

What Cases on Lean Hospital Transformation Tell Us?

*István Jenei (istvan.jenei@uni-corvinus.hu)
Corvinus University of Budapest*

Abstract

The scientific knowledge about the lean transformation of hospital processes is at best in its “emerging” phase; neither related international, nor Hungarian literature offers a systematic, comprehensive description of the phenomenon (Brandao de Souza, 2009). In this paper empirical evidences concerning the lean transformation of hospital processes are researched and systemized. Thus it provides a new insight of existing knowledge in order to provide solid base for further researches and practical actions.

Keywords: Healthcare, Process, Lean management

Objectives

Given its expected effects, the Lean offers an excellent opportunity for the development of health care and especially hospital processes. It is no surprise, therefore, that it has been the subject of increasingly intensive interest ever since the 2000s (Brandao de Souza, 2009), and it is at the basis of the latest series of efficiency-enhancement programmes NHS, the British National Health Service (Proudlove et al., 2008).

To date, the lean transformation of hospital processes is clearly an emerging area, as indicated by the relative scarcity of scientific knowledge on this topic, and the fact that one third of the relevant publications deals with “speculations” (Brandao de Souza, 2009). With the growth of the amount of experiences described by explorative research, however, the time has come for the systematic collection, analysis and classification of data in this area of research (Karlsson, 2009). To date, neither the international, nor the Hungarian technical literature offers a systematic, comprehensive description of the phenomenon of the lean transformation of hospital processes (Brandao de Souza, 2009).

On the basis of the above, I defined the objective of my research as follows:
Collection, systematic arrangement and description of empirical evidence concerning the lean transformation of hospital processes.

Research design

Direct access to the experiences of foreign hospitals was limited by the scarcity of financial resources available to me. Consequently, the cost-efficient method was to tap the available sources, and to supplement and clash the experiences relayed there with a domestic case of process and quality development going back more than a decade, similar to the Lean in its approach and instruments, albeit not in its terminology. Furthermore, by including the Hungarian case, I could enhance the reliability and validity of the research results.

I adhered to following research scenario:

1. I identified the sources which themselves provided a structured overview of the collected pieces of information based on a criterion of some kind. I found four

such works on the lean transformation of hospital activities. Spear (2005) sums up his first-hand experiences gained at several hospitals. Radnor et al. (2006) examine and describe in a systematic way their experiences mainly of the lean efforts of public institutions in the area of Scotland, UK. Proudlove et al. (2008) describe the research experiences of British National Health Service (NHS) in connection with the application of another methodology which is similar to Lean. Finally, Young – McClean (2008) also sum up first-hand experiences gained at hospitals in the United Kingdom.

- I structured the contents of the articles by open coding. That is, I assigned conceptual labels to blocks of information related to Lean in the articles. Then I merged the logically related labels and gave each group the name which best summarised it. I identified 41 Lean factors this way, which I then assigned to 12 main categories. When the code system was ready, I re-read the texts to check the classification of the text parts and to make alterations if necessary. The code system presented here is the result of several checking cycles. It represents the map which outlines previous information and provides a framework for the analysis of further cases (see Figure 1.)

