

DUCK TURNS INTO RABBIT: PARADIGM SHIFTS IN ECONOMICS – CHALLENGES FOR THE 21ST CENTURY MANAGER

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ABSTRACT

The essay aims to draw attention to the subject of changing paradigms in economics and management sciences. Conceptionally, paradigm shifts in social sciences differ from those in natural sciences; resulting in debates over fundamental claims and counterclaims they oppose to one single prevailing theory. Furthermore, economic paradigm shifts are driven by long waves or technological cycles. The 21st century management should be aware that paradigms will determine strategic choices but at the same time strategic choices are likely to create new paradigms and hence they will drive paradigm shifts. For the application of theory in practice, two frameworks of recent trends that are likely to promote paradigm shifts will be discussed. Moreover, new challenges such as the network economy, the role of culture and the empowerment of employees will be addressed as promising avenues for future research.

Keywords: paradigm shift, innovation, megatrends, business strategy, super cycles

INTRODUCTION

Nowadays organizations and their management are able to choose from many different schools of thoughts in order to decide about questions such as strategies, organisational structure, culture and leadership style. Some of these organizations are likely to follow traditional approaches such as Porter's market-based view, others may rather look for more innovative approaches such as agile management. All these decisions are based on factors such as the organization industry or sector, strength of competition, organizational culture or the managements' frame of references, their view of the world based on previous personal experiences as well as their understanding of future needs and developments. This essay aims to highlight some of the challenges for nowadays' management that are based on recent major changes in the world of economics. Therefore, the essay starts with a short definition of terms such as paradigm, paradigm shift and economic cycles before turning to highlight some of the trends or challenges discussed by several scholars and researchers. In conclusion, two frameworks are introduced that are likely to support the 21st century manager in their strategic decision-making by providing structured insights based on recent research studies.

PARADIGMS IN THE CONTEXT OF ECONOMICS

A paradigm can be explained as an existing worldview, or taken-for-granted assumptions (drawn from pattern of events) that influence our understanding of situations and

necessary decisions in the given context. Whereas in the natural sciences a single reigning paradigm is common, in social sciences a “tradition of claims, counterclaims, and debates over fundamentals” (Kuhn, 1972) do exist. Turning to the discipline of organizational theory, organizational culture and here especially the cultural web (Johnson, 2006) also draws on the importance of the paradigm for explaining the current situation and development needs of an organization. As shown in Figure 1, Johnson et al. (2006) put the paradigm at the center of factors influencing strategy formulation.

Figure 1

The role of the paradigm in strategy formulation



Source: Johnson et al. (2006)

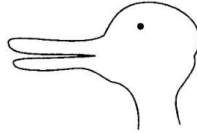
As shown in Figure 1, the paradigm is driven by external factors such as environmental forces leading to opportunities and threats but also by internal effects such as strategic capacities based on an organizations’ strengths and weaknesses. On the other hand, the paradigm itself has strong influence on the organizations’ strengths, weaknesses, opportunities and threats and hence its strategic choices, that again effecting organizational performance. In essence, paradigms are influenced by organizational development but at the same time influence the organizational development.

HOW DO PARADIGMS CHANGE?

The term “paradigm shift” was coined by the American physicist and philosopher Thomas Kuhn in 1962. In his definition, it addresses fundamental change in the basic concepts and experimental practices of a scientific discipline which can be seen as a “scientific revolution” (Kuhn, 1970). Following Kuhn’s (1970) definition, each of the paradigms yielded either new academic approaches to solve the key challenges or recommendations for the application of new methods. Kuhn (1970) draws on Wittgenstein’s famous optical illusion, shown in figure 2, to demonstrate how a paradigm shift causes us to interpret the same information in a completely different manner.

Figure 2

Wittgenstein's duck-rabbit



Source: *Wittgenstein* (1958, 166. p)

Wittgenstein (1958) explains why we can see the illustration as one thing (rabbit) or another (duck) because we interpret what we see and therefore see it as we interpret it. Turning to the disciplines of economics and management, economic, technological or environmental challenges can cause new interpretations of the business world as we saw it before. Taking up *Bakacsi's* (2017) thoughts of new business paradigms, the historical development of paradigms in management is summarized in *Table 1*.

Table 1

Five management paradigms

Paradigm	Key management challenge	Concept development	Key authors
System and order	How to make unskilled people efficient?	Classic management (from ca. 1910 onwards)	Taylor, Fayol, Weber
Satisfaction-performance	How to translate relationship motivation into organizational performance?	Human relations (from ca. 1930 onwards)	Mayo, Parker-Follet, Roethlisberger
Achieving problem solver	How to unleash the self-standing, still bounded-rational problem-solver?	Behavioral decision-making theory (from ca. 1950 onwards)	Barnard, Simon, Cyert, March, Jensen
Competition	Compete outside with competitive people	Institutional theory, Contingency theory (from ca. 1960 onwards)	Williamson, Burns-Stalker, Lawrence-Lorsch, Child, Kotter
Win-win (Empowerment)	How to explore & exploit network synergies	Learning organization (from ca. 1990 onwards)	Senge, Greiner, Prahalad, Porter, Schein, Simons

Source: Adapted from *Bakacsi* (2017, 47. p.)

WHEN ARE PARADIGM SHIFTS LIKELY TO HAPPEN?

As shown before, major changes in defining, interpreting and solving key management challenges are based on a changing understanding of taken-for-granted assumptions. However, these changes do not happen coincidentally. Research that started at the beginning of the 20th century yielded evidence that the world economy does experience cycle-like phenomena of alternating intervals between strong growth in certain sectors and intervals of slow growth. These cycles are called super-cycles, long waves or Kondratiev waves, named after the soviet economist Nikolai Kondratiev the researcher who brought these observations first to attention in 1925. These cycles are explained by different theories, most important for the context provided here in the essay is the technological innovation theory. The theory was put forward by *Joseph Schumpeter* in the 1930s when he hypothesized the existence of very long-run macroeconomic and price cycles, originally estimated to last about 50 years. The waves will arise from innovations that create new leading industrial or commercial sectors based on a technological revolution. The technological cycles can be labelled as follows:

- The Industrial Revolution (1771)
- The Age of Steam and Railways (1829)
- The Age of Steel and Heavy Engineering (1875)
- The Age of Oil, Electricity, the Automobile and Mass Production (1908)
- The Age of Information and Telecommunications (1971)
- The (hypothetical) post-informational technological revolution (2015)

Recent research (i.e. *Šmihula*, 2009) comes to conclude that each new cycle is shorter than its predecessor. Also, disrupting inventions nowadays spread much more quickly as they did 50 years ago. It took the radio broadcasters 38 years to reach 50 million users, TV only 13 years, the internet four years and Facebook two years (*Ovaskainen and Tinnilä*, 2013). Or we can take a look at *Ray Kurzweil's* Law of Accelerating Returns (2005), proposing in the next 100 years we will be experiencing 20,000 years of progress – at today's rate.

Although Kondratiev's cycle theory is not accepted broadly by academic economists (as they argue the theory sees pattern in statistical data that are not really there), it is still important for discussing management phenomena in an innovation-based, developmental and evolutionary sense of economics.

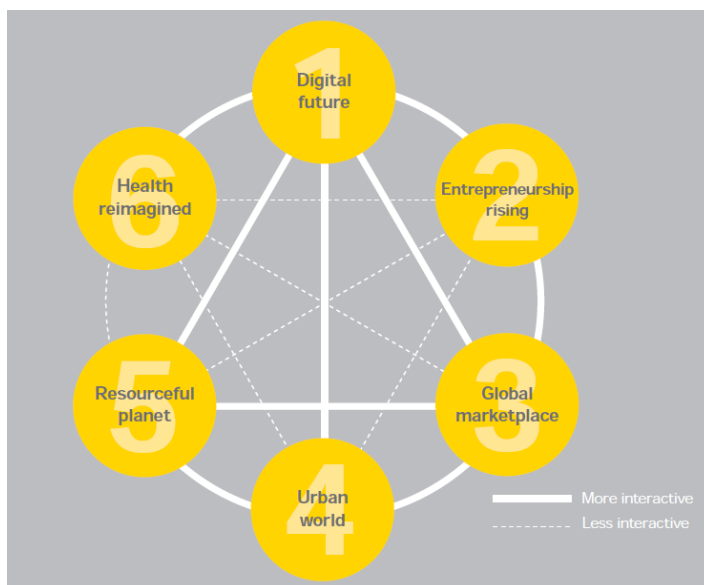
THE RECENT PARADIGM SHIFT IN MANAGEMENT

Economics is a social science; therefore, researchers are still on the lookout for a proposed “grand theory” and, in the meantime continue to provide usable frameworks explaining phenomena. Hence, we are facing several theories and predictions also in regard to paradigm shifts. To apply academic research in a practical sense, two different schools of thought, both are based on empirical research, will be introduced here. The first initiative, “The Millennium Project” is an independent non-profit think tank composed of scholars, researchers, decision-makers and business planners working together internationally in 56 nodes

our daily life and are identified largely with support of worldwide input from many researchers, scholars and businesses. One of the most recent concepts in this area was introduced by EY in their report “Megatrends 2015 – Making sense of a world in motion.” (EY, 2015). *Figure 3* summarizes the identified factors and illustrates the single importance of each megatrend as well as the close relations between each other.

Figure 3

Megatrends 2015. Making sense of a world in motion



Source: EY, 2015

When talking about *Digital future*, the growing demand for anytime anywhere access to information technology is disrupting all areas of life across all industries and in all geographies. New opportunities arise for enterprises to take advantage of the “Internet of Things” to enter new markets or transform existing products. However, digitalization also represents significant challenges, i. e. new competition, changing customer behavior, increasing transparency, data privacy and cyber-security threats (EY, 2015). Especially Small and Medium Sized Enterprises (SMEs) as important economic drivers in most countries are hesitant to take advantage of digital disruption: a recent study carried out by PwC (PricewaterhouseCoopers) reveals that although 90% of German SMEs assess digitalization as the recent predominant topic, only 5% take action and look forward to start digitalization in their own business (PwC, 2017).

Increasing technology is also changing the ways we work. Enterprises and individuals who can seize the opportunities offered by digitalization can benefit hugely, whereas all other will be likely to lose much. Entrepreneurial activity is at

the core of economic growth by providing income and employment for themselves as well as others and create innovative products or services. The megatrend of *entrepreneurship rising* focuses on the growth of “high-impact” entrepreneurship that was once largely confined to mature markets and is now seen also as an important driver of economies in rapid-growth markets. Also, the face of entrepreneurship is changing: more entrepreneurs are of either young age and/or female and many of the start-ups are digital ones from the beginning. Both the public and the private sector play an important role in creating entrepreneurial ecosystems. They and the access to funding (which remains the primary obstacle for entrepreneurs) are the essential factors to promote entrepreneurial success (EY, 2015).

Globalization will remain an increasing force with some new features to deal with. One the one hand, the gap between “mature” and “rapid-growth” countries continues to shrink. Also, there are new “emerging nations” that will draw global attention. Asia is likely to surface as a major hub in rapid-growth markets where innovation will increasingly take place. On a global scale, workforce diversity will increase as a weapon to fight with in the “war for talent” to secure competitive advantage. Interdependences between the economies of the world through trade, investments and financial systems will drive the need for global policy coordination among nations. However, domestic interests will compete with global integration and lead to trade and currency protectionism, sanctions to achieve political aims and anti-globalization protests. Hence, we will experience the strengthening of nationalistic, religious and ethnic movements all over the world (EY, 2015).

As the number and the size of cities are growing across the world, the new megatrend of an *urban world* has to be addressed. Especially the rapid urbanization in emerging markets and continued urbanization in mature markets will result in an increasing amount of the world’s population to live in cities from 54% today to 66% in 2050. To secure the economic benefits of urbanization, effective planning and sustained investment in infrastructure is requested from policy-makers and the private sector (EY, 2015).

The global demand for natural renewable and non-renewable resources is driven by factors such as population growth, economic development and consumers. The megatrend *resourceful planet* addresses finiteness of the world’s supply of non-renewable resources by developing new technologies to access hard-to-reach and valuable oil, gas and strategic mineral reserves. At the same time, natural resources must be managed more effectively, protecting and restoring the planet is crucial for our future. Sustainable approaches are requested to balance economic growth and protection of natural resources (EY, 2015).

The necessity to *reimagine* our approach to *health* is based on the effects of demographic change, rising incomes in rapid-growth markets and an imminent life-style related to chronic-disease epidemic. Hence, health care systems are under increasing cost pressure. On the other hand, big data and new mobile health technologies are enablers for real-time information creation and analysis that lead to a fundamentally different approach: focusing on the management of health, with more focus on healthy behaviors prevention and real-time care instead of the traditional delivery of health care in terms of “sick care” (EY, 2015).

As shown above, megatrends are both offering opportunities and implying threats and hence are likely to drive paradigm shifts. Frameworks, such as the Millennium Project or EY's Megatrends, are particularly suitable for businesses and organizations that aim to observe these trends and to move along to ensure creativity and innovation. Organizations then are well prepared to develop key success factors and strengthen their competitive power.

However, scholars and researchers in academia also strive to shed some light on recent challenges and future paradigm shifts likely to happen next. For example, Professor *Gyula Bakacsi* recently presented his thoughts on several challenges for the 21st century managers at Kaposvár University, Kaposvár. Firstly, the development of a scale free network economy can be assessed as an attractive alternative for preferential attachment and offers an explicit value proposition for network members. However, network economy requests new management concepts to tackle the challenges of freedom and high independency of network members for the benefit of stability and safety of the whole network. Especially the power of networks such as globally super-connected companies should not be underestimated and more focus should be drawn to discuss opportunities and risks arising from such concentration of influence and power (*Bakacsi, 2017*).

The changing role of culture in world affairs presents another challenge. Increasing diversity holds opportunities and risks that have to be brought in balance by management. Also, cultural patterns are key variables for economic wealth and development as supported by the GLOBE research project. However, trust and cooperation within the immediate social environment as well as in an extended, broader social environment are necessary foundations for successful application and management has to face the changing requests in that context (*Bakacsi, 2017*).

Finally, *Bakacsi* (2017) proposed empowerment as the new emerging management paradigm. Nowadays, the economic environment asks for employees with competences such as “self-standing problem solving”. Employees like these are motivated by self-actualization, a win-win situation with value creation for the organization and empowerment for the employee will emerge. However, developing new leadership skills and applying innovative approaches to management such as agile management are essential elements of success for the current generation of management.

CONCLUSION

As shown in the essay, paradigm shifts make people see and interpret phenomena or data in a different light and hence come up with new ideas for solutions to existing as well as new challenges. Paradigm shifts in economics and management are linked to economic cycles that are fuelled by technological innovation. Each new cycle is shorter than its predecessor, due to technological progress and new technologies as decisive factors of any long-time economic development. Each paradigm shift brings new challenges to be tackled by management. Especially in the social sciences, paradigms tend to be brought to life rather as debates over

fundamentals than as a “grand theory”. Therefore, research often results in frameworks suitable to support the practical application of new methods or instruments. Even with regard to the new challenges of the 21st century, managers can draw from an extensive variety of concepts, recommendations or theories to develop organizational culture and strategies. Concepts such as the Millennium Project or EY’s Megatrends are exemplary but only provide a glimpse at the peak of the iceberg of approaches and recommendations discussed recently. For the academia, the discussion of paradigm shifts will be understood as a call for entering these promising avenues for further research.

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THE RELATIONSHIP BETWEEN GENDER DIVERSITY AND CORPORATE SOCIAL RESPONSIBILITY

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ABSTRACT

A couple of decades have passed since Corporate social responsibility and sustainability has become an integral element of the business plans of many corporations. There has been a growing attention to corporate social responsibility (CSR). Nowadays companies have come to realize the risks of ignoring CSR as well as the importance of being environmentally responsible. Yet little is done when it comes to a balanced gender profile at board level. This paper reviews the existing literature on corporate social responsibility, in particular gender diversity in board. It explores how board diversity and the number of women on boards affect firms' corporate social responsibility performance and reputation. The aim of the study is to analyze the relationship between gender diversity and corporate responsibility stressing the role that women directors play in the development of CSR in organizations, and contribute to sustainable development. The analysis confirms a positive link between board gender diversity and corporate social responsibility. The presence of women on corporate boards increase board effectiveness through reducing corruption, ensuring better financial performance, enhancing philanthropy and quality of communication. Firms with a higher percentage of women on the board of directors are more socially responsible and have better corporate reputation.

Keywords: Corporate social responsibility, Gender diversity, Women directors, Sustainable development, Corporate reputation

INTRODUCTION

A couple of decades have passed since environmental sustainability has become an integral element of the business plans of many corporations. There has been a growing attention to corporate social responsibility (CSR). Nowadays companies have come to realize the risks of ignoring CSR as well as the importance of being environmentally responsible. Yet little is done when it comes to women's empowerment and gender equality. Companies make a commitment in gender mainstreaming and enabling women across the world. However, they seem to forget that this should start within the company itself by diversifying the board and having more number of women at board position. Companies rarely see board diversity as a crucial part of corporate sustainability initiatives. Although they recognize the significance of gender equality, they do not really practise it as one part of their business. Companies' involvement in women empowerment is mostly in the form of short programs or initiatives which usually last for a short period of time. We see them raising awareness in the community about gender equality and the role of women but they fail to give the opportunity to women in board position in their own

company. Unless women empowerment starts at the grassroots level within the company it is hard to say that a company is doing corporate social responsibility.

