji}}$, $p_{ii} = 1$, m – the number of criteria.

Each expert evaluates $m(m-1)/2$ pairs, here m – the number of criteria (Kurilovas, Vinogradova, & Kubilinskiene, 2016). It is easy to check that

$$P\bar{w} = m\bar{w} \quad (1)$$

here, \bar{w} – unknown weight eigenvector, which means that the problem of eigenvalues and eigenvectors (1) with the eigenvalue λ equal to matrix series m is being solved.

It was proved by Saaty (1980) that the weight vector \bar{w} is the eigenvector of normalized values of the P matrix consisting with its maximal eigenvalue λ_{max} . The consistency (non-contradiction) of the expert's evaluation is determined by Consistency Index CI and Consistency Ratio CR :

$$CI = \frac{\lambda_{max} - m}{m - 1}, \quad (2)$$

$$CR = \frac{CI}{RI}, \quad (3)$$

here, RI is the random value of the Consistency Index (Saaty, 1980). The evaluation of the pairwise comparison is admitted if $CR < 0.1$.

3.2. The SAW method

The basic idea behind the MCDM methods is to combine the criteria values and weights to obtain a single point of reference for evaluation, i.e. the method's criterion. A common example is SAW (Simple Additive Weighting), where the method's evaluation criterion S_i is calculated by Eq.(4) (Hwang & Yoon, K., 1981) (Podvezko, 2011):

$$S_i = \sum_{j=1}^m w_j \tilde{r}_{ij} \quad (4)$$

where w_j is the weight of the j_{th} criterion and \tilde{r}_{ij} is the normalized (dimensionless) value of the j_{th} criterion for the i_{th} alternative:

$$\tilde{r}_{ij} = \frac{r_{ij}}{\sum_{i=1}^n r_{ij}} \quad (5)$$

3.3. The TOPSIS method

The method *TOPSIS* is based on vector normalization (Hwang & Yoon, K. , 1981) (Podvievko, 2014)

$$\tilde{r}_{ij} = \frac{r_{ij}}{\sqrt{\sum_{i=1}^n r_{ij}^2}} \quad (i = 1, \dots, n; j = 1, \dots, m) \quad (6)$$

where \tilde{r}_{ij} is the normalized value of j -th criterion for i -th alternative.

The best alternative V^* and the worst alternative V^- were calculated by

$$V^* = \{V_1^*, V_2^*, \dots, V_m^*\} = \{(\max_i \omega_j \tilde{r}_{ij} / j \in J_1), (\min_i \omega_j \tilde{r}_{ij} / j \in J_2)\}, V^- = \{V_1^-, V_2^-, \dots, V_m^-\} = \{((\min_i \omega_j \tilde{r}_{ij} / j \in J_1), ((\max_i \omega_j \tilde{r}_{ij} / j \in J_2))\}$$

where J_1 is a set of indices of the maximized criteria, J_2 is a set of indices of the minimized criteria.

The distance D_i^* of every considered alternative to the ideal (best) solutions and its distance D_i^- to the worst solutions were calculated:

$$D_i^* = \sqrt{\sum_{j=1}^m (\omega_j \tilde{r}_{ij} - V_j^*)^2} \quad D_i^- = \sqrt{\sum_{j=1}^m (\omega_j \tilde{r}_{ij} - V_j^-)^2} \quad (8)$$

The criterion C_i^* of the method *TOPSIS* was calculated by

$$C_i^* = \frac{D_i^-}{D_i^* + D_i^-} \quad (i = 1, \dots, n) \quad (0 \leq C_i^* \leq 1). \quad (9)$$

The largest value of the criterion C_i^* corresponds to the best alternative.

3.4. The COPRAS method

The criterion of the COPRAS (Complex Proportional Assessment) method) (Zavadskas, 2007) Z_i was calculated as follows:

$$Z_i = S_{+i} + \frac{\sum_{i=1}^n S_{-i}}{S_{-i} \sum_{i=1}^n \frac{1}{S_{-i}}}, \quad (10)$$

$S_{+i} = \sum_{j=1}^m \omega_j \tilde{r}_{+ij}$ is the sum of the weighted values of the maximized criteria \tilde{r}_{+ij} ,

$S_{-i} = \sum_{j=1}^m \omega_j \tilde{r}_{-ij}$ is same for the minimized criteria,

where ω_j is the weight of the j -th criterion and \tilde{r}_{ij} is the normalized value of the j -th criterion for the i -th alternative is calculated by Eq. (5).

4. Data Description and Evaluation of the Criteria Values for the Determination of Legal Form for Cluster Activity

Each member has completed an evaluation form. They filled in the AHP matrix of pairwise comparisons of the four group of criteria and carry out a direct evaluation of Model A and Model B forms on five-point scale according to criteria. The scale 1-3-5-7-9 of the Saaty's approach AHP was used for comparison. The consistency of the matrix was examined by determining the index and the ratio of the consistency. The values of the AHP matrix filled in by one of the member (Table 1).

Table 1. The AHP matrix filled in by one of the member. Source: Created by the authors.

	crit 1	crit 2	crit 3	crit 4	crit 5	crit 6	crit 7
crit 1	1,00	2,00	5,00	6,00	3,00	4,00	7,00
crit 2	0,50	1,00	4,00	5,00	2,00	3,00	6,00
crit 3	0,20	0,25	1,00	2,00	0,33	0,50	3,00
crit 4	0,17	0,20	0,50	1,00	0,25	0,33	2,00
crit 5	0,33	0,50	3,00	4,00	1,00	2,00	4,00
crit 6	0,25	0,33	2,00	3,00	0,50	1,00	4,00
crit 7	0,14	0,17	0,33	0,50	0,25	0,25	1,00

The values of the weights of the criteria assigned by the member were obtained by using AHP method (1)-(3) are given in Table 2.

Table 2. The values of the weights of the criteria assigned by one member. Source: Created by the authors.

ω_1	ω_2	ω_3	ω_4	ω_5	ω_6	ω_7
0,3547	0,2405	0,0681	0,0451	0,1549	0,1043	0,0324

Seven members filled recommended evaluation form to determine the legal form for the development of the clusters activities, the effect of criteria on the results of evaluation differ. The average values of the weights of the criteria are given in Table 3 according the evaluation of legal activities establishment by Model A and Model B.

