ISSN 2601-8683

9 772601 868006

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Optical Solitons and Demonstration of Its Application

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Abstract

Solitons are structurally stable solitary waves that propagate in a nonlinear medium. In this paper, solitons will be considered as the basis for solving many classical nonlinear equations of motion. Some classical solutions that were modeled through the application of Wolfram Mathematica System and MATLAB programming language. In this paper some soliton solutions will also be compared and some types of solitons were modeled.The dynamics of solitons was studied in consideration of solutions of some equations, such as the Korteweg - de Vries equation and as a particular solution for the nonlinear Schrödinger equation provided that the nonlinearity parameter R>0 in the equation. We concluded by showing solitons in more detail which are often used in practice as a simpler method for explaining complex phenomena and solving non-classical equations

Keywords: Soliton, Shrodinger non-linear equation, Korteweg–de Vries equation, optical soliton, soliton simulations.

Introduction

At present, the theory of solitons has embraced various branches of the natural sciences. Initially, they arose in the study of waves in water and in other problems of hydrodynamics [1, 2]. Afterwards, the solitons penetrated together with the hydrodynamic model into plasma physics and condensed matter physics. Later solitons and phenomena associated with them began to be studied in classical and quantum field theory and statistical mechanics. Solitons are also found in such areas as biophysics, nonlinear optics, etc. It must be emphasized that the study of solitons in nonlinear optics has been possible both theoretically and experimentally.

Most of the considered waves are in the group of monochromatic waves. But besides them, there is a wide group of waves, which are called solitary [1]. A good example of such a wave is the light pulse. Very often, a solitary wave is presented in the form of a wave packet, i.e., a linear superposition of a large number of monochromatic waves having frequencies close to the frequency of the carrier wave. Often, each of the components of a wave packet in space propagates with its own speed, i.e. there is a

velocity dispersion. This phenomenon leads to an increase in the width of the wave packet, i. e. the broadening of its dispersion [5]. The speed of the entire packet is called the group velocity, and the mediums in which the velocity dispersion is present are called dispersing.

In 1965, N. Zabuski and M. Kruskal discovered that solutions of the Korteweg – de Vries equation describing the propagation of solitary waves in shallow water have remarkable properties: they do not experience dispersive broadening and interact elastically, i.e. they retain their shape after collision and passage through each other [1, 2]. To emphasize the exceptional elementary nature of these solitary waves, they were given the name "soliton". Solitons are defined as follows: this is a special type of nonlinear solitary waves (wave packets) that retain their shape and speed during their own motion and collisions with each other [1].

As we know, intense high-frequency (HF) wave packets can propagate in nonlinear mediums without changing their shape, i.e. they are solitons. Soliton solutions arise in many topical problems in various fields of physics while modeling the propagation of intense waves in dispersive media. In physics, there are many types of solitons, such as dark solitons, light solitons, optical solitons, etc.

Different types of solitons are particular solutions of many equations, such as the Korteweg – de Vries equation, the nonlinear Schrödinger equation with the condition that the nonlinearity parameter in the equation is $R > 0$, the Maxwell – Bloch system [4], the sine – Gordon equation, and so on.

In this paper, we will consider some particular solutions of the above equations. These solutions can be presented in the following forms: one-soliton solutions, two-soliton solutions, and cases where the solution is optical solitons. All solutions are modeled and presented in the figures below.

Types of solitons and their applications

As we mentioned above, solitons are solutions of many equations in physics [1]. The below-discussed solitons are among the more widely used solutions of equations. In addition, they are o within the research scope of various fields of physics.

Dark solitons

As we already understood, a soliton is a wave traveling in a nonlinear medium by itself. A dark soliton is formed when this intensity locally decreases in a continuous wave of certain intensity[1, 5]. In other words, these are gaps in the wave, no matter how rough it sounds (fig. 1).
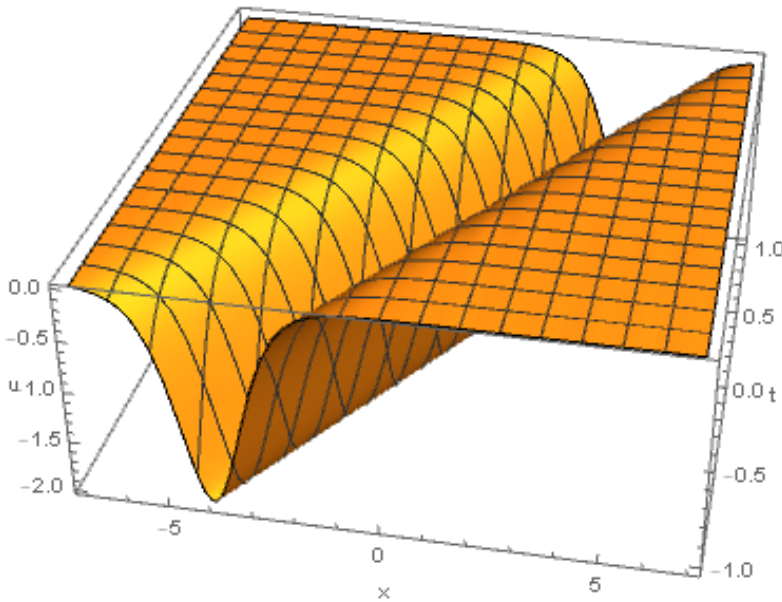
Fig. 1. Dark Soliton

The frequency crests of the microcavity use the nonlinear Kerr effect in the integrated optical cavity to generate a variety of phase-frequency lines [1]. The interval between the lines can reach 100 GHz, which makes the system an excellent multi-wavelength light source for fiber-optic devices and systems. The dispersion of the microresonator affects the physical dynamics itself. Recent studies of the states of the frequency crest have demonstrated the formation of dark pulses in a microcavity with normal dispersion. This kind of "dark-impulse" ridges have become very popular among researchers because of their possible use in coherent communications due to the very high efficiency.

Optical solitons

Optical solitons are optical pulses that preserve the structural stability of the envelope when propagating in a nonlinear medium even in the presence of interfering factors and interactions with other solitons [2, 3]. Depending on the nature of the nonlinear interaction of radiation with matter, the soliton effects in optics are divided into resonant and non-resonant. In non-resonance media, optical solitons are formed as a result of the balance of two competing processes — dispersive spreading and nonlinear self-compression. The most favourable conditions for the formation of a soliton are realized in single-mode optical fibres due to extremely small optical losses and stability of the mode structure of the radiation with an increase in input power up to values close to the self-focusing threshold.

The basis for an adequate mathematical description of the processes of formation and interaction of solitons in the picosecond range of durations is the nonlinear Schrödinger

ISSN 2601-8683 (Print)
ISSN 2601-8675 (Online)

European Journal of
Formal Sciences and Engineering

July -December 2021
Volume 4, Issue 2

equation, which corresponds to the complex amplitude of the field $A(\xi, \tau)$ [1]. The envelope of a soliton pulse has the form $A(\xi,\tau) = \mathrm{sech}(\tau)e^{-i\xi/2}$, where ξ - is the distance normalized to the dispersion length L_D, $\tau = (1-z/u)/\tau_0^2$ — is the running time normalized to the initial pulse duration, u is the group velocity. Schrödinger nonlinear equation belongs to the class of integral nonlinear equations and is solved by the inverse scattering problem. If the power of a spectrally bounded pulse exceeds the critical power, then its asymptotic behaviour as $\xi \to \infty$ is determined by the soliton component. The amplitude of the non-soliton part of the solution decreases.

An important factor in the analytically calculated solutions of a nonlinear Schrödinger equation is N-soliton pulses corresponding to initial conditions of the form $A(0,\tau) = N\mathrm{sech}(\tau)$, where N is an integer. They are a nonlinear superposition of N moving with the same speed solitons with amplitudes $A_m = (2b-1)$, $b = 1, 2, \ldots N$. Important features of N-soliton pulses are that their propagation begins with self-compression, and the complex amplitude modulus is periodic in ξ with a period $\pi/2$.

Fundamental soliton

As we have already mentioned, the bandwidth of fibre-optic communication lines is limited to non-linear effects and dispersion, changing the amplitude of the signals and their frequency [1]. But, on the other hand, the same nonlinearity and dispersion can lead to the creation of solitons, which retain their shape and other parameters substantially longer than anything else. An example of a laser that changes the refractive index inside an optical fiber as it spreads is vital enough, especially if a pulse of several watts is placed into a fiber thinner than a human hair. For comparison, we will clarify that a typical 9-watt energy-saving light bulb illuminates a desk, but is palm-sized at the same time. In general, we will not be far from reality assuming that the dependence of the refractive index on the pulse power inside the fiber will look as follows (1):

$$n(P) = n_0 + n_1 P, \quad n_1 > 0 \qquad (1)$$

After physical reflections and mathematical transformations of varying complexity of amplitude a of the electric field inside the fiber, one will get the equation of the form (2)

$$\frac{1}{2}\frac{\partial^2 a}{\partial x^2} + i\frac{\partial a}{\partial z} - N^2 |a|^2 a = 0 \qquad (2)$$

where z and x coordinate along the propagation of the beam and transverse to it. The N coefficient plays an important role. It determines the relationship between dispersion and nonlinearity. If it is very small, then the last term in the formula can be thrown out due to the weakness of the nonlinearities. If the coefficient is very large, then the

nonlinearity, pressing on the dispersion, will single-handedly determine the features of signal propagation. So far, they tried to solve this equation only for integer values of N. So, for N = 1, the result is especially simple (3) :

$$a(x,z) = \text{sech}(x)\exp(-iz/2) \qquad (3)$$

The function of the hyperbolic secant looks like an ordinary "bell"
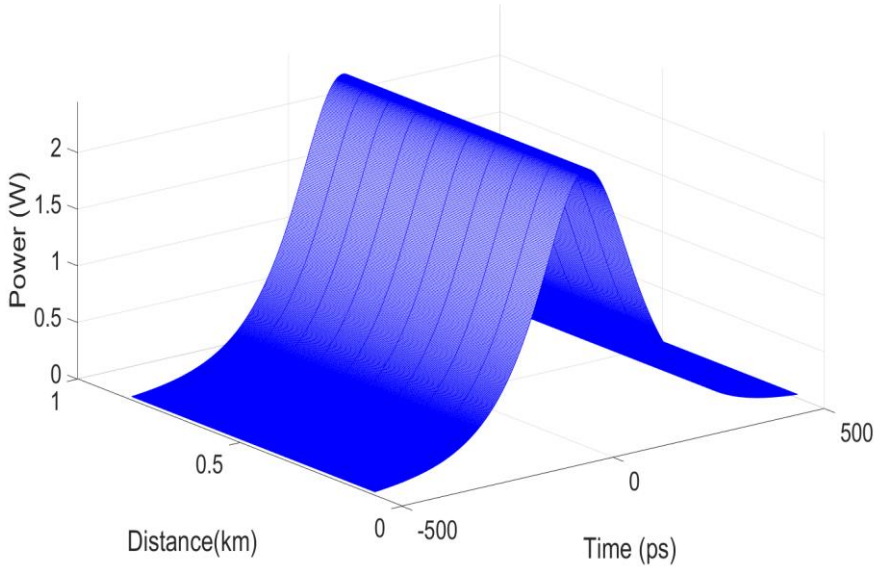
Fig.2. The intensity distribution in the cross section of the laser beam in the form of a fundamental soliton

and is called the fundamental soliton (fig. 2). The imaginary exponent determines the soliton distribution along the fiber axis. In practice, this all means that having shone on the wall, we would see a bright spot in the center, the intensity of which would quickly fall off at the edges.

The fundamental soliton, like all solitons arising using lasers, has certain features. First, if the laser power is insufficient, it will not appear. Secondly, even if somewhere the fiber bends, the soliton passing through the damaged area will change, but will quickly return to its original parameters [1]. People and other living beings also fall under the definition of an autosoliton (the ability to return to a quiet state), which is important in nature.

Second order soliton

The Korteweg-de Vries Equation (KdV equation) describes the theory of water waves in shallow channels, such as a canal [1, 6]. It is a non-linear equation which exhibits special solutions, known as solitons, which are stable and do not disperse with time.

Furthermore there as solutions with more than one soliton which can move towards each other, interact and then emerge at the same speed with no change in shape (but with a time "lag" or "speed up").

The form of Korteweg-de Vries Equation is shown below (4).

$$\frac{\partial u}{\partial t} = 6u\frac{\partial u}{\partial x} - \frac{\partial^3 u}{\partial x^3} \qquad (4)$$

The theory for solutions with more than one soliton is complicated and we will not discuss it, but rather just display a two-soliton solution, verify that it is indeed a solution, and look at its properties [6]. Specifying adequate resolution and number of time steps, my computer ran out of memory.

The theory states that an initial state (5)

$$u(x,0) = -n(n+1)\operatorname{sech}^2(x) \quad (5)$$

results in n solitons that propagate with different velocities. The solution for n = 2 is (6)

$$u(x,t) = -12\frac{3 + 4\cosh(2x - 8t) + \cosh(4x - 64t)}{\left[3\cosh(x - 28t) + \cosh(3x - 36t)\right]^2} \quad (6)$$

It is not immediately evident that the above expression for u(x, t) satisfies the KdV equation, but Mathematica confirms that it does:

Next we plot the solution at time t = 1 in fig. 3:
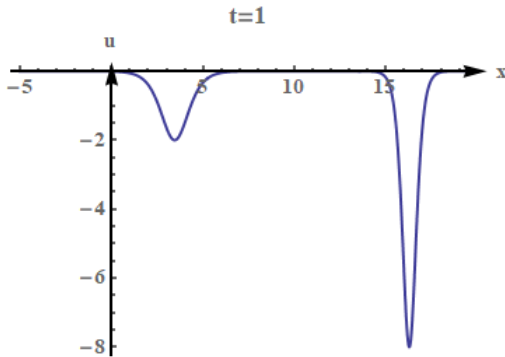
Fig. 3 KdV equation two soliton solution at $t=1$

Other two soliton solution example is sine-Gordon equation [7, 8]. The sine-Gordon equation is a nonlinear hyperbolic partial differential equation in 1 + 1 dimensions involving the d'Alembert operator and the sine of the unknown function. There are two

equivalent forms of the sine-Gordon equation. In the (real) space-time coordinates, denoted (x, t), the equation reads (7):

$$\frac{\partial^2 u}{\partial x^2} - \frac{\partial^2 u}{\partial t^2} = \sin u \qquad (7)$$

where partial derivatives are denoted by subscripts. Passing to the light cone coordinates (u, v), akin to asymptotic coordinates where (8)

$$f = \frac{x+t}{2}, \quad v = \frac{x-t}{2} \quad (8)$$

the equation takes the form (9):

$$\frac{\partial^2 u}{\partial f\, \partial v} = \sin(u) \qquad (9)$$

Multi-soliton solutions can be obtained through continued application of the Bäcklund transform to the 1-soliton solution, as prescribed by a Bianchi lattice relating the transformed results. The 2-soliton solutions of the sine-Gordon equation show some of the characteristic features of the solitons. The traveling sine-Gordon kinks and/or antikinks pass through each other as if perfectly permeable, and the only observed effect is a phase shift [5, 7]. Since the colliding solitons recover their velocity and shape such kind of interaction is called an elastic collision (fig. 4).
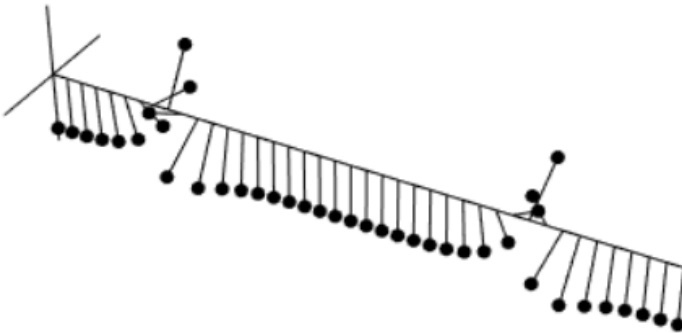
Fig.4 Two solitons Kink-kink collision

Third order soliton

For sine-Gordon equation has three soliton solution. 3-soliton collisions between a traveling kink and a standing breather or a traveling antikink and a standing breather

results in a phase shift of the standing breather. In the process of collision between a moving kink and a standing breather, the shift of the breather Δ_B is given by (10) [5]:

$$\Delta_B = \frac{2\operatorname{arctanh}(\sqrt{\left(1-\omega^2\right)\left(1-v_k^2\right)}}{\sqrt{1-\omega^2}} \qquad (10)$$

where v_k is the velocity of the kink, and ω is the breather's frequency. If the old position of the standing breather is x_0, after the collision the new position will be $x_0 + \Delta_B$ (fig. 5)[8].
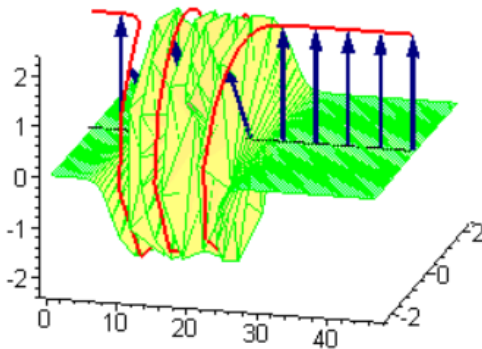
Fig. 5 Moving kink standing breather collision

Conclusion

In this paper, we considered different types of solitons as the basis for solving some nonlinear equations. Particular solutions of the following equations were presented: the non-linear Schrödinger equation, the sine-Gordon equation, and the Korteweg-de Vries equation. Monosoliton, two-soliton and three-soliton solutions were shown. In addition, the influence of the dark soliton on the wave and its significance in modern literature was shown.

Using computer simulation, the behaviour of solitons in a nonlinear and dispersive medium was shown with a particular one-soliton solution of the Schrödinger equation.

In addition to the above, the behaviour of a laser beam in the form of a fundamental soliton was modelled. In this paper, it was proved that solitons are one of the easiest ways to explain complex phenomena and solve non-classical equations.

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Resilience of Urban Infrastructures in a Pandemic Scenario

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Abstract

Most of the work on resilience of urban infrastructures focuses on their technical performance and reliability in disaster situations. In general, when we link urban infrastructure and Civil Engineering, we think of technology, engineering, constructions and technical or control buildings. In a state of pandemic like the current one, the study of the relationship between urban infrastructures and resilience is a phenomenon scarcely studied in the literature. The main objectives of the article are to analyse, from a Civil Engineering and actors' perspective, the role and behaviour of urban infrastructures for the maintenance of the wellbeing of the community in a pandemic situation, and to fill a gap in the existing bibliography. The authors argue that the human factor is the most important element for infrastructure to be resilient in a Covid-19 situation. To achieve the objectives, a review of the literature was carried out considering the works published in the last 10 years. Then, a reflection is made about the influence of the resilience in infrastructures during a pandemic situation considering the relevant sustainability factors. As practical implications of this article, the drawn conclusions are expected to represent value for the societies of the future.

Keywords: Urban Infrastructures, Resilience, Pandemic, Civil Engineering, Sustainability

Introduction

The present work intends to show and to outline how to face the analysis of resilience in a state of global pandemic in critical infrastructures of mobility and transit of passengers and goods, based on a review of the bibliography of the last 10 years. This type of infrastructure is going to be essential to controlling the spread of the disease. Secondly, the dimensions of sustainability in a pandemic situation will be analyzed.

As it is intended to focus on the issue of the resilience of the infrastructures named above in a pandemic scenario, sudden disruptions due to structural collapse, earthquake, tsunami or other catastrophic events that may occur simultaneously are not considered. In the case of pandemics, the role of people is central and important. It is the people who operate the urban infrastructure, who remain in their jobs and who keep them up and running.

When a relationship is made between urban infrastructure and Civil Engineering, common sense leads us to think about technology, engineering and other types of buildings. As a result, most of the work on urban infrastructure resilience focuses on their technical performance in the event of a catastrophe. However, it turns out that, in a pandemic case like the current one, people are the most important element for the whole system to be resilient.

Among natural disasters like earthquakes, many of the world's most destructive catastrophes are centered around water, through floods (excess of water in the wrong places); droughts (lack of water in the places where it is needed); contamination (useless or risky water) (Feagan et al., 2019; Fox-Lent & Linkov, 2018; Heinzlef, Becue, & Serre, 2020; Moatty & Reghezza-Zitt, 2019; Rezende, Franco, Oliveira, Jacob, & Miguez, 2019; Sauter, Feldmeyer, & Birkmann, 2019; Vamvakeridou-Lyroudia et al., 2020; Vitale, Meijerink, Moccia, & Ache, 2020). We are currently experiencing an even more destructive catastrophe than the previous ones, since it affects people's health when a society declares a state of health alarm or pandemic. Therefore, critical infrastructures for the mobility and transit of passengers and goods are going to be essential for controlling the spread of the disease.

The Royal Spanish Academy defines a pandemic as "an epidemic disease that spreads to many countries or that attacks almost all individuals in a locality or region"; this Academy defines resilience as "the ability of a living being to adapt to a disturbing agent or an adverse state or situation", or as "the ability of a material, mechanism or system to recover its initial state when it has ceased the disturbance to which he had been subjected".

Urban resilience is based on the conception of the city as a system of systems, a complex entity that, like the human body, needs the different organs to function properly in order to enjoy good health. The Royal Spanish Academy defines infrastructure as "a set of elements, endowments or services necessary for the proper functioning of a country, a city or any organization"; there is currently talk that infrastructure must adapt to the effects of global warming with a view to the societies of the future. The Intergovernmental Group of Experts on Climate Change (Bernstein et al., 2008), in 2007, defined resilience as "the capacity of an ecological or social system capable of absorbing disturbances while maintaining the same structure and basic forms of functioning, the ability to self-organize and the ability to adapt to stresses and changes". Regarding urban resilience, the most accepted definition (AA.VV., 2020; Masik & Grabkowska, 2020), is

the one proposed by Meerow et al. (2016): "urban resilience refers to the ability of an urban system - and all its constituent socio-ecological and socio-technical networks acrosstemporal and spatial scales - to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity" (Meerow, Newell, & Stults, 2016, pp. 39, 45).

To develop resilience in infrastructures, all possible vulnerabilities and risks, whether infrastructural or operational, related to their proper functioning must be identified. Once identified, they would be analyzed and evaluated, through data analysis, projections, modeling and simulations, to establish possible adaptation strategies to apply at the territorial level.

Therefore, we can affirm that the meaning of a resilient infrastructure is the one that must be prepared to provide service in any adverse situation. Urban infrastructure is based on different networks that provide citizens with water, energy, transportation, waste management, healthcare, education, and other basic services. These networks that form the urban infrastructure are fundamental for life in modern cities and when these fail, human health, well-being, and the economy are endangered putting consequently the pillars of sustainability at risk.

Within urban infrastructures, in this work we will only deal with resilience for critical mobility and transit infrastructures for passengers and goods (elements such as roads, bridges, railway lines, airports and ports) in a pandemic scenario. Infrastructure resilience has been treated in the literature from different aspects, such as from the perspective of terrorism, from the perspective of natural disaster, climate change, etc., but studies of infrastructure resilience from the perspective of a state of a global pandemic such as that currently experienced with Covid-19 are scarce.

