валютного курса при переходе к таргетированию инфляции. Предложена формула для вычисления украинского индекса денежно-кредитных условий (ukrMCIt) для усиления эффективности денежно-кредитной политики на этапе перехода к инфляционному таргетированию в Украине.

Ключевые слова: центральные банки, таргетирование инфляции, монетарная политика, индекс денежно-кредитных условий, монетарные инструменты.

Bulletin of Taras Shevchenko National University of Kyiv. Economics, 2015; 1(166): 39-44
JEL: Q560/I190
UDC: 65.011.42
DOI: dx.doi.org/ 10.17721/1728-2667.2015/166-1/4

V. Sarancha, PhD in Economics,
K. Vitale, Doctor of Sciences, Professor, MPH,
S. Oreskovic, Doctor of Sciences, Professor
University of Zagreb, Zagreb,
V. Sulyma, Doctor of Sciences, Professor
Ivano-Frankivsk National Medical University, Ivano-Frankivsk

LIFE CYCLE ASSESSMENT IN HEALTHCARE SYSTEM OPTIMIZATION. INTRODUCTION

Article describes the life cycle assessment method and introduces opportunities for method performance in healthcare system settings. LSA draws attention to careful use of resources, environmental, human and social responsibility. Modelling of environmental and technological inputs allows optimizing performance of the system. Various factors and parameters that may influence effectiveness of different sectors in healthcare system are detected. Performance optimization of detected parameters could lead to better system functioning, higher patient safety, economic sustainability and reduce resources consumption.

Keywords: life cycle assessment, holistic approach, healthcare management, social responsibility, modelling.

Introduction. The fast industrial development, active population growth, the extremely high level of consumption of resources with the following air, water, soil pollution induced increasing interest to new eco – friendly tools and technologies. In modern science so far so often a rising awareness paid to the concept of social responsibility, which means the obligation to act benefiting society at large and a duty for every individual to perform maintaining a balance between the economy and environment [4]. Forming the basis patterns for a modern science, researchers solved many problems of humanity. Nevertheless, it is necessary to emphasize that since Democritus' reductionist approach was ideologically preferred in the western science, much effort has been directed to the excessive value of details and analysing of processes from the point of view of their decomposition into constituent elements, parts, or small particles. It caused the underestimation of the interrelations and interdependence of system components and respectively led to the loss of understanding of the systems "holistically". Holism was an idea firstly introduced by Plato, later developed by anthropologists stated that all the properties of a given system could not be determined and explained by its component parts alone [5]. The different aspects of humanity were taken into account. There were the physical (biology) and cultural (archeology, linguistics), the cross-cultural, looking at what it meant to be human. Therefore, the system as a whole determined how the parts behaved. Thus, the holistic approach was the examination of all the aspects of humanity. According to Merriam-Webster dictionary – "Holistic means relating to or concerned with wholes or with complete systems rather than with the analysis of, treatment of, or dissection into parts. Hereby, holistic ecology views humans and the environment as a single system" [34]. In course of time the concept migrated to medicine and in 40's was actively popularized by the prominent public health leader Andrija Stampar. He wrote the introductory declaration of the Statute for just established World Health Organization and defined the health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" [6. p.697-708]. Inasmuch our fast developing society requires quick responses to problems and challenges, the modern managerial systems have to be not just well structured, that exactly facilitate the studying of main subjects, but also integral, fast performing, adaptable, sustainable and with ability to be holistically analyzed. The reference frame should be structurally expanded with preservation of objectivity and scientifically reliable conclusions. Thus, through the application of new outstanding tools and technologies inside the boundaries of proposed enhanced framework appropriate new effective methods should been introduced. Among such numerous approaches of a complex analysis this article draws attention to the Life Cycle Assessment (LCA). While been scientifically proven it allows quantifying environmental damages caused by the lifecycle activity of a product. The method developed with purpose to achieve maximum quantification of entire life cycle of a product [7]. A comparatively short history of its emergence began with Harold Smith's report of a calculation of cumulative energy requirements for the production of chemical intermediates and products in 1960's [8]. In 70's the process of quantifying the use of resources and environmental releases of products became known as a Resource and Environmental Profile Analysis, as practiced mainly in the United States. In Europe, it was called an Eco balance. From 1975 through the early 1980's, as interest in these topics waned because of the fading influence of the oil crisis, environmental concerns shifted to issues of hazardous and household waste management. Through this period, sincere efforts to create a protocol or standard research methodology for conducting such works have been made. The multi – step methodology involves a number of assumptions. During these years, the assumptions and techniques used underwent considerable review by US Environmental Protection Agency and major industry representatives, with the result of evolving of the most reasonable methodologies. After years of development in connection with these events, first databases have been created. A broad range of practitioners and researchers across the globe have been further refining and expanding the methodology. The need to move beyond the inventory to impact assessment has brought LCA methodology to another point of evolution and from 1997 to 2002 led to the development of the LCA standards formalized by the International Standards Organization 14000 series [3]. In 2002, the United Nations Environment Programme joined forces with the Society of Environmental Toxicology and Chemistry to launch the Life Cycle Initiative, which now is a welknown international partnership on a subject [9]. The topics like raw materials extraction, energy demand, emission and waste disposal are still important and always in the focus of the integral balancing. New programs and databases aim at putting life cycle thinking into practice and at enhancing the supporting tools through better-acquired data and indicators. One of them is the U.S. Life Cycle Inventory Database that improves global access to transparent, high quality life cycle data by hosting and facilitating expert groups whose work results in web-based information systems [10]. Another one is the Life Cycle Impact Assessment program that increases the quality and global reach of life cycle indicators by promoting the exchange of views among experts, whose work results in a set of widely accepted recommendations [11]. The "Life cycle assessment – Principles and framework" standard was later reviewed and confirmed in 2010 [12].