The Model A Group 1 sets the following advantages criteria: 1) all members are involved into the activities of cluster as the shareholders or members; 2) easy control of the cluster activities; 3) clear structure of legal person management defined by the law; 4) easy to perform contracts as legal person activity is performed independently; 5) the legal person owns property by the ownership right and easy to manage acquired intellectual property; 6) the member of the cluster are not obliged to perform the clusters manager administrative issues. The following disadvantages determined by the Group 2: 1) members of the cluster responsible for the accountability of legal person; 2) additional costs for establishment, management of new legal person; 3) formal establishment of the legal person; 4) accurate legal regulation of the members' relationship; 5) property and non-property contributions restrictions; 6) formal join and withdraw of the member of cluster; 7) legal person liquidation procedure after the finish of the activities.

The Model B Group 1 sets advantages criteria: 1) more flexibility to arrange the additional agreements; 2) possibility to assign management of the cluster to several members; 3) more flexibility in the management of the cluster; 4) costs saving for administration and establishment of legal person; 5) flexibility to join and withdraw the cluster; 6) flexibility to determine value by co-operating property and non-property contributions. Following

disadvantages settled by Group 2: 1) the assets of the cluster belongs to all members; 2) the management of cluster assets based on partners agreement; 3) each partner liable under joint contractual obligations to the extent of all his property; 4) the production received during joint activities, income and results owned by all partners joint-partial.

Table 3. The weights averages of the criteria of Model A and Model B. Source: Created by the authors.

A	Group 1	criteria 1	criteria 2	criteria 3	criteria 4	criteria 5	criteria 6	
		0,1649	0,1200	0,1655	0,2498	0,0951	0,2046	
	Group 2	criteria 1	criteria 2	criteria 3	criteria 4	criteria 5	criteria 6	criteria 7
		0,2752	0,1534	0,1312	0,1257	0,1495	0,0739	0,0910
B	Group 1	criteria 1	criteria 2	criteria 3	criteria 4	criteria 5	criteria 6	
		0,1512	0,1445	0,2481	0,1540	0,1108	0,1914	
	Group 2	criteria 1	criteria 2	criteria 3	criteria 4			
		0,1714	0,2238	0,1849	0,4199			

Source: Created by the authors

The analysis of the results indicated the most value criteria for both models. In the Model A the most important criteria were indicated as easy performance of contracts and independence of legal person, non-obligations of clusters members to perform the administration and responsibility of the accountability of legal person. In the Model B the most value was given to the criteria of flexibility to manage the cluster, to management of assets and the production received during joint activities, income and results ownership.

Recalculation of criteria weights of two groups of each legal form was made by simple data transformation:

$$\tilde{\omega}_i = \frac{1}{g} \cdot \omega_{group}, \sum_{i=1}^m \tilde{\omega}_i = 1, \quad (11)$$

where $\tilde{\omega}_i$ – summarize weights. ω_{group} – are criteria weights of a separate group of criteria, g – number of group of the criteria.

The recommendations about determination of the legal form of cluster activities should be provided for each member. Meanwhile MCDM methods regularly applied for the evaluation of several alternatives in the following case available alternatives were introduced for the multi-criteria decisions making.

The TOPSIS method (8)-(9) was used to solve the following task at the article for the characteristics to give the results at the scale from 0 to 1. Application of the following method for the calculation was applied by three alternative values: the worst alternative, the member real evaluation and the best alternative. The worst alternative values criterion 1 for the maximised criteria and for minimised criteria – 5. Accordingly, the best (ideal) alternative values for the maximised criteria applied criterion 5 and minimised criteria – 1. TOPSIS method for the following case always the worst alternative evaluate by value 0 and ideal – 1. Actual member real evaluation will be displayed at the interval from 0 to 1, that provides the comparison or legal forms available in percentage aspect.

The values of the Model A evaluated by one of the member presented in Table 4. Summarized weights calculated by application of Equalation 11.

Table 4. The values of the Model A by one of the member (TOPSIS method).

Criteria	sum. w	w	Criterion direction	w	worst	real	ideal
1 criterion	0,0491	0,0981	max	0,0981	1	5	5
2 criterion	0,0303	0,0606	max	0,0606	1	4	5
3 criterion	0,1214	0,2429	max	0,2429	1	3	5
4 criterion	0,2034	0,4067	max	0,4067	1	3	5
5 criterion	0,0748	0,1496	max	0,1496	1	5	5
6 criterion	0,0211	0,0421	max	0,0421	1	4	5
1 criterion	0,0518	0,1036	min	0,1036	5	4	1
2 criterion	0,0224	0,0448	min	0,0448	5	5	1
3 criterion	0,1200	0,2399	min	0,2399	5	2	1
4 criterion	0,1771	0,3543	min	0,3543	5	3	1
5 criterion	0,0793	0,1587	min	0,1587	5	3	1
6 criterion	0,0156	0,0312	min	0,0312	5	2	1
7 criterion	0,0338	0,0676	min	0,0676	5	4	1

Source: Created by the authors.

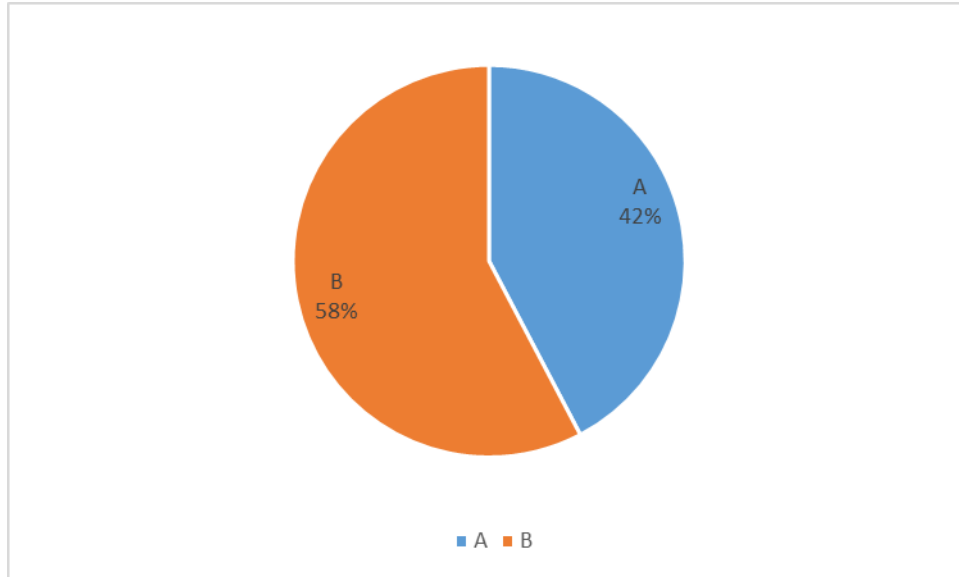
The calculation applied with the use of analogue method for the recommendations to determine the legal form for each member. The result of TOPSIS method (0, real value, 1) based on the evaluation of three alternatives (worst, real, ideal). The recommendation for each member provided in Table 5. The difference determined between two legal forms, the major difference indicate obvious recommendation for the choice of legal form.