As we know, humanity requires useful infrastructures and governments need to invest in road works, bridges, railway lines, tunnels, dams and ports, so that they are resilient, and they need to be operational even in situations of sanitary emergency. It is demonstrated that for the proper functioning of an infrastructure in a state of sanitary alarm, collaboration, control and the involvement of the human factor as the main agent (military control, police control, health control, etc.) are essential. Social fear, family recruitment, military and health control mean that infrastructures need to have action plans to have resilience capacity in migratory movements due to the impacts of a health emergency such as the one we are suffering with the Covid-19. Currently, it has been demonstrated that societies must have contingency plans for critical mobility and transit infrastructures for passengers and goods framework, in order to reduce the problems of their use due to the health emergency, and above all to avoid the spread of the illness.

Resilience in urban infrastructures in a pandemic scenario

Resilience can also be defined as the capacity of a socio-ecological system to anticipate, manage changes and recover from the effects of a disruption when exposed to disturbances and trends, whether economic, environmental, social or political. This can only be achieved by maintaining the long-term absorption, adaptation and transformation capability of the system (Paz, Méndez, & Mukerji, 2017).

The literature has generally focused its resilience analyzes on climatic aspects, calling climatic resilience as the combination of absorption, adaptation and transformation capacities, which can be delineated according to the responses to climatic disturbances and stresses that they provide (Giz, 2014; IUCN, 2014). Regarding the above, we define:

The absorption capacity of a system, as its capacity to repair or recover from the impacts of negative events using predetermined confront responses in order to preserve and restore basic and essential functions and structures (Béné, Devereux, & Sabates-Wheeler, 2012; Cutter et al., 2008). In short, it can be summarized as the system's response capacity to a threat.

The adaptability capacity of a system, such as its capacity to adjust, modify or change its characteristics and actions in order to better respond to existing and future climate shocks and stresses and take advantage of opportunities (Béné et al., 2012; Brooks, 2003; IPCC, 2012).

The transformation capacity of a system, such as the capacity to fundamentally change its characteristics and actions when existing conditions become unsustainable in the face of climatic disturbances and stresses (Béné et al., 2012; Walker, Holling, Carpenter, & Kinzig, 2004).

The previous definitions have been developed in a concept of resilience in infrastructures from a climate change point of view. For example, if we think of a flood-prone area, we should have a levee system. At this point it is worth asking what should the previous capabilities of a mobility infrastructure (absorption, adaptation and transformation) be like if there is a pandemic state?

It should be noted that the concept of resilience is still relatively recent in the field of Civil Engineering, which is why many studies are based on and adapt existing definitions (Wang, Xue, Wang, & Zhang, 2018). This did not restrict the attempt to define infrastructure resilience as "the ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event" (United States National Infrastructure Advisory Council, 2009 apud Quitana, Molinos-Senante, & Chamorro, 2020).

If we recall the sustainable development goals of the 2030 Agenda, the ninth goal marks us: "To develop reliable, sustainable, resilient and quality infrastructures, including

regional and cross-border infrastructures, to support economic development and human well-being, with special emphasis on affordable and equitable access for all".

In a pandemic state, human well-being is diminished by the possible threats of contagion that make it possible to spread the disease, which is why we ask ourselves: has it been considered how a system acts in a situation of pandemic state? The answer is obvious, the only responsible for absorbing, adapting and transforming the infrastructure is the human factor together with technology, for migratory control and preventing the spread of the disease. But are the critical infrastructures of mobility and transit of passengers and goods resilient in a pandemic scenario? They can only be resilient if there are people who operate them. In this situation it is important to have assets that immediately replace operators who become ill. Have you ever imagined a metro network where water is continuously pumped so that the network is not flooded? This is a situation that exists in many cities. Without the man, these pumps could still work for a while, but then they would stop. Why? Because there would be no one to operate or repair them. Despite the computerized world in which we live, the human factor remains fundamental. Table 1 compares the actions of resilience of such infrastructures in climate, war and pandemic scenarios.

Table 1 – Comparison of actions in infrastructures of mobility and transit of passengers and goods (authors)

Critical infrastructure for mobility	Climate scenario	War scenario	Pandemic scenario
Roads/Bridges/Tunnels Railways/Subways Ports Airports	Climate changes due to temperature; Environmental disasters (example: Sea level rise, Rains, Seismic problems).	Alternative route Panic room	Passenger control (temperature measurement); Isolation of affected people; Social distance; Border closure; Packaging disinfection points; Cleaning and disinfection; Isolation rooms.
Ability to absorb, adapt and transform	Improvement of the infrastructure's stability against unexpected mechanical actions derived from climatic or warlike changes		Human factor and technology

Sustainability in a pandemic scenario

The concept of sustainability was first introduced in 1972 at the United Nations (UN) Conference on the Human Environment held in Stockholm. Later in 1987, most definitions of sustainability established by the World Commission on Environment and

Development (WCED, also called the Brundtland Commission), indicate that sustainable development refers to "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (ONU, 1987), being this the definition of sustainable development that has been used by many researchers. The terms sustainability and sustainable development have varied widely over the years (Kaye, Gabriela, & Nijaki, 2012) and both have multiple interpretations and often mean different things to different people (Illankoon, Tam, & Le, 2016). According to Ross (2009), sustainability refers to things that can be done for longer periods without unacceptable consequences. Therefore, the concept of sustainability and resilience are very similar in that they share "enduring time and responding to changes". Ortiz, Castells & Sonnemann (2009) identified sustainability as a concept to improve the quality of life and, therefore, allow people to live in a healthy environment and improve environmental, economic and social conditions for present and future generations. Weybrecht (2010) defined sustainability as the incorporation of the economy, the environment and equity in political values and objectives.

The United Nations indicates three "pillars of sustainability": economic, social and environmental (ONU, 2002). Akadiri (2011) insists that for a development to be sustainable, social, ecological and economic factors must be considered. Du Plessis (2007) pointed out that the relationship between humans and their environment is determined by a certain number of factors. Therefore, over time, new pillars were added to the three basic pillars, with which sustainable development was fed. To date we can talk about the economic, social, environmental, ecological, technological, competitiveness, equality, eradication of poverty, labor well-being, economic growth, etc. as new pillars of sustainability.

Figure 1 generically represents the economic and social sustainability of a given country or city with a single curve, environmental sustainability with another curve, and depicts an increasing evolution of the pandemic over a certain period of time. The behavior of economic and social sustainability as the pandemic evolves, decreases due to the lack of social integration of the community affecting the economic cycle of the region. However, by reducing pollution due to a confinement state, environmental sustainability is improved.

Figure 1 – Evolution of sustainability in a pandemic state (authors)
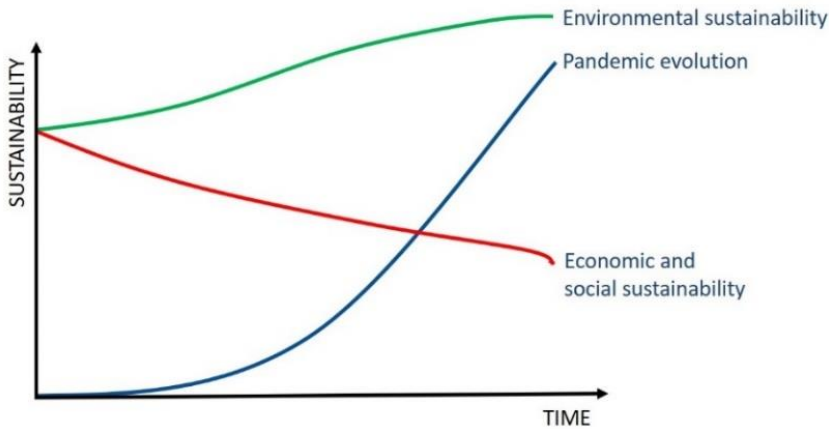
Conclusions

The issue of resilience in a pandemic period has been of fundamental importance in the recent months. This work reflects on the concept of resilience of critical infrastructures for the transit of passengers and goods in times of pandemic. This theme is scarce in the scientific literature, what makes this topic current.

It is verified through this review that the resilience of infrastructure in times of health alarm does not depend on the infrastructure itself, since the capacities for adaptation, absorption and transformation go hand in hand with the human factor and technology.

It has been verified that the infrastructure needs resilience to control the spread of the disease. Countries should develop contingency plans to evaluate options that allow infrastructure to behave appropriately for migratory transit and for disease control.

This study can be used so that stakeholders can make decisions that improve the resilient behavior of cities by optimizing disease control by the human factor and technology at the service of future societies.

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Role of Communication and Technology in Crisis Management

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Abstract

This study aims to indicate the role of the communication process and new technologies in the crisis management, by showing deferent concepts related to the crisis management, its phases, how can we manage crisis using communication, and how can we use technology to manage crisis. The main idea of this study is that stakeholders (internal or external) are very important to overcome on a crisis, and every organization must identify the full range of its stakeholders, so it can receive their help when it is necessary.

Keywords: Communication, Technology, Crisis Management

Introduction

In recent years, there has been a growing number of crisis faced by organizations, and there has been a significant change in the perception of challenges in the field of crisis management, because of that organizations have made a lot of researches to find effective methods to manage these crises, in order to reduce losses, and between these methods we find communication, and thanks to the technological evolution, managing crises becomes realistic.

Definition of the word crisis

The word crisis refers to a situation or a case faced by the decision maker in one of the administrative entities (country, enterprise, project family...), where events comes successively, and where the reasons are intertwined with the results, and because of that, the decision maker will lose control of this situation, and with its future trends (Idriss Lekrini, 2014, P10).

Definition of crisis management

The crisis management is to overcome on a crisis using scientific and administrative tools to avoid its negative aspects, and take benefits from its positive aspects (learning from it) (Mohssine Ahmed Elkhadiri, 2003, P 34).

Also it could be defined as a set of activities (financials & operational), that allows the maximization of a value of an enterprise, by reducing costs associated to the volatility of its cash flows (George Dionne, 2013, P 8).

Phases of crisis management

The crisis occurs in three phases; first, there is the crisis preparation (pre-crisis) which means the appearance of a few or many signs, before the occurrence of a crisis, a sensibility of the prevention is a systematic vigilance of the early warning signals, must also be developed by organizations, Professional abilities (stress management, preparation for the media communications, and organizational (flexibility, communication's fluidity, a quick mobilization of resources, response capacity), could be improved and tested, this first phase could be resumed to two crisis management mechanisms anticipating and sensing.

The second phase is the crisis recovery, where the organization follows one of the most important aspects of the crisis management: "the damage containment", to avoid the crisis affection of other organizations sectors.

Finally, an organization that lives a crisis, must learn lessons and admit its weaknesses, this phase is very hard, because organizations are attempted to hide their faults than learning of it, this phase is the learning process (Marine-Christine Therrien, 2012, P 2-3).

Communication for crisis management

The organization should not wait for a crisis to happen before deciding on how best to communicate during one. Much of the overall crisis communications strategy can be discussed and agreed well ahead of any event. This will give the organization time to develop and test the necessary relationships, plans, protocols and templates well before a crisis hits.

The pre-crisis phase has a strong emphasis on preparation. This should include horizon scanning to anticipate any potential events, which may have a significant negative impact on the organization.

During the crisis, communications can be broken down into three distinct phases: short, medium and long term. As crises differ in duration, these phases are not associated with timeframes but are aligned with how the crisis itself has progressed. These phases are broadly defined as:

- Short time: or 'pre-consequence', where the opportunity still exists to influence how the crisis unfolds and shape reactions to it.

- Medium term: or 'consequence response', where communications are centred around explaining events and how the organization plans to recover from them.

- Long term: or 'post response', focusses on rebuilding (and potentially

improving) the organization's reputation.

The phases of communicating in a crisis (including pre-crisis) and how the organization will approach each part, should be included in the organization's crisis communications plan. When a crisis hits, pre-planning means that the organization have already had the opportunity to think through and potentially exercise what the organization might do in the situation, rather than simply reacting to events (Tony Pearce, 2013, P5).

Stakeholders' identification

A stakeholder is defined as any group or public affected by the organization's operation (Christine M. Bailey and al 2005, P393).

Identifying the full range of the stakeholders of an organization, and their information needs, is a critical in the first step in preparing for any crisis event.

the stakeholders will have both broad and specific information needs and failure to meet these will result in a wide range of negative consequences, that will remain well after the crisis has been resolved.

Stakeholders can be divided into two groups - those external to the organization and those internal to it. During a crisis, concentrating on one group at the expense of the other will inevitably have a negative impact. Both internal and external stakeholders should be considered although not necessarily given equal emphasis.

External stakeholders

An organization's reputation and revenue streams are largely dependent on its external stakeholders. Mapping out the stakeholders prior to a crisis event will enable the organization to ensure that this time-consuming process does not have to be repeated from scratch at the start of every crisis, but rather can be revisited to ensure that the list remains current and any additional stakeholders specific to the crisis are identified.

Internal stakeholders

During a crisis, the organization will face pressure from external sources to re-establish pre-crisis service levels as soon as possible. The organization internal stakeholders are vital to ensuring that any crisis is successfully navigated and that the organization's response is conducted in a timely and effective manner.

Maintaining two-way communications internally is critical to successfully navigating a crisis. It will also ensure that the message is consistent across all parts of the organization. If internal stakeholders are not kept informed, a range of negative consequences may occur that will prolong the crisis.

Whilst the organization may have a social media policy in place, the ease of access to the internet through smart phones or computers means staff will probably access social media during a crisis, regardless of official advice.

Ensuring the staff have up-to-date and accurate information, will help ensure that incorrect and damaging information does not make its way into the public domain (Tony Pearce, 2013, P9).

Choosing the right communication channel

A communication channel is the method by which a message is delivered. There has been a rapid rise in the number of channels available to organizations to use to communicate with their stakeholders, thanks to advancements in technology.

When choosing a channel, you should ask:

- Who is your target audience? Use the channel most appropriate for your audience. For example, if you are attempting to communicate with people in remote communities, radio may be more appropriate.

- How quickly does the message need to be distributed? If it needs to be sent immediately, radio is a better medium than a daily newspaper.

- What resources do you have available? Some channels, such as social media need an organization to monitor and interact rather than acting as a 'fire and forget' resource. Do your staff have the time to perform this function in a crisis?

- How detailed is the message you are trying to convey? Different media have different length restrictions. For example, it may be better to use a text message to direct people to your website where you can publish more detailed information.

- Are you looking to inform or actually engage your audience? Television may be great for getting your message to people, but social media will allow you to get rapid feedback.

The organistion will probably use a mix of communication channels rather than any one individual medium during a crisis. This will allow the organization to communicate effectively with a range of its affected stakeholders (Tony Pearce, 2013, P 13).

Structuring the message

During a crisis, every detail of every message is scrutinised and acted upon. For this reason, the structure, language and content of each of your messages needs to be carefully considered.

Long-winded and rambling communications can lead to confusion, ineffective actions and may prolong the crisis. Well- crafted communications can help resolve the crisis more quickly and may enhance your reputation (Tony Pearce, 2013, P 17).

Collecting, analyzing, and responding to feedback

The organistion should gather feedback during and after a crisis to ensuring that it is

responding in an appropriate and positive way.

This information is also useful for a post-crisis review. It is important to capture the lessons identified during the crisis so that they can be incorporated into the organization's planning for any future event.

During an ongoing crisis, analysing feedback can allow the organization to actively manage and respond to any misinformation that may circulate. Fast and decisive 'myth-busting' can be crucial for correcting false information that stakeholders may be acting upon. It will also help counter any associated reputational damage. Feedback will in addition identify if there are information gaps that are being filled by external speculation, which it can fill with accurate information.

Not all feedback is useful however. Skill is needed to identify quality feedback and use it to enhance the organization's current and future response. Likewise not all feedback should be equally weighted. For example, people with recognised technical expertise may carry more authority than a casual observer (Tony Pearce, 2013, P 20).

Technological aspect of crisis management

In modern societies, technology plays an important role and thereby creates new technological challenges. Due to the proliferation of technology the availability of communication-channels is highly dependent on electricity (Medienwirt Christian Neuhaus, 2010, P 2).

Nowadays, crisis management is not able to operate efficiently without the support of the state of the art ICT. In order to find an optimal operation model in crisis management it becomes more frequent to take the advantage of various technological innovations (e.g. trusted computing and agent-based infrastructure) or organizational solutions (e.g. cloud computing). In this section, an outline of new technological opportunities for improving crisis management is provided (Jan Zych and al, 2012, P 106).

Mobile technologies

Currently, mobile technology is advancing rapidly, both in terms of mobile phone popularity and capabilities. Modern mobile devices (palmtops, mobile phones, etc.) are capable of performing tasks that used to be reserved for personal computers. With regard to capabilities, there is a marked trend to integrate hitherto separate devices into a single solution. Modern mobile devices are often equipped with auto-focus a digital camera with several Mega pixels, Full HD video recording possibility (such resolution was barely achievable for dedicated digital cameras just a couple of years ago); moreover, these devices have several GBs of internal storage (with possibility to further increase using flash memory). Combined with broadband (e.g. based on HSDPA or WiFi b/g/n) data transmission and access to modern services (e.g.: online maps (even with traffic information and predictions), weather forecast or social media) mobile phones are considered to be a great tool in crisis management, used not only for communication

between responders, but also for dissemination of information among the public in general (Jan Zych and al, 2012, P 106)..

Social Media

Social media is set of technologies that allow people to exchange multimedia information. Despite the fact that the information in social media comes from sources that are not verified, social media allow people to exchange information ideas, opinions and experience. Therefore, social media has become very popular and this trend is growing.

The example of the 2010 flooding in Central Europe emphasizes the importance of using social media during crises situations. Citizens of the Bydgoszcz city in Poland were using a forum to inform each other about the water level; this source of information was much more effective than official communiques in traditional media. Nevertheless, with the growing popularity of social media, this information could be disseminated even faster - using applications like Facebook, Twitter, Web log and others. Comparing social media to internet forums, one may notice that the former one allows to exchange information almost in real time e.g. through smartphones. The cost in terms of development and maintenance of infrastructure as well as disseminating the information to many recipients is negligible, since social media does not require any additional costs apart from the Internet connection bills (Jan Zych and al, 2012, P 107)..

Cloud Computing

Another new opportunity for crisis management is the use of dedicated services in modern business models - cloud computing. The main idea behind cloud computing is to provide services from remote centres using the Internet as a communication channel. In other words, cloud computing provides applications that run on the Internet. Cloud computer services are divided into four models:

- IaaS - Infrastructure as a Service. This model provides all the equipment needed by an organization to support operations, it includes hardware, servers, storage and network components. In this model, the cloud provider is responsible for maintaining the equipment.

- PaaS - Platform as a Service. In this model, cloud providers deliver a computing platform including an operating system, a programming language execution environment, database and web server. With PaaS applications developers can design, run and debug their software solutions on a cloud platform, and do not have to worry about buying and maintaining the hardware and software layers.

- SaaS - Software as a Service. It comprises software applications that are installed on the cloud and that can be accessed by cloud users. Since the software applications are located on central hosts, the cloud users can access them through a browser. In SaaS, users do not have to maintain the data and

infrastructure on which the application is running e.g. games, google docs, e-mail, etc.

- BPaaS - Business Process as a Service. This model includes any business processes delivered as a service over the Internet (for example, payroll, printing, e-commerce) and accessible by multiple web-enabled interfaces and devices such as PC, tablets and smartphones.

Cloud computing could contribute to crisis management by facilitating information sharing among first responders at different management levels (central, regional and local) and making the emergency notification more accessible to the public. Additionally, cloud computing reduces costs when it comes to data storage and recovery after a disaster. Companies that own the infrastructure locally could be severely affected by a disaster as their server may be permanently destroyed and backup may be lost. In the case of a disaster affecting a cloud computing data centre, user data will not be lost since suppliers of cloud infrastructure replicate user data and cloud servers across multiple data centres.

Furthermore, the data stored on the cloud is highly secured by cloud providers. In the data centres, the integrity of the information is protected with power generators, monitoring systems and 24/7 security personnel as well as technical specialists.

There is a wide range of possible cloud computing applications in crisis management. It not only improves the current services (in terms of e.g. costs, scalability confidentiality, availability, security, redundancy and performance), but also provides new opportunities (Jan Zych and al, 2012, P 107-108).

Conclusion

In this study we've shown how the communication process could be used to manage a crisis in the right and effective way, also the new technologies and their role in the crisis management, by shortening reactions times, and improving consistency of message, and providing relevant and redundant information for stakeholders and by providing back-channels between organizations and its different stakeholder. Instead of standardizing communication.

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Using a Fast Elitist Non-Dominated Genetic Algorithm on Multi-Objective Programming for Quarterly Disaggregation of the Gross Domestic Product

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Abstract

This research paper we use a fast elitist multiobjective genetic algorithm to solve the new approach that we propose to quarterly disaggregating of the Gross Domestic Product (GDP) by multiobjective programming. Thus, the quarterly disaggregation of the GDP is described as a quadratic multiobjective programming problem that generalizes Denton's proportional method. The proposed approach has the advantage reduce to one the number of optimization programs to be solved. Our proposed method can be applied to the national accounts of any country that has adopted the National Accounting System. The simulation results are compared to those obtained using Denton's proportional method and these results revealed the overall performance of the multiobjective programming approach for the quarterly disaggregation of GDP. Our approach is more suitable for taking into account the links between branches of national accounts, in terms of volumes and prices of products demanded during the production process. Also, it reduces forecast error and volatility of quarterly GDP. Besides, it is worth noting that our method is a usfull step for data processing such as chain-linked measures, overlap growth techniques, seasonal adjustment and calendar effects adjustment, in time series and econometrics analysis.

Keywords: Quarterly disaggregation, quarterly national accounts, optimization, quadratic program, multi-objective programming, genetic algorithm.

1. Introduction

In economics analysis, the main aggregate indicator resulting from the quarterly national accounts (QNA) is the quarterly Gross Domestic Product (GDP). Thus, the problem is that of quarterly GDP estimation for global cyclical economics analysis.

ISSN 2601-8683 (Print)
ISSN 2601-8675 (Online)

European Journal of
Formal Sciences and Engineering

July -December 2021
Volume 4, Issue 2

Generaly, for having quarterly GDP, the economy is divided into several branches or sectors and the quarterly accounts estimation is done per branch defined throught the System of National Accounting (SNA).

The procedures for compiling quarterly national accounts can be subdivided into direct and indirect procedures. The use of direct procedures requires the availability, at quarterly intervals, of the same data sources as those used to prepare the annual accounts, subject of course to the necessary simplifications. Direct procedures are often used in countries with sufficiently developed statistical systems. Indirect procedures is based on quaterly disaggregation of passed annual national accounts and extrapolation for current quater by using mathematical or statistical techniques, with or without reference indicators. Indirect procedures are used in countries without sufficiently developped statistical systems as there is in sub-Saharan Africa. That are subdivided into two groups of methods: mathematical methods and econometric methods.