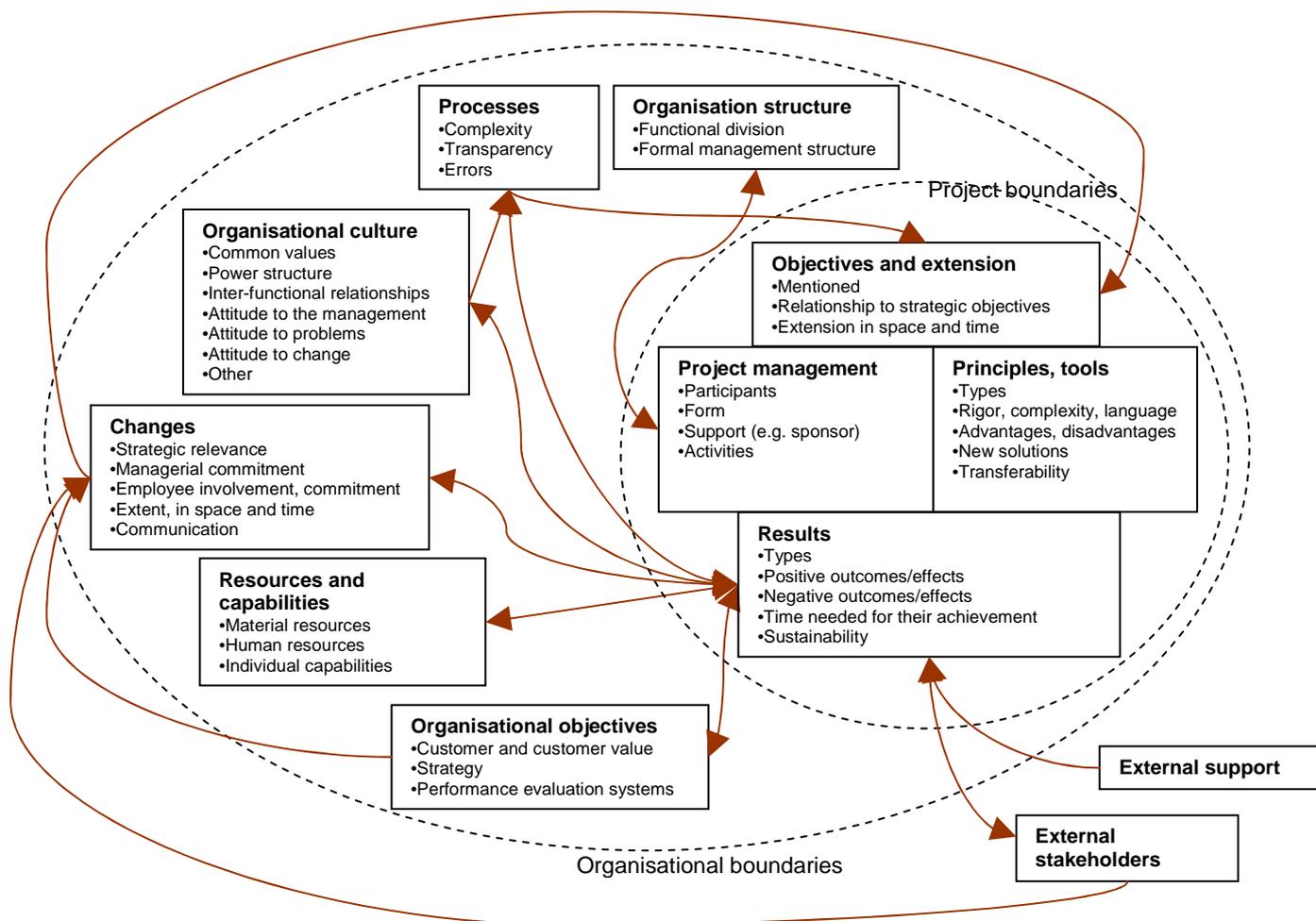


Figure 1 – Lean hospital processes: main factors and their interrelationship, based on the relevant basic literature items. Source: compiled by the Author

3. I collected from international scientific databases the scientific articles on Lean projects implemented at hospitals. I structured their content according to the category system established previously, and then I compared that with the corresponding pieces of information obtained from the basic literature items. The sources and the cases are listed in table 1. Table 1 also indicates in which case the author was insider (IR), thus the reliability of the “story” naturally high.

Table 1 – Interconnection of cases and sources

Venue/source		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		Appleby, 2002	Ben-Tovim et al., 2007	Braaten - Bellhouse, 2007	Fillingham, 2007	Furman - Caplan, 2007	Jimmerson et al., 2004	Kim et al., 2006	Laursen et al., 2003.	Nelson-Peterson and Leppa.	New et al., 2008	Powell, 2009	Raab, 2006	Raab et al., 2006	Rosen, 2004	Shannon et al., 2006	Taninecz, 2009	Wessner, 2005
1	VA Medical Center in the Oakland section of Pittsburg, Pennsylvania USA	O																
2	Western Pennsylvania Hospital, Pittsburgh, Pennsylvania, USA	O																
3	Flinders Medical Centre, Adelaide, Australia		I R															
4	Porter Adventist Hospital, Dever, Colorado, USA			I R														
5	Royal Bolton Hospital, Bolton (Manchester) UK				I R													
6	Virginai Mason Medical Center, Seattle, USA					I R				I R								
7	Community Medical Center in Missoula, Montana, USA						I R											
8	LDS Hospital in the Intermountain Health Care System of Salt Lake City, Utah, USA						I R											
9	Park Nicolett Health Services (PHNS), Minneapolis, Minnesota, USA							I R										I R
10	University of Michigan, Ann Arbor, Michigan, USA							I R										
11	Skejby Sygehus (Hospital), Aarhus, Denmark								I R									
12	A special hospital in the UK										I R							
13	Akron Children's Hospital, Akron, Ohio, USA											O						
14	University of Pittsburg School of Medicine, UPMC Shadyside Hospital, Pittsburg, USA												I R	I R				
15	Toronto's Hospital for Sick Children, Toronto, Canada														O			
16	Allegheny General Hospital (AGH), Pittsburg region, USA																I R	
17	Mayo Clinic, Rochester, Minnesota, USA																	?

