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Dear Readers, Authors and Friends of the Foundation of Management – our wish is the interdisciplinary perception and interpretation of economic phenomena that accompany the managers and enterprises in their daily work, in order to make them more efficient, safe and economic for suppliers and receivers of the products and services in the global world of technological innovation, domination of knowledge, changes of the value of money and constant market game between demand and supply, future and past.

We would like for the Foundation of Management to promote innovative scientific thought in the classical approach towards economic and engineering vision of the managerial sciences.

The Guardian of the journal's mission is its Programme Committee, which participants of which will adapt to current trends and as an answer to the changing economic and social challenges in the integrating Europe and World.

Tadeusz Krupa

CONTENTS

Anna ŁAWRYNOWICZ

GENETIC ALGORITHMS FOR SOLVING SCHEDULING PROBLEMS
IN MANUFACTURING SYSTEMS7

Jarosław DOMAŃSKI

THE ANALYSIS AND SYNTHESIS OF STRATEGIC MANAGEMENT RESEARCH
IN THE THIRD SECTOR FROM EARLY 2000 THROUGH TO MID-200927

Agnieszka HERDAN, Katarzyna SZCZEPAŃSKA

DIRECTORS REMUNERATION AND COMPANIES' PERFORMANCE
THE COMPARISON OF LISTED COMPANIES IN POLAND AND UK41

Anna KOSIERADZKA, Urszula KAŁOL, Anna KRUPA

THE DEVELOPMENT OF PRODUCTION MANAGEMENT CONCEPTS55

Sławomir JANISZEWSKI

PRINCIPALS OF FINANCIAL MODELLING75

Katarzyna SZCZEPAŃSKA, Patryk GAWRON

LOYALTY PROGRAMS EFFECTIVENESS89

Jakub WOJNAR

MULTICRITERIA DECISION MAKING MODEL FOR THE NEW TEAM MEMBER SELECTION
BASED ON INDIVIDUAL AND GROUP-RELATED FACTORS103

GENETIC ALGORITHMS FOR SOLVING SCHEDULING PROBLEMS IN MANUFACTURING SYSTEMS

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Abstract: Scheduling manufacturing operations is a complicated decision making process. From the computational point of view, the scheduling problem is one of the most notoriously intractable NP-hard optimization problems. When the manufacturing system is not too large, the traditional methods for solving scheduling problem proposed in the literature are able to obtain the optimal solution within reasonable time. But its implementation would not be easy with conventional information systems. Therefore, many researchers have proposed methods with genetic algorithms to support scheduling in the manufacturing system. The genetic algorithm belongs to the category of artificial intelligence. It is a very effective algorithm to search for optimal or near-optimal solutions for an optimization problem. This paper contains a survey of recent developments in building genetic algorithms for the advanced scheduling. In addition, the author proposes a new approach to the distributed scheduling in industrial clusters which uses a modified genetic algorithm.

Keywords: manufacturing system, scheduling, genetic algorithm, genetic algorithms for the advanced.

1 Introduction

Scheduling problem is an assignment problem, which can be defined as the assigning of available resources (machines) to the activities (operations) in such a manner that maximizes the profitability, flexibility, productivity, and performance of a production system (Prakash et al. [49]). Scheduling of operations is one of the most critical issues in the planning and managing of manufacturing processes. The literature review indicates that meta-heuristics may be used for the advanced scheduling in manufacturing systems and the genetic algorithm is one of the meta-heuristics that has attracted many researchers. Therefore, the main objective of this paper is to present a survey of the recent developments of evolutionary-based methods for the advanced scheduling. The author has to arbitrarily select the most representative work known to them, because it is impossible to provide an exhaustive literature review discussing every piece of work that has been done over the years.

The survey is structured in the following way. At the beginning, an introduction to evolutionary algorithms is presented in Section 2. Section 3 contains an overview of recent developments in building the genetic algorithms for the advanced scheduling. This survey categorizes the literature according to shop environments, including parallel machines, flow shop, permutation flow shop, job shop, flexible job shop, open job

shop, and others. In Section 4, the author proposes a new approach to the distributed scheduling in industrial clusters which uses a modified genetic algorithm. Finally, a discussion on the current research status and most promising paths of future research is presented in Section 5.

2 Genetic algorithm

The genetic algorithm (GA) belongs to the category of evolutionary algorithm. Evolutionary Algorithms (EAs), a class of heuristic search techniques inspired to survival-of-the-fittest Darwinian evolution principles, work iteratively on a population of candidate solutions of the given problem. The Darwinian metaphor is transformed in a stochastic search algorithm in which genetic crossover, mutation and selection processes are emulated with specific mathematical operators. Unlike some other efficient meta-heuristics, EAs are flexible and therefore they have been successfully applied to many single and multi-objective optimization problems.

Evolutionary algorithms have three instantiations: genetic algorithms (GAs), evolutionary programming (EP), and evolution strategies (ESs). Among them, genetic algorithms are probably the most well known and widely used (Guang and Hong [26]).

Genetic algorithms are probabilistic search algorithms, which mimic biological evolution to produce gradually

better offspring solutions (Ying-Hua and Young-Chang [59]). Each solution to a given problem can be encoded by a chromosome that represents an individual in a population. Each chromosome is made up of a sequence of genes from a certain alphabet. The alphabet can be a set of binary numbers, real numbers, integers, symbols, or matrices (Goldberg [25]). The representation scheme determines not only how effective the problem is structured, but also how efficient the genetic operators can be used. The population is evolved, over generations, to produce better solution to the problem. The evolution of the genetic algorithm population from one generation to the next is usually achieved through the use of three operators that are fundamental in GA: selection, crossover, and mutation. The cycle of evaluation-selection-reproduction is continued until a termination criterion is reached. J.H. Holland in 1975 first described a GA, which is commonly called the classical genetic algorithm (CGA).

2.1 Procedure of the classical genetic algorithm

The overall procedure of the classical genetic algorithm is outlined below.

Procedure: Classical genetic algorithm (CGA)

Begin:

$t \leftarrow 0$;

initialise population $P(t)$;

evaluate $P(t)$;

While (not termination condition) do

Begin

$t \leftarrow t + 1$

select $P(t)$ from $P(t - 1)$

recombine $P(t)$ by crossover and mutation;

evaluate $P(t)$;

End;

End.

The genetic parameters, namely number of generation, probability of crossover, probability of mutation, are optimised relating to the size of problems.

In general, there are need the following basic components to implement an evolutionary algorithm in order to solve a problem (Carlos and Coello [6]):

- 1) a representation of the potential solutions to the problem;
- 2) a way to create an initial population of potential solutions (this is normally done randomly, but deterministic approaches can also be used);

- 3) an evaluation function that plays the role of the environment, rating solutions in terms of their “fitness”;
- 4) a selection procedure that chooses the parents that will reproduce;
- 5) evolutionary operators that alter the composition of children (normally, crossover and mutation);
- 6) values for various parameters that the evolutionary algorithm uses (population size, probabilities of applying evolutionary operators, etc.).

2.2 Representation

In ordering problem using the genetic algorithm, critical issue is developing a representation scheme to represent a feasible solution. As mentioned above genetic algorithms work with a population of potential solution to a problem. A population is composed of chromosomes (i.e. a string), where each chromosome represents one potential solution. Traditional binary vectors used to represent the chromosome are not effective in such a large-scale dimension. During the last years, the following nine representations for the job-shop scheduling problem have been often proposed: operation-based representation, job-based representation, preference list-based representation, job pair relation-based representation, priority rule-based representation, disjunctive graph-based representation, completion time-based representation, machine-based representation, random keys representation and others. A tutorial survey of job shop scheduling problem using different representation in genetic algorithm has been published by Cheng et al. [13].

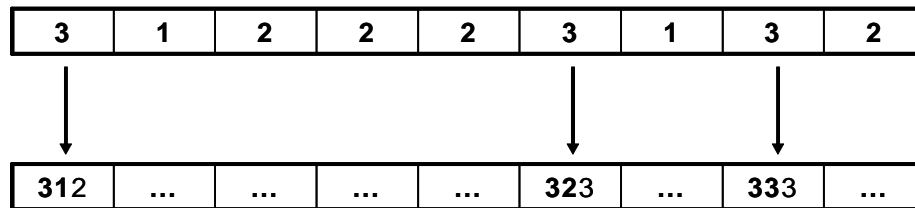
The most popular encoding methods are operation-based representation, job-based representation and random keys representation which are presented below.

• Operation-based representation

In the scheduling problem, the popular representation is operation-based method. This representation encodes a schedule as a sequence of operations and each gene stands for one operation. One natural way to name each operation is using a natural number. A schedule is decoded from a chromosome with the following decoding procedure (Cheng et al. [13]): (a) firstly translate the chromosome to a list of ordered operations; (b) then generate the schedule by a one-pass heuristic based on the list. The first operation in the list is scheduled first, then the second operation, and so on. Each operation is allocated in the best available time for the corresponding machine the operation requires.

Table 1. Example of 3-jobs and 3-machines
(source: own study)

| Job | 1 | | | 2 | | | 3 | | |
|-----------------|---|---|---|---|---|---|---|---|---|
| Operation | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Processing time | 2 | 5 | 3 | 4 | 3 | 2 | 2 | 3 | 4 |
| Machine | 1 | 2 | 1 | 3 | 1 | 2 | 2 | 3 | 3 |

Figure 1. Operation-based representation
(source: own study)

| M | GANTT CHART | | | | | | | | | | | |
|----------|-------------|---|-------|---|-------|-------|---|-------|---|----|----|--|
| 1 | 1/1/1 | | | | | 2/2/1 | | 1/3/1 | | | | |
| 2 | 3/1/2 | | 1/2/2 | | | | | 2/3/2 | | | | |
| 3 | 2/1/3 | | | | 3/2/3 | | | 3/3/3 | | | | |
| Time | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| Makespan | | | | | | | | | | | | |

Figure 2. Decoded active schedule
(source: own study)

The process is repeated until all operations are scheduled. As an example, consider the 3-job 3-machine problem given in Table 1. Suppose a chromosome is given as [3 1 1 2 2 3 1 3 2]. Each gene uniquely indicates an operation, and can be determined according to the order of occurrence in the sequence (see Fig. 1). Let o_{jim} denote the i th operation of job j on machine m . The chromosome can be translated into a unique list of ordered operations of $[o_{312} o_{111} o_{122} o_{213} o_{221} o_{323} o_{131} o_{333} o_{232}]$. Operation o_{312} has the highest priority and is scheduled first, then o_{111} , and so on. The resulting active schedule is shown in Fig. 2

- Job-based representation

The popular encoding method is also the job-based representation. This representation consists of a list of n jobs and a schedule is constructed according to the sequence of jobs. For a given sequence of jobs, all operations of the first jobs in the list are scheduled first, and then the operations of second job in the list

are considered. The first operation of the job under treatment is allocated in the best available processing time for the corresponding machine the operation requires, and then the second operation, and so on until all operations of job are scheduled. The process is repeated with each of the jobs in the list considered in the appropriate sequence.

Consider the 5-job 3-machine problem given in Table 2. Suppose a chromosome is given as [5 4 2 3 1]. The first job to be processed is job 5. The operation precedence constraint for job 2 is $[m_1 m_2 m_3]$ and the corresponding processing time for each machine is [2 3 4]. Firstly, the operations of job 5 are scheduled. Then the job 4 is processed, its operations precedence among machines is $[m_3 m_1 m_2]$ and the corresponding processing time for each machine is [2 4 2]. Next, the jobs 2, 3 are processed. Lastly, the operations of job 1 are scheduled as shown in Fig. 3.

Table 2 Example of 5 job on 3 machine
(source: own study)

| Job | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | |
|-----------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Operation | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Processing time | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 4 | 2 | 2 | 3 | 4 |
| Machine | 3 | 1 | 2 | 3 | 1 | 2 | 2 | 1 | 3 | 3 | 1 | 2 | 1 | 2 | 3 |

| M | GANTT CHART | | | | | | | | | | | | | | |
|----------|-------------|---|-------|---|---|-------|-------|---|-------|-------|-------|----|----|-------|----|
| 1 | 5/1/1 | | 4/2/1 | | | 2/2/1 | | | 3/2/1 | | 1/2/1 | | | | |
| 2 | 3/1/2 | | 5/2/2 | | | | 4/3/2 | | | 2/3/2 | | | | 1/3/2 | |
| 3 | 4/1/3 | | 2/1/3 | | | 5/3/3 | | | 1/1/3 | | 3/3/3 | | | | |
| Time | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Makespan | | | | | | | | | | | | | | | |

Figure 3. Jobs scheduling
(source: own study)

- Random key representation

Random key representation encodes a solution with random number (Chen and Ji [11]). These values are used as sort keys to decode the solution. For n-job m-machine scheduling problem, each gene (a random key) consists of two parts: an integer in set $\{1, 2, \dots, m\}$ and a fraction generated randomly from $\{0, 1\}$. The integer part of any random key is interpreted as the machine assignment for that job. Sorting the fractional parts provides the job shop sequence on each machine.

The rest of this paper presents a brief review of the literature which includes different encoding methods.

2.3 Fitness function

The newly created individuals are evaluated and assigned fitness values. Then, either all or only a subset of the current population is replaced by these new individuals. Thus, the evaluation includes compute fitness value, which is a measure of how well the individual optimizes the function. Test each individual uses the objective function. In other word, the fitness value is used to determine the selection probability for each chromosome. In proportional selection procedure, the selection probability of a chromosome is proportional to its fitness value. Hence, filter chromosomes have higher probabilities of being selected to next generation.

2.4 Crossover operator

Crossover is an operation to generate a new chromosome (i.e. child or offspring) from two parents. It is the main operator of GA. During the past years, various crossover operators had been proposed such as partial-mapped crossover (PMX), order crossover (OX), cycle crossover (CX), position-based crossover, etc. The two most popular crossover operators are partial mapped crossover (Liaw [32], Moon et al. [42]) and order crossover [Arroyo and Armentano [2], França et al. [18], Jolai et al. [29]).

- Partial mapped crossover

Partial mapped crossover was proposed by Goldberg and Lingle [24]. It can be viewed as a variation of two-cut-point crossover that incorporates a special repairing procedure to resolve possible illegitimacy. PMX has the following major steps:

- 1) select two cut-points along the string at random; the substrings defined by the two cut-points are called the mapping sections;
- 2) exchange two substrings between parents to produce proto-children;
- 3) determine the mapping relationship between two mapping sections;
- 4) legalize offspring with the mapping relationship.