In the literature, mathematical methods and econometric methods are distinctly developed for the quarterly disaggregation of national accounts. A full presentation is given in the quarterly national accounts manual [11], [12]. The main difficulty in applying econometric methodologies is the need to have data available over a long period. Thus, the mathematical methods presents the advantage for applying them even with short data series [15]. Overall, mathematical methods based on numerical approach are adapted to less developed statistical systems [15] as in most of sub-Saharan Africa countries. The quarterly disaggregation according to mathematical methods preserves the infra-annual evolution of the quarterly indicator by ensuring consistency with the annual value of the national accounts [15]. Furthermore, the most praticable mathematical method using indicators is that developed by Denton (1971) which is presented in [11], [12] and the modified version done by Sjoberg (1982), Adriaan M. Bloem and al (2001), Cholette-Dagum (2006) can be seen in [12]. Denton method estimates quarterly accounts by proportional divisions based on the related quarterly indicator and also following a fairly smooth quarterly path based on certain criteria. Thus, the quarterly disaggregation of national accounts with Denton's method becomes a minimization problem with constraints. However, it is not evident to find a global composite quaterly indicator related to the GDP in order to quarterly disaggregate directly the GDP by this method.

As we can see, the traditional Denton's proportional method for the quarterly disaggregation of Gross Domestic Product (GDP) have many weaknesses related to the independent resolution of several optimization sub-problems resulting from the decomposition of GDP into branches of the economy according to the nomenclature defined for quarterly national accounts. The resolution of all these sub-problems one by one could be tedious due to the time required for individual processing. Therefore, this approach could lead to differences between the annual series of observed GDP and the GDP estimated from the quarterly accounts after aggregation due to simulation errors which occur at the level of the branches treated separately.

Based on the economy breakdown into several branches or sectors, this paper proposes a novel theoretical mathematical programming approach where the quarterly disaggregation of GDP is formalized as multiobjective optimization problem. Our paper solves the weaknesses of methods based on indirect procedures mainly Denton's proportional method for the GDP quarterly disaggregation. The overall quarterly disaggregation problem is presented using an indirect approach with indicators, leaning on Denton's proportional method. A Multi-Objective Programming for Temporal Disaggregation (MOPTD) model is therefore proposed (section 2) by generalizing Denton's proportional method. Moreover, we manage to build a non-trial hybrid algorithm based on an evolutionary fast elitist non-dominated genetic algorithm (NSGA-II) for solving the model (section 3).

After quarterly decomposition of national accounts by the MOPTD model, the derivated data can be used for some important data processing such as chain-linked measures, overlap growth techniques, seasonal adjustement and calendar effects adjustement, in order to get more consistency of quarterly time series for econometrics analysis. This paper proceeds neither chain-linked measures nor seasonal and calendar effects adjustment. The MOPTD model and the algorithm have been applied to Benin's real data of national accounts, breaking down the GDP into three sectors (primary, secondary and tertiary) (see section 4). The data were obtained from the National Institute of Statistics and Economic Analysis in short INSAE, of Benin.

2. Formulation of the Multi-Objective Programming for Temporal Disaggregation

In this research, the quarterly disaggregation of branches accounts is based on an indirect approach with indicators. The basic idea of quarterly accounts is to "adapt" the indicators to the annual accounts, estimating the statistical relationship that links in the past, the annualised indicator to the corresponding account, and assuming that this relationship observed on annual data is also valid on quarterly data. Among the indirect methods, one of them retains our attention. This is the proportional method of Denton (1971) in [11, 12]. The choice is guided on the one hand by the fact that it minimizes the prediction error of the current year, so that the forecast annual growth rate is very close to the realization and on the other hand, by its ease of implementation because it is a method adapted to short time series. Several works in the literature have used Denton's basic formulation to propose modifications, as have Cholette and Dagum (1994) in [11] and Dagum and Cholette (2006) in [12]. It should therefore be noted that if the time series available on the annul national accounts are not long enough, the econometric approach could lead to inconsistent estimators. Therefore, this research is based on Denton's proportional method, which is also implemented in several countries.

First of all, it is necessary to make a description all things we need for the formulation of the problem.

Description of the entities, cardinalities and indexing of the problem

We have the following entities :

M : the number of branches of national accounts, corresponding to the number of objective functions,

T : the number of years for national accounts observed,

The following indexes are chosen for the problem formalization:

$y \in \{1, 2, 3, \ldots, T\}$, year generic index,

$i \in \{1, 2, 3, 4\}$, quarterly index,

$t \in \{1, 2, 3, \ldots, 4T\}$, generic index of quarters on the T years' period: the indexes i and y allowing to reference an observation are restated using an operator proposed by Raimi et al. [20]

$k \in \{1, 2, 3, \ldots, M\}$, generic branch index of the quarterly accounts nomenclature.

Description of the model variables

Data of the problem

Value of the annual account per branch: let $Z_{k,y}$ be the (known) value added of the branch account , for the year y;

quarterly indicator: let $I_{k,t}$ be the value of the branch indicator k, for the quarter $t = 1, 2, 3, \ldots, 4T$;

$I_k = (I_{k,t})_{t=1,2,..4T}$: the vector of quarterly indicator related the branch k over the entire period ;

Inter-branch interaction: we note $\overline{W}_{j,k}$ the interaction of the branch j on the branch k, considered as the average share of the branch k demand of product coming from the branch j : $\overline{W}_{j,k} = 1 \; if \; j = k$ and $0 \le \overline{W}_{j,k} < 1 \; if \; j \ne k$.

Target variables

Value added per branch: let $X_{k,t}$ be the value of national account for branch k at quarter $t = 1, 2, 3, \ldots, 4T$

The vector of national account value for branch k over the entire period is noted:

$$X_k = (X_{k,t})_{t=1,2,..4T} \, , \; X_k \in \mathbb{R}^{4T} \; ; \; for \; k = 1, \ldots, M \; ;$$

The vector of quarterly national accounts value for all branches over the entire period is noted: $X = (X_1, \; X_2, \; X_3, \ldots X_M), \; X \in \mathbb{R}^{4T \times M} \; ;$

Quarterly Gross Domestic Product for the quarter t : GDP_t .

Relationships between variables and parameters

The target quarterly national accounts are related to the indicators (input data) through proportionality relationships.

The proportionality relationship between estimated quarterly values added and quarterly related indicators is as follow:

$$\frac{X_{k,t}}{I_{k,t}} = \frac{X_{k,t-1}}{I_{k,t-1}} + u_{k,t} \quad ; \qquad \forall \ k = 1, 2, \dots, M; \ \forall \, t = 2, \dots, 4T \tag{2}$$

$u_{k,t}$ is the random term not explained for the quarter t.

The first difference in the BI ratio results in the quarterly residues

$$u_{k,t} = \frac{X_{k,t}}{I_{k,t}} - \frac{X_{k,t-1}}{I_{k,t-1}} \quad ; \qquad \forall \ k = 1, 2, \dots, N; \ \forall \, t = 2, \dots, 4T \tag{3}$$

The sum of the squares of the quarterly residues that must be minimal is as followed

$$\sum_{t=2}^{4T} \left(\frac{X_{k,t}}{I_{k,t}} - \frac{X_{k,t-1}}{I_{k,t-1}} \right)^2 , \text{ for } k = 1, \ 2, \dots, M \tag{4}$$

The quarterly Gross Domestic Product is expressed by the relationship:

$$GDP_t = \sum_{k=1}^{M} X_{k,t} \quad ; \qquad for \quad t = 1, 2, \dots, 4T \tag{5}$$

Annual Gross Domestic Product for the year is obtained by aggregation over the four quarters

$$GDP_y = \sum_{t=4y-3}^{4y} GDP_t \quad ; \quad for \quad y = 1, 2, \dots, T \tag{6}$$

Objective functions

For the analysis with a multiobjective approach, the interaction between all branches is taken into account. In addition, it is assumed that there is an influenced additivity between sectoral residues in the determination of quarterly national accounts. Thus, the objective functions are given by :

$$f_k(X_1, X_2, \ldots, X_M) = \sum_{j=1}^{M} \sum_{t=2}^{4T} \overline{W}_{j,k} \left(\frac{X_{j,t}}{I_{j,t}} - \frac{X_{j,t-1}}{I_{j,t-1}} \right)^2 ; \quad for \quad k = 1, 2, \ldots, M \tag{7}$$

Constraints of the model

In each branch, the sum of the quarterly accounts estimated for the four quarters of a year is equal to the annual account (value added) of the branch for that year:

$$\sum_{t=4y-3}^{4y} X_{k,t} = Z_{k,y} ; \quad \forall y = 1, 2, \ldots, T; \ k = 1, 2, \ldots, M \tag{8}$$

At each year, the total of the quarterly values added towards all branches is equal to the GDP:

$$\sum_{k=1}^{M} \sum_{t=4y-3}^{4y} X_{k,t} = \sum_{k=1}^{M} Z_{k,y} ; \quad \forall \ y = 1, 2, \ldots, T \tag{9}$$

For the variables sign, since the values of the branches annual accounts are positive (if not they can be made positive), it is also assumed that the corresponding quarterly values are positive:

$$X_{k,t} \geq 0 ; \quad for \ t = 1, 2, \ldots, 4T \ and \ k = 1, 2, \ldots, M \tag{10}$$

With regard to maximum values, for a given year, the quarterly values of the accounts may not exceed the annual sectoral value:

$$X_{k,t} \leq Z_{k,y} ; \quad \forall \ t = 1, 2, \ldots, 4T ; \ k = 1, 2, \ldots, M ; \forall \ y = 1, 2, \ldots, T \tag{11}$$

Using remark 1 (a), an additional constraint, relating to the weighted averages of the BI ratios, is added to Denton's traditional equilibrium ratios. It result in :

$$\sum_{t=4y-3}^{4y} \frac{X_{k,t}}{I_{k,t}} \eta_{k,t} = \frac{Z_{k,y}}{\sum_{t=4y-3}^{4y} I_{k,t}} ; \quad \forall \ y = 1, 2, \ldots, T, \quad k = 1, 2, \ldots, M \, ,$$

The weights are given by :

$$\eta_{k,t} = \frac{I_{k,t}}{\sum_{r=4y-3}^{4y} I_{k,r}} ; \quad k = 1, 2, \ldots, M \tag{12}$$

Remark 2

If the constraints translated by the relationships (8) and (10) are satisfied then the constraint translated by the relationship (11) is satisfied. Moreover, the relationship (8) implies the relationship (9). As a result, constraints (9) and (11) are not taken into account in the theoretical model but will be taken into account in the simulation algorithms in order to reinforce the constraints for minimizing the value of the objective functions.

Definition 3 (MOPTD)

By grouping together all the elementary objective functions identified by the relationship (7) for all branches, and the constraints identified by the relationship (8), (10) and (12), the quarterly disaggregation of GDP appears as a problem formulated in the form of multiobjective programming. Thus, the multiobjective programming temporal disaggregation model proposed in this research is as follows:

$$\min_{X} \{(f_1(X), f_2(X), \dots, f_k(X), \dots, f_M(X))\} \tag{MOP}$$

subject to.

$$X = (X_1, \quad X_2, \quad X_{3}, \dots X_M)$$
$$X_k = (X_{k,t})_t \ ; \quad t = 1, 2, \dots, 4T \ ; \ \text{pour tout } k = 1, 2, \dots, M$$
$$-X_{k,t} \leq 0 \ ; \qquad \forall \ t = 1, 2, \dots, 4T \ ; \ k = 1, 2, \dots, M \tag{i}$$

$$\sum_{t=4y-3}^{4y} X_{k,t} - Z_{k,y} = 0 \ ; \qquad \forall \ y = 1, 2, \dots, T \ ; \qquad k = 1, 2, \dots, N \tag{ii}$$

$$\sum_{t=4y-3}^{4y} \frac{X_{k,t}}{I_{k,t}} \eta_{k,t} = \frac{Z_{k,y}}{\sum_{t=4y-3}^{4y} I_{k,t}} \ ; \quad k = 1, 2, \dots, M \ , \qquad \forall \ y = 1, 2, \dots, T \tag{iii}$$

where $GDP_t = \sum_{k=1}^{N} X_{k,t} \ ; t = 1, 2, \dots, 4T$

As it can be seen, this problem is multiobjective quadratic programming.

To reconcile the estimated quarterly national accounts with the true annual observed values, an adjustment is made to the estimated quarterly values. The adjusted value $X_{k,t}^{Adj}$ of the estimated national accounts for quarter t for branch (sector) k is given by:

$$X_{k,t}^{Adj} = \hat{X}_{k,t} - \eta_{k,t} \times Abs \left(\sum_{t=4y-3}^{4y} \hat{X}_{k,t} - Z_{k,y} \right) \times sign \left(\sum_{t=4y-3}^{4y} \hat{X}_{k,t} - Z_{k,y} \right) \tag{13}$$

$\forall \ y = 1, 2, \dots. T$

The weights are given by: $\eta_{k,t} = \frac{I_{k,t}}{\sum_{t=4y-3}^{4y} I_{k,t}}$

$\hat{X}_{k,t}$ is the estimated value of the account for the quarter and $Z_{k,y}$ the value for the year y

$Abs (x)$ is the absolute value of $x : Abs (x) = \max \{-x, x\}$

$sign (x) = 1 \ if \ x > 0 \ and \ sign (x) = -1 \ if \ x < 0 \ .$

The interest of the quarterly national accounts lies in the fact that in a current year when the annual accounts are not yet available, the quarterly accounts for that year can be estimated by extrapolation from the values of the observed quarterly indicators. Thus, starting from Denton's basic extrapolation method and that presented by Di Fonzo, T. and Marco, M. [9] in their formula (5), the relationship presented by Marco [18] through scenario 3, is adapted to the quarterly accounts by considering the values of the BI ratios of the last nine previous quarters. Assuming that m is the last year of observed annual national accounts, the extrapolated value added of the branch (sector) k for the quarter $(4m + r)$ is given by :

$$X_{k,4m+r}^{Adj} = I_{k,4m+r} \left[0.5 \times \frac{X_{k,4m+r-1}^{Adj}}{I_{k,4m+r-1}} + 0.5 \times \left(\frac{1}{9} \sum_{t=(4m+r-1)-9}^{(4m+r-1)} \frac{X_{k,t}^{Adj}}{I_{k,t}} \right) \right] \tag{14}$$

where

$X_{k,t}^{Adj}$ is the adjusted interpolation value added of the branch k for the quarter t

r is the rank of the quarter of year $m + 1$ for which the extrapolation is made,

$r = 1, 2, 3, 4.$

Proposition 1

Under the assumption of a total absence of interactions between branches, the program (MOP) is reduced to the Denton proportional method applied to each of the M branches of national accounts.

Proof

Let suppose that there is no interaction between the M branches of national accounts.

So we have $\overline{W}_{j,k} = 1 \ if \ j = k \ $ et $\ \overline{W}_{j,k} = 0 \ if \ j \neq k \ ; \ k = 1, 2, 3, \dots, M$

Consequently, f_k becomes

$$f_k(X) = \sum_{t=2}^{4T} \left(\frac{X_{k,t}}{I_{k,t}} - \frac{X_{k,t-1}}{I_{k,t-1}} \right)^2 ; \quad \forall \ k = 1, 2, \dots, M \ \ with \ X = (X_1, \ X_2, \ X_3, \dots X_M),$$

$f_k(X)$ therefore depends only on X_k , $\forall \ k = 1, 2, \dots, M$. The problem (MOP) can therefore be written as follows:

$$\min_{X_1, X_2, X_3, \dots X_M} \{(f_1(X_1), f_2(X_2), \dots, f_k(X_k), \dots, f_M(X_M))\} \tag{MOP'}$$

subject to

$$\begin{cases} X = (X_1, \quad X_2, \quad X_{3,} \ldots X_M) \\ \quad X_k = (X_{k,t})_t \; ; \quad t = 1, 2, \ldots, 4T \; ; \text{ for all } k = 1, 2, \ldots, M \\ -X_{k,t} \; \leq 0 \; ; \quad \forall \, t = 1, 2, \ldots, 4T \, ; \, k = 1, 2, \ldots, M \\ \\ \sum_{t=4y-3}^{4y} X_{k,t} - Z_{k,y} = 0 \; ; \quad \forall \, y = 1, 2, \ldots, T \; ; \quad k = 1, 2, \ldots, N \\ \\ \sum_{t=4y-3}^{4y} \frac{X_{k,t}}{I_{k,t}} w_{k,t} = \frac{Z_{k,y}}{\sum_{t=4y-3}^{4y} I_{k,t}} \; ; \quad k = 1, 2, \ldots, M , \quad \forall \, y = 1, 2, \ldots, T \end{cases}$$

By relaxing the constraint $\sum_{t=4y-3}^{4y} \frac{X_{k,t}}{I_{k,t}} w_{k,t} = \frac{Z_{k,y}}{\sum_{t=4y-3}^{4y} I_{k,t}} \; ; \quad k = 1, 2, \ldots, M , \; \forall \, y = 1, 2, \ldots, T,$

we get the following new program:

$$\underset{X_1, \, X_2, \, X_3, \ldots X_M}{\text{Min}} \{(f_1(X_1), f_2(X_2), \ldots, f_k(X_k), \ldots, f_M(X_M))\} \tag{MOP''}$$

subject to

$$\begin{cases} X = (X_1, \quad X_2, \quad X_{3,} \ldots X_M) \\ \quad X_k = (X_{k,t})_t \; ; \quad t = 1, 2, \ldots, 4T \, ; \text{ for all } k = 1, 2, \ldots, M \\ -X_{k,t} \; \leq 0 \; ; \quad \forall \, t = 1, 2, \ldots, 4T \, ; \, k = 1, 2, \ldots, M \\ \\ \sum_{t=4y-3}^{4y} X_{k,t} - Z_{k,y} = 0 \; ; \quad \forall \, y = 1, 2, \ldots, T \; ; \quad k = 1, 2, \ldots, M \end{cases}$$

Since the objective functions have independent arguments, it is possible to optimize the f_k separately to determine the $X_k = (X_{k,t})_t$ for $k = 1, 2, \ldots, M$, so that we can have the GDP_t by summing the $X_{k,t}$, using relationship (5).

This means solving all the elementary optimization program $(EOP)_k$:

$$\underset{X_k}{\text{Min}} \{f_k(X_k)\} \tag{$EOP)_k$}$$

subject to

$$-X_{k,t} \; \leq 0 \; ; \quad \forall \, t = 1, 2, \ldots, 4T \, ;$$
$$\sum_{t=4y-3}^{4y} X_{k,t} - Z_{k,y} = 0 \; ; \quad \forall \, y = 1, 2, \ldots, T$$

It can be seen that the program $(EOP)_k$ is similar to Denton 's program presented in [11], illustrating the Denton proportional method applied to branch $k = 1, 2, \ldots, M$ of national accounts.

Thus, the program (MOP) is reduced to Denton's proportional method applied successively to the M branches to deduct quarterly GDP from the previous relationship (5). ■

Remark 3

From the results of proposition 1, it can be deduced that the proposed MOPTD model is a generalization of Denton's proportional method.

3. Resolution approach and algorithm design

The problem is analysed on the basis of a hypothesis of cooperation between the objective functions. On this basis, Pareto optimal solutions are prospected in solving the problem. The following definition provides an understanding of the Pareto optimality concept.

3.1. Preliminary definition ([19])

Let's consider the vector function $F(x) = \left(f_1(x), f_2(x), \ldots, f_Q(x)\right)$ and U the constrained space (space of feasible solutions) of the problem (MOPP). It should be noted $F(U)$ the value space of the objective functions. We define on $F(U)$ a partial relationship. Let K be any blunt cone such that $K \subset \mathbb{R}^Q$. Let's consider the binary relationship $\preccurlyeq_K$ indexed by K defined as follow:

$$a \preccurlyeq_K b \Longleftrightarrow (b - a) \in K.$$

Since it is not possible to find a solution that simultaneously optimizes all objective functions in the case of a multiobjective program, the notion of dominance in the sense of Pareto is used.

(i)- Pareto-dominance: for two feasible decision vectors x et y, we say that x dominates y in the sense of Pareto and we note $(x, F(x)) \preccurlyeq_K (y, F(y))$, if and only if $for\ all\ q \in \{1, 2, 3, \ldots, Q\}$, $f_q(x) \leq f_q(y)$ and $\exists\ q_0 \in \{1, 2, 3, \ldots, Q\}$ such that $f_{q_0}(x) < f_{q_0}(y)$.

(ii)- Pareto optimal solution: a solution $x \in \mathbb{R}^N$ is called Pareto optimal in $\mathbb{R}^N$ if and only if, there is no vector $y \in \mathbb{R}^N$ which dominates x.

(iii)- The Pareto optimal set is defined as the set of all Pareto optimal solutions.

(iv)- The Pareto optimal front is defined as the set of all objective function values corresponding to all solutions in the Pareto optimal set.

The resolution algorithms of the traditional quarterly disaggregation methods are presented in [1], [2]. In this paper, the simulation method for the model resolution is based on the NSGA-II algorithm developed in the literature for multiobjective optimization [3], [4], [8], [21].

3.2. A brief overview of the NSGA-II algorithm

The NSGA algorithm called "Non-dominant Sorting Genetic Algorithm"[10, 20], after several years of implementation, has become ineffective in ranking individuals [14] especially for large problems treated. To correct this deficiency, it elitism was introduced into the basic algorithm [8] in order to preserve the best solutions from generation to generation [14]. Thus, the improved version of the NSGA algorithm, called NSGA-II, classify the individuals into many levels [6], this classification does not require necessary the choice of sharing parameter [4]. The NSGA-II algorithm is illustrated by the pseudo code given in algorithm 1. It should be noted that elitism in the NSGA-II algorithm contributes to accelerating the rate of convergence and the overall performance of the genetic algorithm incorporated in it.

Algorithm 1 (pseudo-code NSGA-II) [8, 14]

- While (total number of iterations not completed)
- Generation of the initial population
- Repeat
- While (Population is not classified) do
- Evaluation of all borders
- Normalization of areas of constraint violation
- Search for undominated individuals
- Replacement of individuals
- End while
- Selection
- Crossover
- Polynomial mutation
- Until (Criteria for shutdown achieved)
- Recombination of optimal Pareto solutions
- End while

3.3. The proposed MOPTD algorithm designing

The NSGA-II adapted to the problem of multi-target optimization for the quarterly disaggregation of GDP resulted in a fast elitist multiobjective programming algorithm for temporary disaggregation (MOPTD-NSGA-II). The choice of the NSGA-II algorithm as the central nucleus is justified by the fact that elitist algorithms allow better results to be obtained on multiobjective problems [5]. The pseudo code of the MOPTD -NSGA-II algorithm is given in Algorithm 5. The interpolation of the accounts by the model takes into account the reconciliation of the quarterly accounts with the true annual values observed. This reconciliation is done by an adjustment procedure of which the pseudo-code is given in algorithm 3. In addition, the MOPTD model allows quarterly accounts to be extrapolated if necessary using the extrapolation procedure of which the pseudo code is given in algorithm 4.