4. To remedy the deficiencies of the international case descriptions and to create a kind of control case, I identified a Hungarian development project (ZMK) which corresponded to a large extent to the objectives and approach of Lean. To do so, I first demonstrated on the basis of information and empirical research findings accessible in the technical literature that the application of the TQM approach and Lean have a significant intersection, which justifies the use of a case which applies TQM “only”, not lean management. I processed the case so selected, too, according to the previously established category system, and I kept comparing the

results with information based on the basic literature and with the results of the analysis of the international cases.

5. On the basis of the basic literature items, the international cases and the case of the Hungarian hospital, I summarised the scientific knowledge base which is currently available on the lean transformation of hospital operation.

Findings

I used the code-system-based classification to interpret the information contained in the four basic literature items and in the technical literature on 20 foreign cases, one domestic case and the topic in general.

Goals of the Organisation, Customer Value, Performance Measurement

According to the research findings, a certain, apparently minor, group of hospitals applies the Lean as a strategic programme, in line with the philosophy represented by Womack – Jones (1996). The reason for that has not been clarified yet.

Furthermore, since the strategic approach to the Lean is also typical of a few hospitals only, it is hardly surprising that the specification of “customer value” is not a frequent topic either. It is rather thought-provoking, on the other hand, that even hospitals subject to some relevant initiatives usually stop at the “customer = patient” approach. This is partly explained by the work of Womack – Jones (1996), which considers the patient the customer of the health care service. On the other hand, given the well-known characteristics of health care, it would seem logical to proceed to a more complex definition of the customer, as is proposed by several researchers (Young – McClean, 2008; Proudlove et al., 2008; Angelis et al., 2008).

The relevance of performance evaluation systems in relation to value creation, target setting and the assessment of their accomplishment is a commonplace in business economics (Ghalayini et al., 1997; Wimmer, 2002). Although the research of Radnor et al. (2006) points to the negative effects of inadequate performance measurement systems, the foreign experience is that hospitals pay no attention to that. ZMK seems to be an exception in this respect, too, in that they operate such systems, but I could not assess their real effects in the absence of relevant data.

External Stakeholders of the Hospital

In addition to the obvious group of the patients themselves, a hospital may have several groups of external stakeholders. ZMK makes conscious efforts to manage these. In the basic literature, Radnor et al. (2006) identify them in the first place as a force exerting pressure in favour of change, but in relation to the foreign cases, only Laursen et al. (2003) treat the issue at all, and they highlight, through the anti-Lean effect of quota-based financing, the negative impacts which the regulatory authorities may have on operation efficiency.

Hospital Processes and Errors

The findings of a survey covering the hospitals of the US called the attention of the world to the fact that the proportion of errors and undesirable events in health care exceeded several times the corresponding rates typical in industrial production (Kohn – Corrigan, 2000). Human negligence as a targeted problem is frequent also in the researched cases. In addition, there are many problems related to service quality (e.g. waiting time) and efficiency (e.g. cancellation of operations). The basic literature attributes these problems to lack of process organisation and transparency, and to confusion (Spear, 2005; Proudlove et al., 2008; Young – McClean, 2008). This drives

the attention to the absence of process-centred thinking, and of conscious process mapping and planning (Ahlström, 2004), to functionalism (Mezőfi, 2007; Parnaby – Towill (2008) and to the significant influence of the patients. The researched cases confirm these opinions and highlight the complexity of the health care processes which exceeds by far that of the typical industrial processes (Young – McClean, 2008; New et al., 2008; Ben-Tovim et al., 2007).

The Changes

There is no general agreement as to the main factors triggering change. In Britain, on the initiative of NHS, the Lean has become imperative, hence the predominance of the category of “external pressure” (Radnor et al, 2006). An earlier Swedish research project, on the other hand, reported the prevalence of inner motivation (Jesper et al., 2003). The foreign cases do not discuss this issue. As for ZMK, both the environmental trends, and the interest of the young management acted in favour of the launch of the development projects there.