BOARD DIVERSITY AND CSR

Diversity on boards is essential for a sustainable performance of a company. Broadening the composition of the board certainly increases the size of the candidate pool and, more importantly, helps expand perspectives at the top. While most CEOs recognise the importance of appointing directors of different ages and with different kinds of educational backgrounds and functional expertise, they tend to underestimate the benefits of gender diversity. (*Arguden, 2012*)

In 2011 data was gathered by the joint research of Catalyst and researchers from Harvard Business. It was examined how corporate leadership and organizational structure influence CSR, by utilizing in the research the so called, ‘most visible form of CSR’ in the United States, i.e. corporate philanthropy. Focusing specifically on how women leaders might impact CSR, the research suggests that, examined through the lens of corporate philanthropy, gender-inclusive leadership and CSR are linked. The main findings indicate three major results. First, it was found that companies with gender-inclusive leadership teams, compared to companies without women executive leaders, contributed to, on average, more charitable funds. Second, the key factors that might influence total donations were controlled. It was found that the presence of women leaders in Fortune 500 companies still had a significant, positive effect: more women leaders correlated with higher levels of philanthropy. Accordingly, gender-inclusive leadership has a positive impact on CSR in general. In line with increased philanthropy, increases in other CSR areas, e.g. environmental CSR, were observed. Third, gender-inclusive leadership likely affects either the level or quantity of philanthropic investment corporations make in CSR, and the quality of CSR initiatives. However, the meaning of “quality of CSR initiatives” remains relatively negotiable, as proposed examples do not refer to any features or criteria for defining ‘qualitative’ CSR initiatives. *Catalyst* (2011) summing up, the general proposition given in the research points out that “gender- inclusive leadership is good for business and society”

Another study by *Kruger* (2009) indicates that higher level of women representation in board produces positive inclination towards CSR. Furthermore, companies with high board diversity have higher attention towards the welfare of stakeholders indicating that board members with altruistic preferences have pro-social corporate behaviour. As we can understand from the above findings, the more women representation is on boards, the stronger the corporate social responsibility records and improved integration into communication are which help to ensure long term- sustainability.

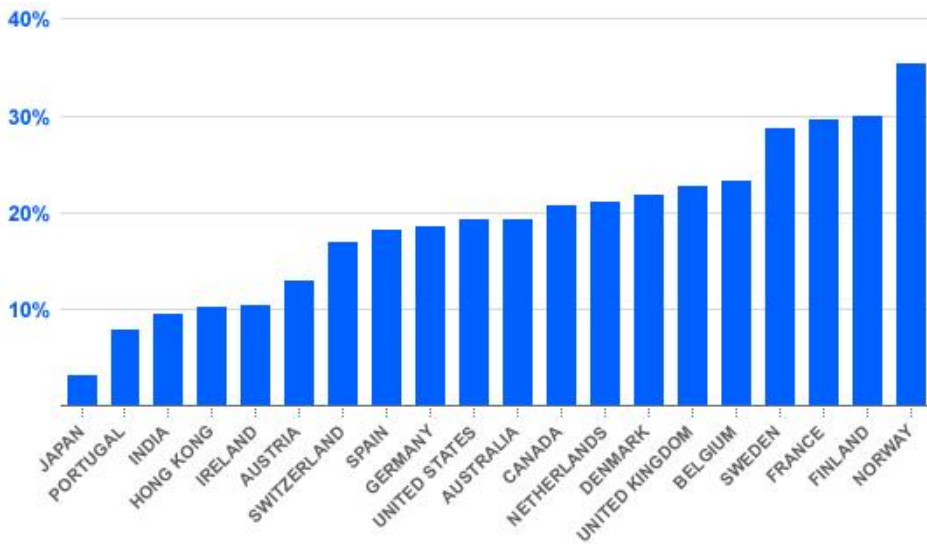
Concerning the financial aspect, many studies indicated that companies with the most women board directors, especially those with three or more women board directors, had better financial performance than those with the fewest women board directors. For example, *Catalyst* (2007) found that companies with more women board directors outperformed those with the least on three financial

measures: return on equity (53 percent higher), return on sales (42 percent higher), and return on invested capital (66 percent higher). Another study by *Forbes*, (2010) examined companies with women CEOs or heads has experienced better financial performance. The study was carried on the stock performance of the 26 publicly traded companies headed by women on its “2010 Power Women 100” and it was found that, on average, companies in the group outperformed their industries by 15 percent and the overall market by 28 percent.

Several countries have started adopting either legislative or voluntary initiative to promote female representation on corporate boards. This includes, for example, Norway (40% gender quota for female directors or face dissolution), Sweden (25% voluntary reserve for female directors or threat to make it a legal requirement), Spain (comply-or-explain type law requiring companies to reach up to 40% female directors by 2015), France (law which requires 50% gender parity on the board of every public firm by 2015) (*Bohren and Strom*, 2010) and more recently Italy (law requiring listed and state-owned companies to ensure one-third of their board members to be female by 2015) (*Arguden*, 2012). In addition to European countries, many developing countries such as India, China, and Middle Eastern countries are also recognizing the importance of female board members’ talent (*Singh et al.*, 2008). Finally, in Australia, the Stock Exchange (ASX) in its recent changes to corporate governance principles now requires listed companies to specifically report on gender diversity at board and senior management levels (*Kulik*, 2011). Most of these initiatives, whether voluntary or legislative, clearly indicate that the presence of women on boards could affect the governance of companies in significant ways (*Adams and Ferreira*, 2009).

Figure 1

Women’s share of board seats at stock index companies

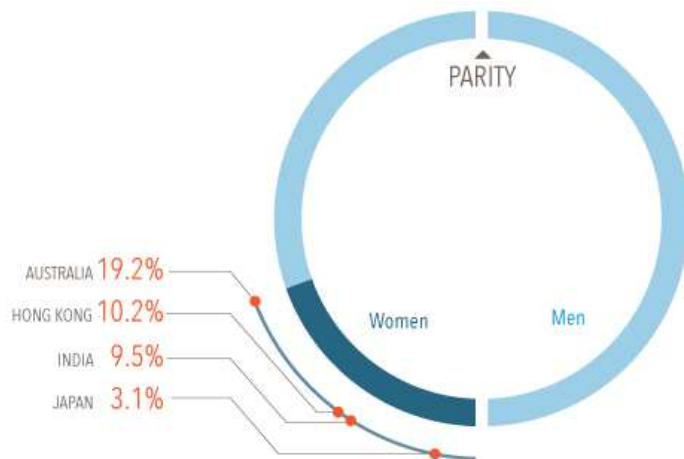


Source: <http://fortune.com/2015/01/13/catalyst-women-boards-countries-us/>

The Scandinavian countries are the ones with the highest gender parity, according to the World Economic Forum, and they are also the countries that generally have the most women on their boards. 35.5 percent of board seats at Norwegian companies are held by women (Norway, for example, was the first nation to mandate a quota for women on boards); 29.9 percent of Finnish board seats are held by women; and in France, women held 29.7 percent of board seats. (*Catalyst*, 2014)

Figure 2

Women's share of board seats at Asia- pacific stock index companies



Source: <http://www.catalyst.org/knowledge/2014-catalyst-census-women-board-directors>

GENDER BASED ETHICAL BEHAVIOUR

Increasing women leaders on board may result in positive ethical behaviors of organizations. Several pieces of evidence show the relationship between women and ethical behaviour. For example *Stedham et al.*, (2007) and *Stephenson* (2004) show that many women find business practices to be unethical and *Limerick and Field* (2003) and *Stedham et al.* (2007) indicate that women are more sensitive to unethical behaviour than men.

According to *Rao and Tilet* (2015) men and women are different in their orientation toward moral principle, largely because women have better internalized ethical and communal values through their social roles. Abundant support was found for this inference, depicting that females are more likely to have stronger moral standards and ethical stances than their counterpart.

Likewise *Ibrahim et al.* (2009) showed that female managers tend to exhibit more positive attitudes towards the adoption of the ethics code in their organization and hold more confidence that the ethics code will raise moral standards in their business operations. Together, this stream of research suggests that female leaders are more likely to have concerns for other stakeholder groups. As such it is reasonable to

expect that female independent directors will embrace their company's CSR more strongly than male directors actively engaging in issues corresponding to the welfare of none – shareholding stakeholders. In addition, there is evidence that female independent directors are often more sensitive to the possibility of rule- violations and thus tend to be more intolerant up on signs of improprieties. For example, in China comparing firms that had no fraud with firms with regulation violations over a ten-year period, it was found that firms with higher proportions of women board directors and led by women chairs were less likely to commit fraud or violate security regulations. Violations include illegal share buybacks, inflated profits, assets fabrication, shareholder embezzlement, and price manipulation. (Douglas, 2012)

Based on the study of *Flynn and Adams* (2004), some shareholders even perceive that the boards of directors with most women provide greater guarantees that their investments are not in conflict with a criminal conversion and, at the same time, show stricter compliance with ethical conduct. In addition, according to *Ramirez* (2003), gender diversity can prevent corporate corruption and fraud, since women are more likely to challenge management with 'tough' questions. As we can understand from the findings, the number of women on board has a positive relationship with the ethical behaviour of a company by improving corporate social responsibility rate and corporate reputation.

Providing those evidences, the author would say women are best for corruption-free CSR benefiting the society at large. For instance, in Ethiopia, women are less involved in corruption for several reasons. One is that they do not want the risk of putting themselves and their family into trouble due to bribes because they care about their family especially their kids but men are less responsible for their family and have the gut to engage in corruptions. According to the author, caring starts from the family, if someone does not care enough for his/her family, how can he/she care for the society?

DIFFERENCE IN GENDER CHARACTERISTICS

While *Eagly et al.* (2003) suggest that characteristics such as assertive, ambitious, aggressive, independent, self-confident, daring and competitive are usually recognized in men, whereas communal characteristics such as a concern for the welfare of other people and being affectionate, helpful, kind, sympathetic, interpersonally sensitive, nurturing, and gentle are identified in women. *Galbreath* (2011) found that women were able to engage and respond well to multiple stakeholders because of their relation building ability, treating it as corporate social responsibility. *Kabreb et al.* (2013) state that women directors are more oriented and pay higher attention to social responsibility as compared to their male counterparts, it seems to me that the characteristics reflected in women go along with CSR. The author believes that women perform better from social aspects than men especially in developing countries. For example, in Ethiopia where the social bond is strong, the role of women in participating in social affairs is very high. They are always there for helping people in different ways. For example, during a funeral they are the ones who cook for the deceased family for the entire week, take care of

everything including hosting visiting guests. And when it comes to cleaning the environment, they are the main actors. They clean the streets in a group, undertake charity activities for children who lost their parents due to HIV AIDS, provide food for homeless people and who are in need. All these activities are voluntary which stems from caring for the society.

Further, women usually hold positions in 'soft' managerial areas such as human resources, CSR, marketing, advertising, etc., *Zelechowski and Bilimoria* (2006) indicating that female representatives on boards are more likely to have in-depth knowledge of soft managerial issues. This evidence further indicates that female directors may perceive community or stakeholders' interests, particularly CSR issues, differently than male directors. It is also worth mentioning that women provide a different insight into the decision process from that of men, which can help a company or business to make the most effective decisions. Adding women to boards can produce a diverse and dynamic leadership team which in turn will reduce monolithic thinking and bring about better decisions. (*Stephenson*, 2004). The evidence and outcomes discussed above so far indicate female directors are more likely to have a positive influence on Social Responsibility. One major barrier that has been pointed out widely identified in literature is that women in top-level positions face discrimination or a stereotyping challenge which restricts their ability to fully contribute to corporate strategy and oversight (*Arfken et al.*, 2004; *EOWA*, 2008; *Galbreath*, 2011). It was also pointed out by *Galbreath* (2011) that gender biases could influence strategic decision making there after the outcomes.

CONCLUSION

We have seen how the diversity of board and the number of women on boards affect firms' corporate social performance and the benefits of having more women leaders from different dimensions. Companies with both women and men leaders in the boardroom are likely to achieve higher sustainability for the company and society. Having women on board will positively enhance the social strategy of organizations due to the sensitivity of women towards Corporate Social Responsibility. Overall, increasing the percentage of women on a board of directors has been linked to improved financial performance, corporate social responsibility, less corruption and high ethical business. Board diversity or balanced gender in boards benefit companies from educational and professional backgrounds. It creates more participative and democratic decision-making process. Increasing heterogeneity among board and CEO provides better oversight of management activities, help ensure that more perspectives and issues are considered in the decision-making process leading the board to achieve a better decision. The presence and the number of women on boards may signal to stakeholders that the firm pays attention to women and is, therefore, socially responsible. However, a single woman director may not be sufficient as it is difficult for them to raise their voice for any issue and make their opinion be heard. In addition, more women can deal better with eradicating gender inequality, be an inspiration and a role model for other women, the increasing number of women in other high- level positions.

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CONNECTION BETWEEN SOURCES OF INFORMATION AND MOTIVATION FOR ENVIRONMENTAL AWARENESS

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ABSTRACT

In my study I have examined the connection between sources of information and motivation for environmental awareness. Studies show that the acts believed as environmentally conscious do not always lead to the expected reduction. I suppose that one of the reasons of such a situation is the lack of the right information. Based on this, I think that with better understanding of the consumers' information sources, we would be able to send more effective messages about the right behaviour and we could reduce the impact of our incorrect environmental activity. For better understanding I revealed the most popular sources of information with on-line survey and I searched for connection between their authenticity and their motivational effects. The research shows that the most popular source of information is the Internet, but many people also rely on previous studies, friends, informative programs. In addition, 75% of the respondents would like to get more information in connection with environmentally responsible behaviour. My results show that more than 30% of the respondents think experts are the most reliable informational source. It can be seen that the most popular sources of information do not match up with the most trusted source. It is also revealed that the family is the first among the motivational factors, followed by taxes, friends and the community. Based on my results, I suggest that it is necessary to provide right information to the people regarding environmentally conscious behaviour. It must be said what to do, thereby facilitating decision-making. We would do it with modern, interactive and widely available sources of information and by involving experts.

Keywords: information, motivation, environmental awareness, right information, effectiveness, experts, services, community

INTRODUCTION

After Rachel Carson's work, the book *Silent Spring* was published in 1962, the idea of environment protection and environmental awareness appeared in the life of mankind. Widely this work drew the attention to the negative process which had started in the environment. The book shocked many people, who realised that activities without knowing the consequences and ignoring the negative environmental impacts are able to ruin our whole living place (Akenji, 2014; Carson, 2007; Rác, 2013a).

Despite this recognition, consumption of nowadays has a significant effect on the surrounding environment. This way of life is based on the continuous purchase of products, while it does not answer the individuals' constantly researched, perhaps long-lost happiness (Hamilton, 2010; Kerekes, 2011; Zsóka et al., 2011).

Research has shown that in general the individuals are aware of the environmental problems, even more they practise some activities as well. But activities that need more effort or renunciation are not so popular at all. In addition, there are activities that are under-estimated in environmental impact or their real impacts are unknown. These forms are the following for example: generating food waste, excessive meat consumption, flying by plane or purchasing environmentally friendly, but imported goods. These activities have a bigger effect than selective waste collection, switching off the lights, although individuals do not realize their importance properly. The reason for this situation could be the lack of information besides other factors (*Akenji, 2014; National Geographic, n.d.; Carlsson-Kanyama, 1998; Chen and Chai, 2010; Csutora, 2012a, 2012b; Monostori, 2007; Nagy, 2012a; Zsóka et al., 2011*).

It is known that the environmental effect of „green“ and non-green consumers are not significantly different. Behavioural change exists, but it does not have the effect that we expect in advance. This phenomenon is called Csutora-paradox by Sándor Kerekes or named as Behavioural-Impact Gap. This theory states that the easily implemented activities or the activities perceived environmentally conscious based on false information, lead easily to higher ecological footprint than the neutral or non environmentally conscious actions (*Chen and Chai, 2010; Csutora, 2012b; Kerekes, 2016, 74. p.*).

On the basis of the Csutora-paradox it is clear that individuals need guidance based on professional background in order to practise the right environmentally conscious behavioural actions (*Csutora, 2012a, 2012b; Hofmeister-Tóth et al., 2011*).

Starting from the problems mentioned during my research I examine the role of information sources on environmental awareness motivation. We need to know from where consumers gather their information, what they consider to be an authentic source and which are those few which encourage them to do real activities. It is important to know where the individuals gather information from. Knowing these sources targeted messages can be sent regarding appropriate consumer behaviour. We are able to avoid higher environmental impact in this way.

MATERIAL AND METHODS

As the methodology of my primary research I chose online interviews. The survey was carried out in April 2016. I applied the “snowball” which belongs to the non random sampling techniques (*Malbotra, 2009*). In the questionnaire I used structured and open questions. My topics were the following:

- the respondents' perception of their own behaviour in relation to environmental issues,
- sources of information as the basis of environmental behaviour,
- demand for additional information,
- incentives which cause environmental act,
- recent change in behaviour and the triggering information source.

During the study I got 243 evaluated responses. The distribution of the respondents according to background variables is shown in *Table 1*.

Table 1

The distribution of the respondents according to background variables

Name	Distribution of the respondents	
	Count	%
Total interviewed	243	100.0
By gender		
Woman	135	55.6
Man	108	44.4
By age groups		
25 years or under	23	9.5
Between 26-35 years	73	30.0
Between 36-50 years	82	33.7
Between 51-60 years	49	20.2
61 years or over	16	6.6
By education		
Primary school	1	0.4
Vocational training	5	2.1
Graduation	55	22.6
Diploma	175	72.0
Others (technician, etc.)	7	2.9
By the existence of a child in the family		
Yes	108	44.4
No	135	55.6
By type of settlement		
Village	98	40.3
City under 100 000 inhabitants	91	37.4
City over 100 000 inhabitants	29	11.9
Capital city	25	10.3
By the presence of any chronic disease within the family		
Yes	188	77.4
No	55	22.6
By per capita income		
Significantly below the average.	2	0.8
Slightly below average	9	3.7
Average	96	39.5
Slightly above average	121	49.8
Significantly above the average	15	6.2

The representativeness of the sample cannot be shown afterwards, but due to the relatively high number of responses received general conclusions can be drawn. The results may be useful to examine the overall behaviour and attitude of the pattern.

In the empirical study I used the following main statistical indicators:

- percentage form using crosstabs,
- for the percentage distributions of significant correlations I used Chi² test (Green and Salkind, 2010; Malhotra, 2009).