Table 5. Recommendations for each member (TOPSIS method)..

Member	TOPSIS		Recommendation	Difference
	A	B		
1	0,55	0,75	B	0,2
2	0,59	0,43	A	0,16
3	0,49	0,42	A	0,07
4	0,57	0,41	A	0,16
5	0,52	0,39	A	0,13
6	0,44	0,40	A	0,04
7	0,45	0,57	B	0,12
Average	0,52	0,48		

Source: Created by the authors

The legal form determination for the cluster activity management presented in circular diagram by percentage.

**Figure 1.** Model A and Model B recommendation by percentage aspect.*Source:* created by the authors.

However, during evaluation according the result presented in Table 5 for the first and for the seventh member the Model B of legal form prevail other members recommendation to apply Model A. The Model A prevails in general case for all member of clusters. Following the recommendations, the members merged to the groups A and B (Table 6).

Table 6. Merged result for group A and B.

Member	A	Member	B
2	0,59	7	0,57
3	0,49	1	0,75
4	0,57		
5	0,52		
6	0,44		
Average	0,52	Average	0,66

Source: Created by the authors

Applied comparator for all members A Model recommendations with the merged result of group A percentage remain the same 52 %. However, B group merged result increased from 48 % to 66 %.

The SAW (4)-(5) and the COPRAS (10) methods applied to solve the following task. These methods without the possibility to apply for the result the calculation interval [0;1] as the TOPSIS method. The calculation done with additional alternative (Table 7). Summarized weights calculated by application of Equalation 11.

Table 7. The values of the Model B one of the member (SAW/COPRAS methods)..

Criteria	Sum. w	w	Criterion direction	real	ideal
1 criterion	0,0214	0,0428	max	5	5
2 criterion	0,0320	0,0641	max	4	5
3 criterion	0,1912	0,3825	max	3	5
4 criterion	0,1252	0,2504	max	4	5
5 criterion	0,0798	0,1596	max	5	5
6 criterion	0,0503	0,1006	max	3	5
1 criterion	0,0477	0,0954	min	4	1
2 criterion	0,0800	0,1601	min	5	1
3 criterion	0,1386	0,2772	min	5	1
4 criterion	0,2336	0,4673	min	2	1

Source: Created by the authors

During the investigation, a comparative analysis for the result of Model A and Model B calculated by percentage from ideal alternative result according following transformation:

$$\text{Recommendation} = \frac{100\% \cdot \text{real}}{\text{ideal}}$$

Table 8. The values of the Model A by one of the member.

Member number	A	B	Recommendation	Difference
1	46	50	B	4
2	52	46	A	6
3	47	47	A,B	0
4	52	43	A	9
5	51	42	A	9
6	45	43	A	2
7	46	50	B	4

Source: Created by the authors

The SAW and the COPRAS methods calculation results of evaluation with the ideal result presented in Table 8. The merge of sum for the results of separate groups calculated with the following methods not applicable. Comparator of the recommendations results calculated by TOPSIS method indicates that the tendency of evaluation analogous.

5. Conclusions

Legal regulation analysis of Agreement on Partnership, law regulating legal persons and evaluation of advantages and disadvantages criteria presents the determination of the legal form Model A or Model B for the management of clusters activities.

The proposed evaluation with multi-criteria decisions-making MCDM methods applicable to provide the recommendations for the legal form determination to manage the clusters activities, MCDM methods are widely

used for comparison and determination of the best alternative. The following recommendations presented in convenient percentage aspect.

The analysis of the results of complex evaluation has shown that the application of MCDM methods necessary to apply with the additional possible alternatives for the calculus of one-member recommendations.

Authors presented different MCDM methods incorporate different calculation principles therefore; the TOPSIS method invoked the best evaluation for the legal form determination in clustering activities, when the recommendations should be presented for a single member from several options and the evaluation results might be merged to separate groups for the calculation average values for comparison of the results.

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Aknowledgements

This research was supported by the project, which has received funding from the European Union's Horizon 2020 research and innovation programme European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme Marie Skłodowska-Curie Research and Innovation Staff Exchanges ES H2020-MSCA-RISE-2014 CLUSDEV MED (2015-2019) Grant Agreement Number 645730730



European Research Council
Established by the European Commission

Raimonda BUBLIENĖ

<https://orcid.org/0000-0003-3576-3975>

Irina VINOGRADOVA

<https://orcid.org/0000-0002-4277-6849>

Manuela TVARONAVIČIENĖ

<https://orcid.org/0000-0002-9667-3730>

Salvatore MONNI

<http://orcid.org/0000-0002-6326-5714>

Register for an ORCID ID:

<https://orcid.org/register>

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TOWARDS ENERGY EFFICIENCY: CASE OF MOROCCO*

Lahcen El Iysaouy¹, Najiba El Amrani El Idrissi², Manuela Tvaronavičienė³, Mhammed Lahbabi⁴, Abdelmajid Oumnad⁵

^{1,5} *Equipe de Recherche en Smart Communications - ERSC (ancien LEC)
Ecole Mohammadia d'Ingénieurs, Mohammed V University in Rabat
Avenue Ibn Sina BP765 Agdal, Rabat, Morocco*

^{1, 2, 4} *Universite Sidi Mohamed Ben Abdellah, FSTF, LSSC,
B.P. 2202, Route d'Immouzzar, Fés, Morocco*

³ *Vilnius Gediminas Technical University, Sauletekio al. 11, Vilnius, Lithuania*

E-mails: ¹lahcen.eliysaou@um5s.net.ma; ²najiba.elamrani@usmba.ac.ma; ³manuela.tvaronaviciene@vgtu.lt; ⁴mhammed.lahbabi@usmba.ac.ma; ⁵aoumnad@emi.ac.ma

Received 15 May 2019; accepted 30 June 2019; published 30 September 2019

Abstract. A major challenge for humanity in the twenty-first century is to combine energy with respect for the environment. During the Rio Earth Summit (2012) the issue of sustainable development was clearly demonstrated. One of the major battles this century for the planet's survival is to include energy efficiency as an international policy priority in order to achieve a significant decrease in greenhouse gas emissions. In this paper, we have presented the current state and outlook of energy efficiency in the transport, residential and industrial sectors, as well as its policy for each sector in Morocco. New strategies implemented by the government for sustainable development were reviewed and discussed. Through these strategies, the shift to energy efficiency is at the forefront of national policy implications for energy security and a low-carbon economy.