In the NSGA-II algorithm, the initial population is generated from the bounded values (minimum and maximum) of the target variables. Since the problem (MOP) is relatively of large size, to ensure rapid convergence of the algorithm towards Pareto optimal solutions, the solution search domain has been narrowed using the annual data provided on account variables. Thus, the variable bounded values were generated from the annual values of the accounts by releasing the constraints (i) of the problem (MOP). The pseudo code of the limit value calculation procedure is given in algorithm 2.

As it can be seen, the NSGA-II procedure introduces a hazard when generating the reference population. Since the search for Pareto optimal solutions is based on this reference population and the Pareto optimal solution does not strictly achieve the minimum of each objective function, an adjustment procedure has been completed in order to reconcile the estimated quarterly values with the true observed annual values. The relationship (13) presented in the theoretical description is used. The pseudo-code of this adjustment procedure is given in algorithm 3.

Algorithm 2 (pseudo code of the Procedure Boundary_values_Calculation (abX, ny))

- BEGIN (Boundary_values_Calculation)
- */Initialization of the values of the annual accounts (all branches/sectors))
- For k = 1 : M
- For y = 1 : lyear
- abX(k,y) ← annual values
- end for
- End for
- */Calculation of boundary values for quarterly accounts
- For k =1 : M
- qbX_max (k) ← [ ]   */ empty box
- qbX_min (k) ← [ ]   */ empty box
- For y = 1 : ny
- qbXmax ← [ ]
- qbXmin ← [ ]
- For t = 4y-3 : 4y
- qbX_max (k,t) ← abX(k,y)/4+[SD (abX(k))]/(lyear-fyear+1)
- qbX_min (k,t) ← abX(k,y)/4-[SD (abX(k))]/(lyear-fyear+1)
- qbXmax ← [qbXmax qbX_max (k,t)]
- qbXmin ← [qbXmin qbX_min (k,t)]
- t ← t+1
- End for
- qbX_max (k) ← [qbX_max (k) qbXmax]
- qbX_min (k) ← [qbX_max (k) qbXmin]
- y ← y+1

ISSN 2601-8683 (Print)
ISSN 2601-8675 (Online)

European Journal of
Formal Sciences and Engineering

July -December 2021
Volume 4, Issue 2

- End for
- qbX_M(k) ← qbX_max (k, 1:nq)
- qbX_m(k) ← qbX_min (k, 1:nq)
- k ← k+1
- End for
- tXmax ← [qbX_M(1) qbX_M(2) qbX_M(3) ……. qbX_M(M)]
- tXmin ← [qbX_m(1) qbX_m(2) qbX_m(3) ……. qbX_m(M)]
- END (Boundary_values_Calculation)

Algorithme 3 (pseudo code of the procedure Adjustment (qX,ny,nq))

- BEGIN (adjustment procedure)
- Initialization
- vector of the abX annual accounts
- vector of quarterly accounts qX
- vector of quarterly indicators qbI
- For k = 1 : M
- qX(k)_Adj ← [ ]
- For cy = 1 : ny
- fcount ←4*cy-3;
- lcount ←4*cy;
- qX_a(k, cy) ← [ ]
- For j = fcount : lcount
- w(k,j) ← qbI(k,j) /sum(qbI(k,j), j, fcount :1: lcount)
- c(1, cy) ← sum(qX(k,j), j, fcount :1: lcount) - abX(k, cy)
- If c(1, cy)>=0
- qx_a(k, j)= qX(k, j)- w(k,j) * abs(c(1, cy))
- Else
- qx_a(k, j)= qX(k, j)+ w(k,j) * abs(c(1, cy))
- End if
- qX_a(k, cy) ← [qX_a(k, cy) qx_a(k, j)]
- j ← j+1
- End for
- qX(k)_Adj ← [qX(k)_Adj   qX_a(k, cy)]
- cy ← cy+1
- End for
- k← k+1
- End for
- END (adjustment procedure)

The extrapolation of quarterly accounts for future quarters is based on the procedure described by the relationship (14) presented in the theoretical description. The pseudo code of the extrapolation procedure is given in algorithm 4.

Algorithm 4 (pseudo code of the procedure Extrapolation (qX_entry, qbl_new, nq ,s))

- BEGIN (extrapolation procedure)
- s ← 4 x (lyear-wyear)
- While (s>0) do
- Call for data on quarterly indicators I(1:nq+s)
- For k = 1 : M
- Colling of the vector I(k, 1:nq+s)
- X(k, 1:nq) ← qX_adjus(k, 1:nq)
- X(k) ← X(k, 1:nq)
- X(k, nq+1:nq+s) ← [ ]
- For r = 1 : s
- X(k, nq+r) ← I(k, nq+r)* (0.5* X(k, nq+r-1) / I(k, nq+r-1)
  - + 0.5*sum(X(k, t) / I(k, t), (nq+r-1):1: (nq+r-1)-9)/9)
- X(k, nq+1:nq+s) ← [X(k, nq+1:nq+s) X(k, nq+r)]
- r ← r+1
- End for
- X(k) ← [X(k) X(k, nq+1:nq+s)]
- k ← k+1
- End for
- Recovery and backup of the matrix [X(1) X(2) X(3) …… X(M)]
- End while
- END (extrapolation procedure)

Finally, the pseudo code of the complete algorithm (MOPTD-NSGA-II) is given in algorithm 5 which is as follows :

Algorithme 5 (main pseudo code of MOPTD-NSGA-II)

- BEGIN (main Algorithm)
- */Initialization time parameters
- fyear   */ first year of the observation period of the annual accounts
- lyear   */ last year of the observation period of the annual accounts
- wyear   */ last year considered for interpolation
- */ Calculation of all other associated parameters
- wy ← (wyear - fyear +1)   */ number of work years for interpolation
- wq ← 4*wy   */ number of quarters for the calculation period
- s ← 4 x (lyear-wyear)   */ number of quarters for extrapolation
- If lyear > wyear then

ISSN 2601-8683 (Print)
ISSN 2601-8675 (Online)

European Journal of
Formal Sciences and Engineering

July -December 2021
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- ny← wy;   */ number of years for interpolation
- nq← wq;   */ number of quarters for calculations
- else
- ny ← (lyear - fyear +1)   */ number of years for interpolation
- nq← 4*ny   */ number of quarters for calculations
- End if
- Boundary_values_Calculation (abX, ny)   */ Execution of the Procedure
- */ Interpolation of accounts on quarterly indicators
- Begin (interpolation)

> **-** Initialization of the other NSGA-II input parameters
>
> M ← number of objective functions
>
> p1← number of constraints
>
> V← nq×M   */calculates the number of variables
>
> Pop_size ← give the size of the population
>
> run ← the number iteration
>
> gen_max ← give the maximum number of generations
>
> **-** Calling up the problem (objective functions and constraints))

- Begin (NSGA)
- Execution of the NSGA-II algorithm
- End (NSGA)
- */ Recovery of results provided by NSGA
- If run==1
- qX ← [new_pop(:,1:V)]   */ Pareto optimal solution
- Else
- qX ← [pareto_rank1(1:V)]   */ Pareto optimal solution
- End if
- */ Adjustment of quarterly accounts
- For k = 1 : M
- Adjustment (qX(k), ny, nq)   */ Execution of the procedure
- qX(k)_Adj ← Adjustment (qX(k), ny, nq)
- k ← k+1
- End for
- End (interpolation)
- */ Extrapolation of accounts to the quarters of the following year
- If (s > 0)

- Calling up indicator values qbI(1:nq+s)
- Begin (extrapolation)
- For k = 1 : M
- Extrapolation (qX(k)_Adj, qbI(k), nq ,s)   */ Execution of the procedure
- qX1_fwd(k) ← Extrapolation (qX(k)_Adj, qbI(k), nq ,s)
- k ← k+1
- End for
- End (extrapolation)
- En if
- END (main algorithm)

4. Application to Benin's national accounts

Simulations are carried out using the databases of the National Institute of Statistics and Economic Analysis (INSAE). The data were subject to prior statistical processing before proceeding to the actual simulations. The GDP is decomposed into three sectors. The results obtained with the proposed model were compared with those obtained using Denton's proportional method applied separately to each of the three sectors.

4.1. Statistical data and processing

This section presents the data sources we used and the processing carried out on data related to national accounts and related indicators.

The databases available at the National Institute of Statistics and Economic Analysis (INSAE) reveals that Benin has the series of annual national accounts (ANA) from 1999 to 2015, compiled according to the System of National Accounting (SNA) 93 with 2007 as the base year, as well as various (quarterly) indicators on economic activity. These data were therefore used for the simulation exercise. It should be noted that work undertaken by the INSAE national accounts department to move from SNA 93 to SNA 2008 [10], with a base year change to 2015, has not yet been completed to make available the new series on the definite accounts over the simulation period.

In the context of this research, the quarterly GDP obtained through the quarterly disaggregation of the values added. Thus, the proposed approach using three indicators is different from that of Abdelwahed Trabelsi and Leila Hedhili [1] for which GDP is quarterly in aggregate form with only one indicator, the industrial production index.

Thus, the resolution approach adopted is that relating to the research for efficient points (Pareto optimum) after problem reduction (MOP) with three objectives.

4.2. Our method results and comparison with Denton's proportional method

Then, several tests were performed on the key parameters of the algorithm in order to retain values that reduce the convergence time of the algorithm. Simulation results and statistics on the quality of the model are presented below. In the literature, some

softwares are adopted for the quarterly disaggregation of national accounts using traditional methods. As part of this research, all simulations are carried out using the OCTAVE software.

Pareto optimality front

The NSGA-II algorithm uses the following key parameters as input parameters: population size (pop_size), iteration number (no_rum) and maximum number of generations (gen_max) beyond which the algorithm stops. The choice of the values of these parameters depends on the size of the problem. In the literature, problems are tested with the NSGA-II algorithm for minimum required values and set at 20 for pop_size and 5 for gen_max [4]. Sometimes, large values can be set: up to 200 for pop_size, 10 for no_rum and 1000 for gen_max in the case of problems with two objectives [8].

Based on these findings, several values were tested for the parameters pop_size as in [14], no_rum, and gen_max, in this research. These tests have been illustrated by different representations of the Pareto front. The Pareto front obtained for the main values of (pop_size, no_rum, gen_max) are presented in Figure 1. The Pareto optimal points are represented in blue.

The analysis of the results shows that if no_run=1, the simulation gives several Pareto optimal points but the number of points increases with the population size (pop_size) and this regardless of the gen_max value, this situation is illustrated by the panels (a1) (b1), (c1) and (c2). It was used in the following pop_size=100 simulations, as adopted in [6] and [21].

a1- (Pop_size, No_runs, gen_max)=(100,1,25)
Elapsed time=214.539 seconds

a2-(Pop_size, No_runs, gen_max)=(100,2,25)
Elapsed time=447.526 seconds

b1-(Pop_size, No_runs, gen_max)=(100,1,100)
Elapsed time=858.307 seconds

b2-(Pop_size, No_runs, gen_max)=(100,2,100)
Elapsed time=1645.12 seconds

c1-(Pop_size, No_runs, gen_max)=(10,1,100)
Elapsed time=124.319 seconds

c2-(Pop_size, No_runs, gen_max)=(10,1,25)
Elapsed time=61.8776 seconds

d1-(Pop_size, No_runs, gen_max)=(100,10,100)
Elapsed time=22518.9 seconds

d2-(Pop_size, No_runs, gen_max)=(100,10,25)
Elapsed time=1703.82 seconds

Figure 1 : Optimal pareto boundary for different simulation parameters

Source: INSAE-data base, Author's simulation

The Pareto boundaries presented in the panels (a2), (b2), (d1) and (d2) indicate that the algorithm converges to a single Pareto optimal point when no_run=100 for any gen_max value with pop_size=100, but the boundaries obtained with gen_max=25 and gen_max=100 have the same configuration; the points obtained for the different cases are all located in practically the same restricted space.

It should be noted that overall, the gen_max values set at 25 and 100 give Pareto front with the same characteristics; however, the runtime of the algorithm for displaying results is relatively longer for gen_max=100 than for gen_max=25. Thus, based on the situations presented above, the simulations which of results are presented below are performed with (pop_size, no_rum, gen_max) = (100, 10, 25).

Comparison of the evolution of interpolated series

For the comparison of the model results with those obtained using Denton's proportional method, MOPTD simulations are performed with the parameter (pop_size, no_runs, gen_max) = (100,10,25). Figure 2 below presents the results of both methods. The series of quarterly national accounts represented in panels (a), (b), (c) and (d) are those obtained after simulations are made over the period 1999-2014 and extrapolated for the quarters of 2015. The quarterly indicators are represented by red dotted lines. The series of quarterly national accounts obtained with the model are represented in black and those resulting from the application of the Denton's proportional method are the blue curves.

As shown in the results presented in Figure 5, the quarterly national accounts series obtained by both methods and the respective quarterly indicators maintain the trends and relationships obtained with the annual data. However, the analysis of the curves presented in the four panels shows that the MOPTD model produces relatively much smoother (less fluctuating) series compared to the series obtained using Denton's proportional method.

(b) Secondary sector value added

(c) Tertiary sector value added
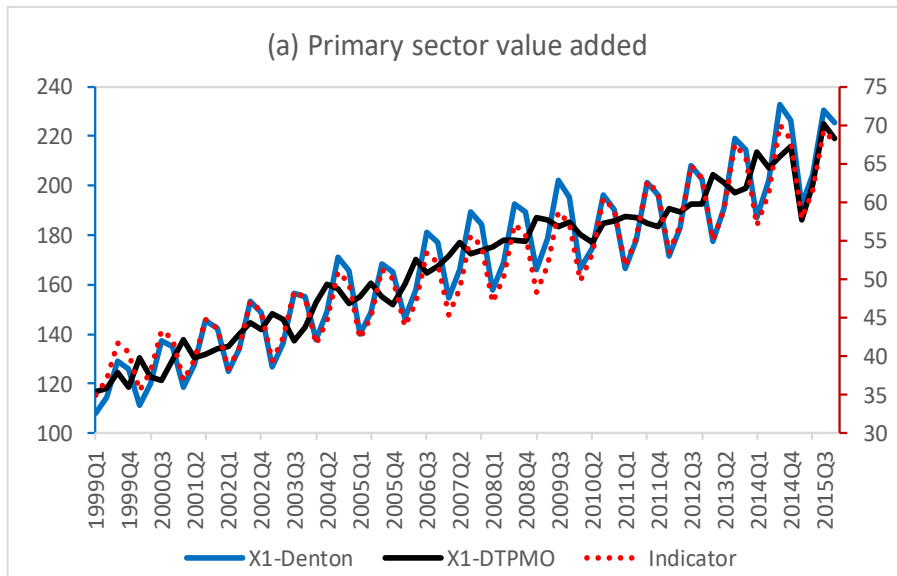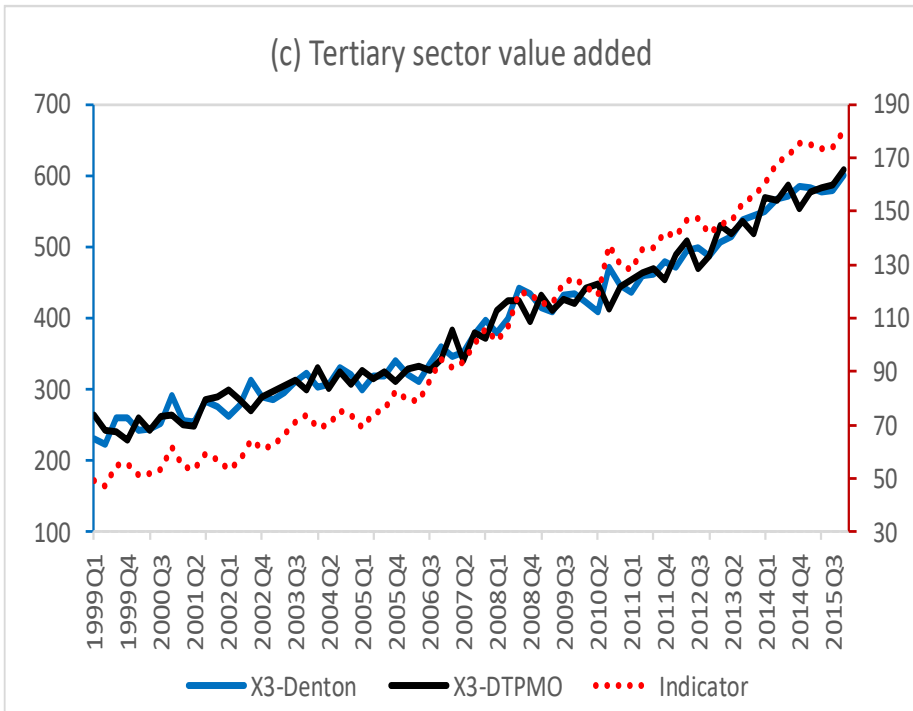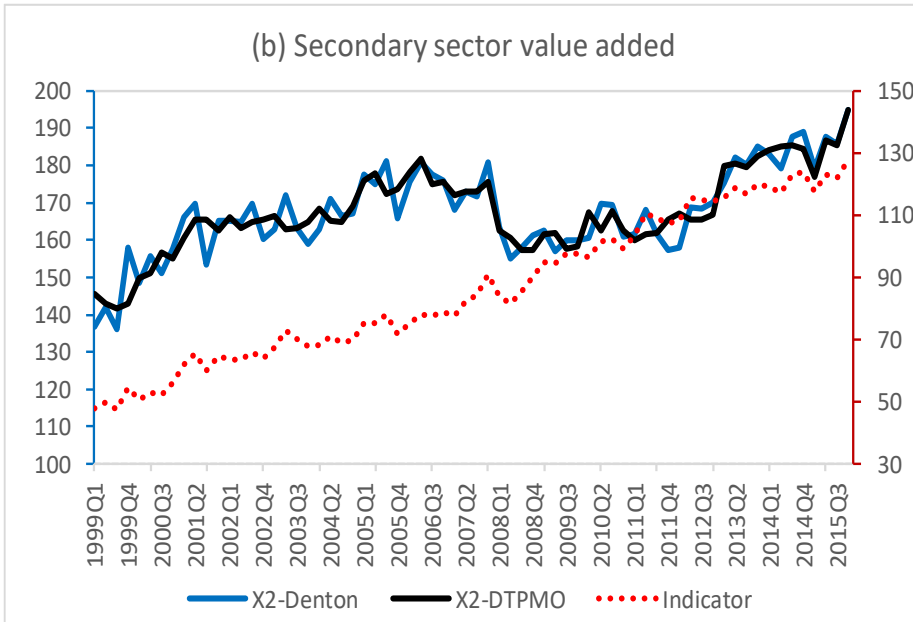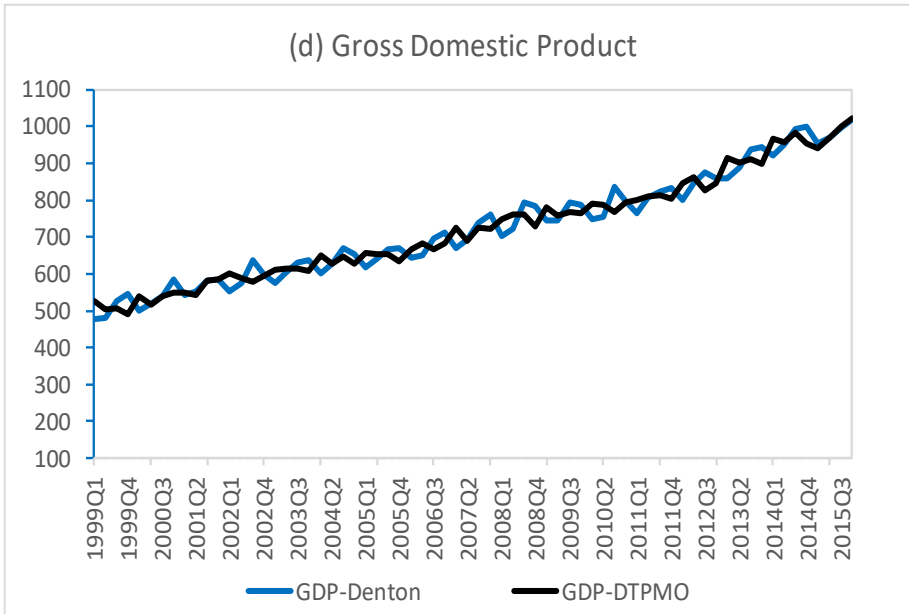
Figure 2 : Comparative evolution of quarterly accounts and indicators

Source: INSAE-data base, Author's calculations

The performance test of the MOPTD model compared to Denton's proportional method is performed in two steps.

The first step in performance analysis is based on a comparison of the level of GDP and growth rate obtained by extrapolation for the four quarters of 2015, after interpolation over the period 1999-2014. Table 1 summarizes the interpolation results compared to the true observed values and Table 2 summarizes the extrapolation results for 2015 in terms of values and growth rates. As the results in Table 1 show, both methods of quarterly disaggregation of GDP replicate exactly the actual observed account values for the retrospective periods (1999-2014).

With regard to the forecast for 2015, as shown in Table 2, for each sector, the annual values obtained by aggregating the quarterly national accounts are different from the real values observed for 2015. The order of magnitude of the difference in values is random, according to an analysis covering the sectors, on the one hand, and the methods, on the other hand. However, by the rule of additivity of accounts and global equilibrium, both methods give the GDP annual values relatively close to the value observed for 2015.

Year	Observed accounts			annual	Annualized quarterly accounts-DENTON				Annualized quarterly accounts-DTPMO			
	X1	X2	X3	GDP	X1	X2	X3	GDP	X1	X2	X3	GDP

1999	477.64	572.96	975.02	2025.63	477.64	572.96	975.02	2025.63	477.64	572.96	975.02	2025.63
2000	503.60	612.75	1027.94	2144.28	503.60	612.75	1027.94	2144.28	503.60	612.75	1027.94	2144.28
2001	534.31	654.22	1070.11	2258.64	534.31	654.22	1070.11	2258.64	534.31	654.22	1070.11	2258.64
2002	561.24	659.70	1142.57	2363.51	561.24	659.70	1142.57	2363.51	561.24	659.70	1142.57	2363.51
2003	574.42	657.29	1213.19	2444.90	574.42	657.29	1213.19	2444.90	574.42	657.29	1213.19	2444.90
2004	623.90	667.25	1262.06	2553.20	623.90	667.25	1262.06	2553.20	623.90	667.25	1262.06	2553.20
2005	622.49	699.62	1274.83	2596.94	622.49	699.62	1274.83	2596.94	622.49	699.63	1274.83	2596.94
2006	662.47	710.03	1326.86	2699.36	662.47	710.03	1326.86	2699.36	662.47	710.03	1326.86	2699.36
2007	694.50	693.48	1472.97	2860.95	694.50	693.48	1472.97	2860.95	694.50	693.48	1472.97	2860.95
2008	708.50	637.89	1654.65	3001.04	708.50	637.89	1654.65	3001.04	708.50	637.89	1654.65	3001.04
2009	741.95	639.36	1689.33	3070.64	741.95	639.36	1689.33	3070.64	741.95	639.36	1689.33	3070.64
2010	727.59	660.37	1747.60	3135.56	727.59	660.37	1747.60	3135.56	727.59	660.37	1747.60	3135.56
2011	742.19	648.71	1837.60	3228.49	742.19	648.71	1837.60	3228.49	742.19	648.71	1837.60	3228.49
2012	765.07	664.75	1954.00	3383.82	765.07	664.75	1954.00	3383.82	765.07	664.75	1954.00	3383.82
2013	801.76	722.61	2102.79	3627.16	801.76	722.61	2102.79	3627.16	801.76	722.61	2102.79	3627.17
2014	848.41	738.97	2274.56	3861.93	848.41	738.97	2274.56	3861.93	848.41	738.97	2274.56	3861.93
2015*	783.89	851.19	2303.51	3938.59	852.63	747.52	2340.89	3941.05	830.99	743.72	2355.94	3930.66

(*) the account values for this year in the case of Denton and MOPTD are those extrapolated

Table 1 : Comparison of the values of the annual accounts actually observed and aggregated after quarterly reporting

The growth rates resulting from the forecast are also close to the GDP growth rate observed in 2015. The actual observed rate is 1.98% while for the Denton proportional method, the growth rate obtained is 2.05% showing 0.06 point of overrun in percentage.