Methodology. For purposes of the following issue and for further understanding of the proposed interpolation of the method to a healthcare system here presented the basic methodological concepts of the LCA. Thus, every product in its life cycle passes through different stages such as raw materials extraction, refinement, processing, manufacturing, distribution, use, recycling, waste disposal etc., and should be analyzed in a frame of reference known as "from cradle to grave" (Fig. 1). It means that certain product should be completely analyzed from the moment of its emergence in various systems ("cradle") to the end of a life cycle ("grave"), when the product is disposed [1, p.1-14; 2, p.15-34].

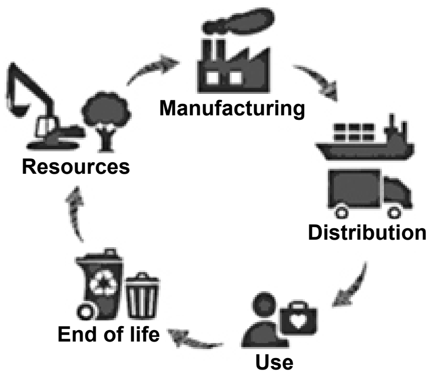

Fig. 1. Stages of a product life cycle

Source: "Éco Entreprises Québec"

Conceptualized goals of LCA conducting are: the quantification of the overall environmental impacts (e.g. releases to air, water, and land in relation to each life cycle stages) of a product; selection of the best product with the least harmful effect on human health and the environment; systematic evaluation of the environmental consequences associated with a given product; estimation of the environmental trade-offs associated with one or more specific products; categorization for a planned action; assistance in identifying significant shifts in environmental impacts between life cycle stages and environmental media; assessment of the human and ecological effects of material consumption and environmental releases to the local community; comparison of the health and ecological impacts between two or more rival products; identification of the impacts of a specific product, etc [3, 12, 13]. Due to the fact at the initial stage of emergence LCA was to a greater extent used for products in industry, today it would be necessary to expand the understanding of the term "product". Such broader understanding gives the Business Dictionary that defines "product" as "a good, idea, method, information, object or service created as a result of a process and serves a need or satisfies a want. It has a combination of tangible and intangible attributes (benefits, features, functions, uses) that a seller offers a buyer for purchase" [35]. This definition allows applying LCA also to processes as well as for guidance for optimization of activities towards a reduction of resource requirements and emissions. The method offers 4 stages, step – by – step assessment process. It includes: goal definition and scoping, inventory analysis, impact assessment, and interpretation (Fig. 2).

