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Process View on Pharmacy Operations

Managing Operations Strategically

Module Leader: Frantisek Liptak

Vladimir Patras

N0166764

I certify that this is entirely my own work and that all collaboration or material from other sources has been clearly attributed in accordance with the requirements of the module and the university regulations.

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This assignment is also available at: http://vpatras.blogspot.com/
Dr. Vladimir Patras (the author) can be reached at: vladimir.patras@alphapharma.eu

Abstract

This assignment is aimed to apply concepts of operations management such as lean thinking, theory of constraints and six sigma to pharmacy operations. The outcome are measures which should lead to efficiency gains.

Tight regulations applied in pharmacy sector must be considered in any analysis. Result is the fact that more of its constraints have external or political origin. Authors researching the topic agree on some vulnerabilities which face pharmacies now which are among others managing inventory, inadequate use of IT, failing marketing.

Inventory management and related issues of information system were analyzed as major constrain in this work. Two particular pharmacies were chosen for presentation of operations, basic economic figures involved and for the analysis. The analysis found that current methods of inventory management are inefficient and outdated, resulting in higher then needed inventory. Advantages of computer inventory management are presented by mathematical model and recommended as solution. The outcome of the analyses is expected more then twofold rise of Return on Investment (when real estate assets are considered separately). Information system was shown to be capable of further improvements. It is capable to manage substantial issues of patient safety what is nowadays problematic to handle satisfactory. Another way is to boost Just in Time capabilities in relation to customers.

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Introduction

Pharmacy Sector Overview

Pharmacy sector in Europe

The retail pharmacy sector across the European Union remains one of the last bastions of tight government regulations and widespread resale price maintenance (Schmidt, Pioch, 2001). Legislation was designed to prevent move toward competitive and marketing measures and to safeguard the pivotal role of the pharmacist within health care system. This in part correspond with prevailing self and professional image of pharmacists who have seen themselves as health-care professionals at the first place. Pharmacists are the only retailers professionally qualified to provide sound advice to their customers (Plummer, 2003). Professional independence and ability to provide unbiased advice are seen as substantial commitment to patients. The original intention of the regulations was also to protect pharmacies as businesses shaping local communities.

United Kingdom is model country that started to detach from tight regulation and become first place in Europe where substantial deregulation took place. This has been result of changing economic environment on one hand and the deregulation itself produced new market circumstances on the other. Pharmacies found themselves loosing market share in OTC products as these were allowed to be distributed in supermarkets. The supermarket retailers were capable to take advantage of economies of scale sales and offer products cheaper in some cases up to 20% (Schmidt, Pioch, 2004). Forming of

multiples is another consequence with independent pharmacy ownership falling from 68% to 51% in 2001 (Schmidt, Pioch, 2004). There is a clear shift from previously prominent position of healthcare professional associations to rise of lobbying power of general retail chains. Another source of competition has arisen as internet pharmaceutical retailers emerged. This channel of distribution is challenging the whole healthcare system as it is capable to provide customers with prescriptional medication without prescription (BBC News – Health, 2002).

Consumption of medicines is generally on rise. This trend is founded on two fundamental developments which are population aging and emergence of life-style trends focused on healthy living. While the first relates mainly to prescription drugs the later deals chiefly with nutritional supplements. Trend of self-medication is also evident. However, prices of medicines per package are falling. Prescription drug prices fallen 10 % between 1990 and 2000 (Euromonitor, 2003).This trend correspond to rise of generic market as protection period of many ethics expire and stellar R&D costs keep new potential active substances out of the market. Under growing healthcare costs state authorities are searching way how to cut drug costs and and they find solution in generic industry which deliver cheaper products.

Naturally this development has its implications on margins and returns. In most established markets number of pharmacies rose slightly during the last decade. According Germany's Bundesvreinigung Deutscher Apothekerverebände (ABDA) of

1999 survey 40 percent of all German pharmacies were making losses and only those above a turnover threshold of DM 2 m were clearly profitable

Authors engaged in economy/management of pharmacies research agree that following deficiencies should be tackled by management of pharmacies - inadequate IT embrace, failing inventory management, absence of strategic marketing (Schmidt, Pioch, 2001 Otewill et al, 2000).

On the other hand regulations that were originally intended to protect pharmacies against competitive environment can easily become business obstacle as illustrated on complicated issue of inventory management. The regulations apply on range of goods offered and prising. The relative lack of overt customer loyalty creates competitive pressures between pharmacies to ensure product availability at all times, thus potentially tying up much capital in stock. This is exacerbated by the large number of generic products and the legal obligation to select the cheapest. Therefore customers are unlikely to return if they do not find product that they seek. (Schmidt, Pioch, 2001)

Circumstances in Slovakia

In Slovakia the sector underwent dramatic development since fall of the communism in 1989. First step in 1990s was privatization of pharmacies (which were under communism owned by the state the same as other healthcare facilities). Number of pharmacies rose sharply throughout 1990s. Until 2003 only pharmacists were allowed to own pharmacy although there were legal possibilities to get around the restriction. In this time

companies are allowed to own pharmacies and series of acquisitions is forming multiple structures. Number of pharmacies is still rising but profitability is becoming serious issue in more competitive market.