RESULTS AND DISCUSSION

The perception of environmentally conscious behaviour

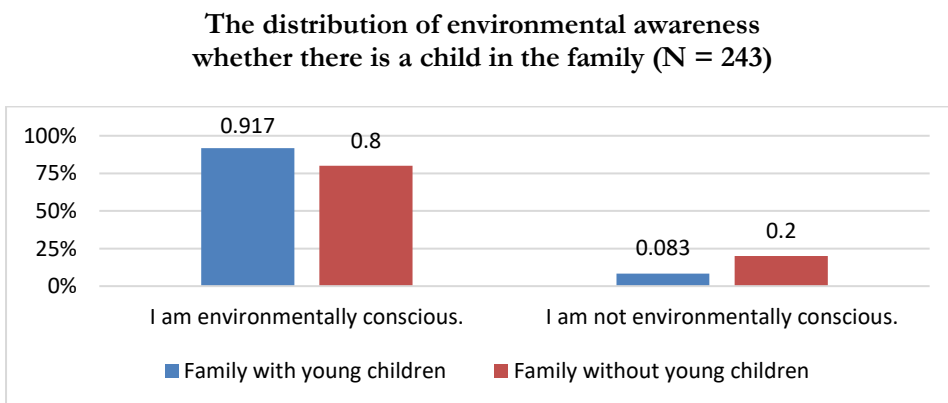
It is known from the literature that people consider themselves to be environmentally conscious, but only a few of them act according to this rule. The number of those is even less who are able to achieve any reduction in their environmental impact (eg. reduction in ecological footprint) (Csutora, 2012b).

In connection with this, my survey revealed that 85.2% of the respondents said themselves to be environmentally conscious. This was their subjective perception. This ratio seems to be very good in itself, but we know that on the one hand the respondents often try to give the socially expected answers in interviews and on the other hand their own judgement can be wrong.

The results obtained showed a significant correlation with the presence of small children within the family ($p = 0.011$). The results are shown in Figure 1.

The results show that respondents who have a young child in their family are more likely to be environmentally conscious. This result is explained by the fact that responsibility for the future of the child may encourage some to environmental behaviours. I consider this to be an emotional motive, which according to the literature, is often stronger than other incentives that affect the mind. In addition, the result is similar to that research which states the following: one of the main reasons of environmental consciousness of the Hungarian population is the responsibility for children (Nagy, 2012b; Rácz, 2013b).

Figure 1



There was also a significant correlation between the assessment of environmental awareness and the type of residence of respondents ($p = 0.018$). The results

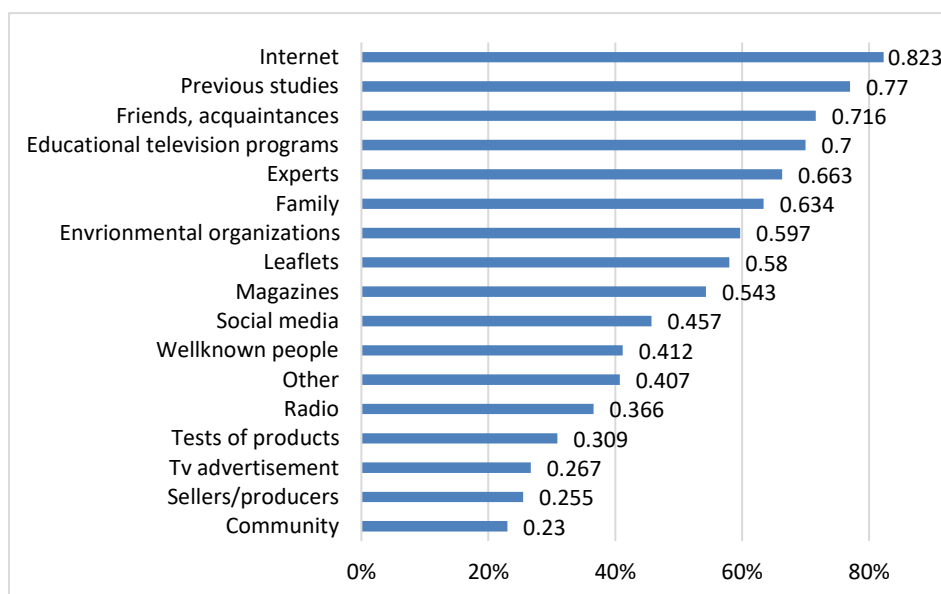
showed that the smaller the settlement of respondents were, the more environmentally conscious they were. This result is explained by the fact that people living in villages have more direct connection with nature and therefore their environmental involvement is higher.

Sources of information about the environmental behaviour

I examined from where the respondents gather information related to environmentally conscious behaviour. I have given more opportunities ahead from which the respondents could choose. The purpose of the question was to find out from what channels, media the information reaches consumers regarding to environmental conscious behaviour. It was necessary to identify the channels which potentially could be used to encourage environmentally conscious behaviour. The results are shown in *Figure 2*.

Figure 2

The distribution of information sources (N = 243)



The results show that the Internet, which is already the main source of information today, has the leading role in the field of environmental awareness. But the role of the previous studies cannot be neglected which partly underly the behaviour according to the literature (*Zsóka et al., 2011*). High proportion of friends, acquaintances and family may suggest that the respondents take into account the views and suggestions of people standing close to them in this area as well. The prestigious location of educational television programs and experts (which offer more professional information) may suggest that individuals are open to information based on professional grounds.

Examination of additional information needs and the most authentic sources of information

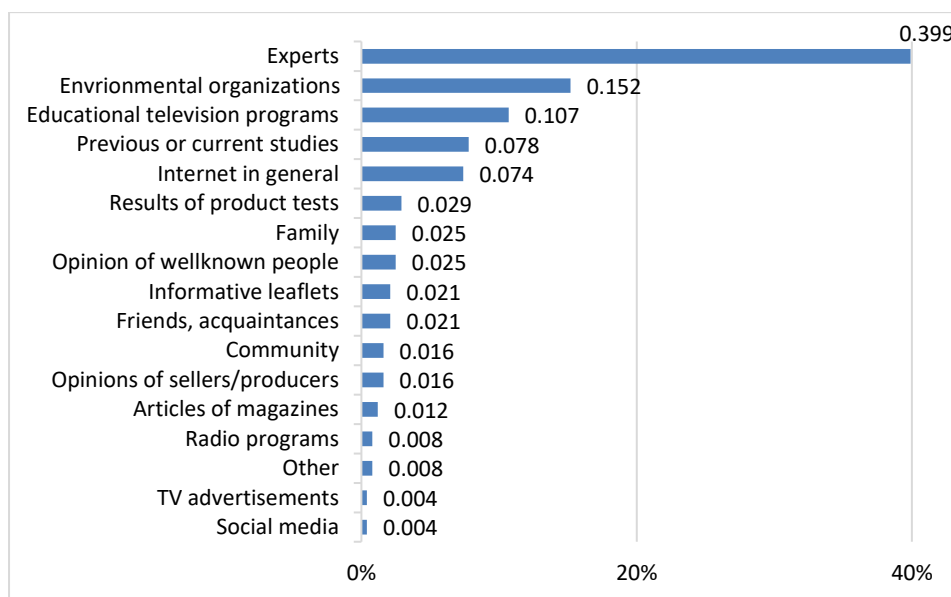
I have examined whether there is a need for more information in connection with environmental awareness. We know based on the findings of the literature that consumers are relatively well informed about the environmental problems. Even they have knowledge about environmentally conscious activities. In connection with this question my aim was to find out if the individuals require any further information about the environmentally conscious behaviour beside the daily information flood (Gleim et al., 2013; Hofmeister-Tóth et al., 2011; Schafferné Dudás, 2008; Young et al., 2010; Zsóka et al., 2011).

On the basis of the results, we can say that 3/4 (75.3%) of the respondents answered that they would like to receive more information regarding environmentally conscious behaviour. This result suggests that the respondents are open to additional information and they are willing to extend their knowledge in this field.

In connection with this, I have examined which information sources seem to be the most authentic according to the consumers. This was necessary to find out which channel was the most trusted by individuals and in the future might be a motivational tool. The results are illustrated in Figure 3.

Figure 3

Distribution of the most authentic information sources (N = 243)



It can be seen that above 1/3 of the respondents think of the experts as the most authentic source of information. This is followed by the 15% ratio of the environmental organizations and the educational television programs, previous studies and the Internet.

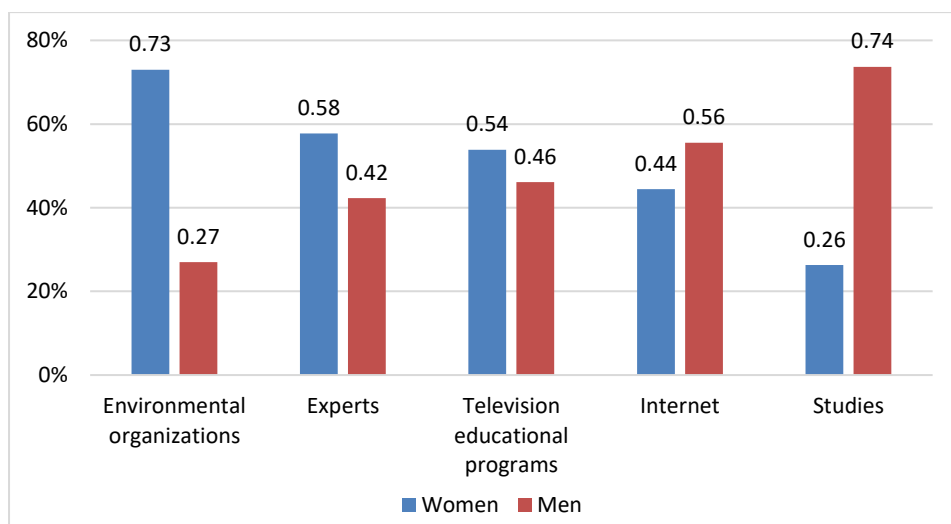
I conclude from the obtained results that respondents are aware of the fact that the most trusted information is provided by experts. Also I would point out that the results of the most common sources of information (Internet, studies, friends, educational programs) do not match the most reliable source of information (experts). This contradiction probably relates to the literature which says consumers know how to act, but they do not act according to their knowledge (Hofmeister-Tóth *et al.*, 2011; Zsóka *et al.*, 2011).

In this case the respondents know what is the most authentic source of information, however other sources are more popular among them. In my opinion the aim is the following: experts should not just be authentic for the consumers, but also should have been looked at as a potential information source or behind the more popular sources of information there should be a professional background.

There was a significant correlation between the most reliable sources of information and the gender of respondents ($p = 0.029$). The results are shown in *Figure 4*.

Figure 4

Distribution of the most authentic sources of information according to gender (N = 197)



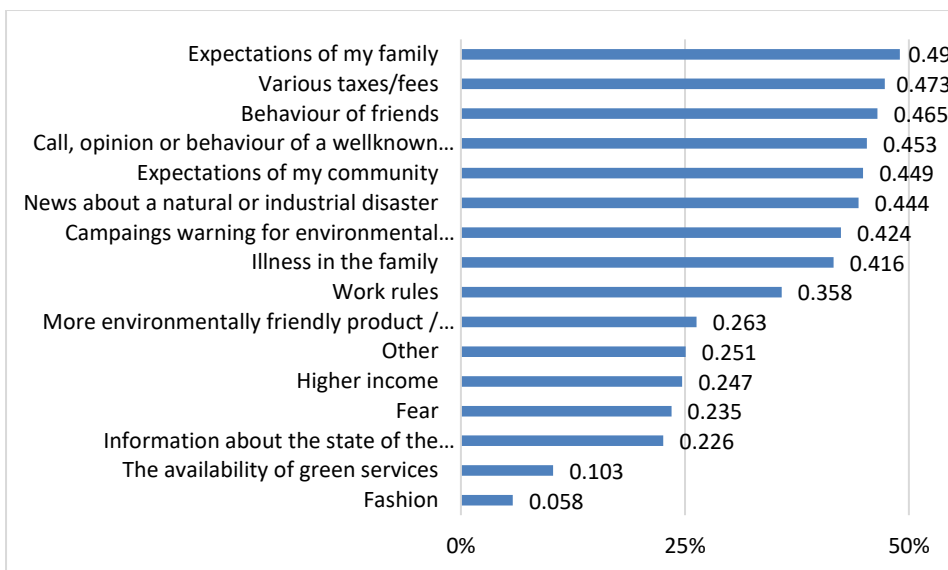
It can be seen that women consider the environmental organizations, experts and educational programs more reliable than men. The internet and previous studies are more reliable for men. I think the reason for the difference is that women prefer to accept the opinions of others, while men rely more on their own views.

The examination of incentives of environmentally conscious behaviour

I examined the factors, which encourage the environmental awareness of the respondents. More could be chosen from the different, predetermined incentives. The data are shown in *Figure 5*.

Figure 5

The ratio of the factors encouraging conscious action (N = 243)



It can be seen that the family has nearly 50% ratio besides others. So the family of the respondents has the greatest influence on behaviour. According to the literature, families have an important role in the rejection or adoption of environmental awareness (Nagy, 2012a; Rácz, 2013a).

The different kinds of taxes and fees were mentioned by respondents in high ratio. It can be said that it is not easy to avoid these kinds of external factors. So they have a strong ability to influence our behaviour. However, it should also be noted that the external effects can even cause resistance and it can manifest itself in non-environmentally conscious behaviour (eg. illegal dumping). So when using these incentives, increased attention should be paid to asserting the necessity of these actions and compensate the concerned individuals for their believed grievance (Kerekes, 2011; Zsóka et al., 2011).

In the following respondents mentioned the friends, well known (opinion leader) people and community as motivational factors in high ratio. This may be based on the consumer need that they would like to belong somewhere. Therefore if the friends or other community have environmental conscious behaviour, then the individual tries to behave accordingly to reach the acceptance of the group. In this context it is worth mentioning that the current consumer society celebrities (or opinion leaders) have an important role in the sale of products. As people want to be similar to the people they follow, therefore they copy their behaviour (eg. they wear similar clothes, same make-up). So if an opinion leader and followed person behaves in an environmentally responsible way and advertises that, then the people following him/her can copy this behaviour. The point is that this activity should have a professional background (Bower and Mateer, 2008; Schafferné Dudás, 2008; Varga, 2012).

The mentioning of disasters was significant, too. The reason for this is that this kind of news can build fear or even guilt in individuals and it may affect (temporarily) the behaviour change. The campaigns also reached significant ratio among the responses. This result suggests that individuals remember the campaigns for a relatively long time. I also would like to highlight the similarly high ratio (about 41%) of the illness in the family. I suppose that there is a relationship between environmental awareness and domestic chronic diseases. This could be explained with the following: disease of a potentially environmental origin could launch an emotional impact in the individuals. If individuals assume that the problem has an environmental origin, then they begin to pay more attention to different environmental problems (Nagy, 2012a; Rácz, 2013a; Zsóka et al., 2011).

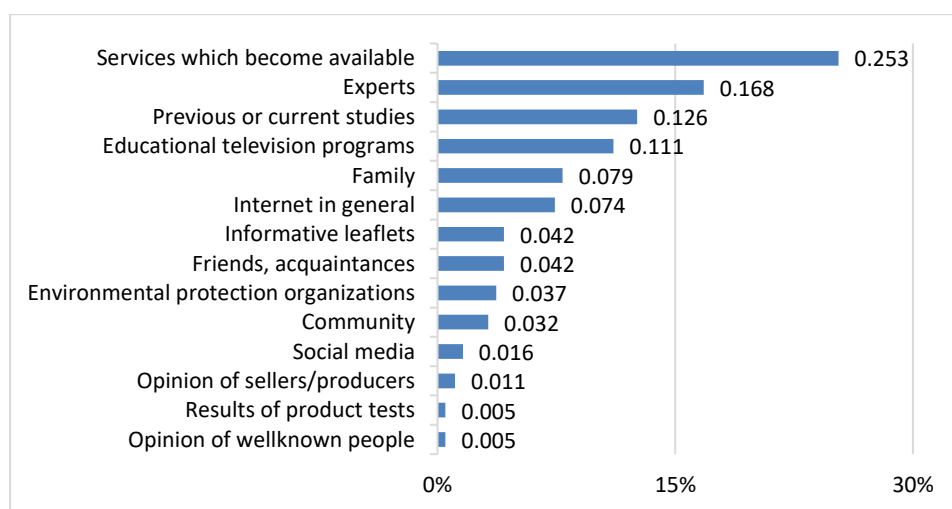
Investigation and exploration of the causes of the behavioural changes

I examined whether the respondents' behaviour changed in an environmentally conscious way or not. With this question I tried to find the answer whether there was any development, improvement in the field of environmentally conscious behaviour in the case of the sample group. Based on the results nearly 80% (78.2%) of the respondents had a change in the behaviour into a more environmentally conscious direction.

I asked what the main triggering factor was that caused a behaviour change among those who had a positive behaviour change. I compared these results with the results related to the sources of information. With this I examined the correlations between the sources of information and the factor triggering behavioural change. The results are illustrated in *Figure 6*.

Figure 6

The main drivers into a more environmentally conscious direction (N=243)



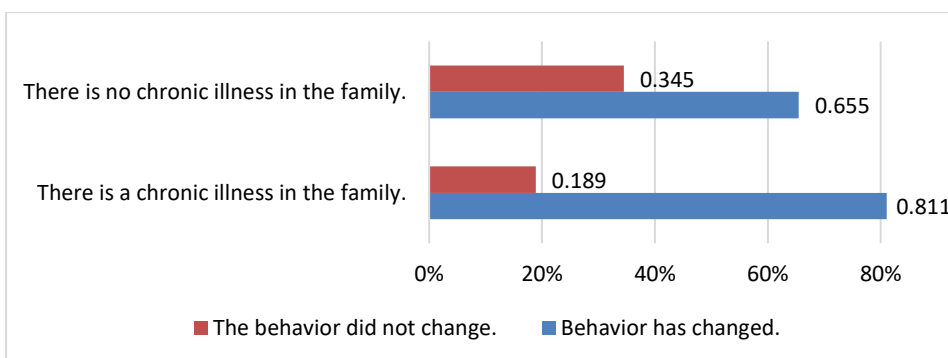
It can be seen that 25% of the respondents linked the services available to the environmentally conscious behaviour. This is in line with the literature which says that the infrastructure (eg. selective waste collection service available at home) has a great influence on the environmental behaviour besides the attitude of individuals (Akenji, 2014; Hofmeister-Tóth et al., 2011).