- Order crossover

Order crossover was proposed by Davis (17). It can be viewed as a kind of variation of PMX that uses a different repairing procedure. OX has the following major steps:

- 1) select a substring from one parent at random;
- 2) produce a proto-child by copying the substrings into the corresponding positions as they are in the parent;
- 3) delete all the symbols from the second parent, which are already in the substring; the resultant sequence contains the symbols the proto-child needs;
- 4) place the symbols into the unfixed positions of the proto-child from left to right according to the order of the sequence to produce an offspring.

A survey of order crossovers can be found in the work of Cheng et al. [14].

2.5 Mutation

Mutation is used to produce perturbations on chromosomes in order to maintain the diversity of population. In the literature, two main types of mutation operators named inversion mutation and insertion mutation are used (Zhang et al. [61]). Inversion mutation serves to maintain the diversity in population. Insertion mutation is used not only to produce small perturbations but also to perform intensive search in order to find an improved offspring. Inversion mutation and insertion mutation act on half of the population, respectively. The mutations are described as follows:

- inversion mutation inverts the substring between two different random positions,
- insertion mutation selects two elements randomly and inserts the back one before the front one.

2.6 Selection

Selection is another important factor to consider in implementing GA. It is a procedure to select offspring from parents to the next generation. According to the general definition, the selection probability of a chromosome should show the performance measure of the chromosome in the population. Hence a parent with a higher performance has higher probabilities of being selected to next generation (Chen et al. [12]).

In the reproduction operation, there are two kind of well-known selection mechanisms: the roulette wheel selection (Chen and Ji [11]) and tournament selections (Vallada and Ruiz [57]).

- Roulette wheel selection

The roulette wheel selection can be visualized by imagining a wheel where each chromosome occupies an area that is related to its value of objective function. When a spinning wheel stops, a fixed marker determines which chromosome will be selected to reproduce into the mating pool (Blanco et al. [4]). Such a selection mechanism needs more numerical computations.

- Tournament selection

The tournament selection is quite simple and suitable for checking whether a chromosome is reproduced or not according to its corresponding objective function. In the tournament selection, $p_r \times N$ chromosomes with minimum objective functions are more added into the population, and correspondingly $p_r \times N$ chromosomes with maximum objective functions are discarded from the population. The population still keeps the same size (Chang [9]).

3 Application of genetic approach for advanced scheduling

Scheduling plays an important role to implement effective operations management methods. But its implementation would not be easy with the conventional information systems (Chang [9]). During the past few decades, genetic algorithms have received a lot of attention regarding their potential as global optimization techniques for complex optimization problems. Therefore, a short literature review on the adaptation of genetic algorithms to manufacturing operations is presented below.

3.1 Parallel machines scheduling problem

The problem can be described as follows: there are m machines in parallel where machines may be identical, or have different speeds or uniform, or completely unrelated. Each job can be performed on any of the machines (Allahverdi [1]). Several approaches were proposed to solve this kind of problems. For example, to solve the parallel machines scheduling problem a two-phase sub-population genetic algorithm was proposed by Chang et al. [10]. The algorithm is divided into two phases. The first phase applies subpopulations, which concentrates on specific search space and prevents all individuals from converging to a local optimal. Then, in order to explore the solution space

ignored or missed in the first phase, sub-populations are regrouped as a single big population. Each individual chromosome in this big population of the second phase is randomly assigned a weight value to explore more of the solution space. Experimental results are reported and the superiority of this approach is discussed.

To solve the multiobjective scheduling model on parallel machines (MOSP), a new parallel genetic algorithm (PIGA) based on the vector group encoding method and the immune method was proposed by Gao et al. [20]. Compared with other scheduling problems on parallel machines, the MOSP is distinct for the following characteristics:

- 1) parallel machines are nonidentical;
- 2) the type of jobs processed on each machine can be restricted;
- 3) the multiobjective scheduling problem includes minimizing the maximum completion time among all the machines (makespan) and minimizing the total earliness/tardiness penalty of all the jobs.

For PIGA, its three distinct characteristics are as follows: Firstly, individuals are represented by a vector group, which can effectively reflect the virtual scheduling policy. Secondly, an immune operator is adopted and studied in order to guarantee diversity of the population. Finally, a local search algorithm is applied to improve the quality of the population. Numerical results show that it is efficient, can better overcome drawbacks of the general genetic algorithm, and has better parallelism.

A new encoding method in order to adapt the GA to non-identical parallel machine scheduling problem was also proposed by Balin S. [3]. The encoding method is as follows: The row i of the matrix X consists of jobs to be processed on machine i . Rows are called ‘‘genes’’ ($g_1, \dots, g_i, \dots, g_m$) and they represent jobs to be processed on each machine; jobs to be processed on machine i are given by elements non-zero of gene i ($x(i, j) = 1$). The completion time of each machine i , (C_i), is equal to the sum of processing times of jobs to be processed on that machine; it is called as the ‘‘value of gene i ’’ and it is defined by the following function:

$$f(g_i) = \sum_{j=1}^n x(i, j) \times P(i, j), \quad i = 1, \dots, m \quad (1)$$

In last years, a hybrid memetic algorithm for maximizing the weighted number of just-in-time jobs on unrelated parallel machines was also presented by Jolai et al. [29]. Unrelated parallel machines can be charac-

terized as machines that execute the same function but have different industrial unit may invest in related machines. A memetic algorithms (MA) is a genetic algorithm hybridized with a local search (LS) procedure used to intensify the search process (Jolai et al. [29]). Besides, in the literature, a genetic algorithm for the unrelated parallel machine scheduling problem with sequence dependent setup times was reported by Vallada and Ruiz R. [57].

3.2 Permutation flow shop scheduling problem

The general flow shop scheduling problem is a production problem where a set of n jobs have to be processed with identical flow pattern on m machines. In permutation flow shops the sequence of jobs is the same on all machines (Nagano et al. [44]). In other words, the permutation flowshop scheduling problem (PFSP) consists in scheduling a set of n jobs on m machines in the same technological order, such that each job is processed on machine 1 in the first place, machine 2 in the second place, ... and machine m in the last place; the processing time of job i on machine j is denoted p_{ij} .

The most frequently used encoding for the PFSP is a simple permutation of the jobs. It is important to note that there are several additional conditions to this problem (Ruiz et al. [53]):

- all operations are independent and available for processing at time 0,
- all m machines are continuously available,
- each machine i can process at most one job j at a time,
- each job j can be processed only on one machine i at a time.

The objective is to find a sequence (schedule) in which these n jobs should be processed on each of the m machines such that a given criterion be optimized (Jarboui et al. [27]). The most common criteria are the minimization of the total completion time of the schedule often referred to as makespan C_{\max} and the total flow time minimization. The PFSP has been extensively investigated by the research community. For example, a genetic local search algorithm for minimizing total flow time in the permutation flow shop scheduling problem was developed by Tseng and Lin [55] and Xu et al. [58]. The permutation flowshop scheduling problem with the objective of minimizing makespan was presented by Nearchou [45], Rajkumar and Shahabudeen [51], Nagano et al. [44], and Ruiz et al. [52, 53].

An effective memetic algorithm for solving multiobjective permutation flow shop scheduling problems with minimization of makespan and total flow time was considered by Chiang et al. [15]. The results of above mentioned study show that the proposed algorithms are very effective.

3.3 Flow shop scheduling problem

In general, the flow-shop scheduling problem (FSSP) is a strongly NP-hard combinatorial optimization problem that has captured the interest of a significant number of researchers (Nearchou [45]). The flow-shop scheduling problem is one of the most well known problems in the area of scheduling. It is a production planning problem in which n jobs have to be processed in the same sequence on m machines. Most of these problems concern the objective of minimizing makespan i.e. the time between the beginning of the execution of the first job on the first machine and the completion of the execution of the last job on the last machine. To minimize the makespan is equivalent to maximize the utilization of the machines (Chen et al. [12]).

The flowshop scheduling problem has been widely studied in the literature and many techniques for its solution have been proposed. Many authors have concluded that genetic algorithms are suitable for this hard, combinatorial problem. For example, the flowshop scheduling problem with the objective of minimizing makespan was considered among other things by França et al. [18], Ruiz and Maroto [52, 53], Kim and Jeong [30], Rajkumar and Shahabudeen [51], Liao and Tsai [34].

França et al. [18] suggested an evolutionary algorithm for scheduling a flowshop manufacturing cell with sequence dependent family setups. They proposed evolutionary heuristic algorithms to minimize the makespan in a pure flow shop manufacturing cell problem with sequence dependent setup times between families of jobs. The heuristic algorithms implemented are a memetic algorithm, a genetic algorithm and a multi-start strategy. Computational results show that the proposed algorithms are relatively more effective in minimizing the makespan than the best known heuristic algorithm. The flow shop scheduling problem with the objective of minimizing makespan was also developed by Ruiz and Maroto [52]. They developed a genetic algorithm for hybrid flow shops with sequence dependent setup times and machine eligibility. Numeri-

cal computation based on benchmarks demonstrated the effectiveness of the proposed method. An improved genetic algorithm with the objective of minimizing the makespan for the flow shop scheduling problem was also proposed by Rajkumar and Shahabudeen [51].

Recently, some genetic algorithms have been developed for the multi-objective flow shop problem. For example, Arroyo and Armentano [2] presented a multi-objective genetic local search algorithm, which was applied to multi-objective flow shop problems in order to find an approximation of the Pareto optimal set. The algorithm is applied to the flow shop scheduling problem for the following two pairs of objectives: (i) makespan and maximum tardiness; (ii) makespan and total tardiness. Computational results show that the proposed algorithm yields a reasonable approximation of the Pareto optimal set. Beside, Onwubolu and Davendra [47] developed a differential evolution algorithm for the flow shop scheduling problem in which makespan, mean flowtime, and total tardiness are the performance measures.

3.4 Job shop scheduling problem

The job shop scheduling problem (JSP) is well known as one of the most complicated combinatorial optimization problems, and it is a NP-hard problem (Gao et al. [22]).

The general job shop scheduling problem (JSP) with the makespan criterion can be described by a set of n jobs that must be processed on m machines. Each job composes of several operations, and the operations of a given job have to be processed in a given order. Each operation uses one of the m machines for a fixed duration. Each machine can process at most one operation at a time, and once an operation initiates processing on a given machine, it must complete processing on that machine without interruption (Zhang et al. [60]). In general, the objective is to find the optimal schedule of the operations on the machines, taking into account the precedence constraints, which minimizes the makespan, i.e., the finish time of the last operation completed in the schedule (Gao et al. [19]).

Many different approaches have been applied to JSP and a rich harvest has been obtained. The most important part of the literature concerning job shop scheduling problems is dedicated to single-criterion optimization. But, in practice, the use of multiple criteria often enables one to compute more realistic solutions for a decision maker working in production

planning. For this reason several works have recently tackled multi-objective job shop scheduling problems. A genetic algorithm for a multi-objective job shop scheduling problem that minimizes the mean weighted completion time and the sum of the weighted tardiness/earliness costs simultaneously was developed by Tavakkoli-Moghaddam et al. [54].

Besides, an efficient memetic algorithm for solving the job shop scheduling problem can be found in the work of Gao et al. [22].

Among various kinds of encoding methods, job-based encoding (Zhang and Wu [62]) and operations-based encoding (Zhang et al. [61]) are most often used for job shop scheduling problem. A genetic algorithm with new encoding scheme for job shop scheduling was developed by Wang et al. [56]. They proposed a novel genetic chromosome-encoding approach. In this encoding method, the operation of crossover and mutation was done in three-dimensional coded space. Some big benchmark problems were tried with the proposed three-dimensional encoding genetic algorithm for validation and the results are encouraging.

A genetic algorithm for job shop scheduling problems with alternative routings was also proposed by Moon et al. [42]. In this approach, the chromosome is composed of two parts. The first part is for the assignment of alternative machines, and the second part is the relative processing order between jobs. The length of each chromosome is equal to the total number of operations. This genetic algorithm generated relatively good solutions quickly.

3.5 Flexible job shop scheduling problem

Genetic algorithms are also used as an optimization tool for solving the flexible job-shop scheduling problem (FJSP). Flexible job shop scheduling problem is an extension of the classical job shop scheduling problem, which provides a closer approximation to a wide range of real manufacturing systems. In particular, there are a set of work centers in a flexible job shop. Each work center has a set of parallel machines with possibly different efficiency. An operation can be performed by any machine in a work center. Consequently, this results in two problems. The first one is the routing problem (i.e., the assignment of operations to machines), and the second one is the scheduling problem (i.e., determining the starting time of each operation).

The combination of the two decisions presents additional complexity and a new problem called flexible job shop scheduling problem (FJSP) (Gao et al. [19]).

In the flexible job-shop scheduling problem, the objective is usually to minimize the makespan. For example, Zhang et al. [60] proposed an effective genetic algorithm for the flexible job-shop scheduling problem with the minimization of makespan.

Recently, some genetic algorithms have been developed for the multi-objective flexible job-shop scheduling problems. For example, Gholami and Zandieh [23] proposed a genetic algorithm where the objectives are the minimization of two criteria, the makespan and the mean tardiness.

The current work pursues research in which GA procedure is combined with experts' knowledge. FMS scheduling with knowledge based genetic algorithm (KBGA) was reported by Prakash et al. [49]. The KBGA is a stochastic search technique with the inherent ability of GA and strength of knowledge to enhance the performance of system and algorithm concurrently. In this study, two objective functions known as throughput and mean flow time, have been taken to measure the performance of the FMS.

In genetic algorithms for the flexible job-shop scheduling problem, many different representations are used. For example, Gao et al. [21] proposed encoding method where every chromosome consists of a machine assignment vector V_1 and an operation sequence V_2 . In this case, $V_1(r)$ represents the machine chosen to process the operation indicated at position r . The authors identify all operations of a job with the same sign; then, they interpret the signs according to the order of occurrences in the sequence of a given chromosome; therefore, each job i appears in the operation sequence vector (V_2) exactly n_i times to represent its n_i ordered operations. The encoding method was adopted by Gholami and Zandieh [23] to schedule a dynamic flexible job shop with genetic algorithm. The same components i.e. machine selection and operation sequence (called MSOS), include the chromosome representation were proposed by Zhang et al. [60] (see Fig. 4).