	Annual national accounts		Annual national accounts growth rate

	X1	X2	X3	GDP	X1	X2	X3	GDP
Real account value	783.89	851.19	2303.51	3938.59	-7.60%	15.19%	1.27%	1.98%
One year-ahead prediction								
Denton	852.63	747.52	2340.89	3941.05	0.50%	1.16%	2.92%	2.05%
DTMPO								
Simulation 1	830.99	743.72	2355.94	3930.66	-2.05%	0.64%	3.58%	1.78%
Simulation 2	827.30	745.18	2370.19	3942.66	-2.49%	0.84%	4.20%	2.09%
Simulation 3	828.01	744.34	2368.94	3941.29	-2.40%	0.73%	4.15%	2.05%
MEAN	828.77	744.41	2365.02	3938.20	-2.32%	0.74%	3.98%	1.97%

Note : the MOPTD results are those of simulation 1 with (Pop_size, No_runs, gen_max)=(100,10,25)

Table 2 : Summary of extrapolated GDP for 2015

With the MOPTD method, the direction of variation of the GDP growth rate differential obtained by extrapolation, compared to that really observed, is mixed. Indeed, in order to test the robustness of the MOPTD model, the simulation was carried out successively three times with the same parameters. But the random nature conferred on the NSGA-II algorithm induced different values of the GDP extrapolated for 2015. The GDP growth rate extrapolated for 2015 from these three simulations is set at 1.78%, 2.09% and 2.05% respectively, giving an average of 1.97% which is close to the real level observed. This reflects that the MOPTD model is relatively robust.

The second step of performance analysis of the MOPTD model is based on the analysis of statistics on the quality of quarterly series adjustments by interpolation and extrapolation. To do this, the mean coefficient of variation which referred to the mean relative standard deviation (MSD), the mean absolute error (MAE) and the mean absolute revision (MAR) were calculated for the comparison of the performance of the MOPTD model with that of Denton's proportional method.

The standard deviations (SD) of the interpolated quarterly accounts over the period 1999-2014 are calculated in order to compare the volatility of the quarterly value added series X1, X2, X3 and GDP. The MSD resulting from the quarterly GDP adjustment operation is given by the expression (15) :

$$MSD = 0.5 \times \left(\sum_{k=1}^{3} SD_{X_k} \bar{w}_k \right) + 0.5 \times SD_{GDP} \tag{15}$$

with $\bar{w}_k$ the average relative share (over the period 1999-2015) of sector k value added out of GDP

$$SD_Y = \frac{\sum_{t=1}^{4(T-1)}(Y_t - \bar{Y})^2}{\bar{Y}} \; ; \; \bar{Y} \text{ being the average of the series } Y$$

With regard to forecast quality, the analysis of predictive power for each of the two quarterly methods is based on the formula proposed by Marco [18] for calculating the average absolute error. For each series extrapolated to a subsequent year, the estimated prediction error (E) is estimated by calculating the relative difference (in percentage) between the extrapolated value and the true value [18]. In practice, the estimated prediction error of the Y series is given by:

$$\hat{E}_{Y,T} = \frac{\hat{Y}_T - Y_T}{Y_T} \times 100$$

$\hat{Y}_T$ being the estimated value of the series Y (representing either X1, X2, X3 or GDP) by extrapolation for year T (last accounting year). Thus, since the relative difference between the extrapolated and observed of GDP values is not obtained by additivity of errors from the sectors in the GDP calculation, the formula (15) proposed by Marco [18] has been modified and the MAE in predicting quarterly GDP is given by the relationship :

$$MAE = 0.5 \times \left(\frac{1}{3}\sum_{k=1}^{3}|\hat{E}_{X_{k,T}}|\right) + 0.5 \times |\hat{E}_{GDP,T}| \tag{16}$$

In addition, as presented above, the extrapolated values of the account series are different from the true observed values. The annual and quarterly national accounts are therefore subject to revision, due to extrapolation errors, seasonal adjustment or revision of quarterly indicators [16], once the temporary or final annual national accounts are available. As mentioned by Marco [18], it is desirable that the impact of short-term movements be limited so that the quarterly disaggregation method minimizes the size of revisions. Thus, the revision effect is captured by the mean absolute revision (MAR) of the last three years of quarterly changes [18]. The proposed formula for the calculation of MAR is a modification of the one used by Marco [18] and is presented in the following relationship (17):

$$MAR = 0.5 \times \sum_{k=1}^{3}\bar{w}_k\left[\left(\frac{1}{12}\sum_{t=4(T-2)+1}^{4(T+1)}\left|\frac{\hat{X}_{k,t}^{(T+1)}}{\hat{X}_{k,t-1}^{(T+1)}} - \frac{\hat{X}_{k,t}^{(T)}}{\hat{X}_{k,t-1}^{(T)}}\right|\right)\right]$$

$$+0.5 \times \frac{1}{12}\sum_{t=4(T-2)+1}^{4(T+1)}\left|\frac{\widehat{PIB}_t^{(T+1)}}{\widehat{PIB}_{t-1}^{(T+1)}} - \frac{\widehat{PIB}_t^{(T)}}{\widehat{PIB}_{t-1}^{(T)}}\right| \tag{17}$$

where the indexes $(T + 1)$ and (T) by exponent represent the last years of observation used; $\hat{X}_{k,t}$ refers to the value added of the sector k for the quarter t.

The Table 3 presents statistics on the MSD, MAE and MAR for sector value added and GDP. The resulting average values are in bold. The analysis of the results exposed in Table 3 shows overall that the MOPTD model performs relatively better than Denton's proportional method in the quarterly disaggregation of GDP process. Indeed, when reading Table 3, the MOPTD model minimizes the overall MAE and MSD statistics (absolute mean). However, Denton's proportional method minimizes the size of revisions MAR.

	Prediction error (%)	Standard Deviation (%)	Absolute Revision (%)
Primary sector value added (X1)			
Denton	8.77%	18.17%	1.10%
DTPMO	5.72%	16.33%	3.77%
Secondary sector value added (X2)			
Denton	-12.18%	6.69%	1.79%
DTPMO	-12.54%	6.20%	4.07%
Tertiary sector value added (X3)			
Denton	1.62%	26.58%	0.22%
DTPMO	2.67%	26.42%	4.27%
Gross Domestic Product (GDP)			
Denton	0.06%	18.97%	0.05%
DTPMO	-0.01%	18.58%	3.17%
Mean Absolute			
Denton	2.94%	19.41%	0.43%
DTPMO	2.88%	18.90%	3.64%

Note : the DTPMO results are those of simulation 1 with (Pop_size, No_runs, gen_max)=(100,10,25)

Table 3 : Summary of statistics in relation to the accounting forecasting exercise

Conclusion

The estimation of quarterly GDP using an indirect approach based on quarterly indicators is often done by quarterly disaggregation of the accounts of the various branches that make up GDP. This approach leads to the resolution of several optimization programs. On retrospective data, the quarterly disaggregation of national accounts, based on branch-by-branch disaggregation for the determination of quarterly GDP, does not take into account the link between branches of national accounts in the production process. This research presented a brand new approach to quarterly disaggregate GDP broken down into several branches or sectors that takes into account the links between branches and generalizes the Denton proportional method.

The proposed approach describes the method of quarterly disaggregation of GDP as a quadratic multiobjective programming. In applying the model to Benin's national accounts for which GDP is broken down into three sectors (primary, secondary and tertiary), the resolution was made using a multiobjective evolutionary algorithm using

dominance in the Pareto sense. Since the theoretical formulation is a generalization of Denton's proportional method, the simulation results of the MOPTD model are compared with those obtained by applying Denton's proportional method on the value added of each sector.

It should be noted that the model proposed in this research paper is better suited for the quarterly disaggregation of GDP. Indeed, the quarterly GDP obtained by the MOPTD model is less volatile than that obtained by Denton's proportional method. In addition, on an absolute average, the forecast errors are small for the model compared to that of Denton proportional. However, it should be noted that the Denton method gives small revision errors for series compared to the MOPTD model. This situation could be explained by the random nature of the model's resolution algorithm.

Finally, this research shows that the extrapolations of GDP using the Denton proportional method and those made using the multiobjective programming approach produce similar results when the quarterly indicators used are strongly correlated to the annual accounts. It should be noted that the multiobjective programming approach is better suited to take into account the links between branches of national accounts in the quarterly disaggregation process and to reduce the volatility of the quarterly GDP obtained. The proposed MOPTD model can be applied to the national accounts of any country using the System of National Accounts (SNA) [10] which describes a uniform methodology for the compilation of annual national accounts.

Acknowledgments

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An Approach for Movie Review Classification in Turkish

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Abstract

Web 2.0 has given to all people the right to become a representative of a huge cast of informal media. The importance of this power is getting more evident everyday. Every social media actor can influence the rest of the world by one's own opinions, feelings, and thoughts generously shared on multiple media. This information belonging to various fields of life can be very handy and be used to one's advantage, gaining precious experience. One of the greatest problems that this poses is the huge number of data spread everywhere, which are difficult to process as row data per se. Social media and general sentiment text analysis is of much valuable use, accomplishing the task extracting pure gold out of raw mineral. The key point of this investigation is to characterize new reviews automatically. To start with, features selected out of all the word roots appearing in the comments were used to train the system according to known machine learning algorithms. Next, critical words determining positive or negative sense were extracted. Another strategy was attempted eliminating common terms and dealing only with the significant class-determining words to build vocabulary with them. Aparts from linear approach, vector based feature sets were prepared out all or some of the features. The outcomes acquired were analyzed and compared leading to important conclusions, emphasizing the importance of feature selection in text classification.

Keywords: Sentiment Analysis, Turkish Language Processing, movie reviews, Machine Learning, Natural Language Processing

Introduction

The phenomena of Word of Mouth has always existed in any society, nevertheless its civilization degree, and it will always be present as long as we will be able to talk about

humankind. It only has changed means, shape, spreadability power, echo intensity, etc. Its power has changed a lot especially after the introduction of Web 2.0. Everyday strategies are renewed to match the dynamic content suggested by the global Word of Mouth. In the new context, any person decides for oneself to take part in the cast of a real life movie, deciding whether to just appear or to be a star. One does so by being an active and interactive participant in social life, which has no strict constraints. Social media provides people with such tools, that enable news reach in seconds any part of the globe, without even having the chance to verifiy them in advance. This is the power of the weapon of 21st century society.

It is estimated that out of 7.8 billion of the world population, more than 4.6 billion individuals (58% of the complete population) is dynamic in web, with North Americans having the most elevated entrance rate with around 95% of their population (Internet World Stats, 2020). As an illustration of a social media platform, Facebook gets visited at least daily by 74% of its clients in the US (Zephoria - Digital Marketing, 2020). People share their opinions and get quite influenced by others' opinions, too. This power of social media can also explain quite the common exploitation of it from the political and business leaders around the world. Each post is followed by countless comments, which reveal a lot about the support or opposition related to the post. Products are associated with several reviews from people who either suggest or complain about the product.

As an instance of a corporation that has appreciably advanced currently is Netflix. The wide variety of paying streaming subscribers differs as 21, 66 and 182 millions of customers respectively in 2011, 2015, and 2020. Only during the first six months of 2020, under the favorable effects of the pandemic situation, 26 millions of new subscribers have chosen this company (Statista, 2020). Before starting to watch for hours people don't mind querying for some moments others' opinions. Sometimes, however, this process can take more than minutes because of the abundancy of the reviews. Tools to summarize or automatically color the data according to their polarity, positiveness or negativeness, are crucial in this area. This is the main goal of this study, to predict movie comments in seconds. In the next sections, the following issues will be dealt with: similar works in this area, explaining the experimental setup, revealing and explaining the results, as well as including some conclusions regarding this study and potential future ones.

Literature Review

An extensive literature review conducted by Mostafa (2013) suggests that most Sentiment Analysis applications might be classified into four distinct categories: product reviews, movie reviews, politically oriented abstractions and stock market predictions. In this study overall efforts to analyze sentiments in online movie reviews, as well as some previous state of the art of the sentiment analysis of texts in Turkish will be covered.

In one study (Na, 2010) the opinion mining of movie reviews from discussion board threads, user reviews, critics' reviews and bloggers' postings were performed. Reviews sentence length, lexicon, and parts-of-speech information was considered, concluding that opinion holder words like verbs and adjectives were used more in reviews, respective to an abundance of nouns used in bloggers or critics posting. The most commonly used positive and negative words and their patterns per each domain were determined.

Zhuang (2006) applied ML techniques movie reviews dataset in order to summarize the opinion polarity. They aimed to retrieve specific feature sets in the text and the expressed opinion, for example, "sound effects" and "excellent". Pang (2002) similarly utilized support vector machines (SVM) acquiring 82.9% of precision in categorizing opinion summaries of movie reviews. They made use of both single words (unigrams) and pairs of consecutive words (bigrams) to classify the comments, as well of different classification algorithms, concluding that Naive Bayes, Maximum Entropy and SVM, have performed better in text classification than in sentiment classification. In fact, it is difficult to get better outcomes, because of specific characteristics of natural languages, but in specific domains, we can get good enough outcomes.

Thet, Na and Khoo (2008) conducted studies classifying online movie reviews. In one of them, they used machine learning and information extraction techniques by correctly determining the pronouns and co-referencing them to relate them to different aspects, such as the cast, the director, the effects, etc. and the overall rating of the movie. In the next task, the authors tried to reveal also the strength of the polarity of the comment according to a suggested computerized method, by taking into consideration the grammatical dependency structure of each clause analyzed according to a computational linguistics approach.

An advantage of the lexicon-based approach as compared to more generally used machine learning is that in the former, training set need not be labeled previous to the classification. They work according to text grammar analysis principles, while the elder fits the algorithms to the training set characteristic patterns. It is interesting that besides being inferior to machine learning methods in specific domains, lexicon-based methods can be quite better for wider domain sets. For instance, a lexicon-based approach (Taboada, 2011) is used for six distinct corpora from various domains, with a 75–80% accuracy. ML techniques, on the other hand, result more efficient for a distinctive domain, with 86.4% accuracy for a movie review summarization for a given dataset (Pang B. &., 2004). Once again it is implied that, although showing a weaker performance in data classification within one domain due to training dataset pattern overfitting, lexicon-based methods are more robust and show better results in cross-domain text classification process, in the current work, getting better scores in blog postings and video game reviews.

Sindhwani (2008) build a semi-supervised lexical model by merging lexical sentiment information, unlabeled data, and labeled training data. In three of the domains used in the study, such as products, political, and movie reviews, this strategy outdid purely supervised and competing semi-supervised approach.

There exist few studies in other natural languages, generally not applying very different methodologies than those used in text classification in English. Nevertheless, they are important in their field as novel applications in other languages. In a study in the Spanish language that has been conducted by Martínez-Cámara (2011) for movie reviews classification, they used several ML techniques and attained a high accuracy of 86.84% when SVM was applied.

Turkish is not an exception for languages other than English, where only a limited number of studies in sentiment analysis area exist. One of them (Kaya, 2013) studied the sentiment analysis of Turkish political columns on web documents. Their approach considered transfer learning in Turkish. In transfer learning, the aim is to extract needed knowledge from one or more tasks and then to transfer extracted information into a target task. In this work, the unigrams and the bigrams together with polar Turkish terms are used as classification characteristics to categorize unseen documents. The authors used four different classifiers: Naive Bayes, Maximum Entropy, SVM, and the character-based n-gram language model and compared their accuracies. They concluded that Maximum Entropy and n-gram language model is more efficient than SVM and Naive Bayes classifiers. The classification accuracy in different cases ranges from 65% to 77%. On the other side, several works have studied causal association rule mining.

Erogul (2009) investigated sentiment in two movie datasets in the Turkish language, applying English language sentiment analysis approaches. Turksent (2010) is an annotation tool developed specifically for manual sentiment analysis of Turkish social media posts. Yet another study in the Turkish language compares methods of text representation (Amasyalı, 2012). An ambitious study (Vural, 2013) aimed to determine the polarity of movie reviews by translating Sentistrength library to Turkish. They used a large corpus of Turkish movie reviews and they stated that although the framework was unsupervised, the performance approached the performance of supervised polarity classification. Amanet (2017) studied Twitter data using the emotion categories like "Happy", "Appreciation" etc., defining the most effective word sets for each emotion. Turkmen (2016) worked on the aspect-based sentiment polarity of online customer reviews. In Kamburoğlu (2018) thesis adjective clustering was used to automatically guess Turkish movie review scores of 76% accuracy. Through this study it was possible to measure also the reliability of the two popular sentiment lexicons SenticNet and SentiWordNet, resulting in a moderate level of agreement between lexicons and human judgments with an accuracy of 79%. Orhan (2014) automatically predicted the text polarity in customer product comments domain by making use of language characteristic features of the reviews and by utilizing ML techniques with a

high level of correctness. An optimistic upcoming aim of their research is to categorize texts on any topic.

Experimental Setup

Data selection

Movie comments from well-known and popular Turkish movie sites, such as (IMDb, 2014), (Sinemalar.com, 2014), and (beyazperde, 2014) were collected. Based on the high and low ranking of the comments, positive and negative were partitioned respectively. In total 305 positive and 305 negative comments were gathered, 205 of them used for training and 100 comments per group for both classes were used to test the system.

Data Preprocessing

Some preliminary tasks were done before selecting the feature sets, such as tokenization, stemming, morphological analysis and disambiguation, getting rid of some stop words, etc. The whole process is shown in detail in this section.

Turkish, together with Korean, Hungarian and Finnish belong to the Altaic language group. It has characteristics of vowel harmony and extensive agglutination, meaning the derivation of new words by adding derivational or inflectional morphemes to the roots as suffixes, resulting in many different words derived from one root or stem. These properties cause difficulties in NLP, because of the complex morphology compared with other languages like English. This makes the computerized processing of data analysis for Turkish more challenging.

Natural Language Processing (NLP) is one of the fields of science and engineering, useful to design computer systems for processing and understanding natural languages (Rehman, 2013). NLP is widely used also in computational linguistics, filling the gap between human expressions and artificial intelligence. The advances in information technologies have driven many studies dealing with natural languages. The basic NLP steps are tokenization, stemming, POS tagging, etc.

Tokenization is one of the preliminary steps of text processing. It is the process of separating sentence structure into word groups, which is applied in order to simplify the process of analysis extracting information from requirements documents (Webster, 1992). First, the sentences are separated into their components by making use of the punctuation marks and spaces as separators.

The next preliminary step is **stemming**. After the text has been tokenized into words, it is cleaned from the inflectional morphemes through the stemming process. Words derived from the roots of nouns and verbs through derivational morphemes, by removing the inflectional suffixes is named a stem (Can, Kocberber, Ocalan, & Vursavas, 2008). Derivational suffixes are used to derive words. The inflectional suffixes are added to the stem of the name and verbs to specify the state, possession, plurality, time.

ISSN 2601-8683 (Print)
ISSN 2601-8675 (Online)

European Journal of
Formal Sciences and Engineering

July -December 2021
Volume 4, Issue 2

However, stemming is a difficult task in agglutinative languages such as Turkish, Finnish, and Korean. Because the sequence of inflectional suffixes can be added to the stem of a word. The stem of the word is accessed by clearing the word from the inflectional by removing them.

Stemming has been done by using the **morphological analyzer** tool tr-tagger (Turkish Language Resources, 2019), a Turkish morphological tagger includes Kemal Oflazer's finite state machines for Turkish.

Next, to get rid of ambiguous tr-disamb, a Turkish **morphological disambiguation** tool was used (Turkish Language Resources, 2019). The tool shows a high accuracy of disambiguation of about 96%, based on the Turkish language rule model for morphological disambiguation. Turkish, being an agglutinative language, close to half of the words of a general text can show morphological ambiguity, which makes the disambiguation task quite tough. The correct form according to the context is chosen among an unlimited number of morphological analyses of a word due to multiple candidate suffixes.

Feature Selection

Feature selection is one of the most important tasks in Sentiment Analysis. After the initial processing of the data, the stems are acquired, which will form the features for different methods. All the unique stems emerging from positive and negative movie comments, together with their occurrences per document, and overall frequency per class, after some normalization procedure regarding the length of the text and the documents population, will contribute to positive and negative word lists. It is known that the most frequent words are usually common in both classes, so they cannot be distinctive. Examples of the common words can be pronouns, articles, etc. The words with similar occurrence frequencies, falling within specific thresh values will be eliminated either from both lists, as non discriminative. Then, different methods will be involved. Some of the concepts are explained as follows:

Thresh values: Some of the words appearing in similar ratio in both positive and negative word lists have been eliminated from both lists.

Erase methods: Some terms which fall between determined thresh values are erased from one or both lists, according to the erase method.

Erase from both lists method: The terms within thresh percentage similar frequencies are erased from both positive and negative lists

Erase from one list method: The terms within thresh percentage similar frequencies are erased from the list that they appear less often and their frequencies difference is kept in the other list

Binary List feature selection method: Initially all words (roots) are considered. According to which thresh ratio and erase method is going to be used, the positive words

list and negative words list are built. If the word used in the positive comment exists in the positive words list, then it contributes to the positivity of the comment as much as the frequency of the word used inside the same comment. The same is done for the negativity of the word from the positive comment, if the word appears in the negative word list for the given thresh and erase method, the frequency of appearance in the positive document is added to the negativity value of the comment. This is done for all the words of the comment. This process is repeated for all positive comments in the train set. The whole process is done also for all negative data from the train set. At the end of the process, a comment will have a positive and a negative value which will be the estimated class value (P for positive, N for negative determined from the difference of the negative value from the positive value calculated). Again all the above is repeated for the test data set, for positive and negative comments.

Frequency List feature selection method: The difference from Binary List method is that each word value occurrence in the document is multiplied by the frequency coming from the positive and negative words list of words. This calculation will affect the total positivity and negativity value of each comment. The rest of the process is as above.