Information coming from experts were the second in the line, but it reached only 16% ratio. However, this factor has become the most authentic source of information. I explain two different results with this: the respondents accept the opinion of the experts, but they do not motivate them to real actions. Among the following studies and educational television programs were mentioned. The family stayed behind even them. In this context I can say that the family was not included among the most authentic sources. Despite that, 2/3 of the respondents mentioned it as a general source of information.

Significant correlation was found between behavioral change and the presence of chronic diseases within the family ($p = 0.009$). The relationship is shown in Figure 7.

Figure 7

Behavioral change and the relationship between chronic diseases in the family (N = 243)



It can be seen that families with chronic illnesses have mentioned behavioural changes in higher rates than those where there is no health problem. This is explained by the fact that a potential environmental illness can trigger an emotional effect in individuals.

CONCLUSIONS

It was found that more than 85% of the respondents claim to be environmentally conscious on the basis of subjective judgment. The main sources of information are the Internet, previous studies, educational television programs, recommendations of experts, opinion of friends and family members. Among these, experts are considered to be the most reliable source, but this is not the most popular source of

information. 75% of the respondents would like to receive more information in order to live a more environmentally conscious life.

The family encourages the respondents most towards a more environmentally conscious behaviour. In addition, there are external incentives such as tax increases or fees which have a significant influence on them. The motivating effect of different groups like friends, family, communities are also very important. Various environmental protection campaigns and chronic diseases in the family also play a role in promoting eco-activities. Over 80% of the respondents changed their behaviour towards an environmentally conscious one, which was mostly justified by the development of service infrastructure.

Based on my conclusions and results I propose the following recommendations in connection with the topic:

- It is necessary to continue providing information to individuals regarding proper and effective environmentally conscious behaviour. They should be told what to do in order to help and facilitate decision-making and reducing detected costs. It could be done by creating free information points and toll free numbers or mobile applications in order to provide modern, popular and widely available information sources to people.
- Experts must be behind different sources of information, in order to provide authentic information to consumers.
- Application of external incentives, regulations are unavoidable, and could be successful if used with attention.
- It would be worthwhile to take advantage of the influential role of the different groups and communities. These days widespread social media, the internet in general and the role of opinion leader people should become a more and more important incentive and tool to support environmental awareness in the future. With the support of experts this may lead to real reductions of environmental impact.
- The development of infrastructure and services that support environmentally conscious behaviour are extremely important. The consumer must be served, in this way convenience and comfort are less disturbed by the potential difficulties of environmental awareness. The problem of individuals must be solved: one cannot be environmentally conscious if conditions are not available for it.
- Alternative environmentally conscious options must be provided to the consumers that are more favourable than traditional behaviour.
- In summary, it can be seen from the literature and from my results that a complex approach is needed to increase the share of environmentally conscious behaviour. This can be achieved by the help of the government and community campaigns and initiatives taking into account the needs of different target groups.

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Due to space limitations the full questionnaire used in the survey is not published, but the material can be asked from the author.

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TESTING OF A DYNAMIC SIMULATION MODEL FOR RECIRCULATING AQUACULTURE SYSTEMS TO SUPPORT MANAGERIAL DECISIONS

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ABSTRACT

*Economic evaluation for design and operation of Recirculating Aquaculture Systems (RAS) may effectively be supported by an appropriate dynamic simulation model. The complexity of the process requires a detailed analysis, while the experimental work is time consuming and expensive. However, this complexity is manageable for the new modelling methodologies. Accordingly, the problem solving capability can be essentially increased by combining experiments with computational model based studies. Considering the importance of the inherent coupling between structural and functional characteristics in design and control of RAS, Direct Computer Mapping (DCM) of programmable structures has been experimentally implemented for simulation of RAS aquaculture operation by the Research Group on Process Network Engineering in the past year. In the present work, the parameter sensitivity of RAS is studied with the help of the implemented model, using available data for African catfish (*Clarias gariepinus*) from the literature, as well as from experiments running at NARIC Research Institute for Fisheries and Aquaculture. From model development points of view, various semi-empirical and empirical formulation for weight increase, feed conversion rate, faecal and ammonia excretion, and mortality are applied. To allow further bio-economic calculations, the recent work focuses on the effect of the ratio of freshwater supply and the efficiency of the biofilter on the operation in a given stage of the process. The simulation model enables us to determine the economic impact of these factors.*

Keywords: Recirculating Aquaculture Systems (RAS), modelling and simulation, Programmable Structures, economic impact

INTRODUCTION

Aquaculture is one of the fastest growing agri-food sectors globally; the supply of aquaculture products increased from 4.7 million tonnes in 1980 to 76.6 million tonnes in 2010, representing an average annual growth rate of 8.3% (FAO, 2017). Although the bulk of the production boom came from traditional pond and cage farming technologies, increased focus on resource efficiency, food safety and the need for programming harvesting schedule has called for the emergence of farming technologies, enabling independence from the external environment and better control of production (Bostock *et al.*, 2010). Due to these sustainability issues, recirculating aquaculture systems (RAS) are in the front of biological and engineering

developments, as these systems are highly efficient in terms water use (0.1-1 m³/kg fish produced, in contrast with traditional pond systems using 5-20 m³/kg fish), as well as nutrient use and discharge (*Verdegem and Bosma, 2010; Sturrock et al. 2008; Martins et al. 2010*). RAS are defined as production units that filter and recycle water by removing waste products excreted by the fish. Due to higher automation and more sophisticated machinery, RAS requires larger investment costs and energy costs per unit production, than traditional inland production systems (*Bostock et al., 2010, Sturrock et al. 2008*). On the other hand, the comparative advantages, described above, make RAS technologies viable in a legal-economic environment, where water and nutrient resources are scarce and costly, while environmental regulation strictly applies the “polluter-pay-principle” and poses high discharge fees on farmers. Operating RAS has also advantage in markets that require programmed (e.g. weekly) supply and where high food safety standards prevail. Given this background, RAS industry mostly flourish in water-stressed countries of Western Europe, such as the Netherlands and Denmark, however in certain aquaculture segments (caviar and sturgeon production and fingerling production of high value species) RAS are also used in Central Europe. In order to move forward in commercialisation of this technology, combining biologic and engineering knowledge with economics is needed (*Kazmierczak and Caffey, 1995; De Ionno et al., 2006*).

Considering this background, the objective of this paper was to analyze how engineering performance variables (biomass density; feeding strategy; ratio of freshwater supply and efficiency of the biofilter) impact the profitability of RAS by simulating the operation of a theoretical system, using literature-based quantitative relationships to model the biological and technological subsystems.

METHODS AND APPLIED DATA

Applied modelling and simulation methodology

The basic idea of Direct Computer Mapping (DCM) is that we map the building elements and the structure of process models onto the elements and connections of a computable program code, directly, without their representation in any single, specific mathematical apparatus (*Csukás, 1998*). On the contrary, the individual brief programs can be executed by a cyclically repeated algorithm, similar to an operational system.

The recently used method automatically generates programmable structures for the simulation models from a network structure and from the meta-prototypes of the state and transition elements (*Varga et al., 2016b, Varga et al., 2017*). In the graphical (GraphML based) model the locally programmable prototypes may be edited from the prototypes. The initialised and parameterised structural model is prepared for the common consideration of "model specific conservation law based" additive measures and of the "over-writable" signals. The general interpreter first generates the case-specific declarative model database, next executes the dynamic simulation. In the applied transition oriented model representation, all of the causally coordinated consequences of the functionalities may be processed together. This feature supports the robust execution of the multiscale models by a general purpose core program. It

makes also possible the unified, common generation and execution of the balance-based and the rule-based sub-models.

Recently the methodology has been experimentally implemented for simulation of RAS operation (Varga *et al.*, 2015; Varga *et al.*, 2016a).

Modelled RAS system and implemented data from literature

In the present study the pilot system of the Department of Aquaculture at Kaposvar University was studied to support the preparations for the future experiments planned.

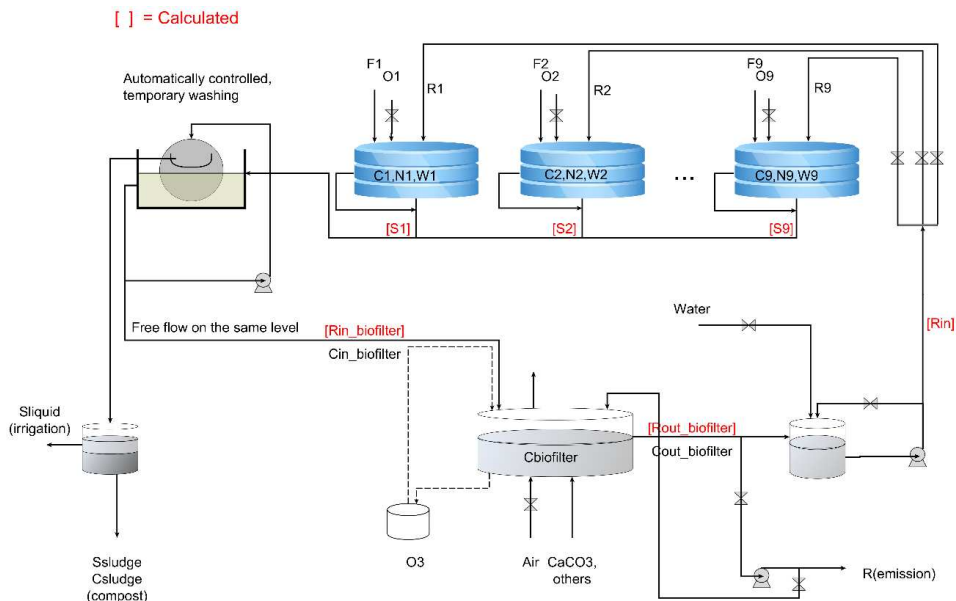
The species selected for modelling was the African catfish due to the fact that the data available for major technological processes, are more abundant compared to other potential species. The calculation formulas were mainly obtained from the description of Verdegem *et al.* (2014) African catfish system, where the empirical relationships were derived by long term production experiments. These empirical relationships cover all the necessary processes to be modelled, such as the increase of body weight, as well as the mortality, the amount of consumed feed, the dry matter content of fish and the protein content of fish body in the percentage of body weight. Regarding the calculation of metabolic waste emission, we utilized the nutrient composition of a widely available and utilized feed Aller Bona Float for African catfish, provided by Aller Aqua (Aller Aqua, 2017).

In line with the planned pilot experiments, we modelled a 150 day production period, where fish were expected to grow from 30 g to about 900 g.

The flowsheet of the investigated process is illustrated in Figure 1.

Figure 1

The modelled pilot Recirculating Aquaculture System



In the *Figure 1*, blue tanks represent the 3 lines of 3 consecutive production tanks with 0.7 m³ individual volume. The production tanks can be characterized by the following parameters:

- C1 – C9: dissolved components (e.g. O₂, NH₄, NO₃) and temperature,
- N1 – N9: the number of fish in the tanks,
- W1 – W9: the average weight of fish in the tanks,
- F1 – F9: the supplied feed to the tanks,
- O1 – O9: the supplied O₂ to the tanks,
- R1 – R9: the recycled water to the tanks.

From the production tanks, water is forwarded by gravity to the biofilter through a drum filter, where the solid containing sludge is separated. S_{liquid}, S_{sludge} and C_{sludge} represent the liquid and dense phases of sludge components. From the biofilter, the treated water is recycled back with a pump to the fishtank, with the appropriate fresh water supply. C_{in_biofilter} and R_{in_biofilter} stands for the components and for the calculated flow that moves from the drum filter to the biofilter, while C_{out_biofilter} and R_{out_biofilter} designate the components and flows towards the fish tanks. Most of the parameters in the *Figure* (written by black letters) can be both measured and calculated, while red coloured parameters in the brackets are unmeasurable, but can be calculated by the model.

RESULTS AND DISCUSSION

Having overviewed the components of the pilot system, we developed the programmable structure of the model in GraphML format (*Figure 2*), in line with the principles of DCM. Model elements of “Fish Tank” and “Life processes of fish” represent the 9 tank pilot system in the model, temporarily parameterized identically. In this graphically editable form, behind the graphical illustration of the model, functionalities (empirical relationships, initial data, etc.) were also added to the structure through the recently applied yEd graph editor.

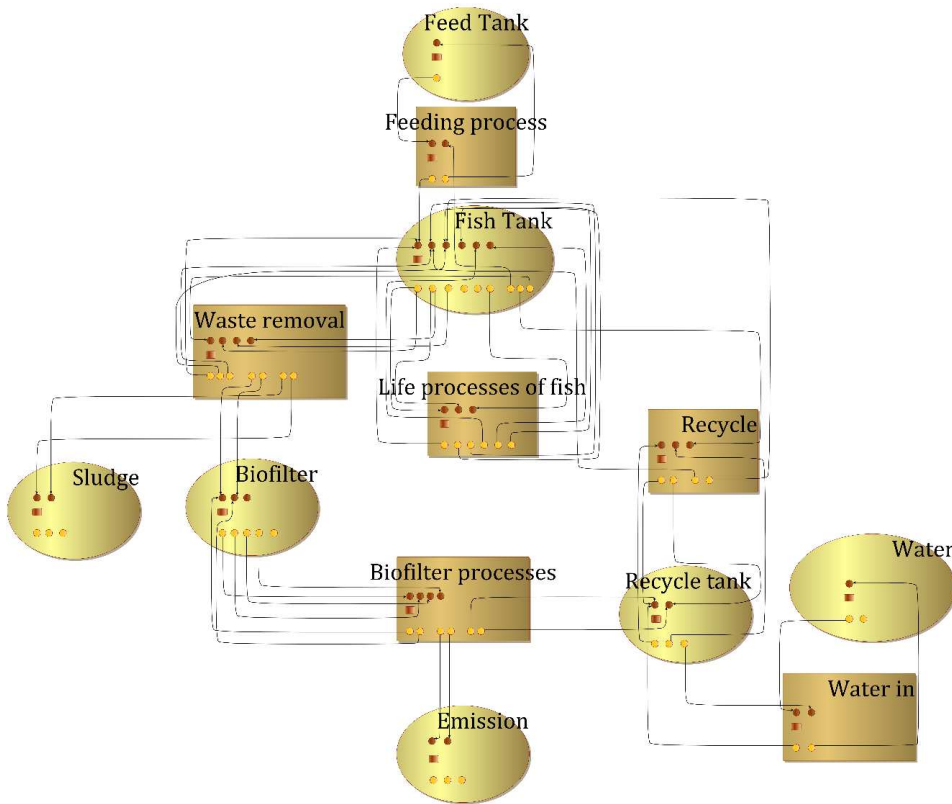
Initial technological parameters of the simulated system are summarized in *Table 1*.

A representative part of simulated results can be illustrated with the following diagrams. *Figure 3* shows the changing of stocking density and concentration of feed in fish tank during the 3600 hours of simulation period. It is to be noted that daily feed supply was modeled according to the prescriptions of *Aller aqua* (*Aller Aqua*, 2017), where 5 feeding stages are suggested in line with the body weight of fish. Considering that these values seemed to be relatively high during the test simulation, we applied a 3 kg/m³ heuristic limit in the model.

During the simulation we took into account the differentiation of fish, assuming a 10% under-sized and 10% over-sized group amongst the produced fish. Accordingly, *Figure 4* shows the growing of fish during the simulation period. *Figure 5 and 6* show the calculated concentration of various components (O₂, CO₂, HCO₃, NH₄, NO₂, NO₃, COD) and feed components (protein, fat, carbohydrate, ash) in the fish tank during the simulation period.

Figure 2

The programmable structure of the modelled RAS



It is to be noted that these components can be monitored in every time step of the model in each tank shown in of *Figure 1* during the simulation, which can serve as a detailed quantified overview about the technological parameters for economic evaluations.

Considering that in the recently made simulations the quality of the feed, the temperature, the dissolved oxygen level, as well as the quality and quantity of fish were the same, we focused on the effects of water consumption and of excess nutrient discharge. Analysis of the detailed numerical simulation results show that pollution taxes are high but not sensitive to the recently changed system characteristics, because pollution is more dependent on the production technology, such as on specific feeding rate, feed conversion, oxygen consumption, growth, and mortalities. In contrast, specific cost of water supply is essentially determined by the recirculation rate and water exchange rate chosen by the farm management, as well as by the efficiency of biofilter. The respective calculation results are summarized in *Table 2*.