As for the nature of the Lean, both the basic literature and the cases reveal two distinct implementation approaches:

1. Short development projects are present in many foreign cases. These usually target local (ward-specific) objectives: quality development, waste reduction.
2. According to the experts, the right way to the accomplishment of sustainable results is to embark on a comprehensive programme-type implementation of the Lean, to ensure “lean operation” which considers the Lean a strategic device (Radnor et al., 2006; Grol et al., 2002; Williams et al., 2009; Joosten et al., 2009). The experience, however, is that a programme-type implementation will also be realised through a series of minor projects (Spear, 2005).

As for the success criteria of the Lean, Radnor et al. (2006) and Spear (2005) refer to the typical factors of successful change management (commitment of the management, clear target definition, good communication etc.), which suggests that change management is a crucial issue for the hospital in relation to the Lean.

Objectives and Scope of Lean Project

The basic literature items stress the importance of the harmonisation of the project and the strategic objectives. Ideally, the projects are parts of strategic changes (Radnor et al., 2006; Spear, 2005; Proudlove et al., 2008; Young – McClean, 2008). In the foreign cases, specific project objectives are seldom identified; in the majority of the cases, we have every reason to assume that the projects are *not* linked to strategic objectives (except e.g. for Royal Bolton Hospital: Fillingham, 2007), but they rather aim at solving local problems (e.g. Raab et al., 2006; Appleby, 2002). The process-centred approach and development in line with it appears in only a few cases (Laursen et al., 2003; Jimmerson et al., 2004).

ZMK’s case shows that strategic changes and the related top-down pre-planned minor or major projects as well as minor projects initiated from below to solve local problems are not in contradiction; on the contrary, they complement each another. The large projects are the instruments of implementing strategic change, whereas minor, *ad hoc* ones are indispensable for continuous development and everyday problem solving and learning.

The above considerations ease the tension between the importance of the strategic approach proclaimed by the basic literature items and the apparent independence of projects discussed in the case studies from the strategy, since supplementary

information available on several hospitals suggests that the two systems can co-exist with success (e.g. Virginia Mason Medical Center, Flinders Medical Centre).

Management of Lean Projects

The research findings suggest that lean projects implemented in the hospital environment are most similar to the corresponding industrial projects: they are usually characterised by RIE (rapid improvement event) type development efforts implemented with the involvement of employees in the areas affected by the development, with the participation of the leadership, with the support of experienced external or internal experts, by cross-functional groups. (Radnor et al., 2006; Spear, 2005).

Project-level success criteria include precise target setting, the motivation of the participants (e.g. through the model example of the management, or the possibility of expressing their opinion), the allocation of the necessary resources and the active participation/interest of the managers. Winning the support of the medical staff seems to be a highly relevant success criterion.

Lean Tools

Within the basic literature, according to the research of Radnor et al. (2006), the tool frequency list is headed by the identification and elimination of the 7 forms of waste and by process mapping. At the same time, the cases mention but a few (mainly analytical) tools by their name known from industry (VSM, 5S, 5 Whys, Cause and Effect Analysis, A3 report etc.). The foreign case studies make explicit mention of only a few tools, which may be indicative of circles of basic-level users, but it may also be explained by the narrower scope of the projects concerned (which gives ground for the application of fewer tools).

The research findings of Radnor et al. (2006) are confirmed by the foreign cases: VSM is the most frequently used analytical tool. As for the development tools, process and activity standardisation and process re-design are the most frequent ones, which indicates the approximation of industrial standardisation. The third most frequently mentioned tool is the “andon principle”, that is, the signalling of irregularities in the process and the suspension of the activity (also jidoka principle). Given the saddening statistical results concerning the number of non-desirable events occurring in the hospital context, this no doubt is a welcome news. A further analysis of the tools point to an adaptive use of the industrial tools. The history of ZMK’s quality and process development efforts going back 20 years are in line with the explanations mentioned above.

The above findings support the assumption that the adapted versions of industrial solutions can stand their ground also in health care.

Furthermore, it has become obvious that in addition to the careful adaptation of industrial solutions to health care, one has to proceed with similar caution in case of the adaptation of solutions invented in the hospital environment from one ward to another or from one hospital to another.

The Results of the Lean

All the authors under study make efforts to highlight the results of the Lean, which I attribute in part to the relevant expectations. It is nevertheless surprising that the case descriptions as well as the basic literature items mention almost only positive outcomes. The decisive majority of results identified by the research can be summed up by the simple statement that standardisation enhances reliability. Enhanced process reliability and the reduction of errors and superfluous work in turn improve many indicators of

care provision (care provision time, number of infections, patient time etc.) and the situation improves also on the side of the care providers (less stress, smaller workload, more time). This leaves more staff time to deal with patients and improves the attitude of the personnel. Patients as well as staff become more satisfied. Last but not least, it has a beneficial effect on financial equilibrium.