Under current legislation tight regulation is in place. Technical requirements for construction of a pharmacy include minimal area (110 square meters), laboratory for preparation and inspection of medicines, pattern of division of the space. Prices of prescription medicines and OTCs are maintained by regulation. There are many provisions in the law that require pharmacy to provide particular services which include preparation of medicines, provide patient with medication needed within 24 hours (with some exceptions), provide customer with generic drug if preferred, report statistics on medicines consumption to state authorities, report adverse drug reactions. Beside this emergency services are ordered by local authorities and pharmacy also take burden of processing of prescriptions for health insurance companies. However, there is no limitation where pharmacy can be placed. Other retailers are not allowed to sell OTC products. It should be noted that law enforcement is not always effective in Slovakia. Many pharmacies do not prepare medicines because this is not profitable activity. OTC are sold at least by some internet retailers.

It is obvious that these requirements result in high input and fixed costs. There are similar market circumstances as in other European countries as described above. Selling medicines and payments from health insurance companies are only income for pharmacies. Slovak pharmacists can expect average net margin of 13 %.

Process View and Operation Management in Healthcare

Lean Thinking

Was born in Japan manufacturing. Its ideas are to focus on eliminating waste production and on customer value. Its design include among other things Just-in-Time (JIT), kanban method, and a high level of employee problem solving. Lean production is described in five elements: lean manufacturing, lean product, development, supply chain coordination, customer distribution and lean enterprise management (Womack et al., 1990). These principles has been widely applied since 1990s in many areas including service industry. According to Karlsson et al. (1995) the focus on zero defect, continuous improvements and JIT in healthcare makes lean production especially applicable. Other authors see this similarly when Young et al. (2004) argue that an obvious application of lean thinking in healthcare lies in eliminating delay, repeated encounters, errors and innappropriate procedures. These studies were performed with focus on hospital patient/customer care but it is clear that they are applicable in pharmacy care as well

. Interest in lean thinking can also be viewed and applied in framework of New Public Management concept as style originated in private sector and include orientation toward results, individual responsibility and flexible organizations, employment and personnel (McNulty and Ferley, 2002). According to Östergen and Sahlin-Andersson (1998) the

introduction of NPM tools have resulted in questioning of the professional`s strong influence on managing healthcare.

Theory of Constraints

Goldratt (1984) proposed the theory of constraints (TOC) as a scientific process for generic problem solving, particularly in manufacturing industries and it has been developed over the past 20 years (Bradbury-Jacob and McClelleand, 2001; Dettmer, 1997; Schienkopf, 1999). Operation management proposed in line with principles of TOC allow dramatic improvement in throughput without extra money/resources. In particular, TOC has simultaneosly increased throughput and reduced both operating expanses and inventory (Rand, 1984; Meleton, 1986; Chase et al., 1998, Miller, 2000).Steps proposed by Goldratt are summarized in chart 1 of the appendices. However, research case studies outside manufacturing are rare. Willcocks at al. Examined experiemce of John Radcliffe Hospital where TOC processes were applied in relation to forming of flatter multidisciplinary teams and wider embrace of IT system. The new structure was seen to be generally more efficient. Pickwood et al (1998) identified political constraints in the system and the difficulty of moving away from hierarchical, functional grouping to a matrix type of organization. He proposed that the setting need to be applied incrementally and selectively.

Six Sigma

It is clear that precision and "defect free" outcomes are neccessary condition in health care. The issue deal with wide range of tasks which include among others appropriate diagnosis, drug prescribing, managing side effects and drug interactions. This can be illustreted by the fact that medical errors are eight leading cause of death in the United States (Institute of Medicine, 1999). According to IOM between 44,000 and 98,000 Americans die each year from medical errors. The number surpass deaths from motor vehicle accidents or breast cancer (Crane and Crane, 2006). This question accuracy of the process involved and clearly call for search of assurance mechanisms in managing healthcare.

Six Sigma can belong to the tools for solving of the problem. Six sigma has been highly successful in application in many industries, its application in the healthcare industry is in its infancy. Its use in healthcare has been rather limited to business administration. Six sigma has not been widely applied to patient care. Studies show the US service industry, which include healthcare, has an average sigma level between 2.0 and 2.5 (Belmont, 2001). This corresponds to 158,700 to 208,500 errors per million cases. Estimated sigma of use of beta blockers is 1.0 (691,500 errors per milion). Antibiotic misuse is estimated to be 66,800 errors at sigma level of 3.0. These high numbers of errors suggest many areas of patient care could benefit from the process improvement outcomes achievable

through Six Sigma. Example of proposed use of Six Sigma is pictured in table 1 of the appendices.

Process Analysis – Case Study

Two particular pharmacies were chosen to be examined in this assignment in relation to strategic operations management. The focus is on inventory management and integrating role of IT system what is viewed as a major constraint. Where possible basic economic data illustrating the processes are presented.