Table 1

Initial technological parameters of the model

Model elements	Parameters	Value	Unit
Fishtank	Total volume	6.3	m ³
	Water exchange	0.8	tank m ³ /hour
	Set temperature	23	°C
	Initial number of undersized stock	100	pc
	Initial average weight of an undersized fish	27	g/pc
	Initial number of normal stock	2700	pc
	Initial average weight of a normal fish	30	g/pc
	Initial number of oversized stock	300	pc
	Initial average weight of an oversized fish	33	g/pc
Feed storage	Initial mass in the storage	10000	kg
	Protein content of feed	0.49	kg/kg
	Fat content of feed	0.12	kg/kg
	Carbohydrate content of feed	0.233	kg/kg
	Ash content of feed	0.077	kg/kg
Feeding process	Prescribed feed level	3	kg/m ³
	Feeding strategy	According to Aller aqua	nd
	Prescribed time step	12	hour
Waste removal	Ratio of non-eaten feed	0	nd
	Ratio of separated solid	0.95	kg/kg
	Specific amount of liquid, used for solid removal in drum filter	30	kg/kg
Biofilter	Ratio of recycling	0.95	nd
	Total volume	4.25	m ³
	Mass of biomedica	573.75	kg
	Biomass	371	kg
	Efficiency of NH ₄ - NO ₂ conversiton	0.95	nd
	Efficiency of NO ₂ - NO ₃ conversiton	0.95	nd
	Efficiency of NO ₃ - N ₂ conversiton	0	nd
Biofilter processes	Efficiency of COD removal	0.9	nd
Sump (recycle tank)	Total volume	2.125	m ³
	Initial volume	2000	m ³
Make-up water	Dissolved O ₂ concentration	0	kg/m ³
	Dissolved NO ₃ concentration	0	kg/m ³

Figure 3

Feed concentration and stocking density in the fish tank

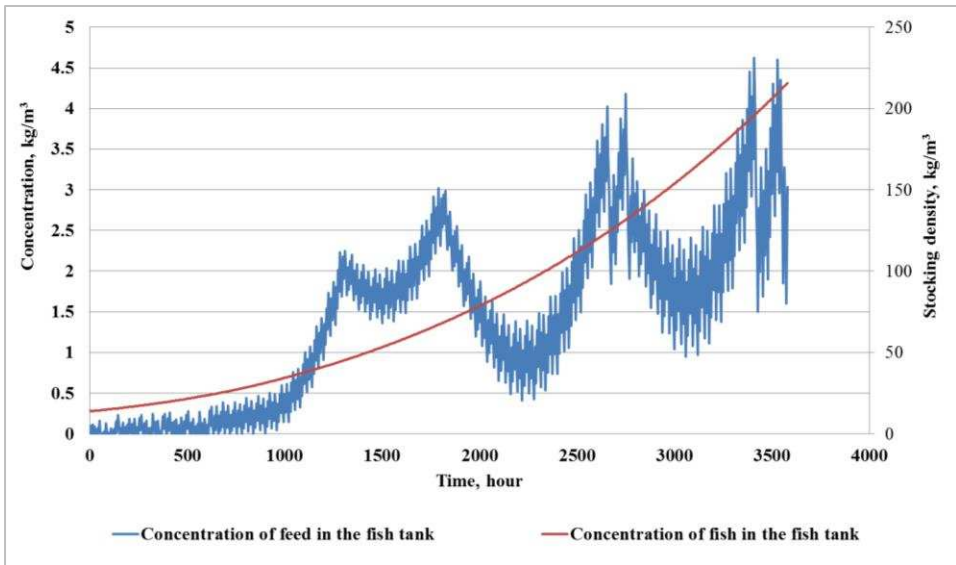


Figure 4

Average weight of fishes during 150 days

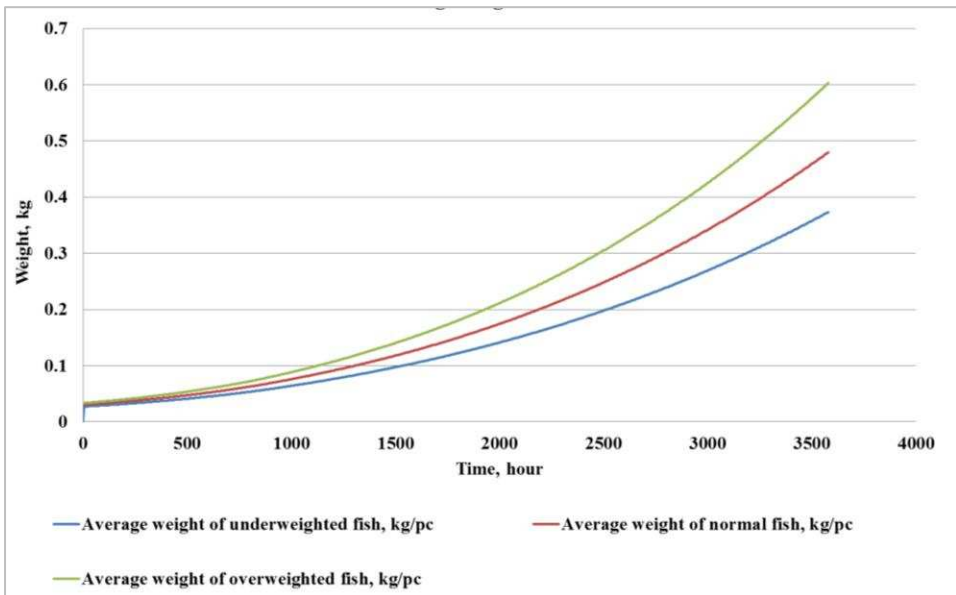


Figure 5

Dissolved components in the fish tank

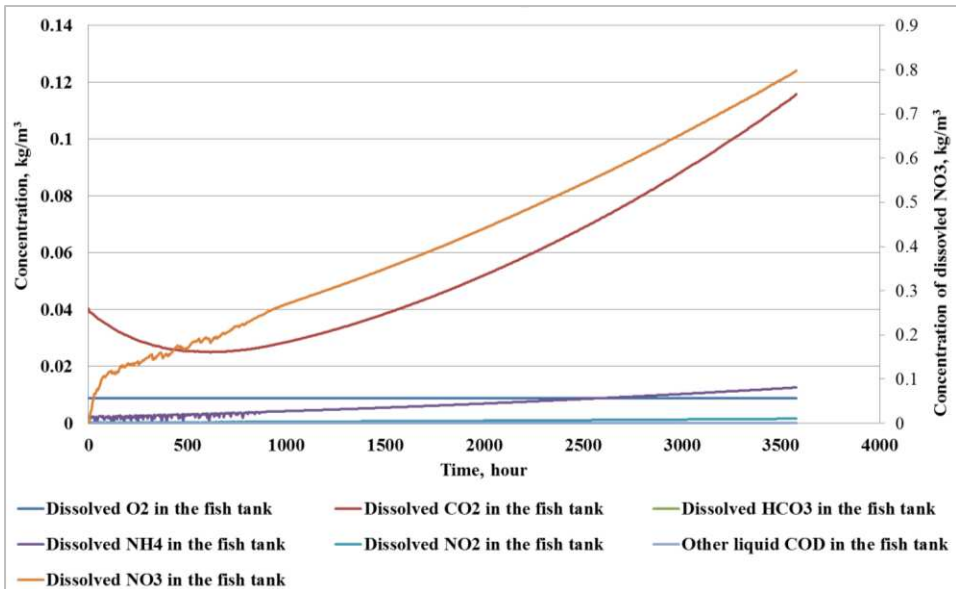


Table 2

Sensitivity of specific pollution taxes and water costs to actually changed recirculation technology parameters

Code of scenario	0 (Ref.)	1	2	3	4	5	6	7	8
Water exchange rate in rearing tank (1/day)	5	5	5	5	4	4	6	4	6
Recirculation rate	0.95	0.95	0.95	0.9	0.9	0.95	0.95	0.9	0.9
Efficiency of biofilter	0.95	0.6	0.3	0.6	0.6	0.95	0.95	0.95	0.95
Specific pollution taxes (HUF/kg net production) ¹	12.1	12.8	14.0	13.3	13.3	12.1	12.2	12.3	12.3
Specific water withdrawal (m ³ /kg net production)	0.66	0.66	0.66	1.32	1.05	0.53	0.79	1.05	1.57
Specific water cost (HUF/kg net production) ²	28.1	28.1	28.1	55.9	44.4	22.4	33.4	44.4	66.5

¹ Emission costs are calculated based on simulated quantity of discharged COD, NH₄, NO₃ and NO₂ and discharge fee tables contained by the Act LXXXIX. of 2013 on Environmental pollution taxes

² Costs of water are calculated from BMOKF (2016). For the calculation we assumed that the category of supply water was classified as secondary quality aquiferic water.

CONCLUSIONS

The presented preliminary work has demonstrated that the applied modelling methodology, based on the Direct Computer Mapping of programmable structures, makes the simulation based detailed analysis of the complex Recirculating Aquaculture Systems possible.

The analysis of the first results have underlined that the complexity and dynamics of the investigated process system really need the utilization of the sophisticated dynamic model based decision support for appropriate design and control.

The model based analysis can essentially contribute to the final configuration of the pilot system and to the preparation and evaluation of pilot tests.

Limited by the available data and experimental knowledge, in this work we focused on the effects of the recirculation and water exchange rates, chosen by the farm management, as well as of the biofilter efficiency. The results underline that the cost of water supply and pollution taxes represent a considerable part of costs.

The experiences highlight that the economic evaluation of planning and control alternatives for these complex systems is almost impossible without the detailed, dynamic simulation of the underlying processes.

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IMPLEMENTATION OF A SIMULATION MODEL FOR THE SCHEDULING OF A MULTI-PRODUCT DAIRY PLANT

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ABSTRACT

Dynamic scheduling of multi-product plants is one of the most difficult groups of problems of high economic importance. The well developed, conventional solutions use various methods of mathematical programming (e.g. MILP), formulated as the optimization of a simplified model. However, the specific technological details and the possible multiple use of the model require also detailed dynamic model based sub-optimal methods. Considering the inherent coupling between structural and functional characteristics of dynamic scheduling, Direct Computer Mapping (DCM) based Programmable Structures of Research Group on Process Network Engineering are experimentally applied for the generation of the dairy plant model. The generation starts from the process network representation of the flow-sheet and from one state and one transition meta-prototype. The flow-sheet comprises storages of raw materials, intermediate materials and end-products, as well as the recipes, the in parallel working multi-functional process units with the numerous time-driven and event-driven constraints. Model generation is followed by the programming of the actual prototypes and parameterization of the model. In the present work the generated process model and the simulation tests will be discussed, focusing on the combined use of the transitions for the description of the material balance, as well as for the interpretation of the time- and event-driven rules, determining the sequence of operations.

Keywords: production scheduling, dairy plant, multiproduct batch plant, dynamic simulation, process modelling, Direct Computer Mapping, Programmable Structures

INTRODUCTION

In the dynamically changing economic environment the food industry has to react and be flexible in more time horizons, which requires flexibility not even in the field of production, but in the planning and scheduling methods as well. Science acknowledged this need and the difficulties to find the best solutions quite early (Puigjaner, 1999). To achieve success, in this field we need a strategy which ensures at the same time the competitiveness and the high economic results, even in variable profile, technology and management resources. The production scheduling and planning allow us to use the resources in a structured form. Consequently, the management of stock, resource and capacity will be improved.

The research in production management defines MTO (make-to-order) and MTS (make-to-stock) production systems (Soman *et al.*, 2004). MTO approaches to solve the scheduling task from the orders of customer specific products. The main

Key Performance Indicator (KPI) is the short reaction time. MTS is characterised by low range of products and low cost of production. In this case the main question is the forecast of the demand. KPIs are stock planning, batch sizes and the forecast.

Dairy industry, as several other ones, is a hybrid variation of these two clear systems. Overall, orders arrive maximum 24 hours before the required transportation date, but only 8 hours earlier on average. Depending on the production technology of different product ranges (milk, cheese etc.), the method of the planning system changes.

Kopanos, Puigjaner and Georgiadis (2010) developed a discrete-continuous MILP model for the simultaneous production scheduling and batch sizing in a yogurt plant, assuming stable resources. The model focuses more on the packaging process, but takes time and capacity constraints into consideration, too. The whole set of rules work with time of conversions, with downtimes of different reasons, and with hygienic rules. The developed resource constrained MILP model decides about tanks and machines utilised, considering the available connections to the filling and packing lines. It finds the best time to clean the tanks and the filling lines given health and nutrition labeling requirements, and cleaning equipment availability. It synchronises the material consumption with white mass availability and freshness. It respects the batching policies for compliance with traceability regulations. It determines an optimal schedule for labour resources. It maintains a steady supply of finished goods within a minimum and maximum inventory level. It supports optimal production rescheduling under unexpected events, such as modifications in product orders.

The shortcoming of the model is that it concentrates only on a part of the flows. The solution is implemented in an off-the-shelf software, CPLEX 11 + GAMS 22.8 interface program. The solution reduces the complexity with complementary formulation (e.g. group of flows). The single objective function is the economic optimum. The authors conclude that „the proper treatment of uncertainty in food industries is of great importance since unpredicted events take place very frequently.”

Considering the actuality of the scheduling problem, the present work focuses on the first steps of the development of a Direct Computer Mapping based scheduling application for the yogurt line of Fino-Food.

METHODS AND APPLIED DATA

Applied modelling and simulation methodology

The basic idea of Direct Computer Mapping (DCM) (*Csukás, 1998; Csukás et al, 2011*) is that we map the building elements and the structure of process models onto the elements and connections of a computable program code directly, without their representation in any single, specific mathematical apparatus. On the contrary, the individual brief programs can be executed by a cyclically repeated algorithm, similar to an operational system.

The recently used method automatically generates programmable structures for the simulation models from a network structure and from the meta-prototypes of the state and transition elements (e.g. *Varga et al, 2016; Varga et al, 2017*). In the graphical (GraphML) model the locally programmable prototypes may be edited

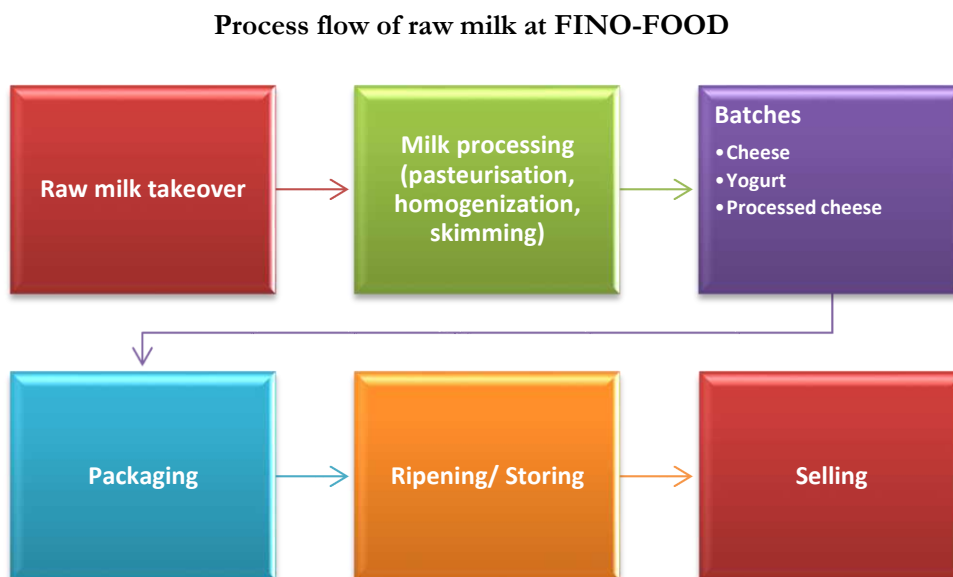
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Recently the methodology has been experimentally implemented for simulation based problem solving of various agri-food systems (Varga *et al*, 2015; Varga and Csukás, 2015).

Modelled dairy plant and implemented data

FINO-FOOD is a Kaposvár based dairy, owned and managed by a Hungarian family in 100%. Their product range includes liquid milk, sour cream, kefir, yogurt, cheese and processed cheese. Fino-Food works with 350 partners from Hungary, Croatia and Italy. Steps of the raw milk processing system is seen on *Figure 1*.

Figure 1

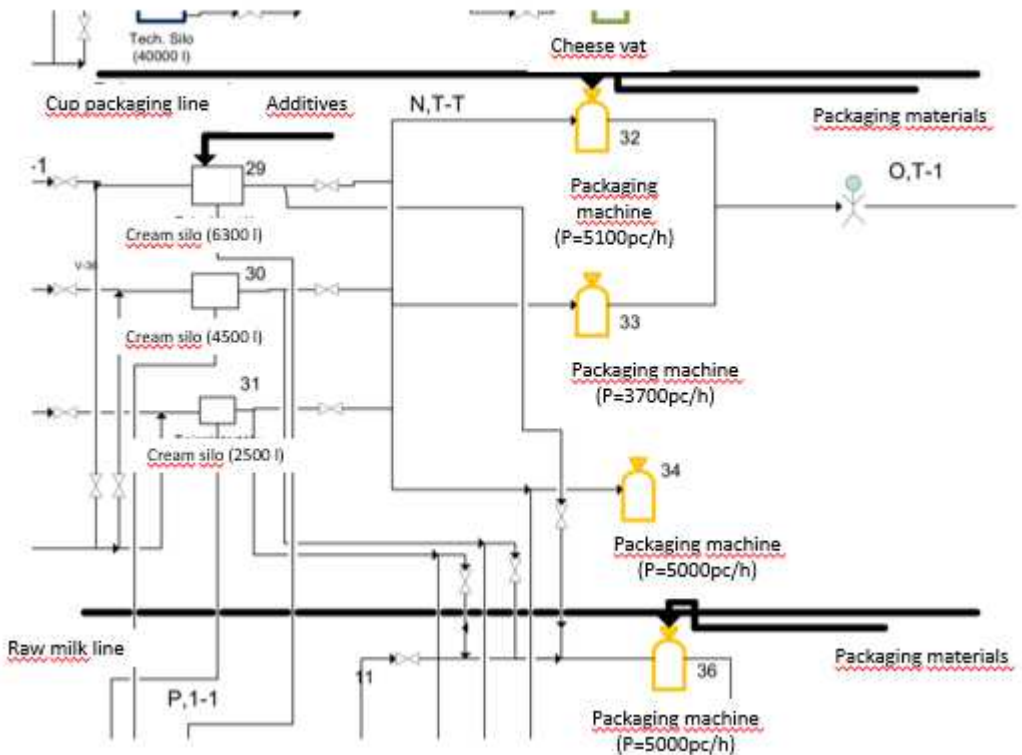


The dairy is currently operating with a three level planning system, monthly, weekly, daily or even shiftily. The targets and the constraints are different on each level. In case of monthly planning, the main target is to equilibrate the raw material balance, which is perhaps the most important factor from the financial performance point of view. The Push feature in the monthly case is the yearly based contracts for raw

milk, which means milk is coming, regardless to customers' order. From Pull side there are only empirical estimations for the expected sales. The weekly scheduling is to achieve 100% serving rate. The Pull features are still only the sales from last week, without exact orders. Raw milk causes a Push feature, because the milk has to be processed in less than 48 hours. The weekly schedule is daily or even shiftly reorganised, as the orders arrive during the production day. The aim is the 100% serving rate, taking also into consideration the minimum number of conversions. Currently, Excel worksheets help the above mentioned process. Data recording is manual from past production, from previous week and from earlier experiences. Assessment of capacity and technological barriers are individual, depending on the planners' heuristics. Because of this kind of process, it faces the problem of inefficient information flow, break-off during the shifts, and lack of resources daily, which results in uncertainty and moreover demotivated workers. As a first trial for the application a non-conventional modelling method for the scheduling of dairy processes, in the present work we focused on the yogurt production line (highlighted with red in *Figure 2*).