Chromosome =

| Machine Selection (MS) | | | | | Operation Sequence (OS) | | | | |
|---------------------------|---|---|---|---|----------------------------|---|---|---|---|
| 4 | 1 | 2 | 2 | 4 | 2 | 2 | 1 | 1 | 2 |

Figure 4. Structure of proposed MSOS chromosome (source: Zhang et al. [60])

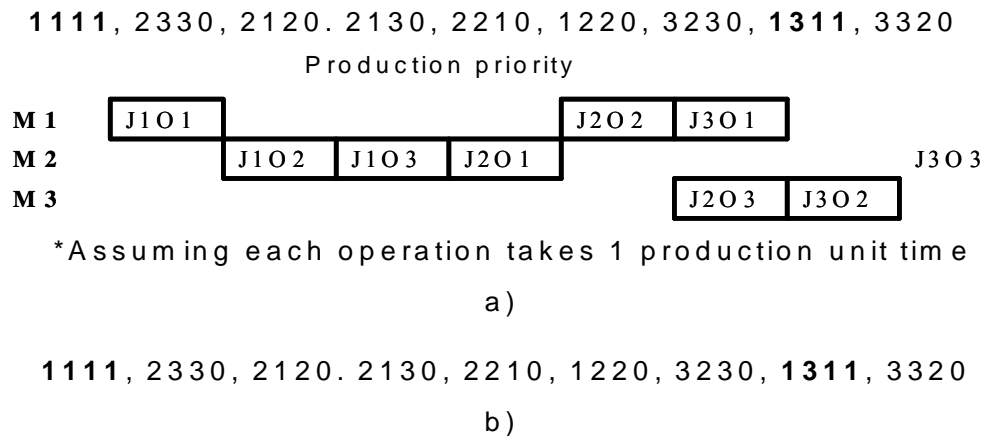


Figure 5. (a) A sample encoding and decoding of chromosome
 (b) A sample encoding of alternative routing
 (source: Chan et al. [8])

An idea, namely genetic algorithms with dominant genes (GADG) in order to deal with FMS scheduling problems with alternative production routing was developed by Chan et al. [8]. It consists of ΣN_i genes, and each gene consists of four parameters representing machine, job, operation, and domination (MJOD).

Fig. 5a shows a sample encoding of a chromosome for the scheduling of three jobs on three machines, and each job possesses three operations with a total of nine genes. In Fig. 5a, the second gene (2330) represents that O3 of J3 is allocated on M2. It is not a DG as the D parameter denoted by 0, otherwise it will be denoted by 1.

The production priority of jobs on machines is defined by the ordering, from the highest priority on the left to the lowest on the right. In this connection, O3 of J3 (the second gene: 2330) is scheduled before O2 of J1 (the third gene: 2120) on M2. However, since an operation can only start after its preceding operation is completed, O3 of J3 will not be considered until O2 of J3 is finished. In this situation, the third gene (2120) O2 of J1 will be scheduled for production instead.

A detailed production schedule is shown in figure 5a. In an FMS environment, assuming O3 of J3 can also be performed on M3, the second gene can be represented as (3330) as shown in Fig. 5b.

An improved memetic algorithm to solve the job shop scheduling problem was also proposed in work of Gao et al. [22]. As mentioned above, the memetic algorithm

is a genetic algorithm hybridized with a local search procedure used to intensify the search process. The flow chart of the proposed MA by Gao et al. [22] is shown in Fig. 6. The procedure of the MA is outlined as follows:

- Step 1
Generate initial population. Set parameters of GA including population size, max iteration, mutation probability, crossover probability, etc. Then encode an initial solution into a chromosome. Repeat this step until the number of individual equals to the population size.
- Step 2
Apply the local search procedure to improve the quality of each individual.
- Step 3
Decode each individual of population to obtain the makespan corresponding with each individual. And compare them to obtain the best solution.
- Step 4
Check the termination criteria. If one of the criteria is satisfied, then stop the algorithm and output the best solution; otherwise, go to step 5.
- Step 5
Generate new population for the next generation. Genetic evolution with three operators including selection, crossover and mutation is applied to create offspring for the next population. Following this, the algorithm goes back to step 2.

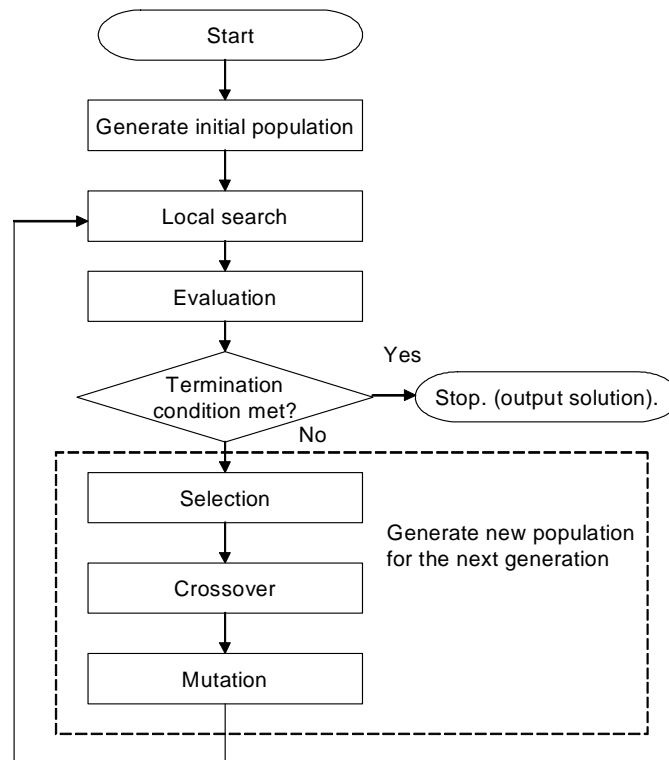


Figure 6. Flow chart of the MGA
(source: Gao et al. [22])

3.6 Open job shop scheduling problem

An open shop scheduling problem (OSSP) can be stated as follows: There are n jobs to be processed on m machines. Each job consists of m operations where each operation can be done on only one of machines for a give process time. Each operation can be processed on at most one machine at any time. On each machine at any time at most one operation can be done. The OSSP is the same as job shop scheduling problem (JSP), except there is no precedence relation between operations in the OSSP. In this way there will be more feasible combinations in the OSSP (Panahi and Tavakoli-Moghaddam [48]).

Low and Yeh [35] developed a genetic algorithm-based heuristics for an open shop scheduling problem with setup, processing, and removal times separated.

Their report proposes a solution to the open shop scheduling problem with the objective of minimizing total job tardiness in the system. In open job shop scheduling problem, there are two essential issues addressing all kinds of open shop scheduling problems: determining the routing for each job, and sequencing

the jobs for each machine.

Adequately, a permutation representation is presented to encode these two things into a chromosome. This representation encodes a schedule as an ordered sequence of job-machine combinations (operations), where each gene in a chromosome stands for an operation. In this representation, operations are listed in the order in which they are scheduled. A chromosome is merely a permutation of the number from 1 to the total number of operations to be scheduled in the system.

Consider a simple example with three jobs and three machines. Each job must be processed on every machine once; operations of a job can be processed in any order. A series of numbers from 1 to 9 is assigned to, each job-machine combination, as in Table 3. Thus a chromosome [6-3-1-4-9-7-2-8-5] can be decoded to routing for each job and a processing sequence on each machine, respectively. A feasible schedule is then determined as follows:

Machine #1: Job 1-Job 2-Job 3
 Machine #2: Job 1-Job 3-Job 2
 Machine #3: Job 2-Job 1-Job 3.

Table 3 Representation of job-machine combination
(source: Low and Yeh [35])

| | | | | | | | | | |
|---------|---|---|---|---|---|---|---|---|---|
| Job | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 |
| Machine | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

3.7 Hybrid approaches

Currently, there is a research trend in the adaptation of hybrid approaches which combine different concepts or components of various techniques. The trends have been presented by Kobbacy et al. [31] in a very interesting survey of applications of artificial intelligence techniques for operations management.

They reported that several authors use genetic algorithms to carry out an intelligent search by proposing alternative schedules and then using neural network to assess the quality and fitness of the schedule. Besides, fuzzy logic and genetic algorithms have been combined effectively for scheduling.

A hybrid genetic algorithm was developed by Chen et al. [12] for the re-entrant flow-shop scheduling problem (RFS). In a RFS, all jobs have the same routing over the machines of the shop and the same sequence is traversed several times to complete the jobs. The aim of this study was to minimize the makespan by using the genetic algorithm (GA) to move from the local optimal solution to the near optimal solution for RFS scheduling problems.

For the job shop scheduling problem, a hybrid evolutionary algorithm was also presented in work of Zobolas et al. [64]. In their work, the optimization criterion is minimization of the makespan and the solution method consists of three components: a Differential Evolution-based algorithm to generate a population of initial solutions, a Variable Neighbourhood Search method and a Genetic Algorithm to improve the population, the latter two are interconnected. Computational experiments on benchmark data sets demonstrate that the proposed hybrid metaheuristic reaches high quality solutions in short computational times using fixed parameter settings.

Besides, a hybrid approach with an expert system and a genetic algorithm to production management in supply networks was also presented by Ławrynowicz [40, 41].

3.8 Planning and scheduling problems

Genetic algorithms have been also successfully implemented to solve various planning and scheduling problems. For example, Lee et al. [33] developed advanced planning and scheduling with outsourcing in manufacturing supply chains. The proposed model considers alternative processes plans for different job types.

Chen and Ji [11] proposed a genetic algorithm for dynamic advanced planning and scheduling with frozen interval. This paper investigates a dynamic advanced planning and scheduling (DAPS) problem where new orders arrive on a continuous basis. A periodic policy with a frozen interval is adopted to increase stability on the shop floor. A genetic algorithm is developed to find a schedule such that both production idle time and penalties on tardiness and earliness of both original orders and new orders are minimized at each rescheduling point. The numerical results confirm that the proposed methodology can improve the schedule stability while retaining efficiency.

A hybrid approach for control problems in a node of the supply network was published by Ławrynowicz [39]. This approach takes into account the loops in supply networks. In this approach, the production planning problem is first solved, and then the scheduling problem is considered within the constraints of the solution. The main objectives of this approach are to produce an Advanced Production Management (APRM) model that minimizes the makespan by considering alternative machines, alternative sequences of operations with precedence constraints, and outsourcing.

Fig. 7 shows the outline of the idea of planning and scheduling using an expert system and genetic algorithms. The first phase involves using a traditional approach combined with the genetic algorithm to produce a preliminary and possibly suboptimal schedule. The second phase uses a combination of an expert system and a genetic algorithm to construct a detailed schedule according to the detailed production plan.

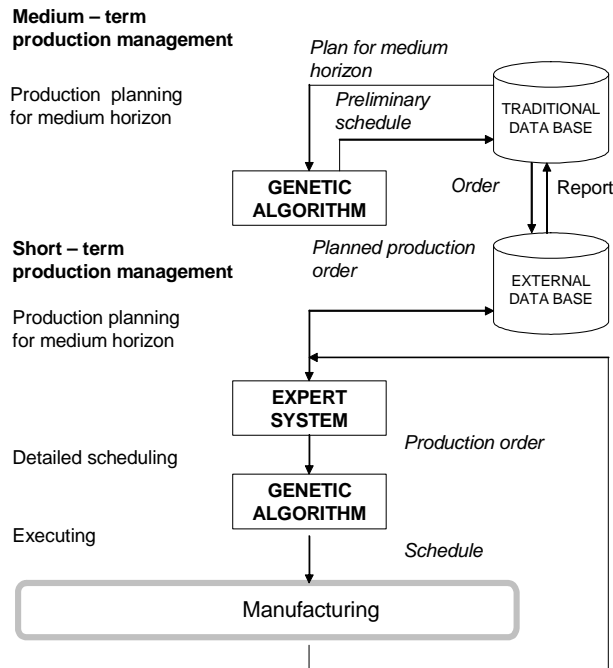


Figure 7. The outline of the idea of operations management using a genetic algorithm
(source: Ławrynowicz [39])

As shown in Fig. 7, proposed hybrid system does not only offer short-term production planning and scheduling to meet changing market requirements that can better utilize the available capacity of manufacturing systems, but also provides support for control. In this approach, the work-piece is one job. Each work-piece (i.e. job) has a unique priority indicator according to the order of the customer. The expert system creating detailed production plans takes into account the planned production orders and work-in process from the report. The report includes scheduled operations, which cannot be performed. In such situations, both kinds of orders – the parts of the production orders (from the report) and whole planned production orders – are an input to the expert system. The job requires different types of production resources. All resources are available in a limited capacity only. Detailed production planning matches future production load and capacities by generating detailed plans that determine the flow of materials and uses of resources over a given planning horizon. In the era of supply network, decisions on the use of resources should concern both internal and external capacities; the internal flow of materials should be synchronized with the incoming and outgoing flows. Therefore, the expert system generates detailed production plans based on available resources of the supply network. The expert system creates a detailed production plan as follows. The first

step involves updating the planned production orders. In the second step, a human expert determines the top limit of priority indicator for orders. In the third step, a human expert selects m -th machine (bottleneck). Then the expert system automatically works out a sum of requirement capacity for m -th machine. After capacity requirement evaluation, the expert system compares the available capacity with capacity requirements. If the sum of requirement capacity is 70–100% of available capacity, then the expert system automatically creates a production plan from orders with a priority indicator smaller than or equal to the top limit indicator. In other cases, during an interactive dialogue a human expert makes a decision:

- is it possible to accept the sum of loads smaller than 70% of capacity of the machine?
- is it necessary to use an alternative processing plan or outsourcing?
- is division of lot-size possible?

The expert system will generate a production order according to the answers of the human expert. Next, the genetic algorithm with the operation-based encoding method is used. The proposed intelligent methods can be applied when there is a need to re-planning or re-scheduling. It is common knowledge that in a real-life factory there are often disruptions in production.

In such situations, the expert system and genetic algorithm executes re-planning and re-scheduling very quickly. In this experiment, the genetic algorithm was used the well-known roulette wheel selector and the next population was created using the partial match crossover (PMX) operator.