The first pharmacy – named A in the assignment is one of the biggest in the town where it operates. It is chain pharmacy of multiple operating nation-wide and consisting of 19 pharmacies as of January 2007. The chain is new and expanding company founded two years ago. The chain use its own brand but do not use branding for products. The pharmacy consist of 7 employees. It is located near health centre.

The second – named B here is independently owned and operated pharmacy. It is located in the same region as A but in some larger city. Measured by turnover or number of employees (2 full time, 2 part-time) is considerably small. It is also located near to health centre but local constructions arrangements make it somehow difficult for customers to be reached.

Scaling the Business – Operations and Value Chain

Aim of this chapter is to present more detail view on pharmacy operations. It identifies which processes are crucial in creating customer value. This basic survey will present starting points to analyze the business constraints and base for lean thinking view. In general processes described apply to both pharmacies. Any significant specifics or differences are described if present. Basic pharmacy operations are sketched on picture 1 of the appendices.

From customer view pharmacy is a place where they can pick up their prescibed medicines, find advise and medication for basic health conditions. Two main services and customer value attributes can be identified as:

- Medicines dispensing (prescriptions), selling (OTCs, nutritional supplements, dietary food, medical material).
- Providing advise on health conditions.

Increasingly some additional services are provided by pharmacies which include wider stock such as baby food and other baby needs, wide range of cosmetics. This is a case of the A pharmacy which tries to hold wide stock and is credited as one of best equiped in the town. More rarely also further specialized services are offered by some pharmacies (not by A or B) which are measurement of blood pressure, cholesterol. Another proposed

but not widely applied service is keeping of "patient book". Aim of this action should be avoiding of drug interactions what is crucial problem related to patient safety. Process obstacles in establishing of "patient books" are: customers usually take prescriptions in various pharmacies, this function is not supported by IT systems recently, the service is not required by customers nor healthcare system. In both pharmacies prescription medicines count for decisive portion of turnover. At least in some cases time is customer value attribute. This apply especially in case the needed medicine is not on stock and have to be ordered. However lead times are short (~4 hours) compared to other branches of retailing and chance to utilize JIT as competitive advantage is limited.

In general variance in demand is low. Most chronically ill people take the same medication for years. Factors as seasonal demand change (like flu season), new product launch and advertising campaigns on a particular product are almost only source of short term variability in demand. With more then 4000 units in inventory range of products is wide. It can be said that inventory range belongs to market winning conditions. Average value of customer`s purchase (including value of prescription) is €15.

There is no substantial emphasis on innovation in pharmacy sector. Services offered remain similar for years. Wider stock offering and additional services are few innovations on product side. From process view also operations are very conservative and in principle not changed for years. The only but quite fundamental source of process innovation is onward application of IT. Because of its substantial role in process integration and as a

core driver of change IT issues will be extensively discussed bellow. IT is also used as key control tool.

Because of reasons introduced above pharmacies tend to hold inadequate large inventory with underlying effects on throughput. Beside inventory large amount of capital is bound to fixed assets. Inventory will be identified as constraint and solutions will be discussed. However, there are more possibilities how to increase throughput and make processes leaner. Inventory management present important process how to increase effectiveness in terms of return on investment. Also other actions performed that are laboratory medicines preparation, reverse logistics (of unused or expired medicines) and others will be reviewed.

There are some strategies aimed to utilize economy of scale and both pharmacies investigated here use some. It is based on the fact that small groups of patients contribute by large amount to total turnover. Furthermore as also prescribing of "valuable" prescriptions is also often concentrated with doctors of certain specialization (such as oncologists). This niche might be viewed as distribution channel where doctors play role of contractors. Pharmacy A which is member of nation-wide chain issue customer cards with 2% value bonus (which include value of prescription). Therefore patients with prescription of high value can actually take additional profit when they use earned bonus for buying of other products. Reversely this group is attracted by the provision. Pharmacy B, which is independently owned, find opportunities in formal contracts with institutions

like old`s people home, prison or unofficial agreements with crucial doctors. Without formal bases.(like customer cards) it also provide discount to some crucial customers.

Pharmacy (and especially the chain pharmacy) has features of bottom-up organization when viewed through process optics. There are formal requirements codified by law who can work in pharmacy. Although not explicitly written down, the law imply that pharmacy should be managed by "the professional guarantee" who is certified pharmacist with at least three years of experience. Prescription medicines can be dispensed by pharmacist with 5 year collage/university degree. OTCs and other stock can be sold and medicines be prepared by pharmacy technicians who have 4 years high school degree. Chain pharmacies employ also function of area manager who is superior to pharmacy manager. However, as pharmacies are able to operate independently area managers took rather tasks of coordination, mediation and information exchange between chain management and pharmacy staff. This structure has patterns of network formed organization what imply further importance of IT in integration of its operations. Pharmacies are dependent on some specialist support especially in accounting and IT. These tasks are usually outsourced. In case of pharmacy A internally from within of the organization and in the B from outside.