Keywords: energy efficiency; low-carbon; energy policy; energy consumption; greenhouse gases; Morocco

**This research was supported by the projects, which have received funding from the European Union: International Research Staff Exchange Scheme (IRSES) FP7-PEOPLE-2012-IRSES, Grant Agreement Number 319017 SHuMED and ES H2020-MSCA-RISE-2014 CLUSDEV MED Grant Agreement Number 645730730*

This work is in principle linked to the project "Energy Efficiency: Cultural Change" financed by NATO Energy Security Centre of Excellence



European Research Council

Established by the European Commission

Reference to this paper should be made as follows: El Iysaouy, L.; El Amrani El Idrissi, N.; Tvaronavičienė, M.; Lahbabi, M.; Oumnad, A. 2019. Towards energy efficiency: case of Morocco, *Insights into Regional Development* 1(3): 259-271. [https://doi.org/10.9770/ird.2019.1.3\(6\)](https://doi.org/10.9770/ird.2019.1.3(6))

JEL Classifications: Q4, Q5

1. Introduction

World demand for energy is increasing through population increase, as well as through industrialization and the urban development process (Energy, Photovoltaic, System, Iea, & Publishes, 2018; IEA, 2017). This underscores the value of such issues such as sustainability, supply security, alternative forms of energy and the strengthening of the national energy source potential. The latest evolutions and trends, the sharp swells in demand, warfare, and diplomatic concerns all contribute to the perception of energy issues as a serious issue on the world's agenda. In some references, energy efficiency is among the energy resources. Rather than starting to build a new plant with high-cost investments, the energy efficiency of the plant can contribute towards meeting the growing need for energy. In addition, it could deliver significant environmental and other operational rewards in terms of cost and greenhouse gas emissions improvements.

Energy efficiency policies are used in various sectors (i.e. residential, industry, transport, etc.) (Allouhi et al., 2015; Kousksou et al., 2015; T. T. Xu, 2011, Tvaronavičienė et al., 2017 Tvaronavičienė, 2018; Dudin et al., 2019; Vlasov et al., 2019; Smaliukienė, Monni, 2019; Rogalev et al., 2018).

By virtue of its status as a developing country, Morocco is considered among the 75 most competitive countries in the world, and among the 140 countries ranked in the 2018 World Competitiveness Report released by the World Economic Forum. The average level of competitiveness in Morocco was 72.17 in the period 2007-2018, reaching an unprecedented high of 77 in 2014 and a peak of 64 in 2008 ("Morocco GDP Growth Rate | 2019 | Data | Chart | Calendar | Forecast | News," n.d.).

Morocco's annual Gross domestic product (GDP) was growing at an average rate of 4.14% from 1999 to 2018, reaching an unprecedented high of 9.30% in the second quarter of 2006 and a record low of 0.50% in the fourth quarter of 1999 ("Morocco GDP Growth Rate | 2019 | Data | Chart | Calendar | Forecast | News," n.d.).

To meet the high demand for electricity which is increased by about 7%., Morocco intends to invest more than 15 billion euros over the next 10 years to increase installed capacity by around 6,750 MW.

The most important measure in Morocco's energy balance is the total consumption of 28.25 billion kWh of electricity per year. This represents an average of 790 kWh per capita. However, Morocco could supply itself completely with self-produced energy. Whereas, the total production of all electricity generation facilities is 29 billion kWh. In addition to pure consumption, production, imports, and exports have an important contribution to make other energy sources such as natural gas or crude oil are used as well. A large amount of electricity used contributes to high levels of CO₂ emissions in Morocco. On the other hand, energy intensity aimed to be decreased by enhancing efficiency measures and promoting clean energy technologies (Iea, 2019).

Energy efficiency in the transport sector in Morocco deserves attention from the point of view of energy security and the environment, as the sector depends almost exclusively on a fuel-oil which represented the lion's share of the energy imported.

The transport is the key factor of global sustainable economic development as reported issued in International Transport Forum (ITF) Transport Outlook 2013 based relatively cost-efficient as well as reliably networked transport. However, the transport sector is responsible for air pollution, because it causes large greenhouse gases emissions into the atmosphere, which eventually leads to climate change. Therefore, the main task for policy makers struggling to elaborate on strategic transport plans is to a trade-off between the pros and cons of transport developments.

Such strategic planning for the long term is only feasible if there is factual and reliable information on transport development which is based on statistics, analysis, and research.

The industrial sector represents between 30 and 70% of the world's total energy use and is responsible for a significant proportion of global greenhouse gas emissions (Broberg Viklund & Johansson, 2014; T. T. Xu, 2011). There have been recent researches that have investigated the potential to reduce greenhouse gas emissions by enhancing industrial energy efficiency (Utlu & Parali, 2013; Worrell, Binde, Neelis, Blomen, & Masanet, 2010; T. Xu, Sathaye, & Kramer, 2013).

Improving energy efficiency in the industrial sector is one of the major pillars of this strategy. Further, intends to require energy audits in the industry sector to achieve the targeted energy efficiency ratio (from 12 to 15%) by 2020. The obligation of energy audits in industries is clearly stated in the 12th article of the Energy Efficiency Law 47-09 (Law, n.d.).

To energy efficiency policies in the area of transport, residential, and industry there are certain theories which should be considered such as the theory of rational choice, the theory of reasoned action, the theory of planned action, the theory of social learning, the theory of cognitive dissonance, and social theory, etc. Further, various energy efficiency surveys in industrials, residentials, transports sectors are exploring energy consumption patterns. The methodology employed in these studies is to interview holds of different sectors such as households to identify their electricity use patterns and understanding the values that are driving their behaviours. The use of questionnaires to outline the efforts of both consumers and government bodies on energy concerns (Dianshu, Sovacool, & Vu, 2010; Whitmarsh & O'Neill, 2010). Also, there are studies suggesting that may be more effective economic concerns rather than environmental concerns (Gyamfi & Krumdieck, 2011).