3.9 Multi-factory scheduling problem

Few researchers have considered methods with genetic algorithms to support scheduling in distribution manufacturing systems. Generally, distributed scheduling problems deal with the assignment of jobs to suitable factories and determine their production scheduling accordingly (Chan, et al. [7]). For example, Chan et al. [7] proposed an optimization algorithm named Genetic Algorithm with Dominated Genes (GADG) to solve distributed production scheduling problems with alternative production routings. In this approach, each chromosome represents a solution corresponding to:

- (i) the allocation of jobs to factories,
- (ii) the production priority of each job's operation in each machine in the network.

A chromosome is composed of genes. Each gene consists of five parameters (i.e. FMJOD), representing:

- Factory number (F),
- Machine number (M),
- Job number (J),
- Operation number (O) of the job, and
- Domination of the gene (D).

Fig. 8a shows a sample coding of a chromosome for the allocation and scheduling of three jobs to two factories, in which each factory has three machines, and each job requires three operations for completion. Assuming each operation requires one unit of production lead time, the scheduling result is shown in Fig. 8b.

In Fig. 8a, the first gene (11111) represents that O1 (Operation 1) of J1 (Job 1) is allocated to F1's M1 (Factory 1's Machine 1), and it is a dominated gene denoted by 1. This coding can also be used to model alternative routings, for example the first gene can also be coded as (13111) to represent that O1 of J1 is allocated to F1's M3, i.e. the J1O1 can be operated in M1 or M3. The scheduling priority of jobs into machines is defined by the ordering, from the highest priority on the left to lowest on the right.

Therefore, Fig. 8a indicates that O1 of J1 (i.e. gene: 11111) will be scheduled before O1 of J3 (gene: 11311) in F1's M1. For each operation, if its preceding operation is not yet allocated, it will not be considered until the allocation of its preceding one is done. The scheduling will then move to consider the next gene, such as the second one (12330). This gene (12330) will only be allocated after its preceding operation (gene: 13320) has been allocated, as shown in Fig. 8b.

a) 11111-12330-12120-13130-22210-21220-23230-11311-13320

b)

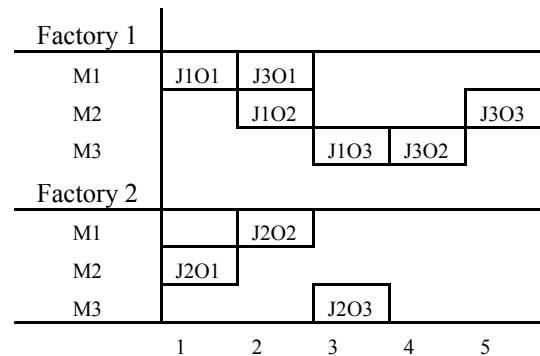


Figure 8. (a) A sample coding of chromosome
(b) Scheduling result of sample chromosome
(source: Chan et al. [7])

Dominated Gene (DG) indicates that this gene can increase the strength (fitness) of the chromosome. Initially, some genes in a new chromosome are randomly assigned to be dominated genes denoted by 1 in the D parameter of the chromosome, otherwise 0. Each chromosome may contain empty, 1, or more than 1 dominated gene. During evolutions, only those DGs undergo crossover in each pair of parents to generate a pair of offspring. Each offspring reserves most of the genes from one of the parents and inherits only the DGs from another parent. If these inherited DGs make the offspring stronger than the parent, they will remain dominated in the offspring, otherwise they will become normal genes. This idea is to identify and record the best genes, and ensure they will be passed to the offspring. GADG implements the idea of adaptive strategy. In this approach, a new crossover mechanism named dominated gene crossover has been introduced to enhance the performance of genetic search, and eliminate the problem of determining an optimal crossover rate. A number of experiments have been carried out. The results indicate that significant improvement could be obtained by the proposed algorithm.

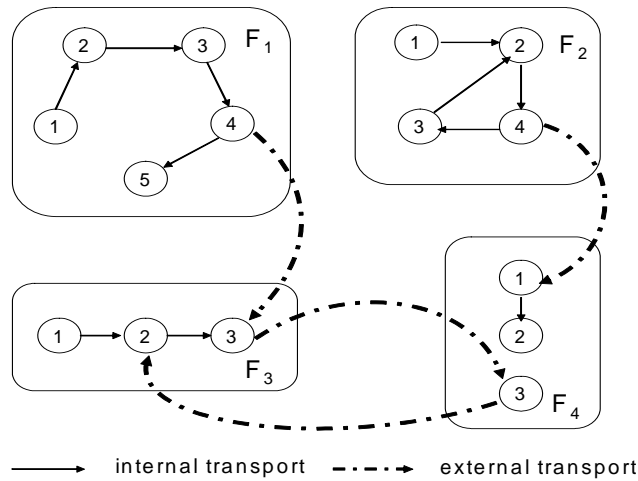


Figure 9. Relationships among jobs, resources, and factories
(source: own study)

Beside, an integration of the genetic algorithm and Gantt chart (GC) for job shop scheduling in distributed manufacturing systems has been also proposed by Jia et al. [28]. The integration of GA–GC is shown to be efficient at solving small-sized or medium-sized scheduling problems for a distributed manufacturing system. Multiple objectives can be achieved, including minimizing the makespan, job tardiness, or manufacturing cost.

Application of the genetic approach for advanced planning in multi-factory environment is also presented in the work of Chung et al. [16]. The proposed algorithm adopts the idea of dominant gene proposed by Chan et al. [7]. The model is subject to capacity constraints, precedence relationships, and alternative machines with different processing time. The objective function is to minimize the makespan, which consists of the processing time, the transportation time between resources either within the same factory or across two different factories, and the machine set-up time among operations. The results show the robustness of the proposed algorithm for this problem.

As shown above, despite many advantages in solving scheduling problems with genetic algorithms, the application of the above mentioned algorithms is questionable. Frequently, the loops in supply networks are not taken into consideration in many works.

4 A new approach to the scheduling problem in industrial clusters

In the industrial cluster, multiple factories can be selected to manufacture the products. The factories may be located in geographically distributed location,

but situated near. In the literature, the term “industrial cluster” is widely used, it is defined as “a geographical and sectoral concentration and combination of firms” (Niu [46]). From the viewpoint of relationships, it is a local supply network based on partnership. The relationships between members within an industrial cluster are shown in Fig. 9.

In the industrial cluster, the individual operating decision making is dependent on the resources of the other factories, and the possibilities of the individual organization to utilize these resources are determined by their place in the network. In many cases, the industrial cluster is a distributed manufacturing system.

In the research of Ławrynowicz [37], a typical industrial cluster, which has J different tasks (products) $(1, 2, \dots, m)$ for F factories $(1, 2, \dots, r)$ is considered. Each factory has R resources $(1, 2, \dots, q)$. All jobs are loaded, according to the predetermined technological sequence given in processing plans.

The routes for the jobs are such that a job may visit some resources and use some transportation more than once. There are several constraints on jobs and resources:

- 1) there are no precedence constraints among operations of different jobs;
- 2) operations cannot be interrupted and each resource can handle only one job at a time;
- 3) each job can be performed only on one resource at a time.

In this approach, the processing plans of jobs can include also external transport operations. The objective is to minimize the total makespan of the industrial cluster.

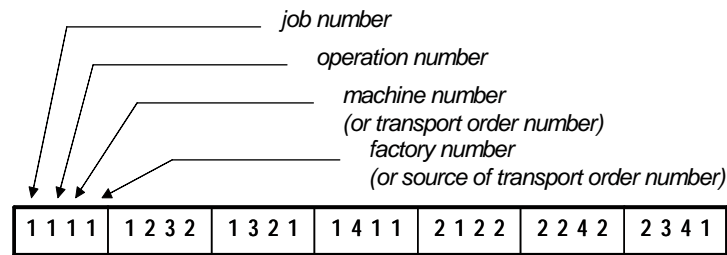


Figure 10. Example of a chromosome type A
(source: own study)

The following notation is used for optimization of scheduling in the industrial cluster (Ławrynowicz [37]):

m - number of jobs,

p - number of operations,

q - number of resources,

r - number of factories,

J_j - the j -th job, where $j = 1, \dots, m$,

O_i - the i -th operation, where $i = 1, \dots, p$,

R_n - the n -th resource where $n = 1, \dots, q$,

F_k - the k -th factory, where $k = 1, \dots, r$,

P_o - the o -th transport order, where $o=1, \dots, q-2$
and $o>2$,

S_t - the t -th source of transport order o ,
where $t=r+1, \dots, r+m$,

T_{ji} - the time of operation i of job j .

In this approach, the source of the transport order is the job. If a considered system includes three factories then the sources of transport orders are denoted as follows: for the first job the source of transport orders is denoted by S_{3+1} i.e. S_4 , for the second job the source of transport orders is denoted by S_5 , for the third job the source of transport orders is denoted by S_6 etc.

From the mathematical point of view, an industrial cluster is a digraph, which has loops and therefore the methods based on "network theory" cannot be easily adopted in supply network management. When the job shop problem is not too large, the methods proposed in the literature are able to obtain the optimal solution within reasonable time. But its implementation would not be easy with conventional information systems.

Therefore, the author proposes a new approach to the distributed scheduling in the industrial cluster which uses a modified genetic algorithm (MGA). The modified genetic algorithm proposed by the author creates schedule for each factory and enables transport

order planning. The MGA is an improved version of prototypes developed by the authors in early stages of this research (Ławrynowicz [39, 40 and 41]).

The design of a suitable chromosome is the first step for a successful genetic algorithm implementation because it applies probabilistic transition rule on each chromosome to create a population of chromosomes, representing a good candidate solution.

Particularly, in the industrial cluster where jobs will be dispatched to many factories, the encoding of the scheduling problems plays an important role to implement effective operations management methods. As mentioned above, in the scheduling problem, the popular encoding is operation-based method. This representation encodes a schedule as a sequence of operations and each gene stands for one operation. By this idea, the author creates new encoding method for a scheduling problem in the industrial cluster. In this approach, a modified genetic algorithm employs two steps to encode the scheduling problem. According to the step, two different types of chromosomes are designed.

In the first step, each chromosome type A represents a potential optimal solution of a problem being optimized. Chromosome type A consists of a set of 4-positions gene. The chromosome structure can be represented as shown in Fig. 10, where the value of the first position of the gene represents the job, the value of the second position the operation number, and the next two values the pair as follows: the resource number and the factory number or the transport order number and the source of the transport order number.

The second step is to copy the first and the second position from the gene of the chromosome A into the gene of the chromosome B, and to translate the last two positions from the gene of the chromosome A into one position gene of the chromosome B. Chromosome type B is designed, as follows.

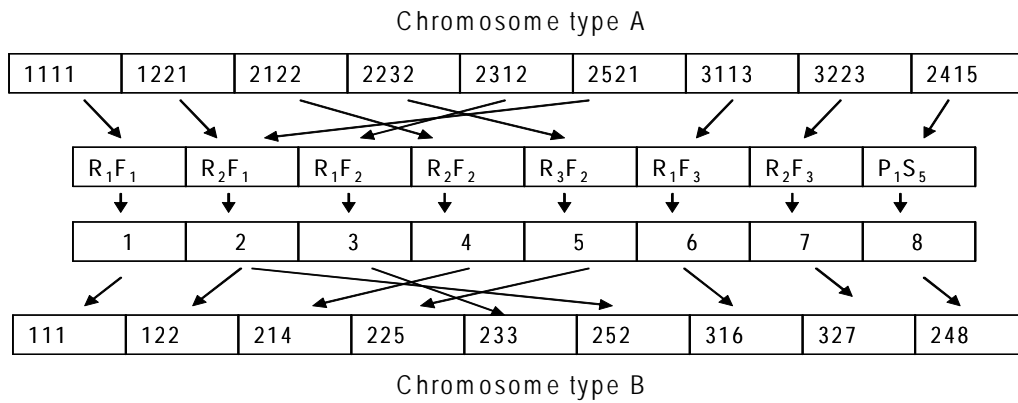


Figure 11. Example of translation
(source: own study)

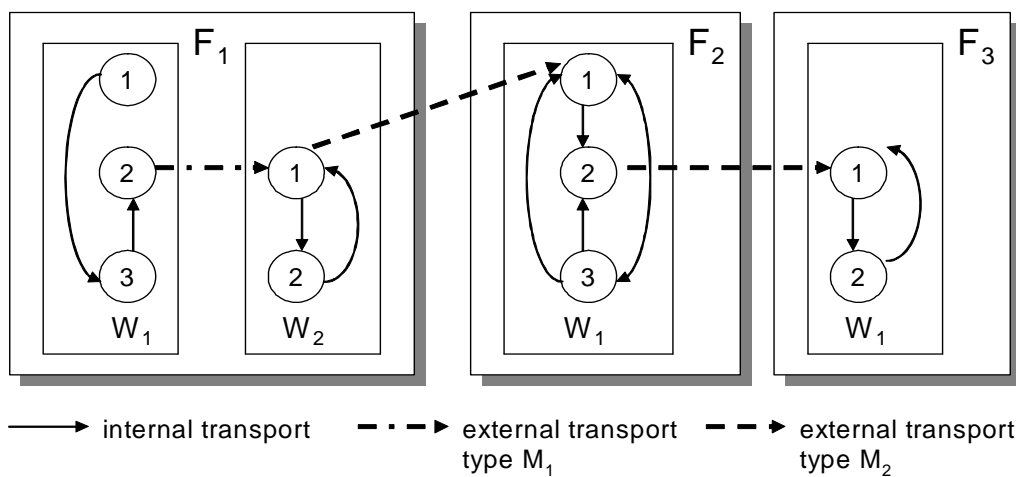


Figure 12. Relationships among jobs, resources, workshops and factories
(source: own study)

Similarly as chromosome type A, the first position represents the job, and the second the operation number, but the last position contains a unique number of the resource.

Fig. 11 shows the way of a translation. Thus, the new encoding method includes both manufacture operations and long transport operations. In procedure of this MGA, two new steps are added (to CGA). The first step is added in the beginning and consists of a translation of the chromosome type A into the chromosome type B. Thus, the initial population is created for type B chromosome.

The other operation is added after the determination of the best chromosome of type B (which gives the smallest value of the makespan using the genetic algorithm with classical encoding method) and consists of a translation of the best chromosome of type B into type A chromosome. In the MGA, the most popular

selection method that is referred to as roulette wheel selector was used.