Elkuzien et al. (2006) mention cases of failure beyond the rosy horizon which, however, are not highlighted in special reports. This is partly confirmed by the negative instances mentioned by others (Laurson et al., 2003; Raab et al., 2006; Furman – Caplan, 2007;) and Jenei et al. (2008) who, albeit they refer to factors hindering development, emphasise that the projects overall had positive results. Although most of the negative effects are short-term ones, which later on reverse to the positive, according to Radnor et al. (2006), the project which originally aimed at cost or staff reduction failed to attain their objectives.

Resources and Capabilities

The success criteria of the Lean include the availability of the necessary human and other resources (Radnor et al., 2006) (primarily time to be spent on the projects) (Spear, 2005; Jimmerson et al., 2004). Both types of resources must be put in place by the management, and they depend on the commitment of the latter (Fillingham, 2007). The case of ZMK supports the above, although lack of resources was a hindering factor there.

In the initial period, resources allocation means primarily the allocation of staff time. Nevertheless, the outcome of the first projects may well be the smaller workload of the staff. Invested time and liberated time, however, will not necessarily occur at one and the same person. The Lean typically includes training to introduce the philosophy and the tools concerned, i.e. human resources development, and it actually demands further training (e.g. cross-functionality, flexibility achievement, awareness of analytical/problem solving tools). The intensity of the Lean may be reduced by the significant difference in capabilities between the employees (e.g. nursing vs. medical staff).

Organisational Structure

A structure based on disassociated functions, on wards and on the distinction of many levels of hierarchy, and encumbered with an extensive bureaucracy, impedes the spread of process-oriented thinking and hence the efficiency of the Lean as well (Spear, 2005, Radnor et al., 2006; Ahlström, 2004; Hellström et al., 2009). These propositions are supported by the relevant statements of the foreign case descriptions. ZMK's case shows detachment from the classic, hierarchical, bureaucratic system in favour of progress towards a process-oriented organisation, but the existing deficiencies suggest that they have a long way to cover yet.

Despite every advantage of a process-oriented organisational structure, no drastic changes are recommended, since these might hinder operationality (Hellström et al., 2009).

Organisational Culture

The culture encountered at hospital organisations – a “blaming culture” – is a serious hindrance to the Lean, since its approach is diametrically opposed to lean thinking (Spear, 2005). According to the “blaming culture”, treatment and therapy are the task and responsibility of the doctors and the nurses as individuals. Therefore, if an error occurs anywhere, that is their responsibility, since the error is caused by their

incompetence (Furman - Caplan, 2007). The identification of the errors of the individuals is hindered by the management's fear of damage claims (Furman - Caplan, 2007), and the fact that those who are at a lower level of the hierarchy feel dependent of those who occupy higher positions, and hence they are reluctant to reveal errors committed by the latter (Shanon et al., 2006). The accepted form of behaviour is, therefore, to hush up errors and to circumvent problems instead of investigating and eliminating them. Since the problems will thus certainly recur, the workers consider them natural, normal, necessary concomitants of care provision, and after a while they go unnoticed (Braaten -Bellhouse, 2007). This way of thinking must be transformed in the course of the introduction of the Lean so as to make troubleshooting the generally accepted norm.

The case descriptions as well as the experience of ZMK highlight that excessive insistence on the autonomy of the doctor will, on the one hand, unnecessarily hinder the Lean (Shannon et al., 2006) and, on the other hand, it is contrary to the application of care-provision standards (Fillingham, 2007).

Despite the significant and direct effect of the team leaders' level on producing the results of the Lean and on their sustainment, success will depend on the attitude of the circle of upper managers. Without their commitment and support, the Lean will be an isolated local initiative (Radnor, 2006; Fillingham, 2007). In ZMK's case, many initiatives are thwarted at the level of department heads, due to lack of motivation coupled with a strong bargaining position among the professionally outstanding medical staff.

Resistance to change (Jimmerson et al., 2004) may be due to natural aversion to change and excessive regulation (Nelson-Peterson – Leppa, 2007), disdain for management tools used in industry (Laursen et al., 2003), an automatic refusal of tools taken over from industry or, as indicated already, the way of thinking of the organisation (Kim et al., 2006). The experience is that initial resistance and aversion can be altered by participation in the events and by understanding the potential outcomes (Jimmerson et al., 2004; Shannon et al., 2006; Nelson-Peterson – Leppa, 2007; Powell, 2009).