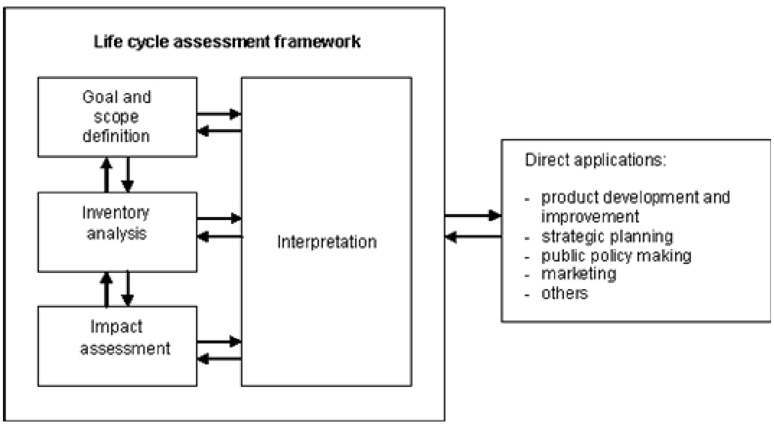

Fig. 2. Stages of LCA

Source: EN ISO 14040

In the 1st stage the main goal definition and scoping have to be determined. A proper description of a product or activity has to be worked out. Therefore, to obtain adequate results it's necessary to establish the frame in which the assessment is to be made with identification of the environmental effects inside system boundaries. In the 2nd stage which is mainly the collection stage, according to standard methodology, the accurate tracking of all product "in – out" flows are identified. The identification and quantification of energy, water, materials usage and environmental releases (e.g., air emissions, solid waste disposal, waste water discharges, pollution with chemical reagents) have to be properly collected. Furthermore, in the 3rd stage the assessment of potential human and ecological effects of energy, water, and material usage and the environmental releases identified in the inventory analysis (2nd stage) has to be fulfilled. The adherence to clear procedure during this stage has to be made to avoid confusion. For example, if manufacturing a product consumes an estimated volume of diesel, in the LCIA phase the CO2 emission effects and global warming impact from combustion of that fuel would be calculated [3, 10, 14]. There are various methods proposed for categorizing the life cycle impact of the flows "to" and "from" the environment [3. p.1-18]. The reason is that the complexity of ecosystems leads to the permanent development of alternative impact modules. Table 1 shortly exhibits some of them. As it can be seen from the table, there is an assessment of a life cycle of product with use of different indicators such as releases, recourse use, damages on human health, etc. A large quantity of proposed methodologies indicates that some of them can be efficiently applied to a particular case and miss the aims of researches in another. Thus, after a qualitative analysis we should admit that every methodology prefers some specific indicators but less attention pays to others. From this perspective it is obvious, that such methodologies as LIME, Eco-indicator 99, IMPACT 2002(+) accounted such factors as climate change, human toxicity, pollution agents inside and outside of analysed space, acidification, eutrophication, and energy extraction [15. p.87-88, 20]. Whereas for such tools as EPS 2000d, TRACI, ECOSCARCITY smaller quantity of factors have been taken into account [16, 17, 18, 20]. These are for example the climate change and a human toxicity. In any case it doesn't point at imperfection of some of these approaches. Rather, the major issue is that they indicate the main points for certain systems relatively when the most important characteristics for assessment are chosen. In this way, from our point of view, the complicity and inefficiency of attempts in creating the universal methodology is evident. However, such factors as human toxicity, including workplace and indoor pollutants, eco toxicity and climate change supposedly should be considered as universal. Further analysis of LCA methodologies reveals possibilities to conduct LCA without spending too much time and costs. Such tool as BEES 4.0 is free of charge, combines a life cycle cost for building and construction materials with a life cycle assessment and should be very adaptable and cost – saving, even more indispensable when applied to institutions of a social sphere [28]. For the purpose of understanding the internal analytic mechanisms, it would be useful to compare two methodologies, for example EDIP97 and Eco-indicator 99 in context of modelling types they use. Thus, the EDIP97 is a midpoint methodology where modelling midpoints considered as links in the cause-effect chain (environmental mechanism) of an impact category. From the other side the Eco-indicator 99 is an endpoint tool where characterization factors (indicators) can be derived to reflect the relative importance of emissions or extractions. Common examples of midpoint characterization factors include ozone depletion potentials, global warming potentials, and photochemical ozone (smog) creation potentials. However, in the endpoint modelling, characterization factors are adopted at the endpoint level in the cause-effect chain for all categories of impact (e.g., human health impacts in terms of disability adjusted life years for carcinogenicity; impacts in terms of changes in biodiversity, etc.). On the Figure 3 is given graphical representation of basic differences between the midpoint (lower row of swinging arrows) and the endpoint approach (upper row of swinging arrows). The small arrows represent models that add information in a cause – effect framework. The question marks indicate information that is available but could not be further modelled. Such cases include unmeasured emissions, unconsidered types of releases (occupational, accidental), and substances where endpoint models have still to be established (e.g. neurotoxic effects on human health) [19]. Both midpoint and endpoint methodologies provide useful information to the decision maker with respect to uncertainty (parameter, model and scenario), transparency, and the ability to subsequently resolve compromises across impact categories using weighting techniques. Following the LCA methodology, the last 4th stage is the Interpretation, which is designed for identification of key parameters and evaluation of results of inventory stage and impact assessment with purpose to select the preferred product or process. Certainly, the clear understanding of the assumptions, used to generate the results of the conducted research has been made. Consequently to support the importance of a holistic approach, we need to insist on the integrating of various aspects of the analysed system into cohesive whole i.e. the general sustainability.