The next population was created using the partial mapped crossover operator (PMX), and the mutation was a random interchange of values in two positions. The number of generations was used as a stopping measure. In the work by Ławrynowicz [37, 38], representative examples are provided to show that the above suggested method can improve distributed scheduling in industrial clusters.

Beside, the author proposed a new genetic algorithm for a distributed scheduling in a supply network (Ławrynowicz [36]) where each chromosome is a set of 5-position genes. The new genetic algorithm enables not only a manufacturing scheduling in supply networks. Additionally, the new genetic algorithm aided planners in transport orders planning.

Fig. 12 shows an example of the relationships among the jobs, resources and factories for a production plan of supply network which was considered by the author. Basing on the above idea of operation codes with 4-position genes, the author developed the new genetic algorithm, where each chromosome is a set of 5-position genes. In proposed by the author encoding method, the value of the first position of the gene represents the job, the value of the second position the operation number, and the next three values the segment X or Y as follows (accordingly): the resource number, the workshop number and the factory number or the transport type number, the transport order number and the source of the transport order number. The results of the experiments show that the proposed new genetic algorithm is a very efficient and effective algorithm.

5 Conclusion

This paper describes how the genetic algorithms have been applied to the optimization of manufacturing scheduling problems. Representation scheme of a feasible solution to the considered problem is a key aspect of evolutionary algorithms. Therefore, in this study, the focus is brought on the coding problems.

It is common knowledge that in solving large-size problems, genetic algorithms show much better performance (Chung et al. [16]). Despite many advantages in solving scheduling problems presented in the existing literature, many applications of genetic algorithms are questionable. As mentioned above, researchers still study small-scale problems or only flow shop problems, where there are many constraints. It is possible that equally important and stimulating research unknown to the authors was unintentionally omitted.

Many genetic algorithms proposed in the literature have been created for scheduling in a single factory. The approach often ignores dividing jobs and interactions between the various firms within supply networks at operations management level in order to improve manufacturing processes. But, in the era of supply network, decisions on the use of resources should concern both internal and external capacities; the internal flow of materials should be synchronized with the incoming and outgoing flows. For this purpose, a system for scheduling must take into consideration the possibility of dividing jobs into factories, loops, and a long transport. Therefore, the author proposes modified genetic algorithm (MGA), which take into account loops in supply networks. Additionally, the proposed

modified genetic algorithm enables dividing jobs between factories, and transport orders planning in the industrial cluster.

Summarizing, advances in genetic algorithms create new prospects for inter-organizational cooperation.

As mentioned above, the main objective of this paper is to present heuristic methods based on genetic algorithms. But, it is noted that another group of researchers proposed an ant colony optimization (ACO) for solving advanced scheduling problem (Rajendran and Ziegler [50], Panahi et al. [48]). Ant algorithms are optimization algorithms inspired by the foraging behaviour of real ants in the wild (Mullen et al. [43]). Within the Artificial Intelligence (AI) community, ant algorithms are considered under the category of swarm intelligence. Swarm intelligence encompasses the implementation of intelligent multi-agent systems that are based on the behaviour of real world insect swarms, as a problem solving tool. Future research can also investigate the possibility of incorporating the proposed ACO for solving scheduling problems in the industry.

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THE ANALYSIS AND SYNTHESIS OF STRATEGIC MANAGEMENT RESEARCH IN THE THIRD SECTOR FROM EARLY 2000 THROUGH TO MID-2009

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Abstract: The purpose of this paper is to analyse the contemporary literature on strategic management in non-profit organizations. The area at hand is divided into five categories: modern management and strategic management approaches/theories; analysis of the roles of externalities and internalities in the Third Sector; review of how strategic management has been applied for non-profit organizations; review of applications and enhanced identification of one or more strategies utilised by non-profit organizations; application of specific methods and tools in strategic management. Four dilemmas faced by modern management theory serve as a synthetic axis. First, how can the existing commercial management concepts and techniques be best adapted to the realities of the non-profit sector? Secondly, which of the established schools of strategic management is the most relevant one for non-profits? In fact, is it appropriate to look for a brand new school of thought? Thirdly, and this is again related to academic pursuits, what coherent theory can explain the efficiency of non-profit organizations. Fourthly, there is the dilemma what strategy to employ when faced with a choice between the willingness and the need to apply competitive strategies and the co-operative strategy in the third sector.

Key words: strategic management, non-profit organizations, Third Sector, strategy, strategic planning, competitiveness.

1 Introduction

There are two underlying observations for this paper. First, strategic management is critically important for the growing Third Sector and not for managers alone but also for researchers who study management and develop new theories. The other observation is that there is a visible lack of literature attempting to characterise and recapitulate existing theories and research findings in the area of strategic management in the non-profit sector developed since early 2000.

The Third Sector has for many years now been considered the fastest growing socio-economic activity segment in modern democracies (Salamon and Anheier [53, 54], Lauer [36], Sargeant [55]). The size of the sector and social significance of non-profit organizations necessitate inclusion of non-profit issues in management theory. Peter Drucker states that forty years ago, 'management' was a very bad word in non-profit organizations. It meant 'business' to them, and the one thing they were not was a business (Drucker [21]). However, specialised knowledge of management is increasingly critical today. There have been some attempts to develop new or adapt existing management concepts, methods and tools to make them relevant for the Third Sector. In all its dimensions, strategic man-

agement can be a useful tool in running a non-profit organization (Bryson [8, 9], Kemp and Kemp [34], Mulhare [42], Courtney [17], Goold [25]). These authors stress that it will lead to the amplification of their strengths and help them grasp environmental opportunities. Most of all, however, it is a remedy for most weaknesses and challenges faced by the organizations nearly on a daily basis. Further, it can be instrumental in mounting an adequate and effective response to major threats from the environment. Non-profit organizations may then be more credible for their stakeholders which should directly strengthen their financial and human resource base.

A review of management literature and studies of non-profit organizations reveal a certain pattern: the sector is lagging behind the business sector by some 15 years in terms of management theory and practice. Literature on enterprise strategic planning emerged in the 1960s and a similar literature on the non-profit sector was first published in mid-1970s. As underlined by Roger Courtney, researches were looking for ways to adapt for the sector the following methods and techniques derived from strategic management: SWOT analysis, PEST, Ansoff's matrix, Porter's sectoral analysis (5 Porterian forces), Boston Consulting Group matrix analysis, stakeholder analysis (Courtney [17]).

Desk research regarding the use of strategic management concepts in the Third Sector was carried out by Melissa Stone and her team and she came up with a number of conclusions with regard to the then state of our knowledge (Stone, Bigelow and Crittenden [61]). She reviewed 66 papers published in major business and non-profit magazines between 1977 and 1992. Her work was pivotal for later authors on the subject who used it as a solid reference material reflecting the state of knowledge in the period.

Our paper is an attempt at filling the time gap in the literature on strategic management in the Third Sector. Whereas much could have changed in management theory since Melissa Stone's work it is pertinent to review the current research focus and the proposed theories in the early 21st century. Equally, it is important to identify at least some of the dilemmas faced by management theoreticians.

This paper has identified 50 magazine articles on strategic management and more specifically on strategic planning between 2000 and July 2009. The first section describes the desk research methodology applied here.

The findings section provides a brief description of each paper and assigns it to a specified research methodology. The paper discusses more than empirical research and this approach may be useful for future authors looking for texts offering a different characteristic. For example, if they show interest in survey studies they will choose an article focusing on surveys; otherwise, they will look for a more conceptually oriented text based primarily on the intuitive method.

Section Three provides a brief summary of conclusions each of the authors offered in his/her paper. Notably, innovative conclusions were highlighted as much as possible to avoid redundancy. All the conclusions are categorised in five key areas, i.e. current management and strategic management approaches/theories; analysis of the roles of externalities and internalities in the Third Sector; review of how strategic management has been applied for non-profit organizations; review of applications and enhanced identification of one or more strategies utilised by non-profit organizations; application of specific methods and tools in strategic management. Again, this format facilitates structured use of the analysis by researchers and practitioners.

The synthetic section is designed to project new trends in management theory and new fields of research into the strategic management in the Third Sector.

As a result, four major dilemmas faced by contemporary management theory have been distilled.

2 Method

The study used EBSCOhost, an online scientific database. The key words used during the search were non-profit and strategic management and dates: since 2000 (i.e. one year after the publication of the work by Melissa Stone et al., as quoted above) till the most recent publications in 2009. The search generated 83 items. With unscientific texts, book reviews etc. left out the number was reduced to 29 (see Table 1, lines 1 - 29, for a brief description).

Subsequently, the search was repeated with modified key words: strategic planning (instead of strategic management). The number of results returned was 231 and a selection is presented in Table 1 in lines 30 - 48. In this selection, entries previously acknowledged were rejected. Uniqueness and significance of findings and conclusions were the factors which ultimately help produce the final list. In addition, the sample included texts marked as online first or early view, which are approved papers in electronic form awaiting print. This part of the study covered the following periodicals: *Nonprofit and Voluntary Sector Quarterly*, *Voluntas: International Journal of Voluntary & Nonprofit Organizations*, *International Journal of Nonprofit & Voluntary Sector Marketing* – these published texts on strategic management in non-profit organizations the most often or provided on-line access to approved, yet unprinted papers. Hence, the sample was extended by two more entries (marked 49 and 50). In total, more than 300 indexed online databases entries were analysed.

The term 'intuitive method' used above is to be understood as a purely intellectual pursuit which consists in a consideration of concepts, presumption, issues, projects and other elements of the broadly defined research work. The 'survey method' is one which asks questions and generates answers and is employed where the researcher wants to receive statements from the sampled population for further analysis. The concept of 'critical analysis' is a desk research which analyses and critiques the literature on a subject. The 'monographic method' will lead to a comprehensive description and a detailed analysis of a single unit or a small number of characteristic units in a sampled population (Pieter [45]).

If the description uses several cases to exemplify a point the terms 'case study' is used. Each of the analysed paper did clearly rely on desk research so this was underlined only in cases where this was the only method used or was equally important as other methods which have been identified.

3 Results

In Table 1, column (2) presents the name(s) of authors and the year of publication of the analysed paper; column (3) summarises the subject of the study and column (4) identifies the research method employed.

4 Analysis

The analysis of the material yields a series of general conclusions. While researchers appear to take much interest in strategic management in the Third Sector the sheer number of empirical studies is somewhat lower than at the end of the 20th century. A review completed by Melissa Stone et al. which covered the period between 1977 and 1992 or 15 years revealed 66 empirical (surveys and case studies) studies in the area, which averages at 4,4 publications per year (Stone, Bigelow and Crittenden [61]). From 2000 through to mid-2009, i.e. during 9,5 years there were 50 studies, including 21 based on surveys, 5 case study reports, 17 intuitive and 2 critical analyses. Thus, according to the Stone's classification there were 2,7 studies per year.

Researchers have apparently focused on five different aspects of the subject: current management and strategic management approaches/theories; analysis of the roles of externalities and internalities in the Third Sector; review of how strategic management has been applied for non-profit organizations; review of applications and enhanced identification of one or more strategies utilised by non-profit organizations; application of specific methods and tools in strategic management.

The first group of papers address current management and strategic management approaches/theories such as complexity science (Paarlberg and Bielefeld [43]), knowledge management (Renshaw and Krishnaswamy [49]), intellectual capital (Kong [35]), key competences

(Bryson, Ackermann and Eden [10]), value management (Moore [41]), open systems theory (Starnes [60]). Clearly, most authors subscribe to the resource-based view of strategic management.

Laurie Paarlberg emphasises that current theories of strategic management, mainly top-down in structure, are not relevant to non-profit organizations which inherently rely on the participation and guidance of various stakeholder groups. She claims that complexity science can be a helpful tool while explaining the strategic management processes, content and implementation (Paarlberg and Bielefeld [43]). It is stressed that the concept of intellectual capital is more effective in the context of non-profit organizations than other contemporary theories of strategic management (Kong [35]).

Sharon Renshaw also notices that non-profits exposed to a competitive market place need a compatible strategic management approach, which includes the need to manage their knowledge resources (Renshaw and Krishnaswamy [49]).

The commercial strategy model applied in non-profit organizations is hinged upon the market, competition and clients/customers, and as such it is not adequate for the Third Sector. Here, the strategy should address the social value generation, sources of relevance and support and operational capacity to deliver value (Moore [41]).

John Bryson stresses the role of managing key competences. He believes that efficient management of key competences in an organization will imply improved performance, stronger relationships with peer organizations due to the same or similar shared values, and better capacity to formulate strategic plans. Further, he observes that the 'livelihood scheme' of generating a business model based on key competences may be successfully applied in non-commercial organizations (Bryson, Ackermann and Eden [10]).

Non-profit organization should be managed as open-ended systems and form strategic alliances as a means to pursue their missions (Starnes [60]).

The resource-based view of strategic management is also close to the hearts of authors who analyse the role of external and internal factors in the Third Sector.