All Words Binary method: All distinct words coming from train documents become the first row of the vector, while all the documents (id's or names) coming from the train dataset become the first column of the vector. If a word appears in the comment, its value is placed as 1, if it doesn't, its value equals 0. The last column contains the information for positivity or negativity of the comment. In the same way also the test data file is prepared, with the exact same first row. For words appearing in test dataset but not in train dataset, no value will be kept, obviously.

All Words Frequency feature selection method: The only difference from All Words Binary method is that not only the occurrence is determined, but also a numeric value is calculated regarding the number of occurrences of the word in the document, the frequency coming from the positive words list and the frequency coming from the negative words list.

Selected Words Binary feature selection method: Instead of taking all the words out of the train data test, according to the thresh value and erase method, a set of those words is taken as the feature set of the vector. The rest is done similarly to the All Words Binary feature selection method.

Selected Words Frequency feature selection method: Instead of taking all the words out of the train data test, according to the thresh value and erase method, a set of those words is taken as the first row of the matrix. The rest is done similarly to the All Words Frequency feature selection method.

This calculation will affect the total positivity and negativity value of each comment. The rest of the process is as above.

Classification with Machine Learning techniques

Machine learning based studies can be categorized into supervised, unsupervised and semi-supervised topics. Feature engineering and feature selection are also vital in a machine learning pipeline.

Supervised learning is one of the most used approaches in ML domain. Although supervised learning is successful in rich set of applications, it has many challenges

Lastly, the features for train and test data prepared by the above mentioned feature methods yield .arff extension files, which are fed to Weka Classification tool. Several existing Machine Learning algorithms are used and their results are evaluated. Voted Perception (VP), Bayesian Linear Regression (BLR), Random Forest (RF) and Logistic Regression (LOG). They can be seen in the Table 1:

Table 1: Accuracy values (%) for all feature selection methods and their ML classifiers

VP	BLR	RF	LOG	Feature Method
90	89	87	88	Frequency List EraseBoth 25% thresh
88	90	87	88	Frequency List EraseBoth 50% thresh
79	80	83	89	All Words Binary
85	89	84	79	All Words Frequency
86	88	83	72	Selected Words Binary EraseBoth 25% thresh
83	90	87	78	Selected Words Frequency EraseBoth 50% thresh

Results and Conclusions

When comparing Binary and Frequency List feature selection methods, Frequency List method clearly outdoes the Binary one to an extent 90% to 79% of respective accuracies.

It can be noted that the highest accuracies of 90% can be obtained from Frequency List feature selection method together when erasing the common terms from both positive and negative word lists within the thresh values 25% and 50% of the values, respectively for Voted Perception and Bayesian Logistic Regression ML algorithms. The same accuracy is obtained also with the Selected Words Frequency EraseBoth 50% feature selection method when classified with Bayesian Logistic Regression ML algorithms.

In general Bayesian Logistic Regression ML algorithm is very accurate, giving 89% value for Frequency List EraseBoth 25% thresh and All Words Frequency feature selection method. While Bayesian Linear Regression does not give a good result with All Words Binary feature selection method, Logistic Regression has an accuracy of 89%.

One can thus conclude that all feature selection methods have similar results with different ML algorithms. All the results are quite high for Turkish movie reviews when compared with previous studies in this field, making this one a promising study for Turkish and generally in this area.

Forthcoming research might exploit machine learning techniques for more significant feature refinement, reducing the feature sets in favor of performance and predicted accuracy.

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The Ecological Cluster as an Energy Transition Engine

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Abstract

The occurrence of successive economic crises, strong competitive pressures, and the degradation of natural and ecological resources are some of the major threats that make energy transition the new holy grail of the 21st century. This awareness of the urgency of the situation opens of the possibility for adopting an alternative approach - one of alliances, partnerships, and cooperation within the framework of exchange and sharing. This is, as Harari put it, the secret of the success of man. It can contribute sure to the goal of sustainable economic development. In line with this, new organizational forms have emerged, with the restructuring of the economy, integration of the principles of sustainable development, and development of renewable energies and clean technologies. These so-called Cleantech ecosystems, clusters focused on sustainable development projects, serve the dual function of at once contributing to economic growth and the attractiveness of an economy for investors and preserving the environment.

Keywords: energy transition, clean technologies, sustainable development, ecological grouping, territorial governance

1. Introduction

In the face of current environmental challenges such as environmental degradation, climate change, and loss of biodiversity, it is necessary to shift from an energy system based on non-renewable energy to one based on renewable energies and clean technologies.

The 1987 Brundtland Report, the 1992 World Conference on the Environment in Rio de Janeiro, and the adoption of the Kyoto Protocol in 1997 were all occasions on which the urgency of the looming ecological and environmental disaster was brought to the attention of states.

Hence the need to turn to an alternative model combining economic growth and

environmental preservation.

In particular, the transition to renewable energy requires switching to an alternative model that restructures the current system and reorders the priorities of the various stakeholders.

It is necessary to adopt a new energy system that reconciles economic and environmental motives through the development of green technologies and specific mechanisms that can reduce negative impacts on the environment.

The success of the energy transition process is dependent on the implementation of governance because the consideration of environmental constraints is influenced by the forms of interaction and cooperation between the various stakeholders.

The green cluster is an alternative model that can help make the energy transition process smoother. Its implementation could particularly enable more effective resource management at different levels (i.e., energy, solar, recycling, waste treatment, eco-construction, etc.).

The purpose of this paper is to demonstrate the close relationship between energy transition and the green cluster and to present arguments supporting the hypothesis that the establishment of the green cluster is a driver of energy transition.

A review of the literature reveals the importance of the analysis of theories of territorial organizational structures and industrial ecology for a better understanding of green ecosystems.

In fact, such structures are based on a combination of geographical, organizational and cognitive proximity, enjoying competitive advantages, a reinforced innovation process, and an easy flow of information.

The question that remains to be addressed is to what extent the establishment of the green cluster contributes to the success of the ecological transition process.

In responding to this query, this paper first presents a review of the literature, looking in particular at theories concerning territorial organizational networks and the definition of hypotheses. Then, it analyzes the links between the green cluster and ecological transition by analyzing the points that the two have in common. Finally, the paper presents the benefits of the ecological cluster and a few case studies from around the world where it has effectively been implemented.

2. Material and Method

Insofar as the question of methodology is concerned, this paper draws on documentary research and bibliographical study in order to enrich the analysis of the theoretical concepts necessary to the understanding the approaches being discussed, notably those relating to territorial networks of organization and industrial ecology.

ISSN 2601-8683 (Print)
ISSN 2601-8675 (Online)

European Journal of
Formal Sciences and Engineering

July -December 2021
Volume 4, Issue 2

The paper also presents pioneering examples from around the world of environmentally friendly policies, emphasizing the specific characteristics and strengths of each model.

3. **Theoretical and Conceptual Framework**

The increasing occurrence of ecological and economic crises reveals the fragility and the limits of the current economic model. It goes without saying that challenges such as climate change, the scarcity of natural resources, and environmental degradation require the implementation of an alternative model.

Theoretical analysis shows a neglect of the spatial and environmental dimension, such that the theories concerning the location of economic activities do not include explicit references to the territory.

By way of example, Fordism, as highlighted by Alain LIPIETZ (1995) ignored the ecological question and the territorial dimension. Post-Fordism, for its part, has fully taken into account the dimension of space and location.

The Fordist crisis has contributed to the substitution of the model of economic development based on standardization and mass production, and based on big business, to a model based on flexible specialization through a spatial concentration of small businesses.

Hence, there is a close relationship between the principles of sustainable development, territorial organizational networks and economic performance (LIPIETZ 1995)

It is only in the period of post-Fordism that taking into account local factors, space and territorial anchorage became important. Following the crisis of Fordism, new forms of organization appeared based on industrial agglomerations. (LIPIETZ 1995).

Theoretical approaches to territorial organizational networks can be presented as follows:

Territorial organizational networks	Theorists	Definition	Specificities
Industrial District Marshallian	Alfred MARSHALL (1920)	Geographically located production system based on an internal division of labor between small and medium-sized companies specialized in different phases of the	Division of work Atmosphere conducive to learning Reduction of transaction costs. Existence of economies of

District industrial Italian	Bagnasco (1977) Becattini (1979) Brusco (1982)	A socio-territorial entity characterized by the association of activities in a circumscribed and historic territorial area.	Flexibility Common values and shared standards Competition-emulation and cooperation Socio-economic
Territorial organizational networks	Theorists	Definition	Specificities
Cluster	Porter (1990)	Geographic concentration of related companies that compete and cooperate with specialized suppliers, service providers, related industry firms and associated	Competitive and cooperative relations between firms located in the same area. Value chain integrated territorially

It should be noted that this table does not represent an exhaustive list, and that there is a multitude of structures and a proliferation of concepts and designations (e.g., industrial pole, technological district, innovative environment, etc.). These forms of organization are mainly focused on the technology sector and more specifically information and communication technology (ICT). The rise of such structures in the industrial, technological and tourism fields suggests that their use may be compatible with green and sustainable sectors.

The theoretical analysis focuses on currents of thought that respond to this problem. Several theories were developed for this purpose, in particular the theories of growth and the theories of regulation, testifying to the importance and interest in this subject, from institutionalism, to the neoclassical current of thought and, more recently, industrial ecology.

It is important to analyze theoretical approaches that combine both economic growth and a transition to renewable energy. Indeed, the new territorial approaches underline the importance of the reconfiguration of the production system by adopting strategies based on the logic of partnerships and cooperation between the different actors in a given territory.

Theories relating to industrial ecology are in line with this approach, as they give a central place to the synergies between industrial players and the protection of the environment. The emergence in the late 1980s and early 1990s of theories of industrial ecology and eco-industrial systems is consistent with respect for principles such as the preservation of the environment.

One author describes this as "a process of synergy of industrial actors for the purpose of closing the flows of materials and energies, in a logic of rationalization of the consumptions of natural resources".

The works of R. Frosch and N. Gallopoulos consider industrial ecology as inspired by the functioning of natural ecosystems.According to these two authors, this approach implies a balance of the incoming and outgoing flows of the industrial system, transformation of the waste of some in order to make new resources for others, renewal of available resources, the reduction of discharges and polluting emissions, and the reduction of energy intensity, losses and use of harmful substances.

This approach is based on actions such as recycling and the reduction of harmful substances in the environment (e.g., greenhouse gases, polluting emissions). Industrial ecology integrates the issues of sustainable development and the dimension of sustainability in the context of economic activities. (BEAURIN and BRULLOT 2011)

Thus, territorial organizational networks and sustainable development have points in common, and indeed economic growth can be compatible with the principles of sustainable development as evidenced by the rise and emergence of green growth.

In order to respond to the challenges of sustainable development, industrial ecology adopts a process of reconfiguration and reconstruction of territories by placing them in a sustainable perspective of economic activities.

This approach is based on constructive modes of coordination, on the games of actors and proximity. In fact, the forms of interaction between the various local actors are essential to the success of industrial ecology. It is deployed locally and is based on strategies aimed at economic and environmental rationality.

In line with this, the adoption of an alternative model such as the ecological cluster is based on a partnership approach integrating sustainable economic development, energy efficiency and the promotion of renewable energies. It contributes to the dynamisation of the energy transition process.

The industrial economy advocates a process of construction of territorial specification beyond the mere agglomeration of actors, which in turn means the modes of coordination and forms of proximity contribute to sustainable territorial development through the creation of new opportunities.

The involvement of different local actors is considered as an essential factor in the context of industrial ecology, and it is therefore necessary to identify the role of each local actor in order to facilitate the linking of the forms of interactions, alliances and the logic of cooperation between them.

4. Ecological Cluster as an Instrument of Public Policy

Energy transition requires the construction of a legal and regulatory framework

ISSN 2601-8683 (Print)
ISSN 2601-8675 (Online)

European Journal of
Formal Sciences and Engineering

July -December 2021
Volume 4, Issue 2

integrating the sustainability dimension and taking into account the environmental and ecological effects in the implementation of public policies.

Indeed, the success of the alternative model depends on an integration of environmental motives and the strengthening of the legal framework through the implementation of transversal and global public policies able to face environmental challenges.

In the process of setting up an alternative model that breaks with the environmentally unfriendly production system, it is necessary to put in place public policies combining both incentives - such as ecological taxation - and regulations encouraging eco-friendly practices. The design of products, support for proactive environmental practices, and funding through grants and subsidies to encourage environmental preservations, combined with coercive measures sanctioning polluting technologies and systems can together go a long way in making an alternative model successful. (CHARLOT- VALDIEU et al 2013)

The establishment of the ecological cluster as a public policy strategy and instrument for the development of renewable energy and clean technology projects is coherent with these proposals.Such a structure contributes to the strengthening of sustainable economic development, the reduction of ecological risks and the carefully measured use of scarce natural resources.

The ecological cluster is an alternative approach aimed at reconciling both economic progress and environmental protection through the development of activities and projects with high added value and focused on green sectors.

There is a need to integrate public policies in a long-term vision by taking full account of the dimension of sustainability (and transversality) to face environmental threats. Action must be focused on the source of degradation.

Montalvo (2008) emphasizes the minimalism of environmental policies, suggesting that they are conservative and shortsighted. They have little incentive and focus mainly on preventive measures, whereas to achieve the desired results, it is necessary to adopt a sustainable approach, sustainable dynamics and a redesign of public policies.

In order to guarantee a successful ecological transition, it is necessary to include environmental and innovation policies by combining incentives and coercive measures so as to stimulate research and development expenditure and reduce negative effects on the environment. (HAMDOUCH and DEPRET 2009)

The success of the ecological transition and the green cluster require the reconfiguration of the production system by integrating the dimension of sustainability, and a complete restructuring of technological, political and institutional elements.

5. Eco Innovation as a Catalyst for the Energy Transition Process

Technological advances and the rise of so-called green and clean innovations play a

considerable role in revolutionizing the potential for environmentally friendly growth. In fact, the success of the ecological transition depends on the process of innovation and advancement.

In this sense, the ecological cluster takes a central place in the innovation process; it corresponds to a model focused on the development of clean technologies and renewable energies (e.g., wind, solar, etc.). In fact, the existence of scientific actors, particularly universities and research centers within the green cluster, contributes to the creation of new knowledge and the dynamization of the innovation process. (COOKE 2010)

The ecological cluster is based on a sustainable integrated approach, and the concentration of different actors in a given area combined with cognitive proximity, contribute to the rapid circulation of information flows and consequently the strengthening of the critical mass of knowledge. Such proximity plays a role in strengthening the innovation process.

It can be considered as a range of innovative products and services aimed at optimizing the use of natural resources and renewing them in the long term. The ecological cluster is a radical change in the protection and preservation of natural resources through the use of clean and green technologies. (DAVIES 2013)

The establishment of the ecological cluster contributes to the revitalization of Eco-innovation through the improvement of environmental sustainability, the reduction of the intensive use of natural resources by developing alternative technologies, reconciliation between the source and the environment, and the reduction of distances and consequently transport costs due to geographical proximity. (DADDI 2012)

The ecological cluster takes into account both economic considerations - by contributing to the performance and the improvement of the competitiveness and attractiveness of an economy - as well as environmental considerations, as evident from its focus on alternative measures.

It is part of an alternative approach that breaks with the polluting production system, contributing to the creation of sustainable economic dynamism and the facilitation of the energy transition through the development of high value-added activities with a special target: renewable energies and green technologies.

It also helps strengthen the positioning of companies operating in the eco-technology sectors by offering them international visibility and a critical mass of knowledge and skills. (HAMDOUCH AND DEPRᴇT 2012) Such benefits are due to the existence of a real scientific base and the strong involvement of research and development actors.

The ecological cluster is part of a global approach to managing activities related to the environment (i.e., waste and wastewater treatment, recycling and purification), the renewable energy sector (i.e., wind, solar, biomass, photovoltaic, etc.) and also so-called

ISSN 2601-8683 (Print)
ISSN 2601-8675 (Online)

European Journal of
Formal Sciences and Engineering

July -December 2021
Volume 4, Issue 2

alternative activities like eco-construction (e.g., sustainable buildings, eco-renovation, and energy management). (Rennings 2005)

Thus, such a structure constitutes an alternative model combining environmental and sustainability needs with efficiency and economic performance. It is based on a partnership approach involving a multiplicity of actors (i.e., companies, public actors, universities, research centers, etc.).

6. Governance within the Ecological Cluster as an Institutional Framework of Interactions

The resolution of environmental challenges and ecological problems requires the establishment of an institutional framework and a partnership approach integrating all economic, social and political factors.

The energy efficiency approach and the success of the ecological transition require the use of a concerted and collaborative approach. The green cluster is, it should be recalled, based on the involvement of a diversity of actors of different natures (i.e., companies, local communities, research centers, universities, etc.). This heterogeneity of stakeholders necessarily means there is a complexity inherent in the system, a divergence of interests which can in some cases even trigger conflicts. The use of governance is therefore essential to avoid failures and blockages threatening the success of the energy transition.

Colletis 2001 defines it as "a process of constructing compatibility between the different institutional proximities uniting geographically close actors (economic, institutional, social) in order to solve a local development project.

This definition highlights the importance of using such an approach and the role it plays in complex problem solving, such as the case of the issue of environmental effectiveness. It is part of a strategic approach contributing to the achievement of a shared vision.

Thus, environmental governance takes center stage in terms of sustainability management based on the mobilization of local stakeholders and the strengthening of alliances, logics of partnership and cooperation.

It constitutes an institutional framework guaranteeing the regulation and management of the various stakeholders necessary to deal with the scale of environmental risks and the success of the ecological transition.

7. International Experiences in the Ecological Cluster

Governments are becoming aware of the need to develop alternative models and adopt measures and mechanisms to deal with environmental problems. Indeed, as shown in the following table, several countries are developing strategies focused on integrating the sustainability dimension into their economic systems. This section introduces the pioneers of technological and environmental advances, including clean technologies and

renewable energies.

Representative Table of the World Cleantech: (Report of the Ministry of Ecology, Energy, Sustainable Development and the Sea on global clusters in the field of eco-technologies)

Clusters	Objectives	Specificities	Analysis
Envirolink Northwest (United Kingdom) operates in the following areas: Water management, waste recycling	Stimulation of activities related to eco-technologies Support innovation and development of innovative products Improving the learning and innovation process	Dynamism and strong portability of the scientific actor: consortium of universities Important role played by regional development agencies Cooperation between different stakeholders (public, private and scientific) Programs such as: low carbon demonstration, Biomass project to achieve progress in environmental protection	The cluster is characterized by an active mode of governance integrating all the stakeholders. The existence of high potential in the areas of recycling, energy-saving technologies and a low-carbon economy. The cluster has helped strengthen R & D capacity in the field of recycling ,research and technology transfer. The cluster contributed to strengthening international visibility, identifying opportunities related to eco-technology markets.
Solar Valley Mitteldeutschland (Germany) specializes in solar energy throughout its value chain	Maintaining the technological and scientific advance Introduction of a quality training offer Strengthening cluster positioning and branding Attractiveness of national and international funding	Strong synergies between the different stakeholders Major Grants for Energizing the Solar Energy Sector Dynamism of the environmental technologies sectors Existence of structures ensuring the control and evaluation of the cluster	The cluster is characterized by the existence of a real strategy for research and innovation Achieving real advances in solar cells and equipment development (cost savings). The achievement of positive results in energy efficiency and the growth of solar technologies. The dynamism of this cluster is evident, as is its ability to foster international cooperation and partnerships. However, there is a need to strengthen the steering and command structure by providing it with stabilized legal power. We must also strengthen the marketing strategy for greater visibility and attractiveness.

8. Results

The establishment of clusters tends to produce certain economic, social and environmental effects:

8.1 *Economic*

In clusters, the economic benefits are due to lower transportation costs because of geographical proximity. In addition, agglomeration of activities leads to increased productivity and skills.

Furthermore, some clusters help and accelerate business creation through the role played by incubators. These encourage companies to establish themselves by providing support and financial and technical monitoring.

Such an initiative is a virtuous circle, creating economic dynamism and local economic growth.

8.2 Environmental

The establishment of the ecological cluster contributes to a rational use of resources and reduces the consumption of extremely scarce natural resources. It also contributes to the development and growth of renewable energies and clean technologies that respect and preserve the environment.

In fact, in the case of the traditional model, the distances between the various stakeholders are substantial, therefore implying an increase in the quantities of fuels used and therefore a high energy consumption linked to this mode of transport. However in the case of the ecological cluster, there is geographical proximity and the externalities related to transport are reduced, thus contributing to the reduction of CO_2 emissions.

The preservation of natural resources is possible thanks to a valuation approach and synergies, so the residues and waste of one company constitute the raw materials of another. Such actions contribute to recycling.

The organizational proximity embodied by the alliances, the logics of partnership and cooperation contributes to a rational use of resources and also to the preservation of waste. The cognitive proximity materialized by the exchange of information and knowledge plays an indispensable role in the creation of new products and processes, for example the promotion of new high-performance and less polluting technologies.

13,3 Social

Cluster presence helps to improve well-being by reducing poverty, unemployment and social inequalities. The cluster contributes to the improvement of the quality of life and the natural environment, in addition to the consolidation of the sense of belonging and identity.

Indeed, the establishment of the cluster based on an innovative approach contributes to

the creation of new economic activity and therefore greater employment. This has the impact of improving the standard of living and creating wealth that reduces social disparities.

The attractiveness of a country is improved within the framework of the cluster because of the strengthening of the belonging and the local culture through the valorization of the specific local resources.

The establishment of the cluster does, however, face certain risks and threats that must be solved:

· Lack of financial means

· Reluctance of some stakeholders

· Existence of lobbies

· Poor financial results

· Stakeholder exit

· Heterogeneity of partners can lead to blockages and conflicts of interest

· Disengagement and exhaustion of stakeholders

· Managerial complexity

· Inertia and bursting

In the face of these challenges, it is necessary to put in place mechanisms and measures that can counteract these risks.

Thus the following table outlines the importance of governance, strategic and territorial management.

	Governance	Strategic and territorial management
Success factors	Governance The need to put in place an institutional framework guaranteeing steering and management actions for all stakeholders. Indeed, the existence of a structure ofmanagement will put an end to situations of blockages, divergences of interests, even to conflicts, thus privileging the collective interest. The establishment of a system of regulation and frameworks of relations between the various stakeholders.	The need to carry out an upstream territorial diagnosis aimed at identifying strengths and weaknesses, but also a categorization of all stakeholders highlighting strategic priorities. It is also necessary to allocate the resources essential to the success of the cluster (i.e., financial, human, technical, etc.) The use of communication campaigns to attract new players, and to limit the reluctance of certain actors.

The analysis of global clusters demonstrates the important role played by the latter in

reinforcing technological advances in renewable and green energies. Indeed, the establishment of the cluster contributes to the improvement of the learning and innovation process and consequently the development of new energies that are more respectful of the environment and less energy consuming, even at a certain cost.

The energy cluster benefits from the support of the various stakeholders through forms of cooperation and synergies that contribute to real dynamism and the promotion of projects focused on environmental technologies.