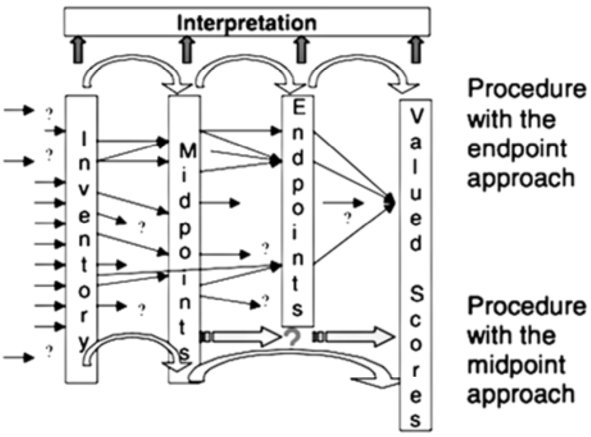

Fig. 3. Graphical representation of basic differences between the midpoint and the endpoint approach

Source: Life Cycle Impact Assessment Workshop Summary Midpoints versus Endpoints: The Sacrifices and Benefits

Table 1. **LCIA methodology**

LCIA methodology	**Eco-indicator 99**	**EDIP 97**	**EDIP 2003**	**EPS 2000d**	**IMPACT 2002(+)**	**LIME**	**ECOSCARCITY**	**TRACI**	**BEES 4.0**
Method description	EP damage approach, including N and default W sets	MP method with N	MP method with N	Category indicators at damage level + W	MP+EP damage including N	EP+damage assessment+W	W method, based on environmental policy goals, to be used for MP categories and selected emissions/ interventions	MP method without N and W	W + N
Reference	Goedkoop at al.(1999),	Wenzel et al. (1997), Hauschild and Wenzel (1998)	Hauschild and Potting (2004), Potting and Hauschild (2004)	Steen (1999) and Steen (1999)	Jolliet et al.(2003)	METI, NEDO, AIST (2003)	Brand G., Braunschwei A.,Scheidegger A., Schwank O.:W , 1998	Bare J.C. et al.(2003)	National Institute of Standards and Technology (U.S. Department of Commerce), 2009
Climate change									
Human toxicity, including workplace and indoor pollutants									
Ionising radiation									
Noise									
Acidification									
Eutrophication									
Ecotoxicity (fate, exposure and effect should at least be considered)									
Energy extractions									
Mineral extractions									
Water resource use									
Human health									
Abiotic man-made environment									
Biotic man-made environment									