Inventory Management

Three months average inventory value of the pharmacies were €64,541 for pharmacy A and €34,476 for pharmacy B. This can be compared to average daily sales of €1,627 for A and €743 of B pharmacy. This is equal to average monthly sales of €49,623 of pharmacy A which is opened 7 days per week and €15,603 of pharmacy B opened 5 days per week. This is equal to average stock cycle of 40 and 46 days respectively. However, large volumes of dead stocks are present. Throughput can equal to sales as there are no directly variable costs. 17% margin was considered when calculating operating profit. When considering Return on Investment I propose that to include all assets excluding real estate (building in which the pharmacy is placed) is more appropriate to evaluate operations effectiveness. I think this is justified by the fact that real estate equity can viewed as capital investment and we can relate its value to real estate market fluctuations and indirectly to economic growth and inflation. Therefore it generate capital profit (equal to rise of real estate market) but this is not related to operations of the business. While the building present major asset (and also rise of its value would be major source of "profit") its inclusion (into ROI calculation) wold rather misrepresent the figure. By this manner calculated ROIs are 17.58% for pharmacy A and 11.00% for pharmacy B. All these figures are summarized in table 2 of appendices.

Reasons that lead to build up of huge inventories are the same as were explained above. Customers demand to buy everything needed at once. On the other hand it is dictated by presence of great variety of products on the market, generic substitution and unpredictability of medical doctor`s prescription patterns. Regulations which insist that essential medicines have to be available to patients all the time contribute to this. Also important factor is requirement of holding of laboratory for preparation of medicines as base materials belong to stocks with lowest turnover. From this point of view there are some given conditions and to some extent implications correspond to rational organizational.

We can easily find out what are crucial flows in creating inventories when observing the process how it is being performed now. Ordering is a manual process preformed by pharmacy technicians. According to their guesstimates they create list of sold and demanded products. This list is reported by telephone to operator of medicines supplier. Orders are made usually two or three times per day in pharmacy A and one or two times per day in pharmacy B.

Evident deficiencies of the method are:

- Calculations of optimal inventory can not be made accurately
- The method is extreme error prone in each step of its creating and processing
- The method is extremely time-consuming
- It brings processing costs to supplier without creating customer value

However, there are also some implications that are not visible at the first sight and play a substantial role. It is important to understand bottom-up structure of the organization and pharmacy technician`s key role in running the pharmacy as they control the order flow and therefore inventory build-up. It is not surprising that they are creating orders that to the best fit their interests. As pharmacy technicians are responsible for delivered goods processing they prefer to take larger batches what is more comfortable for them. The scale of another consequence is even harder to ascertain without deeper analysis. Pharmaceutical companies dealers in their effort to increase their sales try to influence key persons in the sales chain. Medical doctors are naturally primer figures of their interest. Pharmacy order makers are also important and especially in case of OTC products. Offering free samples by dealers is a common provision and an easy way how to corrupt technician responsible for order-making. Because of this reason stocks of products that are being launched as new products or undergoing advertising campaigns can be found in inadequate large quantities in the inventory and their return rate subsequently fall. Minimal value of order (for the supplier) is not limiting factor as it is about €100 (~7% of average daily turnover). What is important supplier do not charge fee for delivery. In same cases products are offered by dealers in lower prices for higher quantities but also in this cases any calculation of efficiency of the order is not performed. This kind of order can be beneficial for the pharmacy. Other kind of discounts present offers by suppliers usually given as discount in percent bind to minimal value of order. This kind of discount is common and also commonly utilized. The interesting fact

worth of remark is that this provision is another of many which strongly favor pharmacies with high turnovers.

Lets now sketch how inventory management should be. According to Dubelaar et al., 2001) can be optimal (safety) stock (SS) calculated as:

$$SS = k*(t*sr^2 + st^2 *r^2)^{1/2}$$

where k = service level objective

t = average lead time

sr = standard deviation of demand

st = standard deviation of lead time

r = average demand or usage rate

It is important to notice that lead times (and lead time deviations) are general low (approx. 2-4 hours) in case of pharmacies. It has been observed that greater product variety result in higher inventory levels (Dubelaar et al., 2001). A strategic retail decision involves the level of customer service the firm plans to provide. By increasing stock levels, a store generally provides higher service levels to its customers. Service level increases with inventory at an exponential rate and can be described as:

$$SL = 1 - e^{-I/B}$$

where B = a regression parameter

I = inventory

e = eugenvalue = 2.14

Therefore if demand is assumed to follow a normal distribution, then service increases with stock at a decreasing rate – and (theoretically) an infinite amount of inventory is needed to assure a perfect 100 percent service levels.

As mentioned above sources of demand variability are limited in this case. This approach is able to handle uncertainty resulting from prescription patterns of doctors as it incorporates standard deviation of demand. Remaining demand uncertainties are seasonal variations and new products launch. However, this affect small portion of inventory.