Organisational culture thus affects the possibilities of the Lean and vice versa. The Lean will be the more effective, the closer the actual organisational culture to that of a lean (learning) organisation, where error identification, analysis and elimination is part of the everyday activities and the process-oriented approach and close co-operation between the various professions is the norm of operation. It is the materialisation of this ideal that Radnor et al. (2006) call organizational readiness, which can be assessed prior to the launch of the Lean and allows to determine the time perspective and resources demand of its introduction.

External Support

One efficient solution for the hospitals is to have recourse to external support (Radnor et al., 2006; Proudlove et al., 2008). However, given the scanty experiences available on the lean transformation of hospital processes, no hospital can spare the learning process, even if they rely on external assistance. In addition to the clear statement of position in the basic literature items and the experiences of the ZMK, information contained in the foreign case descriptions also refer at several places to the use of foreign assistance (Powell, 2009). The special methodology for the shared learning of hospitals and external experts is called action research or action learning (Coughlan – Coughlan, 2002; Jimmerson et al., 2004; Laursen et al., 2003; Jenei et al., 2008).

Conclusion

One of the main messages of the 20+1 cases is that, in reality, the hospital processes and activities are not so very different from other service or even production activities as to be unsuitable for the application (with adequate adaptation) of lean thinking and the many tools developed by Toyota.

The projects described in the cases concerned many areas, from administrative activities through the sterilization process and the laboratory tests to the patient classification system of emergency care units and even the insertion of catheters. None of the papers reported such process characteristics as would have made it impossible to apply the basic principles (e.g. establishment of continuous patient flow, standardisation, fast information flow, etc.). This circumstance and the many different application areas warrant the conclusion that the developments do not have to be limited to the supporting processes, but they can also concern ward-based treatment or the organisation and efficiency of the operating theatre. It seems that the fact that the patient takes part in the process, and even “speaks back” is no cause for concern, but rather helps explore the expectations and identify the potential problems.

Hospital activities, however, have some features that are really different from those of the industrial context, but which are important for the planning and methodology of lean projects, and cannot be assigned to the cultural factors. One is the complexity of the processes and the organisation. Thus, for example, in a general hospital, one point (e.g. a surgical ward) may be connected to so many processes and activities that the ideal process is not obvious and its design is a complex task. Furthermore, complexity aggravates change management. Therefore, it may be necessary to develop new project management tools in the future to overcome these challenges.

The cases also reveal that the counter-arguments raised on the occasion when lean principles are first introduced to health care workers do not represent a real problem in lean transformation if the organisational culture can be transformed so that, instead of the feudalistic, bureaucratic and hierarchical system, a co-operative approach which promotes communication between the various groups and the professions, focuses on the patient and the processes, should prevail. As a matter of fact, one could say that the development of organisational culture and of the thinking of the management is imperative anyway in health care, irrespective of the lean efforts, and the existence of an established “modern” culture will actually significantly accelerate lean transformation (Radnor – Walley, 2008).

Scientific and Practical Relevance

Since, uniquely in this area, the paper provides an in-depth analysis and systematic description of information collected from 17 sources on 20 cases, its scientific findings are of particular relevance to the community of researchers. Consequently, it is suitable for obtaining a general overview of the professional literature on the lean transformation of hospital processes and of the relevant experiences, and can thus be of help to review editors, opponents or researchers who are about to learn about this topic. Since the paper provides systematic information and highlights contradictions and missing details, it can help identify new areas of research and formulate new questions, i.e., it is a good basis for further research.

Systematic information produced as a result of the research provide a good point of reference also to experts active in the design or execution of the lean transformation of hospital processes in the role of manager, employee or consultant. Far from providing a comprehensive image of every aspect of the question, of the problems encountered in the Lean, the topics discussed in the paper will in all probability come up and be among

the most prominent issues in every case study. Furthermore, the questions asked here may encourage the experts to reconsider and upgrade the practice of the Lean.

Limitations

The 20+1 cases processed here can by no means regarded as being representative of the hospitals of the world (the US, or Europe) they nevertheless reveal many experiences in regard of the lean transformation of health care (especially hospital) processes. Although the results so obtained can only be generalised to a very limited extent, they can provide a basis for further research which may confirm or refute the general validity of the experience related here.