Legend:

Endpoint – EP, Midpoint – MP, Normalization – N, Weighting – W,

Considered

Less attention paid or unconsidered

Source: Life Cycle Initiative (a joint organization of UNEP and SETAC).

Notification! The table is modified by the author adjusted to the purposes of this article

Results. Since the invention of the method, LCA has been generally used for products in industries with high-pollution outputs [21, 22, 23, 24, 25]. Many review articles have been written on the topic, but much less attention was paid to consideration of the method application to a healthcare. Even less has been said about pros and cons of this opportunity, and strong and weak points in this relation. Although, industries are of a high – priority because of generating profits and as a wide field for research of impacts, yet a healthcare system still important because of its social significance and influence on public health. In this context an additional key concept – the Life Cycle Management (LCM) should be introduced. LCM is the application of life cycle thinking to modern practice with aim to manage the total life cycle of organizations, products and services toward more sustainable consumption and production. It is the integrated framework of concepts to address environmental, economic, technological, and social aspects of products, services, and organizations. LCM as any other management pattern is applied on a voluntary basis and can be adapted to the specific needs and characteristics of individual organizations [26]. An illustrative example of the LCM application is surgeon and nurse initiated so – called Green Operating Room Committee. It is internal medical staff initiative on the premises of one hospital in the United States. After exchanging of routinely used consumables (single use devices, reusable gel pads instead of disposable operating room foam pads etc.), into recycled and more energy saving, the decreasing amount of wasted water, solid waste reduction, electricity, and great per year spending level was reached. As a result, the ecological initiative provided significant opportunity to improve healthcare unit's impact on the environment and save money [27]. In fact, the clear understanding of the LCM concept would enrich the practical use of LCA and experimentally proves the efficacy of its application to processes, units, and departments of a healthcare system. Such parameters as labour, time, costs would be additionally taking into account. Thus, in the 1st stage of LCA method extrapolation onto processes in a healthcare such goals as design of recommendations for the improvement of the legal framework for environmental safety and increase of a social responsibility of subjects would be added. In the 2nd stage, except usual and accepted parameters, which have been discussed earlier, the level of training of medical staff and their accuracy in fulfillment of medical tasks would be useful to introduce. In the 3rd stage, the main factors that significantly affect the results of a conducted research would be considered. The exclusion of secondary factors, which have not a significant influence, would be done based on the list of inputs and outputs. Therefore, the factors influencing the system with varying intensity would be clearly identified. As well as the possibility of establishing a system of scoring points or complex pattern – matching system for ranging of the influence of different factors would be considered. Furthermore, the correlation analysis (a statistical technique used to examine causal relationships between variables) would determine the weight of each variable in relation to the overall system performance. Among the most important, key factors, which adjust the whole system or process to the optimized level, would be determined. It would be convenient to fulfill using the multifactorial analysis (variation of multiple factors in analysis of multiple factor models). In addition, while leaving free space for discovery of new factors that have not been previously taken into account, such data as the qualification of specialists, social level of patients, etc. would be obligatory analyzed. During the interpretation (LCA's 4th stage) it would be necessary for researcher to summarize results of analysis; obtain answers to questions stated in the first stage; and give recommendations concerning the development and improvement of the quality of products or services in their close connection to the environment, etc. At the end of assessment the necessary policy improvements would be formulated. In some cases the possibility of changing the whole life cycle of a product would be considered. All described innovations would be the drivers for creating of more advanced guidelines for the development of normative – legal framework; guidelines for setting limits for certain hazardous emissions, effects and impacts on the human health [29, 30, 31, 32].