Figure 2

Modelled part (inside the red contour) of dairy production by FINO-FOOD



RESULTS AND DISCUSSION

The GraphML model of the programmable structure, representing the modelled part of the dairy plant is shown in *Figure 3*.

Model building starts with the development of the model structure. In this case, the process was supported by the automatic generation of the structure from a simplified description of the underlying states and transitions. This automatic generation makes possible to develop large structures in line with DCM method. It is to be noted that in case of DCM model the structure generation covers also the automatic creation of the slots for the states and transitions, as well as the connections between them. Slots are responsible for the storage of all inputs, parameters, conditions and constraints that are used for the calculation in every time step during the forward or backward simulation.

For the investigated part of the dairy plant the state and transition elements were the followings.

Bases (state)

Base elements mean the base material of final consumer product. These elements contain the semi-products coming from the first technological process, (pasteurizing, skimming, fat setting).

Cultures (state)

These elements handle the stock of actual cultures for the various cultured products.

Culture tanks (state)

Before packaging, the bases and the culture are mixed together and matured in the so-called culture tanks. Sculttank1_4 and Sculttank5_7 are the state elements containing the constrains of each tank, like capacity, cleaning time and the cleaning frequency. These parameters are responsible for the handling of various rules.

Processes of culture tanks (transition)

Each culture tank has its transition element as well. Since culturing is a technological process, in a transition kind element we parameterise the recipe of each products. The description contains the minimum and maxium of operation time spent in the tank by each SKU, as well as the recipe for the components, wich are mixed in the tank.

Processes of cooling (transition)

After culturing time the yogurt kind products have to be cooled and transferred to another tank. All the cooling possibilities have one element, depending on from which to which tank the process goes.

Packaging materials (state)

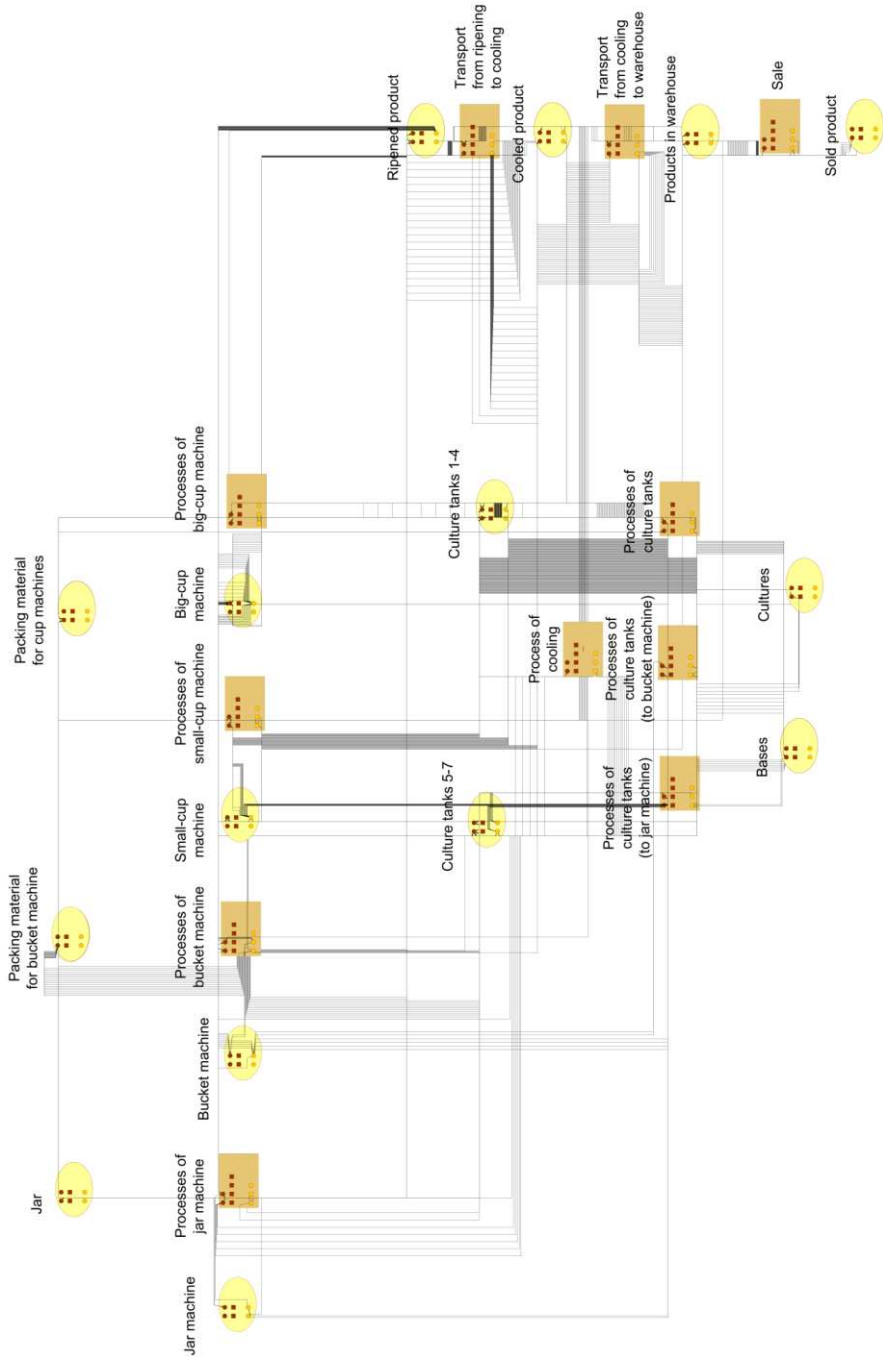
All other material used to the productions, like cup, layer, jar, bucket, etc.

Package machines (state)

Each packaging machine has its state and transition element. The state element contains the capacity and cleaning frequency information of the machine.

Figure 3

The programmable structure of the modelled part of the dairy plant



Processes of package machines (transition)

The transition element of machines makes us possible to put the packaging material and the cultured semi products together and to get the final SKU (stock keepin unit). They contain the recipe of materials needed to one single SKU, as well as the control cycle of the machine.

Ripened product (state)

As an important technological step the model handles the ripening of fermented SKUs, like yogurt, sour cream. After packaging, the product goes to the ripening room and we identify it as a semi-product, so called riped product. Ripening time is a part of the recipe.

Transport elements from ripening to cooling, from cooling to warehouse (transitions)

These kinds of transition elements are responsible for the transport of various stocks between the processing or storing units.

Cooled products (state)

It is the storage for the final cooling of the products with a prescribed time.

Products in warehouse (state)

It is the final storage before the sale.

Sale (transition)

Determines the scheduled sales.

Product (state)

Registers the sold products

Figures 4, 5 and 6 show some illustrative results for the forward and backward simulation of the weekly production of cultured semi product sp_10208, as well as p_10208 products of one packaging machine. Accordingly, the abscissa shows temporal data about the forward simulation from 0 to 168 hours, as well as from 168 to 0, backwards.

Figure 4

Cumulated use of culture and base for semi-product 10208

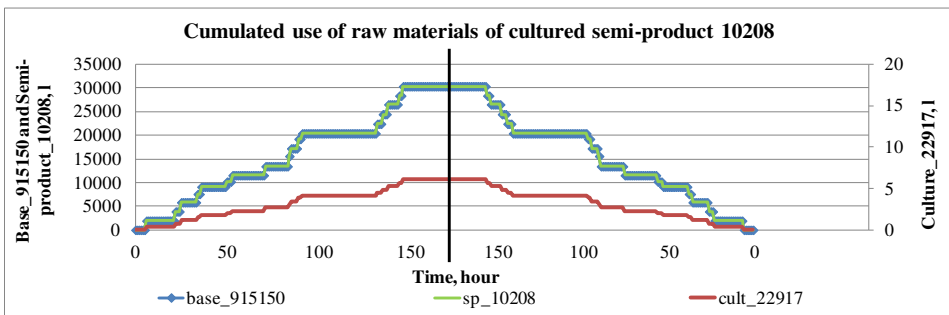


Figure 5

Cumulated use of packaging materials for product 10208

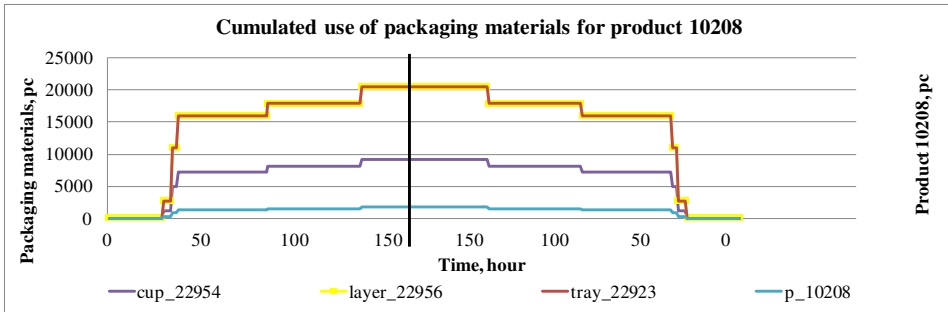
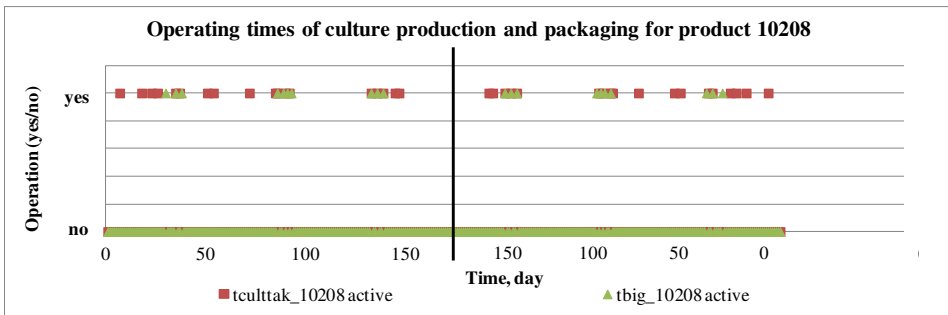


Figure 6

Operating times of culture tank and big-cup machine, producing 10208



CONCLUSIONS

The process system of a multi-product batch dairy plant was implemented in a programmable structure, in sense of Direct Computer Mapping. The automatic generation of the process network from the textual description of the underlying simple network and from the state and transition meta-prototypes was successful. It was followed by the stepwise development of actual local program prototypes of the state and transition elements. Recently the model has been tested for the forward and backward dynamic simulation of the dynamic model.

It has a significant importance in the solution of scheduling problems, because in this case we can start from the actual demands and can simulate backwards in time to determine the amount of necessary raw materials, packaging materials and operation times, with the knowledge of the underlying multiple constraints. The solution for the causally right backward simulation has been proved in the present work. The ongoing work will be continued by the development of backward simulation based dynamic scheduling.

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TEST DATA BASED EVALUATION OF LACTATION CYCLE CONTROLLING RULES WITH A GENERATED SIMULATION MODEL

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ABSTRACT

Economic effectiveness of a dairy farm operation is determined mainly by the produced milk and the costs of fodder, as well as of the fertilization and medication of cows. The whole system is characterized by the stages of production cycle, comprising several steps from the calving to the dry period. In line with these steps, there are respective groups of cows in separated stables. In addition, the ill animals are treated separately during their medication. Accordingly, the production cycle can be characterized by the time-based regular and event-based additional cyclic movement of the cows between the above groups. Considering the requirements for the common representation of the underlying balance model with the movement controlling rules and with the event-driven additional movements, in our study a case specific application of a generated programmable structure in sense of Direct Computer Mapping (DCM) of process models has been applied. The model is automatically generated, programmed and parameterized by the recently developed methodology of Research Group on Process Network Engineering. The test data for a representative set of animals, as well as the (optionally modifiable) rules were given from SmartDairy® Management Systems and from the management of Bos-Fruct Agricultural Cooperative. In the realistic data based hypothetical simulation tests we prepared to study the effect of the feasible changes in the conditional rules on the produced milk and on fodder consumption.

Keywords: dairy farm management, Direct Computer Mapping (DCM), modelling and simulation

INTRODUCTION

Dairy farming is a highly dynamic and integrated production system that requires continuous decision making from the management (Cabrerá, 2012). Nowadays the routine production control tasks of dairy farms are supported by up-to-date tools of Information Technology (Pietersma *et al.*, 1998; Teschner, 2014).

Some widely used management information systems that are also utilized in Hungary are the following: SmartDairy® Management Systems, HerdMetrix™ Herd Management Software, RISKA Herd Management System, ALPRO® Herd Management System (Vojtela *et al.*, 2011). In most cases, these advanced information systems provide good basis for the effective management and control

by the detailed recording of data, as well as by some specific capabilities (e.g. simple embedded calculations, automatic warnings, etc.) of the various subsystems.

However, in spite of the frequently collected detailed datasets, there are still some open questions in the operational decisions of the production cycle. In lower scale control, selection of “optimal” life cycle is a key point (Delgado, 2015) that determines not only the lifetime performance of the cow, but the profitability of the dairy farm. In a higher scale control, utilization of the accumulated data in a trans-sectorial transparency system would be a straightforward initiative (Varga et al., 2012; Dabbene et al., 2014; Tankovics et al., 2014) to achieve whole chain transparency. Solution of both questions could be effectively supported by the combined utilization of the accumulated data and farmers’ knowledge with computational models.

Accordingly, in the present paper we introduce the first steps towards the development of a simplified dynamic simulation model, where we utilize the detailed data and heuristic rules of a dairy farm for the testing of the alternative solutions.

METHODS AND APPLIED DATA

Applied modelling and simulation methodology

The basic idea of Direct Computer Mapping (DCM) (Csukás, 1998, Csukás et al., 2011) is that we let the building elements and the structure of process models map onto the elements and connections of a computable program code, directly, without their representation in any single, specific mathematical apparatus. On the contrary, the individual brief programs can be executed by a cyclically repeated algorithm, similar to an operational system.

The recently used method automatically generates programmable structures for the simulation models from a network structure and from the meta-prototypes of the state and transition elements (e.g. Varga et al., 2016, Varga et al., 2017). In the graphical (GraphML) model the locally programmable prototypes may be edited from the prototypes. The initialised and parameterised structural model is prepared for the common consideration of “model specific conservation law based” additive measures and of the “over-writable” signals. The general interpreter first generates the case-specific declarative model database, next executes the dynamic simulation. In the applied transition oriented model representation, all of the causally coordinated consequences of the functionalities may be processed together. This feature supports the robust execution of the multiscale models by a general purpose core program. It makes also the unified, common generation and execution of the balance-based and the rule-based sub-models possible.

Recently the methodology has been experimentally implemented for simulation based problem solving of various agri-food systems (Varga et al., 2012; Varga and Csukás, 2015).

Modelled dairy plant and implemented data

Our example system, BOS-FRUCHT Ltd. dairy farm Kazsok, is one of the largest and most modern dairy farms in Central and Eastern Europe with almost 2000

dairy cows. The cows are milked 3 times a day on 72 stall Boumatic rotary parlor. The herd is all year calving, high genetics holsteins. They spend the majority of their time indoors in modern, well ventilated and insulated light cattle sheds.

The management of the farm use Smart Dairy® and Herd Metrix™ softwares. These two softwares collect all of the necessary information from individual cows.

Some of the most important data are shown in the *Tables 1-3*.

The cows are fed with Total Mixed Ration (TMR). One side of the TMR's components are home-grown. the other side is purchased. The amount of the TMR depends on the grouping of the cows. Some TMR recipes are shown on *Table 4*.

Table 1

General information for a cow from Smart Dairy®

Name	WILMA 63	Condition	2,8
Mother	585	HU3281805858	WILMA 63
Sire	19238	19238	BUCKEYE
Maternal grandsire	17655	17655	RAMOS
Calving date	2014.02.07.	Lactation number	3
State	Pregnant	Lactation days	187 days
Insemination	2014.04.24.	Expected drying off date	2014.12.01
Bull	Kapt	Expected calving date	2015.01.26

Table 2

Example lifeway of a cow from Smart Dairy®

Reproduction				
Description	Date	Days	Interval	General
BORN	2009.09.16.			
CALVING	2011.10.17.			
AI	2011.12.17.	61		22257 MORPHEOUS
AI	2012.01.02.	77	16	22409 BEACON
AI	2012.02.24.	130	53	22409 BEACON
AI	2012.04.20.	186	56	22285 EMPHASIS
CALVING	2013.01.30.			
AI	2013.04.25.	85		24044 DREAMER
POSITIVE +	2013.06.24.	145		
DRYING OFF	2013.11.20.			
CALVING	2014.02.07.			
AI	2014.04.24.	76		24524 Kapt
POSITIVE +	2014.06.23.	136		

Table 3

Lactation information for a cow from Smart Dairy®

Calving	Two	Age	DIM	Milk kg	Fat %	Prot. %	Fat kg	Prot. kg
2011.10.17.		2.01						
			305					
2013.01.30.	471	3.04	294	9602	4.23	3.13	406.3	300.7
			305	9809	4.26	3.14	417.5	308.4
2014.02.07.	373	4.05	136	6768	2.83	2.98	191.7	201.8
			305	13285	2.84	3.07	376.7	407.4

Table 4

The applied TMR recipes for the different groups

Prep		High	
Corn silage	0.51502	Corn silage	0.4291
Lucern silage	0.08583	Lucern silage	0.11976
Corn	0.02145	Corn	0.05389
Melavit	0.0171	Melavit	0.01996
Hay	0.06438	Hay	0.01996
Straw	0.01716	Straw	0.01397
Beet slice	0.12875	MS rape	0.01996
Wet CGF	0.04291	Dairy conc	0.13373
Prep conc	0.10729	Beet slice	0.09980
		Wet CGF	0.08982
Low		Dry	
Corn silage	0.42914	Straw	0.24437
Lucern silage	0.11976	Lucern silage	0.18649
Corn	0.05389	Hay	0.1157
Melavit	0.01996	Dry conc	0.43729
Hay	0.01996	Rest of TMR	0.0160
Straw	0.01397		
MS rape	0.01996		
Dairy conc	0.1337		
Beet slice	0.09980		
Wet CGF	0.08982		

The relatively wide range of the group changing rule is determined heuristically by the dairy farmer, which is one of the most important managerial questions of the operation, considering the trade off between the length of milking period and the life cycle performance of the cow. An example set of rules is represented in *Table 5*.