There are a lot of energy reduction policies pursued in many countries. Increasing the acquaintance, offering feedback, incentives, disincentives, and social influences are among the examples of behaviour change measures used in policy-making.

These actions are outlined in the following:

- **Public information:** Positive information interventions enhance the level of awareness and knowledge of the energy concerns of the individuals. To disseminate the information that there are several ways among the people: workshops, flyers/posters, mass-media campaigns, home-based audits, energy labelling and modelling (Abrahamse, Steg, Vlek, & Rothengatter, 2005; Robinson, 2009).
- **Feedback:** To keep people informed of their use, it is possible to provide feedback under different forms and at different frequencies. The most common form of feedback for electricity users is utility bills. (Abrahamse et al., 2005; Nachreiner, Mack, Matthies, & Tampe-Mai, 2015).
- **Incentives / benefits:** Both monetary and non-monetary rewards can motivate people to save energy. These can result from a reduction in energy use or a more successful change in energy efficiency behaviour (Abrahamse & Steg, 2009; Bresciani, Colomi, Lia, Luè, & Nocerino, 2016; McMakin & Malone, 2002).
- **Target setting / Investment:** This is an alternative approach to motivate people to become involved to save energy. An engagement is an oral or written commitment or pledge of change, and it may be linked to an

objective. This guarantee can be a bond for oneself, in which case it can be used to activate either of the following a personal norm such a high moral obligation to conserve the energy (Abrahamse & Steg, 2009; Martiskainen, n.d.).

- Social influences: These kinds of measures of attitude and behaviour are taken from a larger group of people than the previous ones. Group or organization leading people to achieve a common purpose or even sometimes to challenge each other between themselves to get the greatest possible reduction in their energy use. (Abrahamse & Steg, 2009).

Through the years, researches have been carried out to foster policies and to study the impact of implementing strategies on energy reduction and efficiency. The full range of literature and the common policy alternatives derived from the literature are not restricted to those outlined above. In recent literature, it has been highlighted again that a more effective combination of awareness and education with cost-effective measures is more efficient (Lindén, Carlsson-Kanyama, & Eriksson, 2006) and shows that the economic rewards of energy saving as a result of these activities increase consumer awareness levels. Through the different studies, the common conclusion was that holds of different sectors were responding to these economic measures and that they needed to be used effectively to achieve energy efficiency (Allcott, 2011).

2. Energy intensity of Morocco

In 2017, the total final consumption (TFC) of Morocco reached 16.1 Mtoe, which represents an increase of 34% over the previous decade (AZEROUAL, EL MAKINI, EL MOUSSAOUI, & EL MARKHI, 2018; Iea, 2019). The TFC is widely driven by the three sectors - transport, residential and industrial - as well as representing over four-fifths of the total final consumption, but also exhibiting high expansion and growth rates. Despite the energy consumption of Morocco increases along with the economic development of the country, however, as compared to a decade ago, energy intensity (TFC / GDP) fell by 9% (see Figure 1). In terms of energy intensity, which is measured by the ratio of TFC per unit of real gross domestic product as settled for purchasing power parity (PPP), it was 60.5 tonnes of oil equivalents (toe) per million dollars of GDP in 2017.

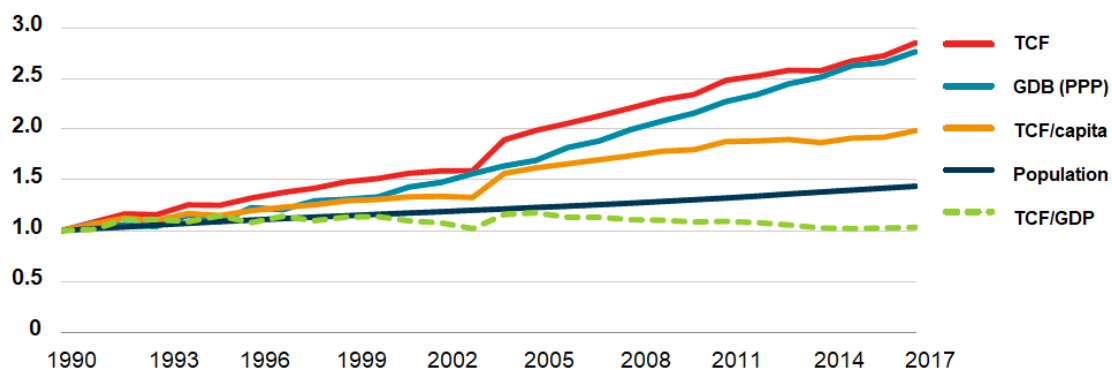


Fig. 1. Energy demand and drivers

Source: IEA (2019 forthcoming), World Energy Balances 2019 preliminary edition, www.iea.org/statistics/

The energy intensity of Morocco has diminished over time (see Figure 2) as well as, within the Mediterranean area, its energy use profile is unique.