There is an inventory log shown in table 3 to demonstrate effects of manual ordering. The method resulted in average of 9.62 in case of product Nutrolin B, 60ml at daily average sales of 0.62 and SD of 0.85. In case of Oscillococcinum cycle stock was even longer. Safety stock values were calculated for the pieces and they are 3 for Nutrolin B, 60ml and 2 for Osciloccocinum (compared to 10.81 actual stock). SS values were calculated for 7 stock pieces and resulted in figures between 15 and 65 % of actual stock with 35% average. We can assume that inventory can be 35 % of its actual size if computer operated without higher delivery costs, little bit higher processing costs and

eliminating errors and time of manual ordering. If this applied we can calculate (computer operated) inventory value for €22,598 of A pharmacy and €12,066 in pharmacy B. This produce ROI values of 40.51% and 24.96% respectively.

The fact is that automated ordering including calculation of optimal inventory value is incorporated in most of recent inventory management information systems. This computer generated order can of course be supplemented manually and recent suppliers IT system enable to inform in time which piece of stocks are accessible. The function is also included in program “Pharmacy” which is used by pharmacy A. Despite this fact the feature is not used there. The only explanation of this state is that managerial incompetence which stems from IT illiteracy, unawareness of basic managerial concepts fetter overall company effectiveness.

Information System

Information systems can be seen as rare instrument of innovation in pharmacy operations that enabled great degree of automation in pharmacy processes. It cover areas of inventory management, accounting, prescription processing and partially incorporates features of health counseling. However, when comparing scale of pharmacy operations and technological possibilities we can find currently used information system rather as constraint. Here are two examples which could result in delivering higher value if applied.

Patient Safety

There is no doubt that patient safety is crucial issue and customer value driver. As shown above there are considerable chance to improve processes involved in patient safety and make them less error-prone. In general there is low emphasis on system approaches to reducing medical errors between both medical professionals and general public. This is in sharp contradiction to approaches applied in other industries such as aviation or automobile industry. However, it is clear that most medical errors are largely preventable (Meadows, 2003) and IT is a key.

What is important to realize is that many drugs interact each with another affecting final treatment effect and leading to adverse reactions. Mechanisms of these interactions are largely known. However, nature of these information is often very complex. An example can be interaction by binding on plasma proteins. One drug can displace another from bind to plasma protein resulting in higher plasma level what correlates to more potent effect (and adverse reactions) as expected. As binding to plasma protein is determined by chemical (not biological) features of drug it produce extensive "table list" of values on interactions that need to be handled by machine. Furthermore individual differences between people play a role. For example older people posses less body fluids and plasma proteins then the younger ones. It means drug interactions are dependent on age, body weight and other factors. There are few thousands of active substances/drugs available on market and its combinations result in enormous number of possible interactions. Naturally pharmacists are educated in drug interactions and should be able to detect most common cases. It is clear that their objective limitations lie in extent and complexity of the issue which need to be handled by integrating IT system.

Recent information systems used in community pharmacies in Slovakia do not use any features tackling drug interactions or other prescription errors. Interactions are also not priority for pharmacists simply because of many tasks in their work. In fact doctors usually do not have sufficient information what medication is particular patient using (when the patient is treated by more specialist at the same time). Because of this reason

and specific pharmacists skills pharmacy is the best place for examination of drug interactions. However, two measures are necessary implementation:

- The first is obvious – integration of data on drug interactions into information systems applied.
- The second is more complex – it need integration of information channels of prescriptioners and pharmacists. It is of course necessary to know for person who takes examination what are all medicines taken by the patient. Mean of this is electronic prescription and electronic medical record with all relevant data should be included – such as body medication, weight, age, allergic conditions in medical history, laboratory tests etc.

It is clear that construction of system of this kind is technologically possible now although costly. According to IOM (1999) medical errors results in costs of $37 billion each year in the US. However, there is considerable opposition against electronic prescribing between medical professionals (pharmacists) as primarily driven by fear of it would present opportunity for internet retailers.

Just in Time

There are further feasibilities on directions of information system integration. While its integration toward doctors as prescriptioners another possible and required is direction

toward customers which would foster JIT approach. There is opportunity for pharmacists to integrate internet retailing with existing outlets. One possibility is offering of nutritional supplements that are not legally limited in internet sales. But another, what is already done in the UK, offer to order prescription medicine that is not normally hold in stock and expedite it when customer visit the pharmacy. This create customer value as shorter time is necessary for delivery and on the other hand present lean solution for pharmacy inventory management.

Conclusions

When evaluating processes involved in pharmacy operations apparent regulatory burden with its fundamental implications must be considered. Pharmacies are by law required to provide some services that may not be economical. Regulations covering price maintenance lead to limited possibilities of marketing actions. On the other hand pharmacies are becoming pressured as margins lower. Rising number of pharmacies and also emergence of new distribution channels as supermarkets and internet retailers results in changing environment into much more competitive one. Also this is a base for searching for ways how to turn operations into more effective processes.