Table 5

Entry and exit conditions of group changing

Entry condition	Group	Exit consequence
Before first calving cow enters from the pregnant heifers group. X_1	Temporary group	$X_1+(25-30)$
$X_1+(25-30)$	High performing group before insemination	$X_1+(52-62)+(n*(20-24))+30+30$
$X_1+(52-62)+(n*(20-24))+30+30$	High performing group after insemination	$X_2-(50-65)-(18-25)$
$X_2-(50-65)-(18-25)$	Low performing group	$X_2-(50-65)$
$X_2-(50-65)$	Dry period group	$X_2-(14-28)$
$X_2-(14-28)$	Precalving group	X_2
X_2	Temporary group	$X_2+(25-30)$
Cows can randomly enter from any group.	Sick group	Cows can randomly leave this group.
Cows can randomly enter from any milking group.	Mastitis group	Cows can randomly leave this group.
Calculation for further calvings: $X_n=(X_{n-1}+(52-62)+(n*(20-24))+30+30)+217$ n =random number between (1-16)		

RESULTS AND DISCUSSION

The flowsheet of lactation cycle and the changing groups can be seen in *Figure 1*.

The respective programmable structure of the model, representing the modelled part of the dairy plant is shown in *Figure 2*.

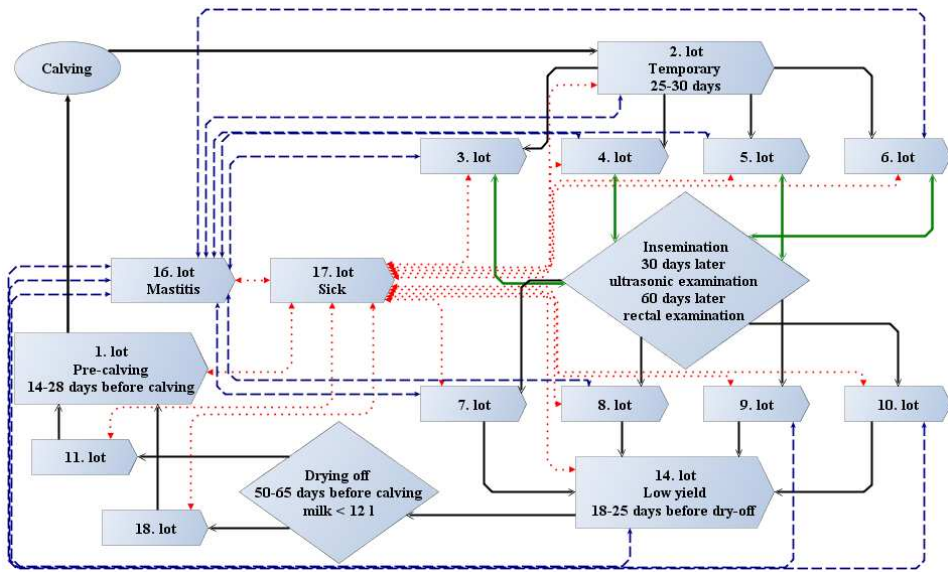
In course of model development, in line with the principles of DCM method, we described the underling processes of the dairy farm in the form of states (signed by ellipses in *Figure2* that represent the various storages, fodders, groups of animals, etc.) and transitions (signed by rectangles in *Figure 1* that determine the changes of states, considering also the prescribed environmental effects). These elementary building blocks communicate with each other, and with their environment via connections.

Both state and transition elements contain so-called “slots” for the storage of inputs, parameters and outputs. These slots are signed by small circles in *Figure2*.

In general, model building starts from the listing of the building elements. In the present version of the applied DCM method, structure building is supported by automatic generation from a simple “from“ – “to“ description of the underlying state and transition elements.

Figure 1

Process flow chart of changing group and lactation cycle



After the automatic generation of the structure, the next step is the formulation of the calculating expressions. Accordingly, beyond the graphical visualization of the model, the developed GraphML description contains also those functionalities that calculate the model outputs in every prescribed time step. For the parameterization of the model we utilized the test data from HerdMatrix™ system.

The actually applied state and transition elements can be summarized as follows.

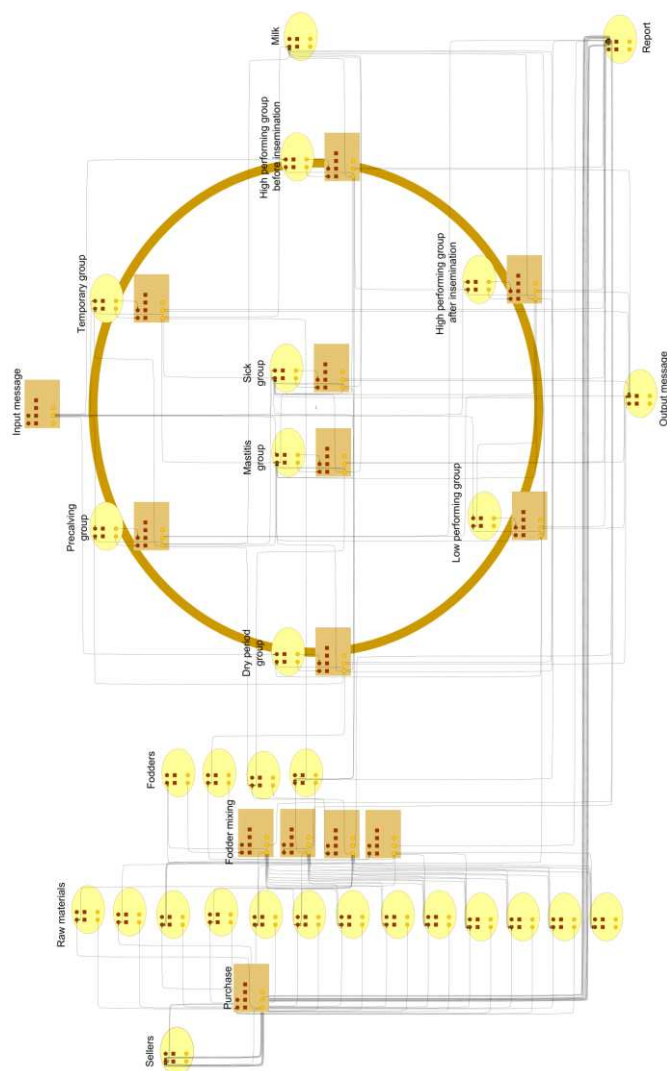
The first state elements are the sellers. In this situation we consider the home-grown fodders as purchased components. The Sellers sell the fodder components for the farm and then move into the buyer storages with purchase transitions. Thereafter we use this raw material for the TMR during the TMR mixing process. Each group has an own TMR recipe. The mixer wagon allocates the TMR to the cows.

Individual cows move from group to group according to their life cycle. Accordingly, cows are represented by the following eight groups in the model:

- Temporary group
- High performing group before insemination
- High performing group after insemination
- Low performing group
- Dry group
- Precalving group
- Sick group
- Mastitis group

Figure 2

The programmable structure of the modelled milking cow breeding



In the individual groups actual cows are identified by their ID, age, date of last calving, dedicated fodder per day, as well as by their daily milking performance.

The compositions of groups are changing from time to time, in line with their individual life cycle. The connecting transition elements are responsible for the “moving” of the cows from one group to another, according to the changing rules.

Via “Input message” element we can add the specific events to the model (e.g. got sick, mastitis, etc.). “Output message” elements stand for the automatic warnings, while “Report” elements are responsible for the monitoring of output data.

The test results of the implemented model are illustrated in Figures 3-7.

Figure 3

Purchas of fodder ingredients along a year

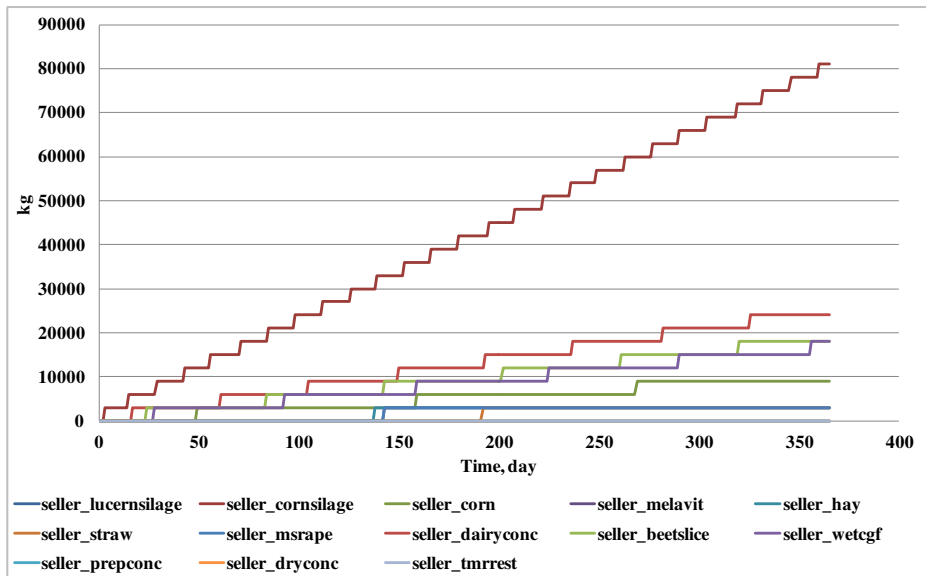


Figure 4

Changes in the amount of fodder storages

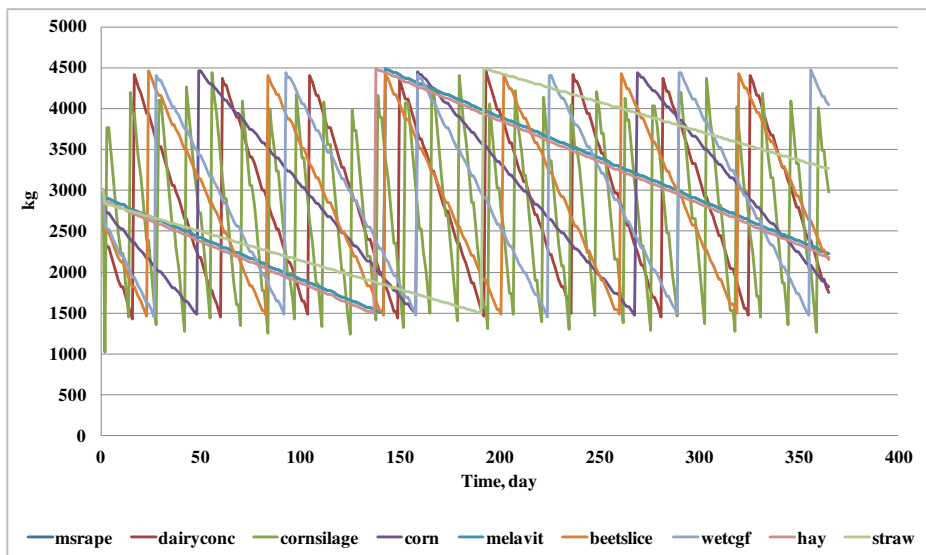


Figure 5

Scheduling of purchases in case of some example fodder ingredient

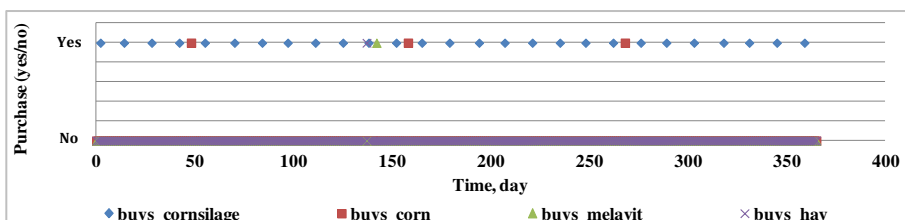


Figure 6

Amount of available fodder (for the low yield group) and its date of mixing (blue)

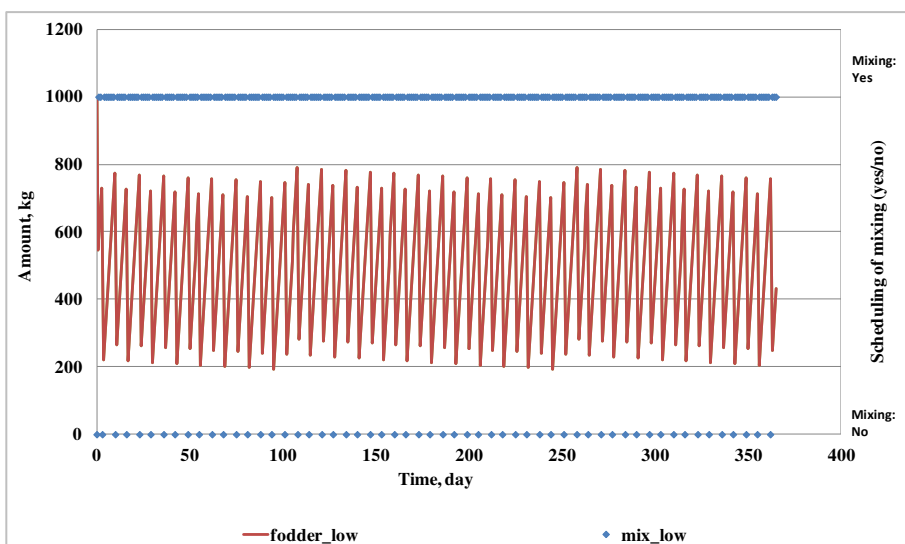
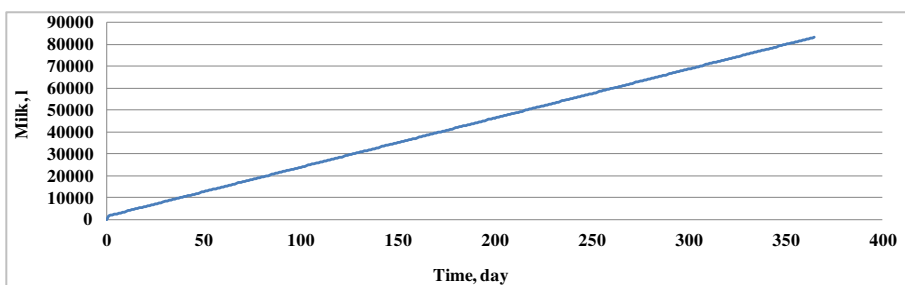


Figure 7

Produced milk of the low-yield group



CONCLUSIONS

As a first step towards the simulation assisted evaluation of lactation cycle controlling rules, the respective process model of a dairy farm has been implemented, using the method of programmable structures. The developed dynamic model of lactation cycle has been tested with a limited set of example data. According to the preliminary results, the methodology can be applied for the solution of the investigated problem.

The suggested computer interpretable technological flowsheet might help to utilize the available data from the up-to-date software tools in the improved farm management, including the analysis of milk production of individual cows with various life-cycle.

The developed dynamic balance model can also contribute to implement trans-sectorial transparency modelling in the future.

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REGION, TOURISM DEVELOPMENT, AND CULTURAL HERITAGE¹

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ABSTRACT

The paper shows how the newly restored palace representing part of the Hungarian cultural heritage changes the tourism economy of a micro-region. The research was based on sociological interviews conducted in 2016 with the mayor and representatives of municipalities, leaders of touristic NGO's, touristic and other service managers in the region. According to the stakeholders' opinion, the tourism industry must change in many ways in the region. The Esterházy Palace could be the 'flagship' of the micro-region's tourism. The tourism entrepreneurs, the representatives of local governments and NGOs, played a significant role in the tourism of the micro-region, and they tackled the new challenges posed by the new initiatives in different ways according to their interests and position. On the whole, we can conclude that in the touristic activity of the region the most significant problem for some stakeholders is the lack of cooperation.

Keywords: Regional and tourism development, micro-region, cultural heritage, entrepreneurship

THE REGION AND THE ESTERHAZY PALACE

The microregion is situated on the southern bank of Lake Fertő on the Hungarian side (*Figure 1*). Previously it used to be a traditional agricultural area famous for its olericulture and processing of reeds. Before 1945 and especially before the First World War the Hungarian and Austrian villages next to the lake had normal and lively cultural and economic relations. The area was isolated between 1945 and 1990 due to the Austrian border and the Iron Curtain built on the border. This isolation also led to the fact that the region was not particularly attractive for industrial investments (the political situation would not have allowed it anyway). The lasting advantage of this isolation is that the natural resources have remained relatively intact (*Brown-Kulcsár 2000; Kulcsár 2012*).

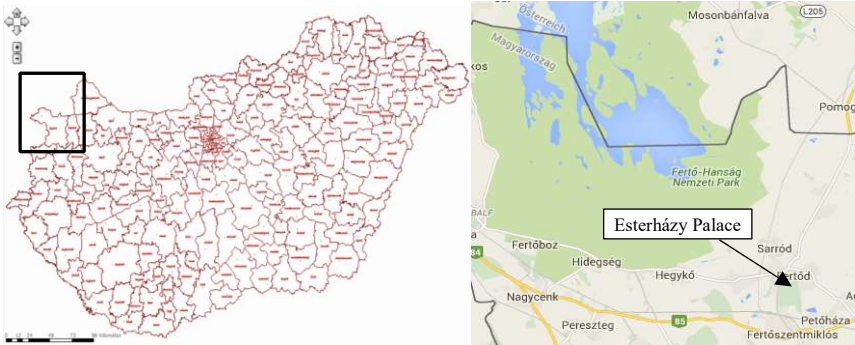
The development of tourism started and succeeded at different rates in different villages in the second half of the 1990s. In most cases, there is a lack of

¹ Part of the article was presented at the Conference of “Smart Ideas and a New Concept of Economic Regeneration in Europe” – SINCERE. Dubrovnik 28 September - 1 October 2016. (László Kulcsár, László Anzelm Bodrogai, István György Vizi: Tourism Development and Cultural Heritage: The Stakeholders' Opinion on the Role of Restored Esterházy Palace in Western Hungary).

coordination and integration between the various developments or the individual municipalities.