The green cluster and energy transition are closely linked. Together, they promote the transition from a highly polluting production system to an alternative system reconciling economic and environmental motives.

They are based on strengthening the process of innovation and learning by giving a central place to eco-innovation, so that it offers more sustainable technologies and products.

The green cluster and energy transition cannot achieve the expected results without the mobilization and involvement of all stakeholders, be they public, private or scientific, in an institutional framework based on the principles of governance, exchange, and information sharing.

Therefore, the green cluster can be likened to an energy transition engine, capable of providing an institutional, legal and technological base to guarantee the success of the transition towards sustainable economic development.

Conclusion

The current socio-economic crisis and the ecological impasse require the reconfiguration of the current production system by adopting an alternative model centered on the question of sustainability.

To this end, the ecological cluster is a model based on the involvement of a host of public and private actors and also civil society with a common goal of sustainable economic development respectful of the principles of sustainable development. These actors develop alternative pathways in contrast to traditional production systems.

Cooperation and the logics of partnership between the various stakeholders (e.g., companies, universities, local communities, etc.) are essential to carry out such an approach.

The green cluster can be considered as an engine of ecological transition combining both the dynamisation of the economic system and the strengthening of the ecological system.

Energy transition is dependent on a restructuring of the economy and a reorganization of stakeholders' priorities by putting in place an alternative model focused on the principles of development and the logic of partnership and cooperation present within ecological clusters.

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Identification of the Tourism Risks for Z-Value Based Risk Assessment

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Abstract

The growing importance of the tourism sector to the global economy contributes to the increase of research in tourism risks assessment. In view of this tendency, the results of research in the field of the risk analysis on tourists' travels in various countries during the last decades have been analyzed. Commonly used in these studies statistical methods allow to reveal and identify country-specific tourism risks and threats. But it is necessary to underline that relevant statistical data on risks are available not in all cases and countries. Moreover, in most cases, the reliability of the information available is questionable. In order to improve the reliability and quality of the tourist risk assessment, it is proposed to consider tourist travel as a project. The proposed project approach to tourist risk analysis provides an opportunity to go beyond assessment based on available country-specific inferior statistical data and allows to develop a more flexible and versatile method for risk evaluation. Common risk factors and sub-factors for tourists were identified for further risk assessment using suggested by L. Zadeh Z-number. A bi-component Z-number Z = (A, B) with perception-based and imprecise parts A and B, allows taking into account the reliability of the information. Risk experts deal with the prediction like this one "very likely that the level of threat N is medium" or "extremely likely that this factor is very important". This prediction can be formalized as a Z-number based evaluation and a pack of Z-valuations is considered as Z-information. Experts evaluate identified risk factors and sub-factors and their importance weight using Z-numbers.

Keywords: project approach, travel risk factors, tourism risk assessment, Z-number-based evaluation

Introduction

Humanity is surrounded by a large number of potential threats and uncertain events. Absolute security and safety do not exist in nature and cannot be achieved in any activity.

ISSN 2601-8683 (Print)
ISSN 2601-8675 (Online)

European Journal of
Formal Sciences and Engineering

July -December 2021
Volume 4, Issue 2

Risk, being the most comprehensive integrating concept, actually serves as a measure of the threat/danger perceived by a person or existed in his life and activity.

Traveling like any other human activity is potentially dangerous and despite the protective measures taken, there is always some level of risk.

In literature risk assessment study in tourism first of all related to the activity of tourism firm. Much fewer research papers related to the journey risk analysis. However, single tourism is becoming increasingly popular in the world, especially such types as extreme, leisure, etc. Moreover, the development of digital technologies does not preclude the organization of tourist trips in the future through the use of products similar to Uber, E-tourism etc.

Regardless of the way travel is organized, risk analysis, especially for security, will always be relevant. Studies of recent years are aimed at improving the methodology for analyzing tourism risks.

It should be noted that questionnaires are widely used for risk analysis in the tourism sector(Ragavan,   Subramonian&Sharif, 2014;Chew&Jahari,2014;Chahal&Devi,2015;Yağmur&Doğan,2017).At the same time, researchers give less consideration to the issues of compiling the questionnaires (questions, sub-question, etc.).

In our work, we have studied the threats to tourists, identified the travel risks and have compiled a register of risk factor son ground of expediency (suitability) of application a project approach and Z-information for the tourist trip risks analysis and assessment.

Risks in tourism sector: literature review

According to Wilks, Jeff &Moore (2004) and COMCEC (2017) the World Tourism Organization identifies risks to the safety and security of visitors, host communities and tourism employees from four sources: *the human and institutional environment* – when visitors fall victim to common delinquency, terrorism, wars, social unrest and a lack of public and institutional protection services; *tourism and sectors related to tourism* such as transport, sports and retail trade, can endanger visitors' personal security, physical integrity and economic interests; *individual travelers or visitors* can endanger their own safety and security (practicing unsafe activities, inadequate conflict behavior, losing personal documents and money through carelessness); *physical and environmental risks* –travelers are unaware of the natural characteristics of the destination's flora and fauna, have not vaccinations, prophylaxis, do not take the necessary precautions in their personal hygiene, etc.

The effectiveness of institutions related to safety and security sectors (police, medical, emergency, etc.) does not mean absolute security and safety for travelers. Many problems related to safety have weather and nature conditions. For example, many countries with effective security sector have inappropriate or insecure nature conditions

(for many reasons it is not suitable to note the names of countries). But it does not mean that these countries are insecure for travelers. Many problems of travelers are related with themselves. Travelers can have bad habits/health problem can reduce the level of personal security.

In (Abukhattab, Al-Maslamani& Al-Khal,2018) the example of tourists from Qatar the pre-travel assessment risks of acquiring infectious diseases associated with food and water, arthropod bites, environmental conditions, sexual behavior is conducted. During research the patient demographics (gender, age, nationality), travel characteristics (timing of pre-travel consultation, travel destination, number of countries to be visited, departure date, travel duration, reason for travel, and type of accommodation) and medical conditions (chronic diseases, treatments, and pregnancy) and travel purposes were taken into account.

In other work (Nair, 2013) research focuses on the Risk Assessment Factors (RAF) to be considered in tourism with specific context to Qatar. For the tourism industry among risk assessment factors the tourist-based, relationship (interaction between participants) and general risk factors play a major role and have a significant influence on tourism performance. Each type of factors may be in several forms (for example tourist-based factors of risks - environmental, financial, security and etc.)

The importance of climate and weather conditions for the tourism industry and tourists is studied by Scotta&Lemieuxa (2010). Conducted research shows that climate is important limiting factor that generate risks to be managed. Moreover, in paper underlined that "climate also has an important influence on environmental conditions that can deter tourists, including infectious disease, wildfires, insect or water-borne pests and extreme events such as tropical cyclones. Many outdoor events are held at certain times of the year in order to take advantage of certain climatic conditions or reduce climate risk". Researches underline that in the destination choice the image of destination is a key determinant (among other macro scale influencing factors, such as travel distance, time, holiday cost, travel motivation etc.) and that climate is dominant attribute of destination image along with scenery and cost. Coastal flood risksare analyzed in (Kellens et al, 2012).In paper mentioned that coastal tourism has variations according to climate, holiday seasons and seasonal traditions. The relationship between tourist behavior and weather conditions is not straightforward and for example, storms may not necessarily keep tourists away. This occurrence often attracts "storm watchers" or "storm chasers.

In (Herron et al, 2016) disaster and climate change risks assessment process focuses on the direct and indirect risks to different types of projects from three climate-induced hazards: sea-level rise, hurricanes (including storm surge), and flooding (both coastal and riverain) because these hazards are considered to pose the greatest threat to the Caribbean region.

In order to determine the factors affecting on the risk management of the travel agencies, exploratory factor analysis has been used and crime, cost of transport, airline safety, airport safety and security, natural disasters, political instability in neighboring countries, lack of proper financial systems, too high prices in tourism industry and etc. are mentioned as commonalities of risk factors (Nayebzadeh&Harandi, 2014)

Disasters can cause serious property and safety loss to tourists (Sun, Yang& Chen, 2018). A disaster risk evaluation model is suggested by authors use selected 17 economic and social indicators (for example - age ratio of visitors, number of shelters, insurance completeness) from tourist destinations in Jilin Province based on the four-factor (hazard, exposure, vulnerability, recover capacity) theory of natural disaster risk formation.

Hazard for tourism such as atmospheric (frosts, floods, storms and etc.), geological (earthquakes, tsunamis, erosion and etc.), biologic (epidemics, fires), human (crime, terrorism, traffic accidents and etc.) are presented in (Fotiou, 2013). Among risks for tourists the environmental, diseases, financial, socio-cultural, product liability, property damage, security are outlined.

Based on the weights and scores of tourism safety risk indicators such as hazard *(slope altitude and precipitation levels, type of surface vegetation cover, management standard indicator, visitor behavior variability indicator)*, exposure *(visitor ratio, facility ratio, tourism income ratio, tourism resource amount)*, vulnerability of the hazard-bearing body *(visitor vulnerability indicator, tourism capacity, tourism resource level)*, and the ability of disaster prevention and reduction *(visitor safety awareness, safety management ability, medical rescue ability, general rescue ability, convenience of transportation)* the level of risks of Changbai Mountain scenic areas are evaluated (Zhou& Liu,2017)

Environmental risk, business and human resource risk are the most important and the influencing factors on resort business and operation (Puteh Salin, 2017)

The article (Ruan, Li & Liu, 2017) indicates that the perception of the tourist destination consists of the accumulated travel experience, information from print sources and media. Perceptions change over time. Individual's mental representation of knowledge, feelings, and impressions will influence their destination choice and their order of priorities when planning to promote tourism destination. Factors such as certain disease control measures in the airport, culture, and tradition, the accuracy of travel information affect the choice of travel destinations. Moreover, the quality of service may improve the original negative images of destination.

Presented in (Chang TY et al., 2018) the literature review indicates risk factors for travelers. Studied risks for tourist guides related to travel should be taken into consideration - natural disaster risk, traffic safety, food safety, accommodation safety, personal health problems, infectious diseases, dietary irregularity. Moreover, operation

problems of travel agencies, the quality problems of local service agencies, and even the neglect of service by suppliers, such as cars, ships, hotels, restaurants, scenic spots and so on, it is easy will lead to risk situations.

According to the literature review presented in (Biswakarma, 2017) we can conclude that the travel risks include diseases, crime, natural disasters, problems with hygiene, transportation, culture/language barriers, uncertainty related to destination-specific laws and regulations, terrorism, epidemics and health, political instability, crimes against tourists. The perceived risk by the tourist (Nepal example) calculated from perceived risk, health risk, terrorism, violence.

Factors (socio-psychological risk, physical risk, financial risk, health risk, disaster risk, and radiation risk) of perceived risk are studied in (Chew &Jahari, 2014).In the paper mentioned that the tourism industry has the intangible nature of its product. Images of destination are formed according to the perception rather than reality. So, the relationship between perceived risks and destination image is significant. In the next paper of these researchers (Chew&Jahari, 2014) the analysis of perceived risks and destination images in relation to revisit intention are presented. The target population of this study was Malaysian tourists who had been to Japan prior to this study. Data collected from the questionnaire. The survey instrument comprised of scales measuring perceived physical risk, socio-psychological risk, financial risk, cognitive image, affective image, and intention to revisit.

The impact of tourist perceptions, destination image and tourist satisfaction on tourist loyalty was studied and perceived risks were mentioned as attributes and determinants of tourist satisfaction and loyalty in (Rajesh, 2013).

In (Yağmur&Doğan, 2017) mentioned that tourists often prefer destinations with low cost and low-security risk. Despite absolute (real) risk which is objective assessment the perceived risk can be described as a subjective expectation of potential loss. In study the destination risk perceptions scale (DRS) was used and questionnaire included 29 items based on physical *(food, diseases, disasters, car accident, crime, terrorism, political unrest, tourist behavior)*, financial *(money, extra expenses and etc.),* performance *(hotel, site, food, attitude of locals)*, socio-psychological *(personal satisfaction, thinks and etc.)*, time *(vacation time, trip time)* risk factors was implemented.

Risk influence, tourist behavior and tourism is an intangible service that is exposed to potential risks and threats (Hashim et al., 2018). Differences among tourists in their risk perception exist and the importance of every risk factor differs according to the person and their particular situation. Moreover, in the paper, the 13 types (crime, cultural, physical and etc.) of perceived risk related to tourism are shown and a framework of 6 types of risk for travel intention is proposed.

Travelers have limited knowledge about the new destinations and make choice based on information from media and social groups (Ragavan, Subramonian& Sharif, 2014). The

travel destination is described by a set of attributes named travel attributes. Tourists evaluate travel attributes and different demographic groups of travelers have different perceptions of these attributes.

It should be noted that the types of risks associated with tourist trips are reflected in detail in works devoted to perceived travel risk. However, since the threats for tourists are common, the results of the literature review of perceived risks of travel destinations were also taken into account during the study.

2. Project approach to tourist trip risk assessment

Today project management has moved from narrow professional spheres to all areas of business. Every day all of us carry out projects in our daily life: travelling, shopping, construction, etc. All these activities have a number of common features specific to projects. They are aimed at achieving specific goals; include coordination of related activities; have a limited time, with a certain beginning and end; unique and not repeatable.

Any tourist trip is aimed at achieving goals - adventure, excursions, treatment, etc. To achieve the goals, coordinated implementation of interrelated actions is necessary - preparation, solving the travel documents problem, temporary absence issues, etc? Travel has terms of departure and return. Each journey is different from the other, even if the same country was committed (different years, changing circumstances, etc.).

Therefore, it is advisable to use the project risk analysis methodology for risk analysis of a tourist trip/travel.

Project management always occurs under the influence of many factors that are changing in the process of project implementation. These factors may be the result of internal and external project processes. Uncertainty is the integral feature of the project and refers to the incompleteness or inaccuracy of information about the internal and external environment of the project. Consequently, one of the main processes in project management is the management of project risks, which present at all stages of the project life cycle.

The application of the project approach allows us to expand the scope of research. In the project approach, threat analysis does not have critical significance. Only the risks are important. When taking into account project risks, not only the absolute losses or benefits themselves are important, but also the consideration of their influence on the final result of the project.

Using a project approach to risk analysis allows to go beyond the framework of the researcher's own country-oriented assessment and allows to develop more flexible and universal methods for assessing tourism risks.

Tourism (travel) risks identification and analisys

3.1. Travel risk factors and threats for tourists

Risk assessment in the tourism sector is used for evaluation of the level of danger to human life and activity. People, involved in the tourism business and responsible for the prevention of adverse outcomes, need a detailed and clear stricturing of the possible undesired outcomes. The problem of classifying tourism risks has not been resolved completely due to the variety of conditions and factors leading to situations of different levels of risk. Risks in the tourism sector can conditionally be divided into two groups: risks to the life/health of tourists and business risks. Since the business in the tourism sector is based on travel and the risks to life/health are primary, then in our work, we will consider the safety risks of travelers.

The conditions for the occurrence of risks to the life/health of travelers are the existence of risk sources and emergency of a risk factor at a level that is dangerous to humans.

In most research publications the term a perceived risk is used. In the case of perceived risk analysis, studies are usually carried out among tourists who have visited a particular country (object of study). This is possible for researchers conducting an analysis of the situation in their home country/partner country or when it is possible to work with tourists who have visited/are visiting the country - the object of the study. To do this, there must be an appropriate flow of tourists to the country under study (Björk & Kauppinen-Räisänen, 2013; Chew & Jahari, 2014) and only after that statistical processing of information is possible - examples of Nepal, Malaysia, Turkey, India (Biswakarma, 2017; Hashim et al., 2018; Ragavan, Subramonian & Sharif, 2014; Yang, Sharif & Khoo-Lattimore, 2015; Yağmur & Doğan, 2017; Gupta, Gupta & Arora, 2010)

But how to assess the risks of visiting a country located on another continent, or if the flow of tourists to the studied country for one reason or another is very small? In practice, situations often arise when it is necessary to assess the risks of traveling to a particular country, based on insufficient information (Internet data, impressions of individual tourists, etc.).

Given these circumstances, in this paperit is proposed to consider a tourist trip as a project and, accordingly, to assess risks asrisks ofthe project.

When considering a trip as a project, the specific types of risks themselves are not as important as the mechanism and methods for assessing them and calculating risks. At the initial stage of risk identification, the main threats to travelers have been identified.

After the detailed study of the subject area, the following groups of threats to the personal safety of the tourist have been identified:

- Threats at the planning stage of a tourist trip
- Threats during the journey
- Threats associated with inappropriate activities of tourism service providers

- Threats related to the incorrect tourist behavior or non-compliance with safety rules
- Transport threats when traveling to / returning from the country of destination (travel/transportation)

Based on this grouping, the register of threats has been compiled.

3.2. Risk analysis

It is necessary to take into account that the threat registry, in contrast to the risk registry, is to a certain extent more extensive. It includes almost all potential (real and imaginary) threats. The authors do not claim that the compiled register is the most complete or perfect. Into the presented register of threats were included those threats which, in our opinion, deserved attention.

At the next stage, for the final identification of risks and compiling a register of risks, determining the main risk factors and their sub-factors, a Delphi analysis was carried out with the involvement of both local and foreign experts. We do not go into details of Delphi analysis rounds because this method is widely used in the tourism sector research (Kaynak&Marandy, 2006; Chang, Shen&Li, 2018; Knowles, 2019). After two rounds of the Delphi analysis, in order to avoid unnecessary complexity, the factors with relatively small likelihood and factors, impractical for other reasons, were excluded from the list of threats. So, when assessing the security risks of the trip, it should be taken into account that the likelihood of realizing threats, associated with the inability to travel due to force majeure circumstances, is negligible.

In the case of emergency events related to a potential tourist, the trip becomes impossible and further analysis becomes meaningless because losses from travel abroad and losses associated with force majeure circumstances are not comparable. When analyzing the risks of camping trips, the risks associated with transport accidents/accidents are not of practical importance. This area belongs to the competence of the management of transport companies. Tourism experts do not have key information for risk analysis of the activities of transport companies (for example, the level of training of the airline's flight personnel, the degree of preparedness of the airport controllers of the destination country, etc.) and will not be able to conduct it. In addition, from further consideration, the dangers of occurrence risks that bear a pronounced country-oriented specificity - (for example, radiation risk - since it is not very relevant for most tourist routes) were excluded.

The resulting risk register can be used to select a safe trip among several alternatives, as well as to assess the risks of a safe trip to a specific country. It should be noted that the question of whether it is safe or not to travel to a particular country should be considered as a more psychological one, because, in most cases selection of a specific country with an extreme risk environment is adventure driven.

After conducting a detailed study of potential threats/factors main risk factors and risk sub-factors that should be taken into account when assessing the generalized risk of travel safety in a given country have been identified. Table 1 lists the main tourist travel risk factors.

Table 1. Tourist travel risk factors

Risk factors	
1	Destination country's risks
2	Natural environment's risks
3	Tour operator's risks
4	Transportation risks
5	Traveler's risks (personality based)

The compiled list of risk factors for a tourist trip is not complete and universal. Necessary changes can be made to it, it can be expanded or shortened, other subfactors can be added. It is necessary to underline one specific feature of Delphi analysis as applied to the framework of our study. Since in the future research we are intending to use not only statistical information but also fuzzy estimates for risk assessment, the resulting list of factors allows using the Z-number based approach. The compiled list of factors was used to assess risks in (Nuriyev&Jabbarova, 2019)

Z-number based travel risk assessment

Various mathematical tools such as probability theory, the theory of possibilities, fuzzy approach, etc are used for risk assessment. The first tool of formalization of the uncertainties was a probability. Among other tools, it should be noted the imprecise (interval) probability and representations based on the theories of possibility and evidence, as well as qualitative approaches (Aven, 2016; Zhang, Li & Zhang, 2016; Ghasemi, Hossein Mahmoudi Sari, Yousefi, Falsafi & Tamosaitiene, 2018). A lot of literature has been devoted to the application of these methods for risk analysis, and we will not dwell on them.

Tools of risk assessment based on traditional probabilistic or possibility models have a limited capacity of description and processing project-related uncertain information and not in all cases are relevant for the risk assessment. The reliability of relevant information unaccounted in mentioned approaches and this circumstance limits their power of description.

Zadeh (2011 p.1) noted that "In the real world, uncertainty is a pervasive phenomenon. Much of the information on which decisions are based is uncertain. Humans have a remarkable capability to make rational decisions based on information which is uncertain, imprecise and/or incomplete. Formalization of this capability, at least to some

degree, is a challenge that is hard to meet. It is this challenge that motivates the concepts and ideas outlined in this note". Zadeh suggested a bi-component Z-number Z=(A,B) to represent a restriction on the values of the uncertain variable (A) and its certainty. Z-number Z = (A, B) allows to take into account the reliability of the information. Usually, A and B are sense-based and in effect are imprecise. Recent advances in computation with Z-numbers allows to conceptualize and process uncertain information by using perception-based and linguistically expressed fuzzy numbers, describing both restrictions on the value of the uncertain variable and reliability of the value.

Since its introduction, the concept of Z-numbers has been successfully applied as a new direction in the analysis of uncertain and complex systems in various areas of science and technology. Aliev and colleagues suggested a general and computationally effective approach to computation with Z-numbers. The approach is applied to the computation of arithmetic and algebraic operations, t-norms and s-norms, and construction of typical functions (Aliev, Huseynov&Zeinalova, 2016; Aliev et al., 2015; Aliev, Huseynov&Aliyev, 2017; Aliev, Huseynov&Alieva, 2016).

The work of Zadeh (2012) discusses different methods, applications, and systems based on the Z-number concept. Zadeh (2013) indicated risk assessment as one of the main areas of application of Z numbers.

It should be noted than in many areas, risk experts deal with the prediction like this one *"very likely that the level of threat N is medium"* or *"extremely likely that this factor is very important"*. This prediction can be formalized as a Z-number based evaluation X is Z (A, B) (Aliev, Alizadeh&Huseynov, 2015). A pack of Z-valuations is considered as Z-information. In suggested approach experts evaluate risk factors and sub-factors (Table 1) and their importance weight using Z-numbers. So we have **Z-value based risk** or risk factors for each alternative (country). Using Z-numbers to calculate the level of risk or risk factors for project risk assessment in case of tourist travel shown in (Nuriyev&Jabbarova, 2019). Arithmetic operations on Z-numbers as well as the ranking of Z-numbers (Aliev, Huseynov&Serdaroglu, 2016) and aggregation of Z-information allow using Multi-Criteria Decision Analysis (MCDA) for the solving decision-making problem which can be utilized for risk factors estimation (Nuriyev, 2019). And as for next step the (MCDA) can be used for the solving decision-making problem of choosing a safe travel destination. The example of tourist travel risk Z-evaluation using risk factors and sub-factors given in Table 2.