Table 1. Review of Modern Literature on Strategic Management in Non-Profit Organizations
(source: own work)

| | Author, year of publication | Subject | Study method |
|-----|--|---|---|
| (1) | (2) | (3) | (4) |
| 1 | Paarlberg and Bielefeld, 2009 [43] | Foundations, parameters and impact of complexity science on strategies of public good organizations | intuitive |
| 2 | Gunby Jr, 2009 [27] | Study of impact of one of the strategic management models on organizations' performance, including non-profit organizations | survey |
| 3 | LeRoux and Goerdel, 2009 [37] | Study of an empirical model where various organizational factors influence the organization's activity. Explanation of one of the aspects of strategic management | survey |
| 4 | Renshaw and Krishnaswamy, 2009 [49] | Emphasised need for strategic knowledge management in non-profit organizations | intuitive, critical analysis |
| 5 | Cochran, David and Gibson, 2008 [16] | Mode of creating an effective mission statement | intuitive, critical analysis |
| 6 | Jarmon, 2008 [31] | Competition between non-profit and for-profit organizations | critical analysis |
| 7 | Speckbacher, 2008 [58] | Considerations on the role of stakeholders in the context of economics and governance theory in organizations | intuitive, critical analysis |
| 8 | Schalm, 2008 [56] | Application of the strategic score card in non-profit organizations (long-term medical care) in Canada | intuitive, critical analysis, 10 interviews |
| 9 | Carman and Fredericks, 2008 [11] | The role of evaluation as a tool, <i>inter alia</i> in strategic management | survey |
| 10 | Kong, 2007 [35] | The meaning of the intellectual capital concept in strategic management of non-profit organizations | intuitive, critical analysis |
| 11 | Bryson, Ackermann and Eden, 2007 [10] | The role of key competences according to the resource-based view of strategic management | intuitive, critical analysis |
| 12 | Vandijck, Desmidt and Buelens, 2007 [63] | Mission statement in Flemish non-profit organizations | survey |
| 13 | Taylor and McGraw, 2006 [62] | Human resources management as a strategy in strategic management in sports organizations in Australia | survey |
| 14 | Golensky and Mulder, 2006 [24]) | Study of strategies employed in 112 organizations in California | survey |
| 15 | Chew, 2006 [13] | Positioning strategy in strategic management, study of organizations in the United Kingdom | survey |
| 16 | Hafsi and Thomas, 2005 [28] | Effect of volatile environment on strategic management in philanthropic organizations in Montreal | monography |
| 17 | Chien-Tzu Tsai et al., 2005 [15] | An innovative strategy case study in Industrial Technology and Research Institute, Taiwan | case study |
| 18 | Alfirević et al., 2005 [1] | Application of the strategic score card, a case study from Croatia | case study |
| 19 | Reeves and Ford, 2004 [48] | Differences in strategic management between non-profit and for-profit organizations | survey |
| 20 | Pijl and Sminia, 2004 [46] | Relevance of strategic management for non-profit organizations – case study | case study |
| 21 | Carney, 2004 [12] | The role of middle management in strategic management in hospitals | survey |
| 22 | Fillis, 2003 [22] | Image, reputation and identity as issues in strategic management | intuitive |
| 23 | Katsioloudes and Tymon, 2003 [33] | Study of the use of strategic management in a sample of 53 organizations in Philadelphia | survey |
| 24 | Reussner, 2003 [50] | Strategic management model for museums | intuitive, critical analysis |
| 25 | Speckbacher, 2003 [59] | Efficiency management in non-profit organizations, role of the strategic score card | critical analysis |
| 26 | Frumkin and Casey, 2003 [23] | Components of strategic management for schools | intuitive, critical analysis |

| | | | |
|----|---|---|--------------------------------------|
| 27 | Berrett and Slack, 2001 [5] | Sponsor acquisition strategy in sports organizations | survey |
| 28 | Inamdar et al., 2000 [30] | Application of the strategic score card in health care | monography |
| 29 | Crittenden, 2000 [18] | Study of 31 organizations regarding strategic management impact on financial strategies | survey |
| 30 | Hwang and Powell, 2009 [29] | Strategic planning as an indicator of rational operations in organizations with hired paid personnel and full-time managers in the San Francisco area. Rational activity is on a higher level in such organizations | survey |
| 31 | Bratt, 2009 [6] | The role of strategic planning in more efficient operations in a volatile market. It can help organizations which focus on housing for the poor | intuitive, critical analysis |
| 32 | Chew and Osborne, 2009 [14] | Identification of key factors influencing the positioning strategy in organizations. The factors make up a theoretical model which is better aligned with charities | intuitive, survey, critical analysis |
| 33 | Mazzarol and Soutar, 2008 [39] | Study of Australian education institutions with regard to Porterian positioning strategies. Findings demonstrate that organizations which fail to use consistent strategies note less satisfactory performance | survey |
| 34 | Johnson and Lipp, 2007 [32] | A case of a cognitive map employed for goal identification, a the first step in strategic planning for a major university faculty | monography |
| 35 | Slyke van and Brooks, 2005 [57] | Study and model for a better alignment of the fund-raising strategy to socio-demographic and economic characteristics of individual donors | intuitive, survey |
| 36 | Rhodes and Keogan, 2005 [51] | Analysis of individual strategic choices and strategic planning process in non-profit organizations in Ireland, sample of 25 organizations | survey |
| 37 | Balser and McClusky, 2005 [2] | Stakeholder relations management, two case studies | case study |
| 38 | Pike, Roos and Marr, 2005 [47] | The role of intangible assets in value creation and strategic planning | case study |
| 39 | Brown and Iverson, 2004 [7] | Study of 132 organization regarding strategy conceptualisation vis-à-vis products, services and organizational structures; 4 types of strategic behaviours have been identified | survey |
| 40 | Griggs, 2003 [26] | Effect of strategic planning on organization's performance. Study of 148 organizations in Australia | survey |
| 41 | Miller, 2002 [40] | Issues of strategic management in religious organizations; sources of competitive advantages, role of strategy and strategic alliances | intuitive, critical analysis |
| 42 | Barman, 2002 [13] | Differentiation strategy in the context of the changing environment and competitiveness of non-profit organizations | monography |
| 43 | Pavičić, Renko and Alfirević, 2001 [44] | Role of competition and competitiveness analysis in non-profit organizations | survey |
| 44 | Mara, 2000 [38] | Use of computer tool to support strategic planning in small non-profit organizations | monography |
| 45 | Crittenden and Crittenden, 2000 [19] | Study of characteristics of non-profit organizations and their impact on strategic planning | survey |
| 46 | Moore, 2000 [41] | Value management as organizational strategy, among others in non-profit organizations | intuitive |
| 47 | Bart and Tabone, 2000 [4] | Study of the relationship between mission statement and performance of Canadian hospitals | survey |
| 48 | Starnes, 2000 [60] | Impact of open systems theories and strategic alliances on competitive advantage in non-profit organizations | intuitive, critical analysis |
| 49 | Domański, 2009 [20] | Analysis of strategic groups of 485 Polish organizations focusing on education and culture. Identification and description of 5 groups, use of cluster analysis | survey |
| 50 | Ridder and McCandless, 2008 [52] | Critical role of human resources management and its uniqueness in non-profit organizations | intuitive, critical analysis |

They recognise the role of: the environment (Hafsi and Thomas [28]), human resources (Taylor and McGraw [62] and Ridder and McCandless [52]), middle management (Carney [12]), intangible resources (Pike, Roos and Marr [47]), stakeholders (Speckbacher [58]) and (Balser and McClusky [2]).

Taïeb Hafsi mentions the stimulating role of a volatile environment. Strategies in philanthropic organizations are more effective and ensure viability and growth is they are not hinged upon the concept of autonomy and take environmental dependence for granted and acknowledge it affects the organization's behaviours (Hafsi and Thomas [28]).

Efficient human resources management can make a difference for non-profit organizations. However, its basis components known from the private sector should be tuned to the needs of the Third Sector which works with volunteers along with paid staff. Very few non-profit organizations have a human resources management strategy; (Taylor and McGraw [62], Ridder and McCandless [52]). In this context, it is essential that the strategy be formulated jointly by the leadership and personnel alike and this includes middle management. This translates into improved ownership and more effective implementation (Carney [12]).

Further, it is acknowledged that intangible assets of a non-profit organization play an essential role in value creation (Pike, Roos and Marr [47]).

Stakeholders are looked upon as key resources of the Third Sector. The key challenge of non-profit organizations is to increase the value of the contributions made by stakeholders and yet to minimise transaction costs and the cost of decision-making (Speckbacher [58]). Organizations which build their external relations with stakeholders by projecting an image of a well managed organization and do it consistently with various stakeholder groups tend to receive accolade from external evaluators (Balser and McClusky [2]).

The third group of papers relates to the application of strategic management for non-profit organizations. Normally, research papers aim at demonstrating the relevance of this concept for the Third Sector, analysing the scope of implementation, building partial models either for specific types of organization (museums, schools, sports or religious organizations) or for specific strategic planning phase (mission, vision, planning).

5 Strategic Planning

Strategic planning in non-profit organizations is positively correlated with their performance in the following dimensions: orientation to external environment, functional orientation and focus on key personnel involvement (Griggs [26]). Strategic planning helps organizations better concentration on the rapid changes in the environment (Bratt [6]).

Non-profit organizations are committed to strategic planning yet managers appear to see an inadequate contribution of analyses conducted in the process (Katsiolouides and Tymon [33]). The relative importance attached by organizations to detailed planning is closely correlated with their nature and pressure on traditional organization structures – organizations which have a management board, paid administration, voluntary members and various committees engage their stakeholders (e.g. administration, volunteers and clients) in the planning process (Crittenden and Crittenden [19]).

Organizations which have existed for a long time attach greater importance to strategic planning but they have no influence over this process: the age of members, fund-raising sources, education of administration staff and the level of bureaucracy (Crittenden and Crittenden [19]). Organizations must take into account the qualitative dimension of the strategic management process while evaluating it; a multi-dimensional approach to this process ensures a greater return on assets (ROA) (Gunby Jr [27]).

6 Strategies

Organizations employ a wide variety of both internal and external strategies most of which meet or even exceed their expectations and the selection of the strategy should depend on its effectiveness and efficiency (Golensky and Mulder [24]). Strategies developed by organizations place special emphasis on such dimensions as structure and mission (Rhodes and Keogan [51]).

A number of observations regarding their strategies imply a view that non-profit organizations (churches) are competitive organizations. Strategies must on occasion result from the choice between tradition and innovation and may be guided by collaboration (Miller [40]). Organizations should find an adequate response to the two fundamental strategic dilemmas: the choice

between membership and influence, and between representation and control (Pijl and Sminia [46]). Organizations are successful when: the various strategies that they employ are closely interrelated and oriented towards funding from diverse sources, they apply marketing tools and their growth comes from improved utility of their offer (Crittenden [18]).

7 Mission Statement

Managers in non-profit organizations realise that a well stated mission may be extremely advantages (Vandijck, Desmidt and Buelens [63]). An effective process of developing a mission statement may involve the following steps: introduction, analysis of: components, communication, connotations, and applicability (Cochran, David and Gibson [16]). According to research, top management makes the biggest contribution towards formulating a mission statement (Bart and Tabone [4]).

The involvement of a broad spectrum of stakeholders in developing a mission statement is positively correlated with performance and the process should not be top down but informal and creative across a possibly broad range of participating stakeholders (Bart and Tabone [4]). However, non-governmental organizations' leaders should not only concentrate on fulfilling the mission but also pay attention to managing their organizations through a fast changing environment (Frumkin and Casey [23]).

8 Key Sources of Effectiveness

Factors affecting the performance and effectiveness of non-profit organizations are addressed in literature. It is recognised that organizations management by full-time managers and employing paid staff have more rationalised operations (Hwang and Powell [29]).

Factors which have a major impact on organizations' performance are: experience accumulated in the course of collaborative efforts, adequate relations with major donors, managers equipped with lobbying skills, dependence on government resources and competition for resources in the environment (LeRoux and Goerdel [37]).

9 Other

A partial strategic management model for museums oriented towards granting visitor access to resources has been developed by Eva Reussner. She claims that a strategic management model for a non-profit organizations should be comprehensive and attuned to externalities such a government (culture) policy and the obligations arising from public functions (Reussner [50]).

The role of reputation, image and identity is emphasised by Ian Fillis. Reputation, identity and image management may be relevant also in small organizations and may be viewed through the lens of marketing and enterprise (Fillis [22]).

While there are significant differences in strategic management and performance evaluation between non-profit and for-profit organization it is plausible to study them at the same time (Reeves and Ford [48]).

The analyses of applications and a better definition of one or more specific strategies employed by non-profit organizations fall under fourth identified category of papers. Authors focus on: competitive strategies (Jarmon [31], Pavičić, Renko and Alfirević [44]); positioning strategies (Chew [13], Chew and Osborne [14], Mazzarol and Soutar [39]) innovation strategies (Chien-Tzu Tsai et al. [15]), fund-raising strategies (Berrett and Slack [5]), (Slyke van and Brooks [57]); differentiation strategies (Barman [3]); strategic behaviours (Brown and Iverson [7]).

Non-profit organizations may reasonably compete against commercial organizations in certain markets, e.g. health care (Jarmon [31]). The use of competition analysis method and the marketing orientation improves the competitiveness of non-profit organizations (Pavičić, Renko and Alfirević [44]).

Charitable organizations employ positioning strategies which are a function of a wide variety of internal and external factors and performed at two levels: sub-sectoral and one which is part of the general response of the Third Sector to the environment where they compete for resources (Chew [13], Chew and Osborne [14]). Strategies should lead to an adequate positioning of the offer in specific market segment. Organizations that do not have a consistent strategy tend to have unsatisfactory performance (Mazzarol and Soutar [39]).

Further, research studies examine the drive for innovation among non-profit organizations both as part of their strategies or as one of their core activities. Innovation in non-profits can be assessed using a three-dimensional model and this may be part of an overall assessment of strategic management (Chien-Tzu Tsai et al. [15]).

Tim Berrett identifies key factors that affect non-profit organizations' ability to raise funds: use of media to promote projects and the level of participation (Berrett and Slack [5]).

One strategy typical of non-profit organizations is the fund-raising strategy designed to attract donations and financial support. Fund-raising strategies should be tailored to the social and demographic profile of potential donors (Slyke van and Brooks [57]).

Emily Barman analyses differentiation strategies. She claims that organizations use differentiation not only to improve competitiveness but also to mark their uniqueness and superiority over rivals (Barman [3]).

Organizations can be classified according to four strategic types: defenders, seekers, analysers and responders (Brown and Iverson [7]).

Finally, the last identified group of contemporary research papers address the applicability of tools and techniques in strategic management in the Third Sector. The tools and techniques include: the strategic score card (Schalm [56], Alfrević et al. [1], Speckbacher [59]), Inamdar et al. [30]; evaluation (Carman and Fredericks [11]), cognitive mapping (Johnson and Lipp [32]), computer-aided planning (Mara [38]), strategic groups analysis (Domański [20]). Largely, authors conclude that the specific tools and techniques can be used by non-profit organizations, possibly with some sector-specific modifications. They also describe specific outcomes resulting from the use of specific tools.

10 Synthesis

The identified papers can be summarised around four key areas of concern or dilemmas faced by modern management theory. First, how can the established commercial strategic management concepts and techniques be best adapted to the specific needs of the Third Sector? Secondly, and more generally, which of the existing schools of thought is the most relevant for the type of organization at hand? Is there a room for a brand new theory? Thirdly, how can management

theory and research find a cohesive and consistent concept that explains the effective performance of a non-profit organization. Lastly, how to address the strategic challenge of choosing between the willingness and need to employ competitive strategies and the relevance of opting for a collaborative strategy and a generally co-operative approach to the non-profit environment?