Pharmacies have clearly some strong primacies thanks tor strong professional orientation in their services – counseling and providing medicines to customers. However, when facing changes of business environment they were found to be vulnerable in some positions – marketing, managing inventory, efficient use of IT systems and others. These and some other issues have been identified as constraints that suppress effectiveness of processes and throughput. This assignment is focused on inventory management as part of operations which conduct can be relatively easily turned into much higher efficiency through simple measures. Also in this relation issues of IT systems is discussed and viewed through principles of six sigma approach and effort to make the system more reliable. This relate to substantial issues of patient safety and system openness to customers what is beneficial for both sides. As expected in regulated business some constraints stems from outside of pharmacies operations and also solutions of these constraints need to be found in elsewhere

Two pharmacies of different kind but from the same region were examined and compared in their operations and basic economical data. Both of these suffered of common pharmacies problems with inadequate large inventories and long stock cycles. These problems were found to be related to manual ordering. This method suffer from severe shortcomings which are: there is not rationally set optimal value of stock in inventory, the method is extreme error-prone, time and resources consuming. Additionally there are some system reasons why the persons responsible for ordering do not create orders best fitting pharmacy needs as the same employees are responsible for

delivered goods processing and in ordering larger batches find a way how to reduce labor needed for the processing. Mathematical model for optimization of inventory levels through safety stock and service levels is presented in the assignment and applied in examples from the pharmacies. Switch to electronic ordering is presented as solution. This feature is integrated in information system used in the pharmacies and therefore no additional costs are required for change. Mathematic examples illustrate that this would lead to higher throughput and return on investment. Based on estimate of examined sample inventory could by reduced up to 35% resulting when computer operated bringing significant gain of ROI – for pharmacy A from 17.58% to 40.51% (assumed real estate assets are not included). The B pharmacy could improve from 11.00% to 24.96%.
Beside advantage of higher efficiency through better inventory management it would lead also to direct savings as by use of electronic data exchange compared to manual ordering.

It is well known that medical errors are relatively common problem related to medical treatment. Statistics show alarming numbers with medical errors as eight leading cause of death in the US. Despite knowledge of this problem and availability of solutions it seems it remains underestimated. This has never been prime issue of professionals in healthcare managing positions nor professional associations. This work present IT as key in finding the solutions. Integrating capabilities of information systems are becoming apparent with networking. Key problems in solving medical errors is complexity of information involved and lack of coordination or multidisciplinary team approach. These are manageable by by current technological possibilities. Instruments in achieving the goal is

establishing of electronic prescription and electronic medical records. Because of its central role pharmacy is most suitable place which can integrate the processes and by this perfect its position in healthcare system. Information system is further explored as mean of Just in Time delivery what has already been applied in some cases. Changes in information system can be viewed as borderline issue as it is not applicable solely inside of pharmacies without cooperation with software producing companies. Approach in which IT is considered as momentous instrument in solving many problems of the sector can be illustrated by Schmidt, Pioch (2004) citation: "Arguably the use of email preordering, electronic and repeat prescribing and touch screen provision of health information could be precisely the tool which would enable the community pharmacist to manage time much more flexibly and be able to provide advice services rather then being tied to the dispensary because of queues"

The last domain are clearly political constraints. It is not surprising to find them in regulated sector. The principal ambiguity can be disproportion between deregulation on one hand and persisting requirements to provide some uneconomical services which are essential in healthcare system. It is clear that solutions are as well political. Deregulation in areas that would acquit pharmacies and enable them broadly apply market mechanisms is one possible way. Of course not everyone would profit from this approach and appropriate compensations for services offered in public interest can be the other one. However, it seems there is an agreement what direction services offered in pharmacies should be focused. There is emphasis on counseling and beyond. Recently pharmacists in

the UK became involved in prescribing of drugs. Professionalism is recognized as base for pharmacy services and therefore sustainable competitive advantage should be based upon it. The sequence from product through service toward "solution" (picture 2) is generally accepted in both business operational theory and by thinkers focused on medical services (Smecka, Kolar, 2000).

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Appendices

Chart 1: Stages of TOC application according to Goldratt

TOC application to the operational environment

1. Identify the constraint. Every system has a constraint/bottleneck. This is the weakest link that limits the system in some way. The system`s effectiveness is defined by the rate of the weakest link, and these can vary from physical bottleneck such as machines or equipment that have the least capacity in the system, or policy, or behavorial constraints and external constraints that are outside the system
2. Get the most out of the constraint. There are several ways in which the effectiveness and efficiency of the constraint can be exmined.
3. Support the constraint through subordinating the non-constraints to the constraint. In this step, the non-constraint machines (i.e. The vast majority in the system) are subordinated to the constraint machine.
4. Elevate the constraint. The fist three steps mainly focus on changing the way the constraint is used without spending money.
5. Go back to step 1. Goldratt argued that TOC was an iterative process of improvement. Introducing the steps described earlier ussually means that another point in the system becomes the constraint. Therefore, you need to re-evaluate and hit the next constraint by going back to step 1.