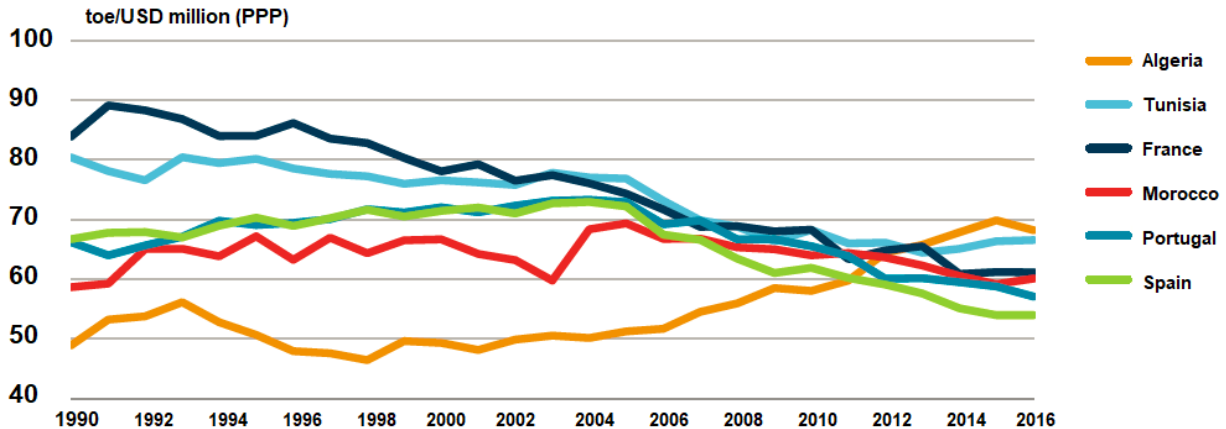


Fig. 2. Energy intensity in Morocco and selected countries

Source: IEA (2018a), World Energy Balances, 2018, www.iea.org/statistics/

3. Energy Efficiency in the Transport sector

3.1. Energy consumption

The transport sector used 5.8 Mtoe in 2017, representing the highest proportion of Moroccan TFC. Energy use in transport has increased by 58% since 2007 and increased more than four times since 1990 (AZEROUAL et al., 2018; Iea, 2019). Petroleum is the most dominant transport fuel in Morocco's rapidly expanding transport sector, while electricity and biofuels have no role to play.



Fig. 3. Transport energy demand by transport mode and fuels, 2017

Source: IEA (2019 forthcoming), World Energy Balances 2019 preliminary edition www.iea.org/statistics/

Highway transport uses 99% of transport energy, with about 86% of this consumption being from diesel and the remaining from gasoline (see Figure 3). Transport use in Morocco is mainly driven by freight, passenger cars, cabs, and commercial vans. The constant growth in the overall vehicle fleet reflects Morocco's GDP per capita growth of the country's government, and its aspiration to be a regional pole of the automotive industry.

3.2. Various policy targets in transport sector

Measures for energy efficiency in the transport sector have been enacted in various strategies (Iea, 2019; Law, n.d.):

- The strategy of the Ministry of Equipment, Transport, Logistics and Water (METLW) for 2017-2021 highlights the importance of sustainability, economic and socially efficient transport systems, which are more reliable, more energy efficient to use more user-friendly.
- Strategy for developing the competitiveness of Moroccan logistics is intended to decrease the use of energy by 2030, as well as to foster multimodal transportation and the transition to more efficient modes of transport.

Also, several measures have already been taken in place in road transport to reduce greenhouse gas emissions in a significant way (METLW, 2018). Moreover, developing a national roadmap for sustainable mobility supported by the German Development Institutions (GIZ).

4. Energy Efficiency in the residential sector

4.1. Energy consumption

The residential sector has consumed 4.0 Mtoe in 2017, which represents a 26% increase compared to 2007. The oil, essentially liquefied petroleum gas (LPG), is the main fuel used by 63% of total consumption in the industry, followed by electricity (23%), and biofuels (14%) (Figure 4.7) (AZEROUAL et al., 2018; Haas, 1997; Lebied, Sick, Choulli, & El Bouardi, 2018). During the period 2007-2017, the use of LPG increased by 50% and electricity by 67%, which replaced the solid biofuels that had been the primary source of heating and cooking. In the residential sector, the uptake of traditional types of biomass-wood and charcoal dropped to 43% over the same period. This is reflective of the efforts made by the Moroccan government to develop alternatives to biomass, in order to avoid deforestation as well as the health problems that are related to their use.

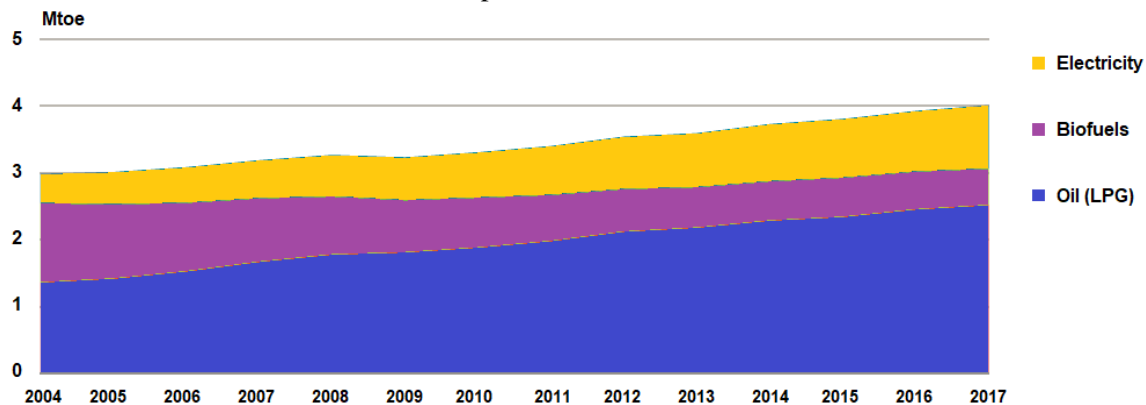


Fig. 4 TFC in residential sector by source

Source: IEA (2019 forthcoming), World Energy Balances 2019 preliminary edition www.iea.org/statistics/

Morocco's cooking represents roughly two thirds of the residential sector's total energy use. Other main residential energy needs include water heating, refrigeration, lighting and electrical appliances. Heating and cooling of space account for a very small part of total household energy consumption, such as shown in Figure 4.

Meanwhile, residential energy use rose by 27% over the period 2006 to 16 in parallel with demographic growth, the energy use by building sector slightly declined over the period, reflecting the turnover of the building fleet with new and more energy efficient dwellings (see Figure 5).

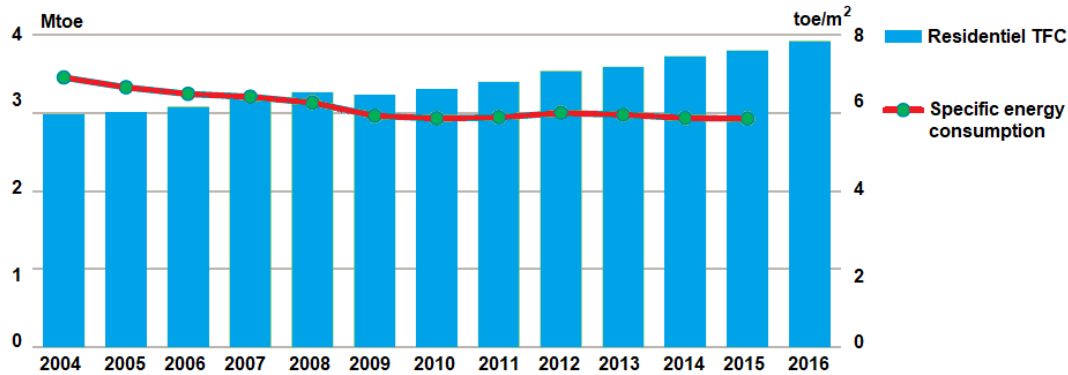


Fig. 5. Residential consumption and energy intensity

Source: IEA (2018a), World Energy Balances, 2018, www.iea.org/statistics/

The consumption of oil is still representing about 63% of residential energy use in Morocco. Morocco has reached the universal access to electricity on the part of its rural population, which promotes an increasing and widespread use of electricity as well as the use of modern appliances, especially to meet cooling and other needs.