The sampled population of research studies suggest that in terms of non-profit management theory it is essential to note that established commercial concepts do to fit into the Third Sector setting, inter alia (Renshaw and Krishnaswamy [49], Moore [41]). Clearly, this statement originates from the perceived differences between strategic management in non-profit and for-profit organizations (Reeves and Ford [48]). The 'top-down' approach is especially criticised as inadequate for strategically managing non-profits (Paarlberg and Bielefeld [43]).

Hence, much of the conceptual work is focused on mission statement, goal setting, top level planning and communication to lower levels with a view to building tactics. Implementation is left to rank-and-file personnel. The above pattern is inadequate for non-profit organizations. Their operations must be guided by a wide group of stakeholders and this has a bearing on strategic management (Paarlberg and Bielefeld [43]). This is mentioned by Carney who stresses the need for a greater staff and middle-management involvement (Carney [12]).

There is ample evidence that the inclusion of stakeholders in strategic management is advantageous non-profit organizations. It may boost the quality of management with more management dimensions properly addressed in strategic planning (Gunby Jr [27]). Moreover, it fosters effectiveness and improved performance (Balser and McClusky [2], Griggs [26], Bart and Tabone [4]). Surely enough, the involvement of clients in the process of, perhaps, not goal setting but identifying ways of goal implementation will help non-profit organizations build a more 'useful' offering. Such utility will be one of the keys to success (Crittenden [18]). The removal of pressure from key managers to deliver under strategic plans by delegating will help top management focus on day-to-day management in a volatile environment, claims Peter Frumkin (Frumkin and Casey [23]).

The review of research reveals that non-profit organizations recognise the need to include a broad spectrum

of stakeholders in strategic planning. However, this concept is implemented by organizations with an extensive organizational structure with both voluntary and paid personnel, including administration (Crittenden and Crittenden [19]).

Hence, there seems to be a ready and universal answer to the challenge of applying commercial strategic management in non-profit organizations. The answer is 'Involve as many stakeholders as possible in this process and you will be successful'. But will you, really? Is such a democratic management at all feasible? Is democracy not the best of systems only because nobody has ever thought of a better one? And what about the cost of decision-making in such a model? In fact, cost is one of the major issues non-profit organizations must address (Speckbacher [58]). Consequently, there is a need for a 'golden means', a balance between the key role of top management and the marginal delegation of strategic planning responsibilities. What is the point of balance? Apparently, the answer to this question has not been found yet.

Another dilemma, a theoretical rather than a practical one, is: which school of management theory should strategic management of non-profit organizations be part of. Again, contemporary researchers are not single-minded about this and propose the resource- and competence-based view. An overwhelming majority of papers adhere to this school. Its adequacy for non-profit organizations is strongly argued by John Bryson who claims that a key competence-based livelihood scheme may be successfully applied by them (Bryson, Ackermann and Eden [10]). He goes on to argue that adequate management of key competences in the organization implies improved performance and is a strong basis for strategic planning. The concept of intellectual capital which belongs to this school of thought equally falls into the interests of modern research. Authors tend to recognise its effectiveness in the non-profit setting (Kong [35]).

Knowledge management is another concept which can and should be adapted to meet the needs of non-profit organizations (Renshaw and Krishnaswamy [49]) as is value management (Moore [41]). A wide spectrum of organizational resources are analysed and described: human resources (Taylor and McGraw [62], Ridder and McCandless [52]), including managers (Carney [12], Katsioloudes and Tymon [33], Vandijck, Desmidt and Buelens [63], Bart and Tabone [4], Frumkin and Casey [23], Hwang and Powell [29]); personnel

(Griggs [26]) and donors (LeRoux and Goerdel [37], Slyke van and Brooks [57]), and stakeholders (Paarlberg and Bielefeld [43], Speckbacher [58], Balser and McClusky [2], Crittenden and Crittenden [19], Bart and Tabone [4]), then non-tangible resources (Pike, Roos and Marr [47]), mainly reputation and image (Fillis [22]). The above demonstrates the absolute prevalence of the resource- and competence-based view in strategic management in the Third Sector.

The sole attempts to go beyond this view are limited to references to other established management theories for non-profit organizations such as systems theory (Starnes [60]) and the computational complexity theory (Paarlberg and Bielefeld [43]). They are viewed as useful tools. There are no theories around dedicated non-profit management concepts. Eva Reussner claims that a comprehensive strategic management model should not only rely on externalities, but mainly address the public function (Reussner [50]).

The special role in public value creation is also mentioned by Mark Moore (Moore [41]). At the level of strategy conceptualisation, one central non-profit-specific strategy is that of fund-raising (Berrett and Slack [5], Slyke van and Brooks [57]). Here, research papers call for a choice between membership and influence and between representation and control (Pijl and Sminia [46]) and a choice between tradition and innovation (Miller [40]). Most papers, however, focus on the established concepts or methods, perhaps addressing the unique applications in non-profit organizations. Researchers do not ask explicit questions that would lead them to new and unique concepts that consolidate the existing schools of thought in strategic management. This is a new challenge faced by the academic community. Theory should not only explore existing concepts but, perhaps first of all, search for new and better conceptual schemes.

The third dilemma is strategic management of non-profit organizations is about their effectiveness and efficiency (including the effectiveness and efficiency of strategic planning), rationalisation and how specific strategic affect these parameters. Modern theory provides a wide variety of answers. Non-profits operate more effectively when they recognise and adequately respond to their environment which quite often offers a high level of motivation (Hafsi and Thomas [28], Griggs [26]). A well defined mission will be an effective response (Vandijck, Desmidt and Buelens [63]), and the formulation process should involve

the following steps: introduction, and the analysis of: inputs, communication, connotations and applicability (Cochran, David and Gibson [16]). Mission statement is one of the strategic dimensions used by non-profit organization (Rhodes and Keogan [51]), and the lack of a mission statement implies inadequate performance (Mazzarol and Soutar [39]). Non-profit organizations become successful if the various strategies they employ are closely interrelated, based on fund-raising from diverse sources, use marketing tools and grow by strengthening the utility of their offer (Crittenden [18]). Strategies in philanthropic organizations are more effective and support growth and viability when they are not hinged upon autonomy as a core value. Note that the selection of a strategy should be driven by its effectiveness and efficiency (Golensky and Mulder [24]). The selection of a strategy is part of strategic planning which can be effectively supported with IT tools (Mara [38]) and which helps organizations concentrate on changes in the environment (Bratt [6]). Furthermore, strategic planning is positively correlated with performance in the following dimensions: external environmental orientation, functional orientation and focus on key personnel involvement (Griggs [26]). The key personnel are managers and non-profit organizations (Hwang and Powell [29]). Managers should have lobbying skills (LeRoux and Goerdel [37]). While they seem to recognise the insufficient contribution of analytics into the strategic management process (Katsioloudes and Tymon [33]), they have the biggest impact on the organization's mission (Bart and Tabone [4]). As noted earlier, the process should involve other stakeholders as there is a positive correlation between the involvement of a wide spectrum of stakeholders in creating the mission and the performance of the organization. The process should not be top-down but a fairly informal and creative co-participation of as many stakeholders as possible (Bart and Tabone [4]). Stakeholder involvement will facilitate strategy implementation (Carney [12]). Finally, organizations which build their external relations by consistently creating among their stakeholders a perception of a well managed structure tend to receive higher ratings on effectiveness (Balsler and McClusky [2]) in external evaluations, as described by Joanne Carman (Carman and Fredericks [11]). One of the core and at the same time unique strategies of a non-profit organization is its fund-raising strategy. This strategy should be aligned with the social and demographic characteristics of prospective donors

(Slyke van and Brooks [57]). Among key success factors of a non-profit fund-raising strategy is the appropriate use of the media (to promote projects) and the level of participation (Berrett and Slack [5]). Researchers point to a performance measurement tool which is likely to be most suitable for non-profits, i.e. the Strategic Score Card (Schalm [56], Alfirević et al. [1], Speckbacher [59], Inamdar et al. [30]).

A question arises as to whether we are, in fact, missing a single coherent theory that would explain and measure performance in the Third Sector. Where profit is not a goal what is? What is the single most important goal that non-profit organizations are trying to meet? Is it to increase the stakeholder value (as opposed to shareholder value in commercial organizations)? How can you measure the value in the absence of a market valuation mechanism such as the share price? These questions are still to be answered.

Another challenge to contemporary research on strategic management in the Third Sector is about the type of strategy that should be pursued, and more specifically, whether the guiding principle should be competition or co-operation with other players in the sector. This dilemma appears to be solved already at the first glance as the majority of writers on the subject underline the need intrasectoral competition. Kent Miller suggests that non-profit organizations should be seen as competitive, which implies a number of observations regarding their strategies (Miller [40]). In this context, competition is mainly for resources in the environment and it is becoming a major factor affecting performance (LeRoux and Goerdel [37]).

Competition and marketing orientation analysis is postulated as key method of improving competitiveness (Pavičić, Renko and Alfirević [44]). Further, the strategic group analysis can be successfully applied in this sector as it will help identify the closest competitors and barriers to entry to other, less competition-intensive areas of operation (Domański [20]). The competitive dimension, however, goes beyond rivalry between other organizations in the non-profit sector. Indeed, non-profits can aggressively compete against commercial organizations in certain markets, e.g. health care (Jarmon [31]).

Non-profit organizations employ positioning strategies which are a function of both external and internal factors and are executed at two levels; sub-sectoral and sectoral, the latter being part of the Third Sector's general response to the pressures of the environment where

they compete for resources (Chew [13], Chew and Osborne [14]). Another strategy is that of differentiation where the goal is to promote uniqueness and superiority over rivals (Barman [3]). Four strategic behaviours are identified: defenders, seekers, analysers and responders (Brown and Iverson [7]). In contrast, Becky Starnes pushes competition to the sidelines and argues in favour of strategic alliances. She claims non-profit organizations should be managed as open systems and form strategic alliances to pursue their missions (Starnes [60]). Also, Kent Miller, points out that religious organizations that he has researched could employ collaborative strategies (Miller [40]). Mark Moore concludes that the strategic model based partly on competition that has been used by commercial organizations is not adequate for non-profit organizations (Moore [41]).

In the context of these observations and the fact that a large majority of non-profit organizations not only fail to protect their key skills against competition but indeed in the name of public good share their good practices with others in the same market one may ask a fundamental question whether the theory of Third Sector management should not place a far greater emphasis on the concepts of collaborative, alliance-based and co-operative strategies. Such an approach would be much closer to reality and could yield a more faithful description of the status quo of non-profit organizations. Moreover, it can produce more efficient management strategies and methods. This is the role of applied research studies such as the study of management.

11 Conclusion

This paper aimed at reviewing contemporary literature on strategic management in non-profit organizations. Whereas much could have changed in management theory since Melissa Stone outlined her findings from a study of management literature between 1977 and 1992 it seems pertinent that a similar review should be conducted to identify focus areas and proposed concepts in the early year of the 21st century. Our study has concluded that from 2000 through to mid-2009 (9,5 years) there were some 50 publications, of which 21 were mainly surveys, 5 were case studies, 5 monographies, 17 used the intuitive method and 2 were critical reviews of existing literature.

While analysing the areas of interest of contemporary authors it is clear that there are five such fields: modern management and strategic management approaches /theories; analysis of the roles of externalities and internalities in the Third Sector; review of how strategic management has been applied for non-profit organizations; review of applications and enhanced identification of one or more strategies utilised by non-profit organizations; application of specific methods and tools in strategic management.

Four dilemmas faced by modern management theory serve as a synthetic axis. First, how can the existing commercial management concepts and techniques be best adapted to the realities of the non-profit sector? Secondly, which of the established schools of strategic management is the most relevant one for non-profits? In fact, is it appropriate to look for a brand new school of thought? Thirdly, and this is again related to academic pursuits, what coherent theory can explain the efficiency of non-profit organizations. Fourthly, there is the dilemma what strategy to employ when faced with a choice between the willingness and the need to apply competitive strategies and the co-operative strategy in the third sector.

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DIRECTORS REMUNERATION AND COMPANIES' PERFORMANCE THE COMPARISON OF LISTED COMPANIES IN POLAND AND UK

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Abstract: This paper examines the determinants of CEO compensation. There are many factors that influence CEO compensation. For this research three factors has been selected: companies size, accounting factor and market factor. The study looks at the relationship between each of this factors and directors remuneration. Sample of companies listed on London Stock Exchange (LSE) and Warsaw Stock Exchange (WSE) has been investigated over the period of 2007 – 2010. Data has been collected through annual reports content analysis and announcement on websites of LSE and WSE. Linear regression has been run on collected data. Positive correlation has been found between directors' remuneration and companies' size in both British and Polish listed companies. The relationship is also positive between directors pay and companies performance. Companies' performance has been assets by return on equity ratio (ROE) and Tobin's Q. All the findings are consistent with the outcome presented within previous research by variety of scholars.

Key words: corporate governance, companies' performance, director's remuneration, agency cost, CEO compensation.

1 Introduction

Corporate governance was first introduced by A. Smith. He highlighted the changes in companies' behaviour as a consequence of separation of ownership and control. There is an ongoing debate at present how corporate governance should be define (Jarzemowska [13], pp. 22-34). The concept of corporate governance can be looked at form legal and economic perspective. Economic approach describe corporate governance as "an institutional mechanism for regulating the relationship between the participants of corporate contracts, especially between managers and shareholders (...). It is a set of principles affecting the supervision and accountability of the company." (Ignys-Lipowiecka [12], pp. 215-216).

Corporate governance is strictly related with:

- accountability - the way in which managers are accountable to shareholders,
- communication - how the company obtain and communicate information,
- relationships - diversified in terms of economic conditions and national traditions, between the owners and managers of corporations.

The main aim of corporate governance is to protect shareholders interest against misused of their capital

by managers of a company. The rationale for the use of these practices may be the fact that the principles of corporate governance are an important factor when assessing a company. It could affect the valuation of the company or influence the investment decision of potential investor.

The models of corporate governance are the formal systems of accountability of top management to shareholders and they that should create an integrated value for the shareholder. These models are based on two assumptions:

- maximization of shareholder value is the best way to ensure their prosperity,
- financial goals can be achieved by building long term relationships with all stakeholders.