Conclusion & Discussion. Introduction of LCA refers to one of the building blocks of the Europe 2020 Strategy – "Roadmap to a Resource Efficient Europe" and proposes ways to increase resource productivity and to decouple economic growth from both resource use by units and environmental impacts, taking a life cycle perspective (i.e. considering Input of materials, production, use, final waste management and all necessary transport in an integrated approach). LCA is a relatively new approach with constantly developing methodology. It would be a confident backwater for holistic description of a life cycle of products and services, specifically in healthcare, where the use of sustainable technologies, materials and processes are extremely important. Taking into account permanent scarcity of resources, materials and emphasis on a cost – saving procedures in a social sphere, the method would be an efficient way for the optimization of economic and environmental performance of a healthcare. Inside proposed framework new factors should be identified and lead to creation of new models and techniques for the impact assessment. LCA should be successfully applied to analysis of healthcare system units (e.g. department, laboratory, hospital, ambulance, operating room), study of a life cycle of a single process, efficiency of medical staff as well as for analysis of performance of healthcare system of particular country etc. In addition, the rising social responsibility, corporate social responsibility and Life Cycle Management would be drivers for development and widespread application of such methods as LCA to processes and activities of healthcare institutions [31, 33]. As a result it would be of great importance for developing and implementation of effective public healthcare system model based on relevant, meaningful, robust, results and principles of careful use of resources, improvement of convalescence of patients and economic efficiency of units.

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Надійшла до редколегіїї 27.10.14

В. Саранча, канд. екон. наук
К. Вітале, д-р техн. наук, проф.,
С. Оресковіч, д-р техн. наук, проф.
Загребський університет, Загреб, Хорватія,
В. Сулима, д-р техн. наук, проф.
Івано-Франківський національний медичний університет, Івано-Франківськ, Україна

ОЦІНКА ЖИТТЄВОГО ЦИКЛУ В ОХОРОНІ ЗДОРОВ'Я. ОПТИМІЗАЦІЯ СИСТЕМИ. ВСТУП ДО ПРОБЛЕМАТИКИ

У статті описаний метод оцінки життєвого циклу (ОЖЦ) та можливості його використання в системі охорони здоров'я. ОЖЦ звертає увагу на дбайливе використання ресурсів, охорону навколишнього середовища і соціальну відповідальність індивіда. Моделювання вхідних екологічних та технологічних ресурсо-потоків дозволяє оптимізувати продуктивність системи. Позначаються чинники та параметри, які можуть поліпшити ефективність функціонування різних секторів системи охорони здоров'я. Оптимізація продуктивності виявлених параметрів дозволяє поліпшити функціонування системи, забезпечити більшу безпеку пацієнтів, економічну стійкість і знизити споживання ресурсів.

Ключові слова: оцінка життєвого циклу, цілісний підхід, управління охорони здоров'я, соціальної відповідальності, моделювання.

В. Саранча, канд. экон. наук
К. Витале, д-р техн. наук, проф.,
С. Орескович, д-р техн. наук, проф.
Загребский университет, Загреб, Хорватия,
В. Сулима, д-р техн. наук, проф.
Ивано-Франковский национальный медицинский университет, Ивано-Франковск, Украина

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В статье описан метод оценки жизненного цикла (ОЖЦ) и возможности его использования в системе здравоохранения. ОЖЦ обращает внимание на бережное использование ресурсов, охрану окружающей среды и социальную ответственность индивида. Моделирование входящих экологических и технологических ресурсо-потоков позволяет оптимизировать производительность системы. Обозначаются факторы и параметры, которые могут улучшить эффективность функционирования различных секторов системы здравоохранения. Оптимизация производительности обнаруженных параметров разрешает улучшить функционирование системы, обеспечить большую безопасность пациентов, экономическую устойчивость и снизить потребление ресурсов.

Ключевые слова: оценка жизненного цикла, целостный подход, управления здравоохранения, социальной ответственности, моделирования.