4.2. Various policy targets in residential sector

The main laws that govern this sector of residential are (Iea, 2019; Law, n.d.):

Law No. 47-09 on the energy efficiency of 17 November 2011:

- Requiring the company to provide information on power capacity and the use of energy, as well as to carry out mandatory energy audits if the use exceeds 500 toe (oil equivalent) tonnes per year.
- Implementation of the standard NM 14.2.300 on the labeling of household appliances and electrical products. The appliances that require mandatory labeling are cooling appliances (refrigerators, freezers and air conditioners), cooking appliances (electric ovens), cleaning appliances (dishwashers, washing machines and dryers).
- Increasing the public awareness initiatives to promote the transition to more efficient appliances as well as to provide the benefits of using appliances with higher efficiency standards to the public.
- Implementation of summer time, by adopting the GMT+1 time zone during the summer months (May-July, September-October) to improve the use of daylight.

On the other hand, there are plans to:

- Renovation of the city's public lighting installations.
- Extension of the public lighting network to the entire urban territory.
- Reduce the impact of energy costs on the municipal budget (consumption and maintenance).
- Establish a preventive and corrective maintenance regime to ensure that equipment is maintained in optimal technical and economic conditions.

the implementation of the Law No. 47-09 on the energy efficiency is estimated in the side of labeling to save a net of 8% of national electricity consumed within 15 to 20 years. Further, the implementation of energy efficiency law will reduce the emissions of greenhouse gaze.

5. Energie efficiency in the industrial sector

5.1. Energy consumption

The major energy sources used in Morocco are oil and electricity (see Figure 6). Fuel oil or other petroleum products are by far the most significant energy source, representing 68% of overall use in 2017, while electricity is the second most important source, 3% biofuels and waste as well as 2% of natural gas. The TFCs in the industry reached 3.8 Mtoe in 2017, up from the peak reached during 2011-13 (AZEROUAL et al., 2018; Iea, 2019). The use of oil decreased from 2013 onwards as subsidies for fossil fuels were abolished and subsequently increased again in 2017.

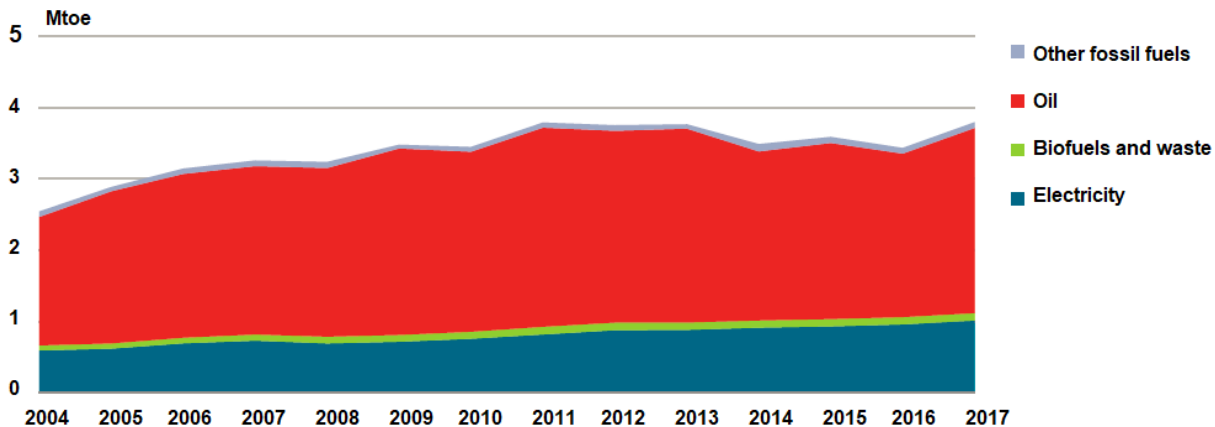


Fig. 6 TFC in the industry by source

Source: IEA (2019 forthcoming), World Energy Balances 2019 preliminary edition, www.iea.org/statistics/

The non-metallic minerals industry and the mining and quarrying industries are the two most important industries regarding the use of energy, representing about 60% of the sector's total use. However, the cement industry (Lafarge, Ciments of Morocco) is the only responsible for a third of total industry use. The extraction and chemical process of phosphate rocks in Morocco covers more than 20% of industrial energy consumption and represents 50% of total GDP.

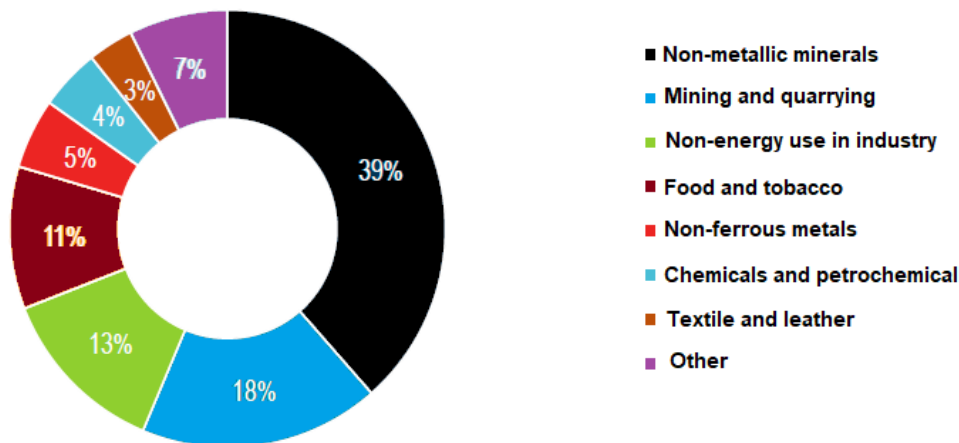


Fig. 7. TFC in industry by sector, 2016

Source: IEA (2019 forthcoming), World Energy Balances 2019 preliminary edition, www.iea.org/statistics/

The production of chemicals involves the processing of phosphate into fertilizers and other chemicals. The remaining industrial sectors, which include the processing industries, such as pulp and paper, food products (i.e sugar production) and tobacco processing, textile, and leather production (Figure 6).