Lubitsch et al. (2005)

Table 1: Six Sigma model

Six Sigma stages applied to the Six Sigma model for improving patient safety	
Six Sigma stages	Application to Six Sigma model for improving patient safety
Identification	Understand customer expectations
	Develop high quality standards that include patient safety
	Identify key patient safety processes
Characterization	Define patient safety goals using JCAHO Sentinel Event Policy
	Procure data to understand key patient safety processes
	Create an action plan to narrow the gap between existing and desired level of patient safety
Optimization	Identify key sources of variation in patient safety processes
	Control variables contributing to adverse events
	Improve the key patient safety processes
Institutionalization	Determine the collective results of each process improvement
	Integrate Six Sigma principles into decision making
	Create a high quality, patient focused organizations

Revere et al. (2004)

Picture 1: Fundamental pharmacy operations

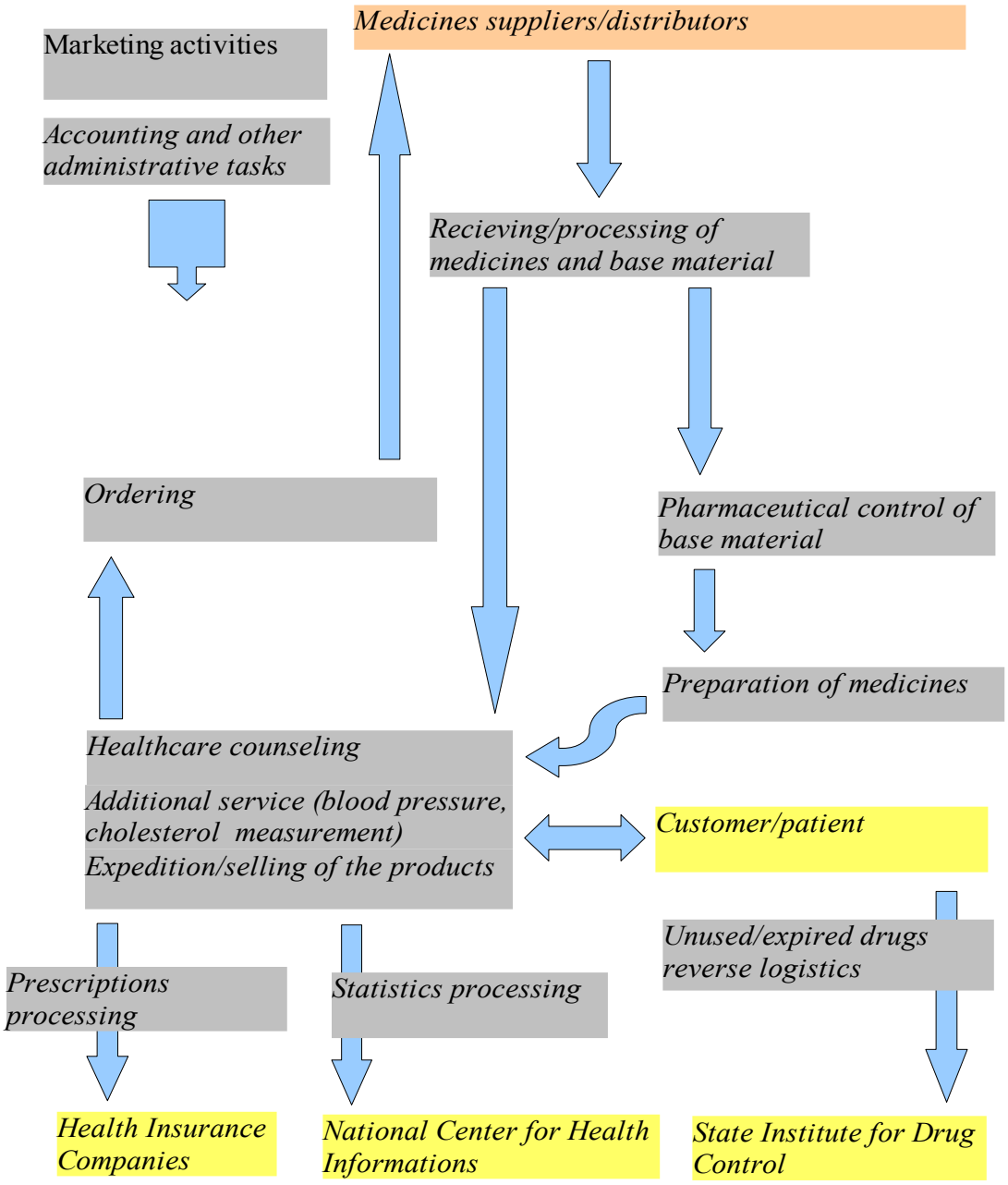


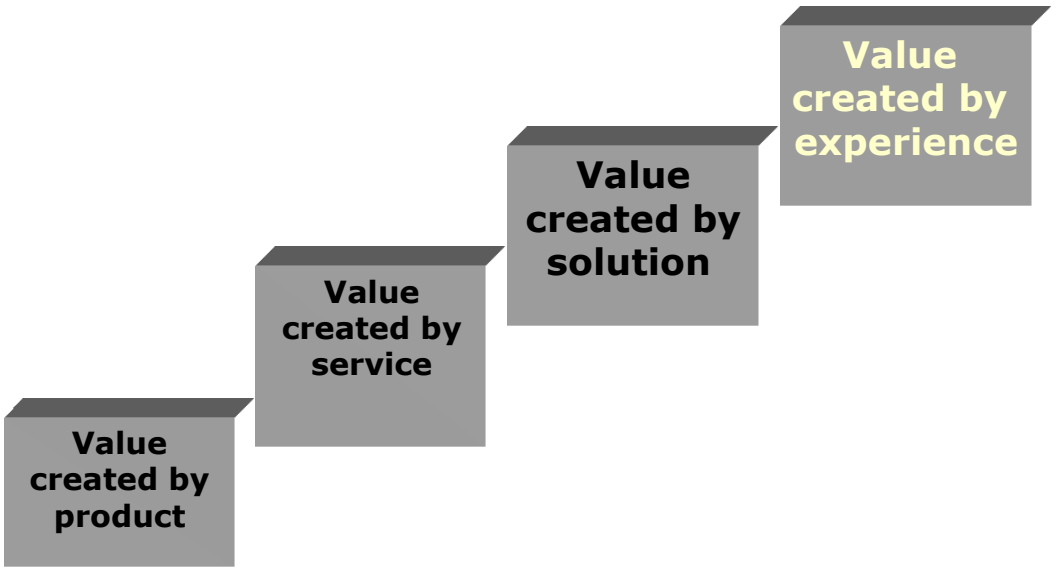
Table 2: Basic economic indicators of the pharmacies, figures in Euros

	A	B
Sales per month (Throughput)	49623	15603
Inventory	64541	34476
Average stock cycle (days)	39.67	46.4
Investment (incl building)	209570	118740
Investment (excl building)	9570	5600
Margin (17%)	8435.91	2652.51
Operating expanses	7350	2285
Operating profit (per month)	1085.91	367.51
Operating profit (per year)	13030.92	4410.12
Return on Investment (excl building) in %	17.58	11.00

Table 3: Inventory stock log

	Nutrolin B, 60 ml		Oscillococcinum	
Date	Stock	Sales	Stock	Sales
10/23/06	13	1	10	0
10/24/06	12	1	10	0
10/25/06	12	0	10	0
10/26/06	11	1	10	0
10/27/06	11	0	9	1
10/28/06	8	3	9	0
10/29/06	8	0	14	0
10/30/06	6	2	14	0
10/31/06	6	0	14	0
11/01/06	5	1	14	0
11/02/06	10	0	14	0
11/03/06	10	0	12	2
11/04/06	9	1	12	0
11/05/06	9	0	12	0
11/06/06	9	0	12	0
11/07/06	9	0	12	0
11/08/06	9	0	12	0
11/09/06	9	0	11	1
11/10/06	7	2	10	0
11/11/06	6	1	10	0
11/12/06	6	0	10	0
11/13/06	5	1	10	0
11/14/06	15	2	8	2
11/15/06	15	0	8	0
11/16/06	15	0	8	0
11/17/06	15	0	6	2
Av	9.62	0.62	10.81	0.31
SS	3		2	

Picture 2: Sequence of value creation



Sebo (2006)

Tutor (Jan Sebo) comments on the assignment according the selected criteria:

Criterion 1: Assignment objective and problem definition
Author sets the assignment objective clearly and directly, whilst the fulfilling of the objective is present in every part of the assignment. Problem is defined accurately and explicitly with clear focus on searching form improvements in Inventory management of selected pharmacies.

Criterion 2: Assignment methodology and processes of solution
Author determines suitably the process of problem solution through exactly defined theoretical approaches of TOC methodology with support of inventory management approaches. Some reservations could be assigned to the opening area for six sigma approach, which was mentioned in the text but no analysis and no work with this approach appears in the assignment.

Criterion 3: Using the literature and theoretical approaches
The use of literature as well as the choice of theoretical approach to problem solution in the assignment is evaluated highly positive, and with regard on the set objective and defined problem author has chosen suitable theoretical approaches and sufficient range of the study literature. Author demonstrates his ability to critically examine theoretical postulates with clear focus on problem solution.

Criterion 4: Analyses and suggestions
Author demonstrates high ability to apply theoretical approaches and to solve identified problem. Smaller lack of the assignment is in the depth of the solved problem and managerial processes concretization with graphical illustration of suggested solution. The small weakness of the assignment is the analysis of processes only with the economic and financial date concerning inventory. Stronger focus on processes would allow author to draw more relevant conclusions including exact definition of processes after introduction of managerial approach toward inventory management and IT solutions.

Criterion 5: Formal requirements of the assignment
Formally, the assignment is of high level and contains all essential requirements, whilst the layout remains clear and understandably organised. Generally, the assignment can be evaluated as high-quality work demonstrating authors knowledge of theoretical approaches and practical application with deep understanding of analyzed environment.