References

- Appleby, Chuck (2002): "Industrial strength. Patient safety means leading pre-industrial health care into a post-industrial world". *The Journal For Hospital Governing Boards* [Trustee]Vol. 55 (1), pp. 10-19,
- Ben-Tovim, David I. – Bassham, Jane E. – Bolch, Denise – Martin, Margaret A – Dougherty, Melissa – Szwarcbord, Michael (2007): "Lean thinking across a hospital: redesigning care at the Flinders Medical Centre", *Australian Health Review*; Vol. 31, Issue 1; pp. 10-15.
- Braaten, Jane S. - Bellhouse Dorothy E. (2007): "EImproving patient care by making small sustainable changes: a cardiac telemetry unit's experience." *Nursing Economic* Vol. 25 (3), pp. 162-166;
- Brandao de Souza (2009): "Trends and approaches in lean healthcare", *Leadership in Health Services*, Vol. 22. No. 2, pp. 121-139.
- Coughlan, P. and Coghlan, D. (2002), "Action research for operations management", *International Journal of Operations & Production Management*, Vol. 22 No. 2, pp. 220-240
- Demeter, K.– Losonci, D. – Jenei, I. (2007): "The effect of position and gender on perceptions of lean transformation - the case of a Hungarian automotive parts supplier", *proceedings of the 14th EurOMA annual conference*, Ankara, 16 June.
- Elkhuizen, S.G. – Limburg, M. M. – Bakker, P.J.M. – Klazinga, N.S. (2006): „Evidence-based re-engineering: re-engineering the evidence – A systematic review of the literature on business process redesign (BPR) in hospital care” *International Journal of Health Care Quality Assurance*, Vol. 19 No. 6, pp. 477-499
- Fillingham, D. (2007): "Can lean save lives?", *Leadership in Health Services*, Vol. 20. No. 4, pp. 231-241.
- Ghalayini, Alaa M. –Noble, James S. –Crowe, Thomas J. (1997): „An integrated dynamic performance measurement system for improving manufacturing competitiveness”, *International Journal of Production Economics*, Vol. 48. No. 3, pp. 207-225.
- Ghosh, M. – Sobek, D.K. (2006): „A Test of the Design Rules in Health Care," *Proceedings of the 2006 Industrial Engineering Research Conference*, Orlando, FL, USA
- Jenei, I. (2009): „Are quality awarded hospitals also lean?”, *proceedings of the 16th EurOMA annual conference*, Göteborg, Sweden, June 14-17. <http://www.euroma2009.org/Proceedings/Papers/FCXST-09068951-1564364-2.pdf>
- Jimmerson, C. (2007): "A3 Problem Solving for Healthcare – A Practical Method for Eliminating Waste", *CRC Press*
- Jimmerson, C. - Weber, D. - Sobek, D.K. (2004): "Reducing Waste and Errors: Piloting Lean Principles at Intermountain Health Care" draft submitted to *the Joint Commission Journal on Quality and Safety*, 6/28/04. http://www.coe.montana.edu/ie/faculty/sobek/IOC_Grant/JCJQS_submit_rev2.pdf Date:2009.09.30.
- Karlsson, C. (2009): "Researching Operations Management", in: Karlsson, Christer (ed.) (2009): "Researching Operations Management", Routledge, pp. 6-41.
- Kim C. S. – Spahlinger D.A. – Kin J.M. – Billi J.E. (2006): "Lean health care: what can hospitals learn from a world-class automaker?", *Journal Of Hospital Medicine* Vol. 1, Issue 3, pp. 191-199;
- Kohn, Linda T. – Corrigan, Janet M. (eds.) (2000): „To Err Is Human: Building a Safer Health System” Committee on Quality of Health Care in America, Institute of Medicine,
- Laursen, M.L. – Gersten, F. – Johansen, J. (2003): „Applying lean thinking in hospitals – Exploring Implementation Difficulties”, *Center for Industrial Production, Aalborg University, Denmark* , <http://www.lindgaardconsulting.dk/pdf/altih.pdf> , 2008-06-12

Leape, L.L. (1994): „Error in Medicine”. *Journal of the American Medical Association*, Vol. 272, pp. 1851-1857. in: Natarajan, R.N. (2006), “Transferring best practices to healthcare: opportunities and challenges” *The TQM Magazine*, Vol. 18 No. 6, 2006, pp. 573-582

Mezőfi, M. (2007): „A sürgősségi ellátás, mint az akut jellegű ellátás filozófiája és gyakorlata”, *Nemzeti Egészségügyi Programok Kongresszus*, Budapest, Semmelweis Egyetem, 2007. márc. 21-23.