Despite the fact that industrial energy use rose by 41% in 2004-2015, its intensity declined during the same period by 13%. A decrease in energy use intensity per unit of GDP is mainly due to more energy efficient industrial processes or to structural changes in the national industry.

5.2. Various policy targets in commercial sector

The main laws that govern this sector of commercial are (Iea, 2019; Law, n.d.):

Law No. 47-09 on energy efficiency in the industrial sector:

- Requiring companies to declare their installed capacity and energy use, as well as to carry out mandatory energy audits, if the use exceeded 1500 tons of oil equivalent (toe) per year.
- Training sessions to assist companies of large scale business in the process of optimization and streamline their use.
- Shifting the energy use of Morocco's industrial sector from the super peak tariff in order to benefit from a significantly lower rate in hours of low demand. For instance, the companies of high energy-intensive companies, including the steel industries, have been joining this program of energy efficiency to decrease their energy bills.
- Morocco's industrial sector is very sensitive to peak electricity prices. The super peak tariff for industries prompts them to shift their energy use out of the peak periods on a voluntary basis, in order to benefit from a significantly lower rate in hours of low demand. Further, several energy-intensive companies, including the steel industries, have been joining this program of energy efficiency to decrease their energy bills.
- Encouragement of the companies to become more energy efficient by setting limits on air pollutant emissions. Further, improvements in energy efficiency, meanwhile, reduce Greenhouse gases emissions.

Conclusions

The high levels of energy demand resulting from socio-economic development are the key concerns of the 21st century world. In fact, policy makers around the world are pursuing suitable innovative strategies to reach sustainable development, in which enhancing the life-quality and protecting the environment are high priorities.

The national energy strategy in Morocco, focusing on improving energy efficiency, is surely the most important national concern. It makes Morocco one of the most ambitious countries in the world in terms of promoting sustainable development. Consequently, Morocco has been the centre of significant investments in energy efficiency, mainly as a result of the high availability of energy resources.

In this paper, we reported the energy efficiency in Morocco in sectors of transport, residential, and industrial and emphasized that the swift transition to energy efficiency constitutes the main challenge for the Moroccan government. Consequently, we have briefly reported the energy policy for different sector and their achievements in Morocco.

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Aknowledgements

This research was supported by the projects, which have received funding from the European Union: International Research Staff Exchange Scheme (IRSES) FP7-PEOPLE-2012-IRSES, Grant Agreement Number 319017 SHuMED and ES H2020-MSCA-RISE-2014 CLUSDEV MED Grant Agreement Number 645730730

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Lahcen EL IYSAOUI was born in Morocco, in 1989. He received the B.S. degree from Faculty of Sciences, Fez, Morocco in 2012 and M.S from Faculty of Sciences, Fez, Morocco in 2015. He is currently member of Electronic and Communication laboratory at Mohammadia School of Engineering -university mohammed v in Rabat -Morocco, and Signals, Systems and Components Laboratory at Faculty of Sciences and Technologies-University Sidi Mohamed Ben Abdellah –Fez, Morocco. His research interests include Power Electronics, Renewable Energy, Photovoltaics, Electrical Engineering, End Use of Photovoltaic Technology, Energy Efficiency, Energy Management.

ORCHID ID: <https://orcid.org/0000-0001-9649-898X>

Najiba EL AMRANI EL IDRISSE is Ph. D professor at the Electrical Engineering Department, Faculty of Sciences and Technologies-

University Sidi Mohamed Ben Abdellah –Fez, Morocco. She's coordinator of the research team Signals, telecommunications and smart

grids of the Signals, Systems and Components Laboratory. She was graduated Engineer in Computer System and has a Ph.D. degree in

Electrical Engineering: Electro-technique and Power Electronics, from EMI (Mohammadia School of Engineering) Rabat, Morocco. She

has been:

- Program committee member of several international conferences.
- Head of Electrical Engineering department – FST- USMBA
- FP7 (7th Framework Programme for Research and Technological Development) ICT-National Contact Point of Morocco
- National Coordinator of several national and European projects FP6, FP7 and Horizon 2020 (MAP-IT, ShuMED, ClusMED,
- Idealist2011, MED-Dialogue, Idealist 2014, ClusDevMED, FETUMA...)
- Chairman of the ETC's (ESCWA Technology Centre) technical commission 2013-2014
- Member of the Moroccan local team of Higher Education Reform Experts (HEREs); 2014-2018

Author ID: 56122394900

Manuela TVARONAVIČIENĖ is professor at Vilnius Gediminas Technical University of Lithuania. She is national head of European Union's Horizon 2020 research and innovation programme European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme Marie Skłodowska-Curie Research and Innovation Staff Exchanges ES H2020-MSCARISE-2014 CLUSDEV MED (2015-2019) Grant Agreement Number 645730730.

ORCID ID: <http://orcid.org/0000-0002-9667-3730>

Mhammed LAHBABI is professor in the Department of Electrical Engineering at Faculty of Sciences and Technologies-University Sidi Mohamed Ben Abdellah –Fez, Morocco. Received the state doctorate in optoelectronics from Faculty of Sciences and Technologies-University Sidi Mohamed Ben Abdellah –Fez, Morocco, in 2002. Received the research doctorate in physical science from University of Sciences and Techniques of Languedoc (Montpellier II) in 1990. He's Head of Signals, Systems and Components Laboratory.

Author ID: 56615430900

Abdelmajid OUMNAD is Professor in the Department of Electrical Engineering at Mohammadia School of engineering (EMI) and member of the Laboratory of Electronics and Communication (EMI). He received his Ph.D. in electronics of the Claude Bernard University in Lyon, He is a professor in Electronic and Communication Technology at the Department of Electrical Engineering in Mohammadia School of engineering in Rabat.

Author ID: 57201156464

Register for an ORCID ID:

<https://orcid.org/register>

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