Figure 1

The area of research



The Esterházy Palace (*Figure 2*) had its heyday in the second half of the 18th century. Its intellectual aura went beyond the small village, and it became the political and cultural center of the Hungarian and Austrian elite. Furthermore, it became one of the most famous places in Europe thanks to Joseph Haydn's 30-year long stay at the palace and his compositions.

Figure 2

The restored Esterházy Palace in Fertőd, Hungary



Its significance dropped in the 1800s, and it also suffered from considerable damage, primarily due to the neglect of the previously highly indebted estate. During the first half of the 20th century the owner, Duke Miklós Esterházy largely renovated the site, but it could not redeem its cultural, political and intellectual life it had previously played, which was also due to the peace treaty signed in Paris, resulting in changed state borders. During World War II it sometimes functioned as a Russian military hospital, barracks, warehouse, etc., which resulted in a significant deterioration of its environment and its furnishing.

The third golden era of the Esterházy heritage is connected to the Eszterháza Cultural Research and Festival Centre created in the year 2014. Renovations began in the second half of the 1990s, and they accelerated during the first decade of the 21st century, and even today major projects are underway.

INTRODUCTION TO THE RESEARCH

The 21st century is the century of marketing, according to marketing specialists (*Kourdi, 2011*), but it was culture that played a truly important role in this century's marketing trend. In this case, culture incorporates a tool coordinating the way of life and common values in a certain area, the push factors for cultural attitudes, as well as the cultural pull factors of a certain institution. The social-cultural composition of a region's population determines the relationship to the tourist institutions in the region, including the effectiveness of marketing activities performed by these institutions. Based on the assets of the area, cultural tourism marketing focuses on heritage tourism and its institutions as well. As to the economic importance of cultural heritage building complexes, such as a palace complex or a Belvedere of a historical and cultural value, these are indisputably part of the local assets. Their situation and their developments are the competitiveness and status indicator of the area. The knowledge related to this is an important part of the knowledge capital, which is closely related to the social capital present in the region. *Oppio et al. (2015)* adds that the relationship between cultural capital, economic growth and the well-being of the people living in the area is also clearly positive.

The fundamental principle of our research is close to the ecomuseum concept which was born in the early years of 1970s in France (*Varine, 1996; Davis, 2011*). The ecomuseum concept concentrates on the cultural heritage of the region: natural, economic, and social amenities. The ecomuseum is an open concept, which counts on the participation of the local community, for the protection of the cultural heritage values, education, research, and presentation of them.

Caserta and Rasso (2002) make the difference between the “primary tourist product” which is the cultural heritage institution itself (Esterházy Palace) and the “secondary tourist product” which are the attractions that can be found in that area. The palace can be a primary or secondary tourist product, depending on the palace as a starting point or the other tourist products in the region.

Therefore, the reconstruction of a historical monument is not only a question of restoration and architecture. The reconstruction process must not be interpreted as the restoration of the concerned buildings and their local area. The objects of an

architectural heritage - as *Winkler* (2002) notes -, cannot be separated from its historical, regional role. Therefore, the reconstruction process also includes the creation of renewed features, as well as their role in history and reinforcing identity. Cultural heritage tourism is increasingly important in Hungary, and in the same way as in Europe, increasingly contributes to the growing GDP. The European Union's official report (*European Commission*, 2015) stresses that cultural heritage institutions do not simply represent the cost of that country, but also a major source of revenue. So, you must evaluate the cultural heritage tourism in Neusiedler See region and the role of the Esterházy Castle in it in this way.

This multi-directional relationship shows that the tourism activities of the palace complex cannot be separated from those of the region. In practice, however, the situation is not that simple. The tourism players of the region should realize that cooperation is in their interest. Co-operation among the tourist attractions in the region can result in significant synergies, which favorably affects the positions of those involved.

The region's situation shows serious inequalities in this respect, and also, the attractiveness of some events in the palace are reduced by infrastructural deficiencies in the region. It has been said several times that because of poor access to quality and sufficient accommodation in the area, the attendance of cultural programs of the palace is impeded (e.g., the music of Haydn).

THE METHOD

Our basic approach was to measure to what extent important touristic stakeholders view the palace and its surrounding area. This approach is very important because the mostly small, regional tourist attractions having a loose relationship with each other cannot exploit the region's full potential. On the other hand, the touristic development of the palace - which is more than a simple restoration - cannot happen independently and isolated from the local area.

The survey was conducted in the region, interviewing entrepreneurs, mayors, municipal representatives and tourism professionals. The chosen method was the in-depth sociological interview. Among the interviewees, we find the head of the Esterházy family, Prince Antal Esterházy, and his wife². The interview focused on two main topics: (1) the resources of the micro-region and its position from a touristic point of view, and (2) the features, the programs and visitor attendance of the renovated Esterházy Palace. During the qualitative interviews, the most important and influential people of the region answered our questions. The answers did not always cover each of the examined topics, so the analysis focused only on the most important issues raised. Thanks to their work and status, the interviewed stakeholders have (and had in the last decades) a strong influence on the region's tourism. They do this on one hand through their businesses; on the other hand,

² The interviews were made by the following persons: five mayors and municipal representatives; Three tourism entrepreneurs; 6 tourist NGO leaders; Duke Antal Esterhazy and his wife.

they are influential people in the development of the region's settlements, and thirdly, they are conservation experts as well. The activity and the opinion of the decision-making tourism experts in the area can significantly facilitate or hinder the Palace's efforts and its connection to the region, and most importantly, effective cooperation.

The interviews focused on the questions in *Table 1*.

Table 1

The questions were divided into the following categories

The situation of the region and its tourism	Programs and visitors' attendance of the Esterházy Palace
1. Touristic competitiveness of the region	1. Evaluation of touristic services and their price
2. Tourist attractiveness of the region	2. Main target groups, groups of visitors
3. Tourism offers and services in the region	3. Assessment of the palace's marketing communication
4. Necessary improvements, vision for the future	4. The palace and the region

LOCAL STAKEHOLDERS, THE REGION, AND THE PALACE

Microregional competitiveness

The crucial element of the opinions about the region's touristic competitiveness is how coordinated the tourism programs and their infrastructure are, and how fragmented is the marketing activity related to tourism in the area. If every attraction focuses solely on their activities coordination between tourism programs is small, and it results in an inadequate competitiveness. It is especially true to a region where a prominent tourist attraction dominates the region, moreover, it has recently entered the market. In other words, it entered a market that was unchanged for a long time, and now the region's tourism needs to be reconsidered under the usual conditions.

The interviews show that the local tourism operators see the region's competitiveness in different ways. Austria's proximity is considered rather as a disadvantage than an advantage. But they do not recognize that this disadvantaged situation requires an even greater cooperation. They acknowledge the leading role of the palace and they have their expectations accordingly. It is feared that with this in view they feel exempted to take the necessary steps.

„We have everything here: ecotourism, recreational tourism, wine tourism, spa tourism. And we haven't yet mentioned the cultural values or the historical monuments. I think that viewed from the supplier's side; competitiveness is unequivocal. But the service providers have a lot of work to do.”

„The danger lies in that people cannot think regionally. The problem is that as soon as a business starts to become profitable, everyone just wants to use it for

their interests. That is what happened in the past few years. And they cannot think regionally.”

„It would be crucial for the municipalities to have efficient cooperation related to tourism. There is no real cooperation between the municipalities in the areas of tourism.”

„Clearly, on a national level, we are on the top. But we shouldn't forget about Austria either since we are in a cross-border region. Again, my opinion is that we lack the necessary infrastructure.”

„When the Fertő-Hanság National Park was created, the Austrians were already there, and Hungarians only joined by the time of the change of regime, and Austrians had already built the lakeside resort facilities, and Hungarians now cannot build any because the National Park does not allow a marina or a beach to be built. On the Hungarian side, because there was nothing before, and now it is not allowed anymore.”

„We lack one leading attraction that would attract visitors, and this would link to other attractions. We cannot say that people come here for the spa because it is not that big. In this regard, I feel this is somewhat of a disadvantage in competitiveness. Obviously, based on recent developments, the Palace can become the most important attraction in time.”

“The National Park was created, but its limitations also caused traumas, and people are still stunned because of them. Lands cannot be used; villages cannot develop - basically many things that are possible in other villages, are not done here because of the protection imposed by the National Park.”

„The most important tourist attraction in the region is the Esterházy Palace. Of course, the Fertő-Hanság National Park as a World Heritage is also a very good buzzword.”

„I think that for domestic tourists, this region also has the promise of Austria. What we do not realize is that the guests arriving from Eastern Hungary see the promise of Austria, of Burgenland in us and the western standard of living and values. Regarding values, I think it is very important that we preserved a large amount in architecture, culture and natural heritage. To be able to have a National Park, a World Heritage site here, it was necessary that for forty years this region could be entered only by border guards, hunters, and fishermen.”

„For further development, everyone needs to realize that in a common European market it makes no sense to talk about the Hungarian and the Austrian Lake Neusiedl and its environment separately, but we need to treat this region as one. Lake Constance is a good example, where three countries treat it as a common good and they came to an agreement regarding common products and communication, and everyone tries to comply. In this regard, we are highly underdeveloped, and I don't see any encouraging signs.”

„So even though we promote ourselves as an integrated region, I believe that Austrian patriotism and nationalism is still stronger in which that they are reluctant to let guests into Hungary. It's like a hotel which doesn't let the guests leave to visit the area to achieve full spending on the premises when at the same time we market ourselves as part of a region.”

„Our strengths: geographic location, transportation access, since the Bratislava and Vienna airports are reachable in an hour - so the accessibility is not bad. Highway connection from the western side is almost completely solved the border since the road reaches Csorna - I believe that this is already a huge achievement. Our strength is still the attractive and diverse touristic programs. What makes this place unique: it is a meeting point of the Alps, the plains, and a steppe lake. The weakness is the lack of strategic thinking. A beach on Lake Neusiedl will not be competitive compared to an Austrian one since there were no developments. The lack of a wide range of accommodation - from camping to five-star hotels - is also a weakness. It is also a weakness that there is no dialogue between the stakeholders. It would be important to have discussions about how to act as collaborators in remote markets and not as competitors. This cooperation is still lacking from the region.”

„I believe in the development of cycle tourism, I see that this topic will be in focus on the area, so this area and the Palace could be a staging post during a cycling trip.”

„Our big problem is that a huge number of tourists who are there on the beaches of Lake Neusiedl is only just passing through us. Accommodation is scarce, and the municipality of Fertőszéplak didn't realize the assets they have (e.g., the heritage of Széchenyi), and on the other hand, we have the only one open-air museum presenting the architecture of the region, but sadly, it is not managed by the municipality. I think that this could be a much more important tourist attraction if we could be its managers. „

„The key question in this regard is whether in the future we will be able to develop the palace or other attractions in a way so that private capital would see a better opportunity in investing in accommodation. I have a feeling of absence regarding the region, namely the fact that the developers didn't attract private capital investments.”

Attractiveness of the Esterházy Palace complex of Fertőd

Every participant praised the renewal of the palace, and its European significance and the efforts of the management. They stressed, however, that there is a significant difference between the Palace's and the town's (Fertőd) attractiveness, the level of development and atmosphere to the detriment of Fertőd. The differences in development and the infrastructural problems make it almost impossible keeping the guests to visit the Palace for exclusive programs, to achieve multiplicative effects.

The respondents mentioned minor difficulties from the part of the palace regarding tours and service. Proposals have been made to attract guests, e.g., authentic clothing when welcoming guests or giving tours. Marketing and communication practices were also considered weak.

„I think the cultural programs and concerts are excellent. However, during tours, I'd put more emphasis on the appearance. For instance, guides could wear authentic clothing while giving tours.”

„This is Hungary's largest baroque palace: it has a milieu, an atmosphere. When I go to such a historic place, I feel goose bumps thinking that princes, kings, and queens walked here before me. I love history; I visit lots of castles and battlefields. I am touched by these things, the same way I think of this Palace. „

„There is a huge gap at Eszterháza between the palace and the town. The palace is developing very nicely, but the township is lagging behind. Something needs to be done here. If I were the mayor, I would be working on this day and night. At Hegykő we use lawn mowers for the green areas and not a tractor, especially the areas near the bath and the ones frequented by visitors. The adequate environment is already part of Hegykő's rank, its milieu, and its many guests. I don't see this at Fertőd.”

„I think the site is excellent. I also saw brochures, but these should be placed and disseminated in more frequented areas. And not only brochures: every caterer should be taught to recommend the Palace - this is a problem I often have in Hegykő as well. We should reach the point where they recommend a visit to the palace: an oral recommendation is an excellent advertisement.”

„Our goal should be to sell the region - and its leading attraction is the palace at Fertőd.”

„Its strength lies in its absolute value: it is unique and can be advertised on the European level as well, not forgetting Haydn's³

„It is difficult to deal with the target group of the palace separately because it cannot be very different from the target group of the area - if this should happen, we have a problem. But the region's target groups are not defined clearly, which is also a regional problem.”

„Accommodation possibilities are incredibly bad. There is no accommodation at Eszterháza, Fertőd, Süttör that would be worthy of the palace. This situation has not been developed either from private capital or with funding from tenders. Although there is no fine dining in the area, I think that the catering service is decent. There is a cycling path, but they don't appear next to the palace. We see examples in Western Europe that next to a historical site, you can find completely new things, like an adventure park or a fun park, complementing each other to target different groups or the time spent. A recurring problem in the region is the lack of beaches in the summer. If we narrow our analysis strictly to the palace and Fertőd, we could say that the touristic background is weak, and the Fertőd Cultural Landscape has a common service and touristic background.”

„Just a few examples: Joseph Haydn, Prince Nikolaus Esterházy, Maria Theresa - they should be more visible. Or there is that beautiful Esterházy porcelain dinnerware: it should be used. During the tour, a child could be chosen from the group, seated at the table and be told that she is Maria Theresa, her husband, the prince of Lorraine sat here, here sat a Thane, this was the seat of the prince, and this is where Haydn sat. These things should be more dominant because this is crucial. Regarding the palace and of future communication it is crucial, what appears in the social media. If I come here as a father and I am a regular Facebook user, then the best case scenario is that I put a post on Facebook that I was here, and it is visible to all my friends. But if my daughter is playing the role of Maria Theresa, then I take ten photos and show them off for two weeks for everyone to

³ Joseph Haydn was principal conductor and composer at Eszterháza between 1766 and 1790 in Prince Nikolaus Esterházy's service. He composed and premiered his famous farewell symphony in honor of Empress Maria Theresa's visit to Eszterháza.

see that my daughter is Maria Theresa, my son is the prince of Lorraine or that my child sat in Joseph Haydn's chair and touched the reproduction of Haydn's instrument. I digressed a little, but I think that every visitor is also a member of a target group. But they are a channel for communication at the same time. I believe that this can and must be strengthened.”

„In my opinion, it is very important to treat the question of permeability: we need to consider how many visitors we allow and how we handle these groups so that the experience is enjoyable to them. As a marketing specialist, I consider the late communication of the programs as one of the weaknesses.”

„The enormous advantage of the palace is the cultural and historical background and the monument itself, which is a true treasure. But it puts us at a disadvantage if we only consider the region as the place of the Esterházy Palace. Therefore, it is not enough to narrow our thinking to the palace, because there are people who don't like exhibitions or museums: they come in, take the tour and then leave. Naturally, the main attraction of the region should be the Palace, but we need other things to complement it as well. It is dangerous to be conceited and say that we have the Palace, so tourists will just flow in. The attraction of the Palace is not enough alone. It would be nice, but it is not true.”

„The palace is an enclosure in Fertőd and the region as well. For the outsiders, it has always seemed that the relationship between the management of the palace and the municipality of Fertőd is apathetic at the very least. As in other villages, we can safely say that the existence of the palace had no positive or negative effect on us. This changed for the better dramatically in the past couple of years, because of several causes. I could mention four causes for this: for instance, the management of the Esterházy Centre was changed, and the new management was talented enough to be able to promote the cause of the palace. On the other hand, they developed a strategy and a direction of what they would like to achieve, which didn't exist until now, so the Palace has been just there. There were some concerts and the usual exhibition, which I saw when I was a child, and never again, because there was nothing new about it. So now we have an established trend, and there is a political will as well, which is very important for the castle complex to be able to exist and to develop. On the other hand, there is an economic background, because it should be known and it is also obvious that the palace is not one of many. This building is the most beautiful and the largest baroque palace in Central Europe, a building complex, which was built to cater to this beautiful Palace. Their features are not existent anymore, which means that we need to find new features for them. This will never be a profitable investment: it is its intangible value and its uniqueness that ensure its survival. If this works well and it attracts tourists, then we can benefit from it as well, since if there are lots of visitors, then many of them will go and visit the area as well.”

„I think that the external relations of the region and the relationship with local NGOs and municipalities should be strengthened.”

„Here, you cannot just start digging without prior consultation. It is highly improbable that the palace just flies to China from one day to the next, and then we could have a beautiful pond on the top of the hill, so we have to struggle with these things until death.”

CONCLUSIONS

On the whole, we can conclude that in the touristic activity of the region the most important problem for some stakeholders is the lack of cooperation. They admit that the natural values could be conserved due to history, but we should not forget that the more traditional, business-oriented stakeholders treat the National Park as an obstacle, rather than an advantage. Austria's proximity is an advantage and a disadvantage at the same time, and the marketing activities that targeted the Austrian market have not brought any tangible results. It is an advantage regarding the region's attractiveness, especially for visitors from remote areas, but it is a disadvantage regarding competitiveness, where the area is lagging behind compared to Austria. The most outstanding issues are the low-quality tourism infrastructure facilities and inadequate services.

In the case of the palace, the interviewees mentioned that the palace is not an enclosure anymore, and they treat it as a unique cultural, artistic and touristic attraction. The infrastructural deficiencies in the area cause significant problems to the palace as well. The small town surrounding the castle is rather rural, and its level of development is considerably below the desirable level. There is a lack of authentic representations from the period; the tour is not imaginative enough. According to the stakeholders, these issues are detrimental to the consistency of the programs offered. However, the programs recapture the palace's rich, European-class cultural life and atmosphere that existed in the 18th and 19th centuries.

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