Table 2. Tourist travel risk Z-evaluation

Item Risk factors&sub-factors	Country A1 evaluation of threats	evaluation of importance	Country A2 evaluation of threats	evaluation of importance weights

		weights			
1	Destination country's risks				
1.1	Terrorist threats	(Low, Very Likely)	(High,Very Likely)	(Low,Very Likely)	(High,Very Likely)
1.2	Crime situation	(Medium, Extremely Likely)	(High,Very Likely)	(Medium,Likely)	(High,Very Likely)
1.3	Cultural/mental differences	(Low, Very Likely)	(Low,Very Likely)	(Medium,Likely)	(High,Very Likely)
1.4	Level of local sanitation	(Medium,Very Likely)	(Medium, Likely)	(Medium,Very Likely)	(Medium,Likely)
1.5	Level of local emergency services	(Medium,Very Likely)	(Medium, Likely)	(Medium,Likely)	(Medium,Likely)
1.6	mobile communications / Internet	(Very Low, Likely)	(Medium, Likely)	(Low, Very Likely)	(Medium,Very Likely)

Conclusion and further researches

Potential risks of traveling to various countries have been studied and based on analysis most common risks that travelers can encounter (almost in all countries, in any season, on any means of travel, etc.) are identified.

Tourist trip is studied as a project and based on the project approach travel risks have been identified and a generalized risks register for the tourist trip is developed.Identified risk factors are independent of the data processing tools (statistical, expert opinion study, fuzzy approach, etc.) and can be used for the comparative analysis of the trip risks in various countries.

The use of Z-value based risk assessment in combination with the project approach allows us to develop a more universal methodology for assessing tourism risks. Such assessment methods are not directly dependent on the country being studied. Application of the project approach allows establishing more general risk factors for a tourist trip, which are independent of the country and the amount of statistical information. In some cases, in addition, comparative analysis can be carried out and, based on the results of the study, country-specific factors can be added.

Based on the Z-Value Based Risk Assessment, it is possible to more effectively compare the risks of tourist trips to a particular country using perception-based predictions of risk experts. The results obtained creates necessary prerequisites for the use of the Z-number in future studies not only for assessment of the tourism risks but also for assessment of project risks in other areas of human activity. The provided methodology allows compiling a register of project risk factors and sub-factors for further Z-Value Based Risk Assessment.

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Time Management and Control: A Bibliometric Analysis

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Abstract

Time management and control are crucial for project success, and it has known an increasing interest by researchers around the world since the appearance of project management and until now. The aim of the present paper is to provide a comprehensive overview of researches in this field. A bibliometric analysis of researches in time management and control published in the Web of Science (WoS) during 2012-2021 was conducted in order to find the most influential publications in this field, as well as, the countries that contribute the most to these researches, and the most used key words. The VOS Viewer was used for mapping and visualizing bibliometric networks. The results show an increased trend of publications in this field. And that the major contributors to researches in Time Management and Control are People's Republic of China, the United States of America, and England. Moreover, Labadie (2004) was the most cited author. Also, the results show 3 main levels of keywords, the first was related to time management in general, the second was related to the models and systems using and the third concerning the tools, the methods used in time management and control. These findings could help researchers to understand more the topic of time management and control, and it opens up the scope of view to conduct studies in related fields.

Keywords: Time Management, Time Control, Bibliometric Analysis, Web of Science, VOS Viewer

Introduction

Time is probably the most valuable asset available to people and organizations (Mbachu, Jasper 2007). It is irreversible, irreplaceable and it determines the efficiency of the processes necessary for the management of companies.

Time can be managed, spent, mastered and controlled (Lakein, 1973 cited by B.A.H.Al-Nady et al. 2016), and unless it is managed, nothing else can be managed. Therefore, time management is crucial to reach the stage of project success, according to Gransberg and Ellicott, 1997 (cited by Boyd and Madzima 2017) projects that are managed well in terms

ISSN 2601-8683 (Print)
ISSN 2601-8675 (Online)

European Journal of
Formal Sciences and Engineering

July -December 2021
Volume 4, Issue 2

of time management from inception through to practical completion have the potential to succeed.

Time management which was initiated with the famous PERT (Program Evaluation and Review Technique) planning tool and which dates back to 1958 (Dombkins 2009), was a topic of concern to researcher for more than half a century, and in the last two decades time control has known an increasing interest by researchers worldwide.

In order to provide a comprehensive overview of published articles in the field of time management and control and to understand the underlying developing models, a bibliometric analysis has been conducted.

Bibliometric analysis is the application of statistical and mathematical methods for the analysis of scientific publications in many disciplines and fields of study to find the most influential publications, journals, organisations, and countries (Yu et al. 2018). Bibliometrics can also analyse information more intuitively by mapping social networks, such as co-word, co-authorship and co-citation networks.

Several network visualisation tools can be used in bibliometric analysis methods. In our study the bibliometric analysis is done using the Visualisation Of Similarities Viewer (VOS Viewer).

VOS Viewer is a software package developed at the Center for Science and Technology Studies (CWTS) at Leiden University (Netherlands) and is very popular for constructing, mapping and visualizing bibliometric networks.

These networks include journals, researchers, or individual publications,…etc, and they can be constructed based on citation, bibliographic coupling, co-citation, or co-authorship relations.

Research objectives

This study aims to answer the following questions:

What is the publication trend of articles related to time management and control?

What are the dominant areas of research in time management and control?

Which countries have contributed the most to these researches?

What are the influential publications in this field of research?

What are the most common keywords used in research on time management and control?

Research methodology

A bibliometric analysis of research on the field of time management and control has been done using the VOS Viewer Software. The data set used in this analysis was obtained from the ISI Web of Science (WoS) database on 29 March 2021.

Our query was done using the following two terms "Time Management" and "Time Control" and only publications in English language were considered, also the scope of our search was not limited by a specific duration. The search including title, abstract and keywords gave us 983 results dated between 2012 and 2021.

The figure 1 summarizes the method used in this study and the results obtained from the analysis are presented in the followings sections.
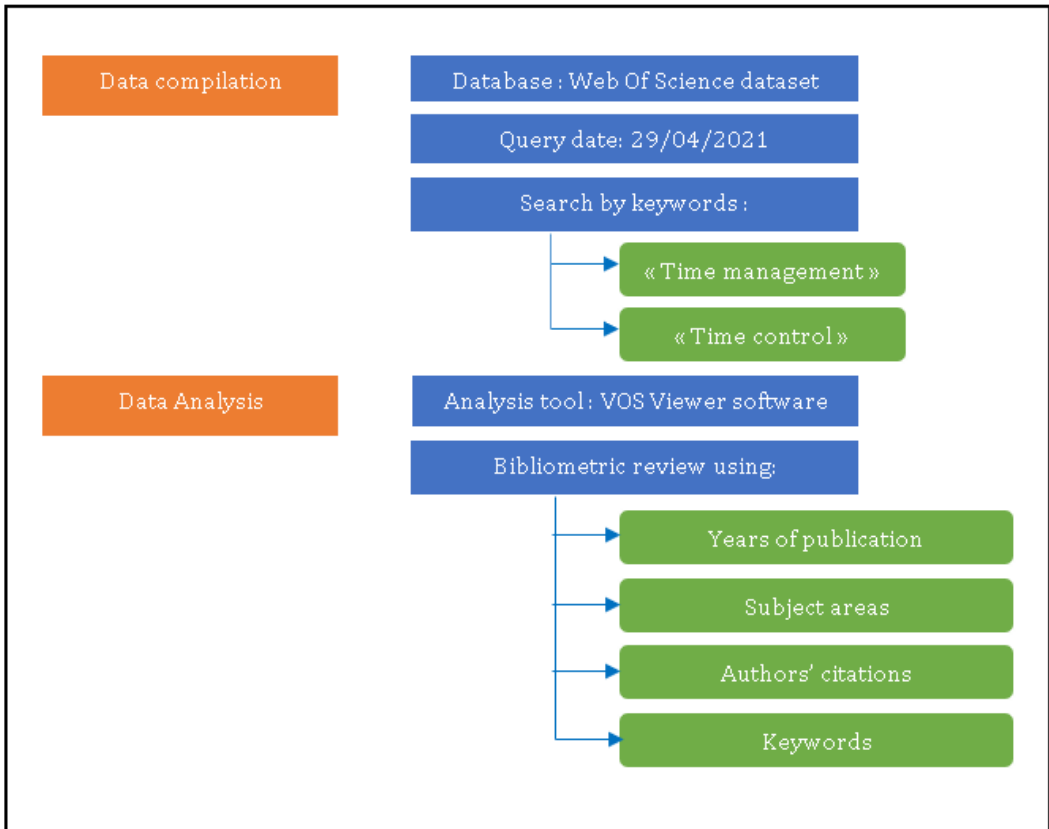

Figure 1: Research methodology

Discussion and results

4.1. Research growth: the publishing trend of "time Management and control" related publications

Using the Web of Science as a database, 983 publications in the field of time management and control were found. Figure 2 shows the frequency of publications per year and the trend in the number of publication from 2012 and 2021. The results show an increasing trend of publications ranging from 35 publications in 2012 to 95 publications in 2017.

On the other hand, the number of publications during the year 2018 decreased slightly to 85 publications, then the rhythm of evolution returns with 90 publications during the year 2019 and a peak of 100 publications during the year 2020.

However, only 15 publications were found in the year 2021. This is not surprising and quite normal as our research is done in March 2021 so it is only the result of 3 months and an expected increase for the number of publications is possible during the current year (2021).
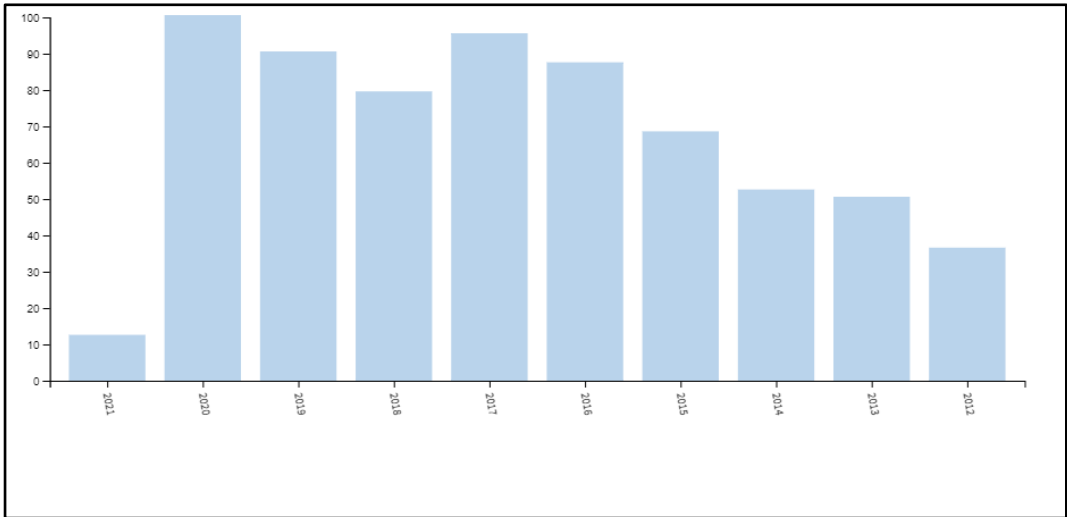

Figure2. Frequency of publications in time management and control field during 2012-2021

4.2. Subject area of time Management and control

The distribution of the sectors in which time management and control have been addressed is shown in Figure 3. From this figure it can be seen that there is a diversity of disciplines in which time management and control has been discussed.

Overall, the distribution indicates that research on time management and control is emerging in various fields: civil engineering, construction building technology, industrial engineering, management …etc.

As shown in figure 3, the top 3 dominant sectors in terms of publications and research in management and time control are the civil engineering sector with 29.37% followed by construction building technologies with 20.51 % and industrial engineering with 12.49%.

From these results it can be seen that the construction sector is the most dominant in terms of time management and control research, which is logical as time is an important pillar and cornerstone for the success of construction projects.

The management sector has also experienced a large interest in time management and control compared with the other sectors. This can be justified by the fact that time management is a branch of project management and follows the general rules and principles of management.
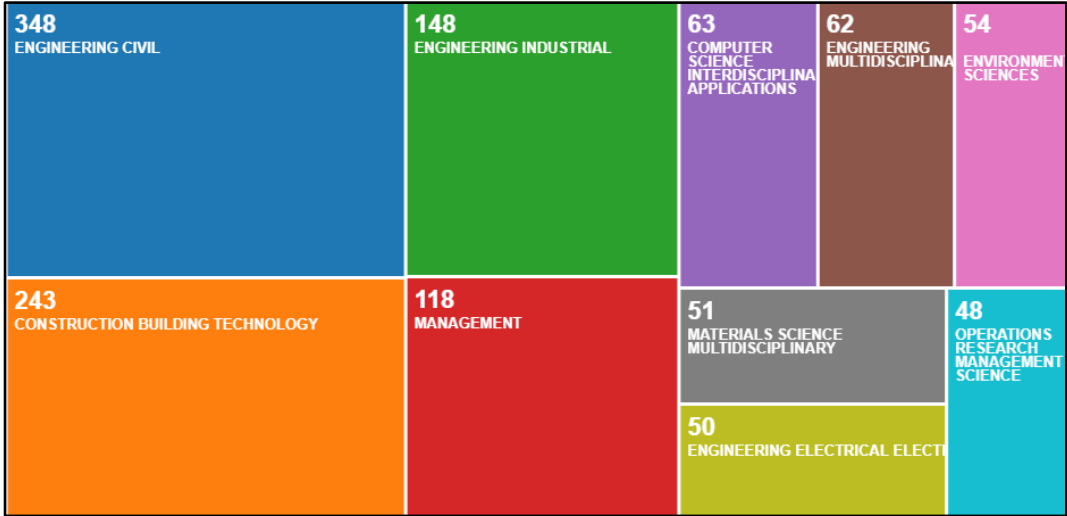

Figure3. The top 10 of most subject area used in publication.

4.3. Geographical distribution of time Management and control publications

Figures 4 and 5 show the geographical distribution of publications on time management and control. From these figures, it can be seen that publications in this area of research are unevenly distributed, and that time management and control has attracted much attention in North America, East Asia, Europe, the Middle East and Australia. However, few researches have been found in South Asia, South America, and Africa.

It can also be noted that the People's Republic of China is the major contributor in Time Management and Control research with a total number of 245 publications and 1541 citations, followed by the United States of America with 172 publications and 3337 citations, England (58 publications and 851 citations), Canada with 52 publications and 949 citations, and Australia (49 publications and 917 citations).

These results are not surprising and can be explained by the fact that the majority of these countries are pioneers in the field of management in general and project and time management in particular; and can be is demonstrated by the number of organisations created by these countries.

China has seen a growing interest in project management over the last two decades (the introduction of the PMI's "*Project Management Professionals (PMP)*" in 2000, then the IPMA's *"International Project Management Professional (IPMP)"* in 2001, and the creation of project management organisations such as *"the Construction Project Management*

Committee of China Construction Industry Association", "the Project Management Committee of China International Project Consultation Association", and "the Project Management Instructional Committee of China Project Consultant Association".

Moreover, the Americans are pioneers in the field of management (Harry Igor ANSOFF the pioneer in "management and strategic planning", Edward DEMING the founder of the "quality movement" and of the famous quality circles known as "the Deming wheel", Douglas GEGOR the author of the "authoritarian and participative management theories" known as "the X and Y theories", Abraham MAWSLOW the famous designer of the "pyramid of needs", and Frederik TAYLOR the father of the "scientific management theory" and the inventor of the "time study" and the "work methods" are all of American origin), but they are also pioneers in project management (*"the American Management Association (AMA)"* created in 1923 and *"the Project Management Institute (PMI)"* founded in 1969) and in time management in particular (the PERT, GANTT, critical path and LOB methods are designed by Americans).

In the UK, Johan ADAIR was the pioneer of British management thinking, and in terms of project management "The Association of Project Management" (APM) founded in 1972 and "The Chartered Management Institute" (CMI) founded in 2000 are based in the UK. On the other hand, Henry MINTZBZRG who defined the 10 main roles of leaders is of Canadian origin and Elton MAYO was the guru of management in Australia, and concerning project management, the Australian Institute of Project Management (AIPM) was founded in 1976.

4.4. Bibliographic network analysis

4.4.1 Citation network analysis (CAN)

A network citation analysis was made to find the most powerful articles which have the most connection with the research subject in the field of Time management and control. The results found (as presented in figure 6) show that the top 5 most influential authors are Labadie (2004) with his article entitled "Optimal operation of multireservoir systems" which has reached 1796 citations, followed by Bryde, Broquetas, and Volm (2013) with 1211 citations of their article "The Project Benefits of Building Information Modeling (BIM) ", then Lok (2010) with a number of citations 563, and Akinci et al. (2006) in the 4th place with a total of 344 citations, and Yewhalaw (2009) in the 5th place with 135 citations.
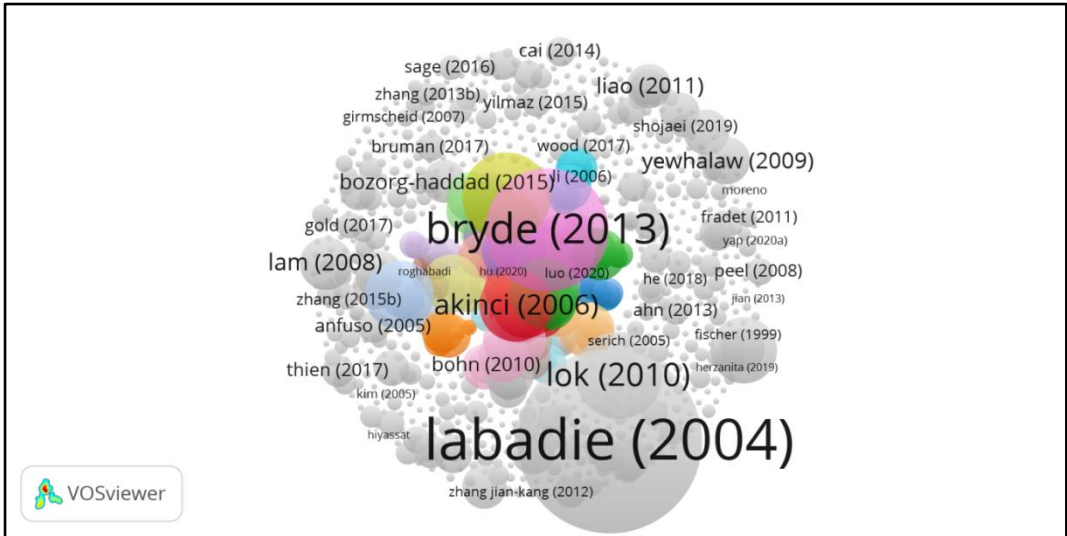
Figure4. Geographical distribution of publications

Figure5. Geographical distribution of publications (zoom in on part A)

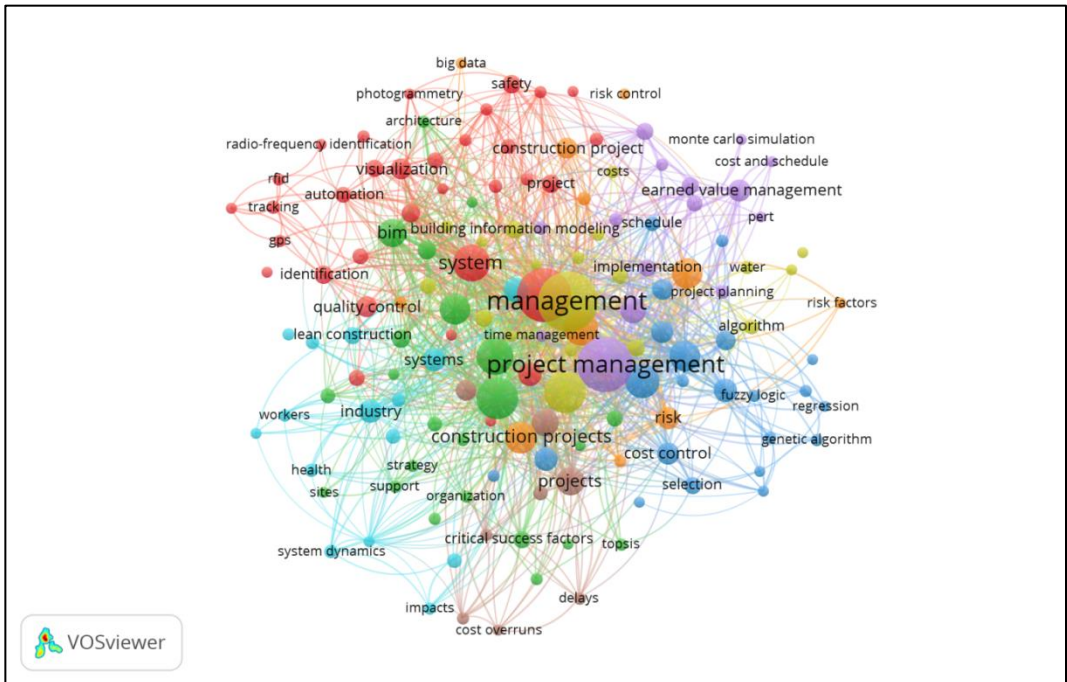Figure6. Authors' citations

4.4.2 Keywords Analysis

Figure7. Network visualisation map of keywords

The keywords obtained from the 983 articles studied were mapped using the VOS viewer software. The associated keywords are indicated by different colored balls and they are usually listed separately, however they are closely related to each other.

The results presented in Figure 7 show 3 main levels of ranking:

In the first ranking, the most frequently cited words (more than 100 citations) were divided into 3 major groups: "Management", "Construction", and "Project Management", with occurrence rates of 141, 116 and 118 respectively.

In the 2nd ranking the words that have a strong connection with each other and with the 1st rank keywords and that also have a strong occurrence in the field of time management and control are: "performance", "model", "design", "system", "structure", "cost", "construction projects".

The 3rd ranking includes words related to time control: "time", "construction management", "BIM", "projects", "simulation", "Lean", "visualisation", "algorithms", "fuzzy logic", "earned value management" .... etc.

Conclusion

A comprehensive overview of researches published in the Web of Science (WoS) during 2012-2021 on time management and control field has been conducted through a bibliometric analysis in order to find the publishing trend of publications, the most influential publications in this field, as well as, the countries that contribute the most to these researches, and the most used key words.

A total number of 983 publications was analysed and the bibliometric networks of these papers was mapped using the VOS Viewer software. The results show an increased trend of publications in this field. And that the major contributors to researches in Time Management and Control are People's Republic of China, the United States of America, and England. Moreover, Labadie (2004) was the most cited author in the fieled of time management and control. Also, the results show 3 main levels of keywords, the first was related to time management in general, the second was about the models and systems using and the third concerning the tools, the methods used in time management and control.

These findings could help researchers to understand more the topic of time management and control, and it opens up the scope of view to conduct studies in related fields.

Our study undoubtedly have some limitations among which the dataset used in this study includes only papers published in the ISI WoS, also only studies in English language are considered in this research. Similar researches could be done using other databases, and including articles with other languages. Further, it is suggested to carry out a study for comparing the ISI WoS findings with the findings of others databases.

ISSN 2601-8683 (Print)
ISSN 2601-8675 (Online)

European Journal of
Formal Sciences and Engineering

July -December 2021
Volume 4, Issue 2

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