Miller, D. (ed.) (2005): “Going Lean in Health Care”, *Institute for Healthcare Improvement (IHI)*, Innovation Series 2005,
<http://www.ihl.org/IHI/Results/WhitePapers/GoingLeaninHealthCare.htm> , 2008-03-28

Natarajan, R.N. (2006), “Transferring best practices to healthcare: opportunities and challenges” *The TQM Magazine*, Vol. 18 No. 6, 2006, pp. 573-582

Nelson-Peterson DL, Leppa CJ (2007): "Creating an environment for caring using lean principles of the Virginia Mason Production System", *The Journal Of Nursing Administration*, Vol. 37 (6), pp. 287-294;

NHSIII (2007): „Going Lean into the NHS”, *National Health Service Institute for Innovation and Improvement*, Warwick

New, Steve – Cathpole, Ken – Kreckler, Simon – McCulloch, Peter (2008): „Application, evolution and synergy in operations innovation: the patient safety movement and the Toyota production system”, *proceedings of the 15th International annual EurOMA Conference*, June 15-18. Gröningen, The Netherlands

Powell, Cheryl (2009): "Akron Children's adopts lean operating strategies", *Acron Beacon Journal*, Monday, Apr 13, 2009,
<http://www.ohio.com/lifestyle/42889087.html>, 2009. 04. 22.

Proudlove, Nathan – Moxham, Claire – Boaden, Ruth (2008): “Lessons for Lean in Healthcare from Using Six Sigma in the NHS”. *Public Money and Management*, Vol. 28. Issue 1, pp. 27-34.

Raab, Stephen S. (2006): "Improving patient safety through quality assurance." *Archives Of Pathology & Laboratory Medicine* Vol. 130 (5), pp. 633-637;

Raab S.S, Grzybicki D.M, Sudilovsky D, Balassanian R, Janosky J.E, Vrbin C.M, (2006): "Effectiveness of Toyota process redesign in reducing thyroid gland fine-needle aspiration error." *American Journal Of Clinical Pathology*, Vol. 126 Issue 4, pp. 585-592;

Radnor, Zoe – Walley, Paul (2008): „Learning to Walk Before We Try to Run: Adapting Lean for the Public Sector”, *Public-Money & Management*, February, pp. 13-20.

Radnor, Z. – Walley, P. – Stephens, A. – Bucci, G. (2006): „Evaluation of The Lean Approach to Business Management and its Use in The Public Sector”, *Scottish Executive Social Research*, Edinburgh, UK

Rosen, L. (2004): "Applying industrial engineering practices to radiology", *Radiology Management*; Vol. 26, Issue 6, pp. 32-35;

Shah, R. – Ward, P.T. (2007): „Defining and developing measures of lean production.” *Journal of Operations Management* 25 (2007) 785-805

Shannon, R.P. - Frndak, D. - Grunden, N. - Lloyd, J.C. - Herbert, C. - Patel, B. - Cummins, D. - Shannon, A.H. - O'Neill, P.H. - Spear, S.J. (2006): "Using real-time problem solving to eliminate central line infections.", *Joint Commission Journal On Quality And Patient Safety*; Vol. 32, Issue 9, pp. 479-487

Sobek, D.K. - Jimmerson, C. (2003): „Applying the Toyota Production System to a Hospital Pharmacy," *Proceedings of the 2003 Industrial Engineering Research Conference*, Portland, OR

Sobek, D.K. - Jimmerson, C. (2006): "A3 Reports: Tool for Organizational Transformation," *Proceedings of the 2006 Industrial Engineering Research Conference*, Orlando, FL.

Spear, S. (2005): “Fixing Health Care from Inside, Today”, *Harvard Business Review*, September, pp. 78-91.

Taninecz, George (2009): „Best in Healthcare Getting Better with Lean: Mayo Clinic Division of Cardiovascular Diseases improving patient-flow processes.” http://www.lean-management-institut.de/fileadmin/downloads/HC_Mayo_Clinic_Lean_Final.pdf , 2009. 08. 27.

Wessnerr, David K. (2005): “Toyota System Helps Patients, Health Care”, *the Minneapolis Star Tribune* on June 18,
www.parknicollet.com/fullstory.cfm?objectid=A08EF9B3-A57E-6659-C8DF6891CE7A0E05
Downloaded: 2009. 08. 18.

Womack, J. – Jones, D. (1996): “*Lean Thinking*”, Simon and Schuster, New York, NY

Womack, J. P. – Jones, D. T. – Roos, D. (1990): *The Machine that changed the world*, Rawson Associates, New York

Young, T.P. – McClean, S.I. (2008): “A critical look at Lean Thinking in healthcare”, *Quality and Safety in Health Care*; Vol. 17. pp. 382-386.