This allows to regard relationships with employees, customers, investors, suppliers and the community as an essential source for improving companies competitiveness. Good relationship is understood as value of information, reputation, contracts. The model of stakeholders groups (a network of formal and informal relationships of corporations - a pluralistic approach) is based on the assumption that the company is a social institution and therefore can extend its influence on the prosperity of society and brings benefits not only to shareholders but also to wide groups

of other parties, as many companies may spend part of their profits on social objectives. This shows the direct connections “between social obligations, social responsibility and corporate social response.” (Kopycińska [17], p. 197).

The UK represent single tier corporate governance model. The major role is played by The Board of Director (executive and non-executive), who are elected at General Annual Meeting (AGM). The role of Board of Director is to manage the company on behalf of and in the best interest of shareholders (Gajewska-Jedwabny [7], p. 492). On the other hand Polish capital market is at quite early stage of developing corporate governance practice. The corporate governance principal aim is to prevent some negative phenomena, such as fraud or violations of rights of minority shareholders (Gajewska-Jedwabny [7], p. 502).

Solarz ([26], p. 274) stress that as Anglo - Saxon model has a strong relationship between the remuneration of director and company performance, for Polish companies the remuneration of directors grow faster than profit, return on assets (ROA) and return on capital employed (ROE).

The recent academic debate within corporate governance concentrates on the relationship between CEO remuneration¹ and companies' performance. Investors are becoming more and more concern by companies' mismanagement after a series of corporate scandal such as Enron, World Com, Parmalat, Maxwell, Polly Peck etc. “Investors are shocked and apprehensive after recent news about huge payment of £1,7 billion in bonuses to the managers of RBS (Royal Bank of Scotland) despite bank making a £3,6 billion loss during 2009” (Seel [24]). This example shows the inconsistency of classical compensation theory, as only improved performance should be awarded by higher remuneration. Investors start questioning high paid management contracts as being unreasonable more often than ever.

The problem with discrepancies between managers' compensation and investors' expectation is strongly address by agency theory and has been investigated by many researchers in the last three decades (Jensen et al. [14], pp. 255-268; Kato et al. [16], pp.1-19; Oetomo et al. [20]). According to agency theory principal - agent relationships is a contract under which one

or more persons (the principal engage another person - the agent) are engaged to perform some service on their behalf which involves delegating some decision making authority to the agent. For this services and contribution to shareholders wealth the agents are expecting to be properly rewarded, but the agents for obvious reasons do not always act in a way which contributes to maximising shareholders' (owners', principals') wealth.

Hence, the owners are forced to create and implement different incentive schemes and monitoring schemes for agents to minimize deviations. As it has been proved by many research managers (agents) work more efficiently only if they receive strong motivation such as perks, bonuses, fringe benefits, stock options, etc. If the agent should act in the best interest of the shareholder the efficiency (E - a desirable effect) is based on the appropriate relationship between following factors: the agent action in the interests of principal (b), the intensity of work the agent (i) and agent remuneration or criteria on which remuneration is based (w). (Gruszecki [9], pp. 220). This is expressed by the formula:

$$E = f(b, i, w) \quad (1)$$

Regardless the large number of conducted researches concerning agency costs there are still some reservations about the role the different incentives play in managers performance and what is the best structure of managers (directors) remunerations. Although many empirical studies claim that incentive schemes can notably increase productivity of managers and an optimal compensation contract is a cure for the principal - agent conflict, some research or even recent examples, give grounds for considering high pay-performance contracts as not reasonable².

Therefore, it becomes increasingly interesting to test the relationship between directors' remuneration and company performance. The first part of the paper describes the different incentive incorporated in directors' remuneration package. The second part analyse current state of research with directors pay-performance. Third part discusses the methodology used in the study and results obtained. The last part presents conclusions and recommendations.

¹ For the purpose of this paper compensation, remuneration, salary, pay, payment will be used as synonyms and will describe the total value of reward allocated to the directors.

² See RBS example.

The research has been conducted on companies listed on London Stock Exchange and Warsaw Stock Exchange. The period taken into analysis covers the years 2007-2010.

2 Directors remuneration

Companies' directors can be rewarded in many ways. They receive basic salary, which includes pension contributions and prerequisites such as companies' car, club membership, etc. In addition, top executives usually obtain bonuses that are usually linked to the directors' performance. They can also be entitled to long-term incentives plans usually in the form of stock options. The most common incentive programs are:

- stock option plan,
- restricted stock plan,
- performance plan,
- deferred compensation plan,
- performance based cash compensation plan,
- profit related plan,
- company Share Option Plan.

The basic executive salary is usually determined through benchmarking method. This is conducted by remuneration committee and is based on directors' qualification, experience, past success and firm size. In the recent years, it can observe continuous increase of directors' salaries as they usually argue for competitive rewards and expect the increase on yearly basis. The new trend has been detected of new CEO (Chief Executive Directors or Managing Directors) requesting higher remuneration package than currently serving CEO.

At the end of financial year director are usually rewarded with cash bonuses. The size of the bonus is based on the company performance over the previous 12 months and is typically is related to profit measurement such as earnings before interest and tax (EBIT) or earning per share (EPS). The other commonly use measure is economic value added (EVA). In addition to the mention measures CEO contract usually have a minimum threshold that needs to be reached in order to qualify for the bonus. The bonus can be paid as a lump sum or as a percentage in relation to chosen measure. Many professional bodies are in favour of bonuses versus pay rise as bonuses are awards

for realised current achievements and pay raises are increase for the future unrealised performance³.

The most popular market - orientated incentive pay is executive stock option. It allows directors to purchase the shares at a fixed price, called price or strike price. This means that if the share price reaches the higher level than strike price, the directors will gain additional profit. This approach encourages CEO and other directors to efficiently manage the company as the better company performs the higher share price can be achieved. Most of the researchers consider this method as aligning the managers and shareholders goals⁴.

Some researchers stress that executive option contributed to governance failure in 1990s and early 2000s (e.g. Enron). That's why two new incentives have been recently introduced; restricted stock grants and performance share. Restricted stock include common stocks on which limitation has been imposed. The limitations are related to the time for which the share cannot be sold or to the certain goals that is need to be achieved before the shares can be sold. The advantage of this tactics versus option is that its value is not impacted by asymmetric⁵. Performance share approach describes the situation in which the executives are award the shares only if certain criteria are achieved such as for example EPS. In this sense, the shares are regarded as rewards for past - realised achievement⁶.

3 Directors payment and companies performance

The academic interest in executive pay began in the early 80's. Most of the researchers tried to find out relation between executive pay and firm performance. Some tried to figure out what factors influence executive compensation, how much the firm should pay or when firm should pay more to motivate executives etc. The majority research on executive compensation has been guided by agency theory. As managers are the main decision makers, it is therefore essential to motivate managers or directors through contract

³ The median bonus payment for directors in large American firms was \$2,17 million in 2007.

⁴ The most common stock options are for 10 years.

⁵ It has been 12% increase in long-term restricted stock in the last 6 years.

⁶ It can be observe that in the last 5 years the use of performance share as an element of directors remuneration increased by 36%.

or offer so that they bind their interests with the interests of shareholders.

Several researches undertook investigation into directors' remuneration focusing on relation between CEO pay and firm performance (Cosh et al. [3], pp. 469-492; Conyon [2], pp. 493-510; Gregg et al. [8], pp. 1-9; Kato [16], pp. 93-510; Randøy et al. [21], pp. 57-81). Jensen et al. ([14], pp. 255-268) tested pay - performance sensitivity in different variations of incentives (salaries, bonuses, stock options, etc) and found that there is a positive and statistically significant relationship between performance of a firm and managers' pay but it is rather small. The sensitivity of directors' remuneration is "about \$3,25 per \$1 000 change in shareholder wealth". They also established that CEOs of larger firms have fewer stock options and enjoy less monetary incentives than CEOs from smaller firms, which is consistent with Demsetz et al. ([4], pp. 1155-1177) study.

Jensen et al. ([14], pp. 255-268) stress, that their findings are incoherent with optimal contracting models. They also argue that the change in shareholder wealth may not be the best indicator of CEO performance. They agree with Holmström ([11], pp. 74-91) hypothesises that optimal contracts and performance objectives for managing directors should not be only linked to main shareholder objective – increase in shareholder wealth, but also should reflect the range of consecutive measures, which will help to assess how close, is executives' choice of actions to principal's goals. It can be different accounting indicators, comparison with other CEOs from the same industry and etc.

Edmans et al. [5] proposed a multiplicative model, which incorporates the integrated theory of sensitivity and level of executives' pay in market equilibrium. The innovation in comparison to the current approach is "Firstly, motivated by first principles, consumer theory, and macroeconomic models and multiplicative preferences in the principal – agent problem" and secondly "endogenize total pay in a market equilibrium by embedding the principal-agent problem into a competitive assignment model of CEO talent" (Edmans et al. [5], p. 2).

Demsetz et al. ([4], pp. 1155-1177) as well as Jensen et al. ([14], pp. 255-268) stress that incentives schemes are very weak in big corporations probably because of weakness of corporate governance in such firms. This means linear models predict that dollar – dollar incentives should be constant across CEOs, and thus

independent of size does not work in practice. This means that millions and billions of dollars (pounds, euros) might be lost every single period, which actually demands for very strong governing policies.

Hansell et al. ([10], p. 28) found that for 158 large US companies the CEO remuneration and companies' performance were moving in different directions for 2007 till - 2008 which is in line with a press rumours about excessive executive pay during the economic downturn.

The important factor influencing directors' remuneration as well as company performance is company size. A study by Rosen (1982:311-323) indicates that small difference in the quality of CEO can make a big difference in larger firms, so, larger firms try to attract the best directors for their firms. This results in higher remuneration packages in larger companies as to acquire the best CEO for the firm and to keep him or her interested in the firm.

Studies of many scholars reflect the influence of performance on director's remuneration. When the firm perform well in the market, CEOs are rewarded with compensation package. Lewellen et al. ([19], pp. 710-720) have shown that CEO remuneration is strongly influence by generating profit. Gregg et al. ([8], pp. 1-9) examined UK listed 288 large firms over the period 1983-1991. They found the evidence that directors pay is related strongly with firm size. They confirmed that 50% increase in a firms revenue resulted in 10% increase in directors remuneration. Baker et al. ([1], pp. 593-616) studied the relation between managing directors' payment scheme and revenue. They found positive relation between CEO compensation and firm size. Firm that grow 10 % in size usually pay 3 %more to its CEOs.

Kostiuk ([18], pp. 90-105) has determined approximately the same result when he examined 73 large firm of U.S over the time 1968 to 1981. Zhou ([27], pp. 213-251) examined on 755 firms which are all Canadian firms and his works also found that CEO pay is positively correlated with firm size. The same tendency has been confirmed within Japanese companies by studies of Zhou et al. ([28], pp. 665-696) and Kato ([16], pp. 93-510).

Baker et al. ([1], pp. 593-616) establish smaller pay performance sensitivity on CEO compensation in large firms. Their work also show that insignificant CEO owns amount of firm's stock's of larger firms, which

are usually more than CEO's of small firms. This is why pay performance sensitivity is less significant in small firms but more significant in larger firms. They also highlight, that motivation strength of CEO's can be linked with the number of stock owned by CEO's. This has been established based on minor efficiency of CEO's effort rising in accordance with firm size.

The recent study of Kato et al. ([15], pp. 1-19) on Japanese firms' performance shows the influence of firm performance to CEO remuneration scheme. Their works show especially strong impact of accounting measures on directors pay but less impact of stock market performance.

Lewellen et al. ([19], pp. 710-720) examined whether any positive relation can be found between CEO compensation and firm performance. Their research on 50 US firms over the period from 1942 to 1963 shows that generating profit is strongly depends on CEO compensation.

Rosen ([22], pp. 311-323) established that the influence of ROE on CEO compensation in 0,1 – 0,15 range and the elasticity of CEO pay and firm size are not significantly different from beta of 0,3.

Gregg et al. ([8], pp. 1-9) in their study of large UK firms found that, in terms of share returns over the whole fiscal year, the influence of CEO pay on firm performance is very weak. When they examined the relation between CEO pay and firm performance again after slitting the data into 2 time period which were 1983 – 1988 and 1989 – 1991, they found that CEO pay is positively related to firm performance for the first period of time.

Finkelstein et al. ([6], pp. 179-199) looked at 1000 Fortune firms and found that CEO compensation is positively related with ROE (Return On Equity), firm size and managerial discretion such as R & D intensity, market growth.

4 Research methodology

This research concentrates on investigating whether CEO remuneration is positively related to companies' size, accounting performance and to market performance. The investigation try to addresser the following questions:

- Does relation between firm size and directors' remuneration exist in selected sample – this part

of the research follows the approach of Oetomo et al. [20], who examined directors' remuneration in relation to companies' size. They used book value of total assets as a proxy for firm size. Rosser et al. ([23], pp. 115-126) also used book value of total assets as firm size when they investigated the impact of firm size on CEO compensation. Following regression model is used to determine the relationship between CEO compensation on firm size:

$$\text{CEO remuneration} = a + b \{ \text{firm size (total assets) } \} + e \quad (2)$$

- Does company performance impact directors remuneration - to answer this question Shim et al. ([25], pp. 93-116) path will be followed. They used return on equity (ROE) as a proxy for accounting performance indicator and Tobin's Q as a performance measurement for market factor to determine the impact of company performance on directors pay. To determine the relationship between CEO compensation on accounting factor: following regression model is used:

$$\text{CEO compensation} = a + b \{ \text{accounting factor (ROE) } \} + e \quad (3)$$

- ROE is calculated by dividing Net income after tax with total equity,
- net income is selected after tax and preferred stock dividends but before common stock dividends,
- preferred shares are excluded from total equity.

To determine the relationship between CEO compensation on market factor following regression model is used:

$$\text{CEO compensation} = a + b \{ \text{market factor (Tobin's Q)} \} + e \quad (4)$$

Here market value equals to:

$$\text{Tobin's Q} = [\text{MVE} + \text{DEBT} + \text{PS}] / \text{TA} \quad (5)$$

where:

MVE - is the market value of shareholders equity,

DEBT - is the value of the firm's short – term liabilities net its short term assets plus the book value of the firms long term debt,

PS - is the liquidating value of the firm's outstanding preferred stock,

TA - is the book value of the total assets of the firm.

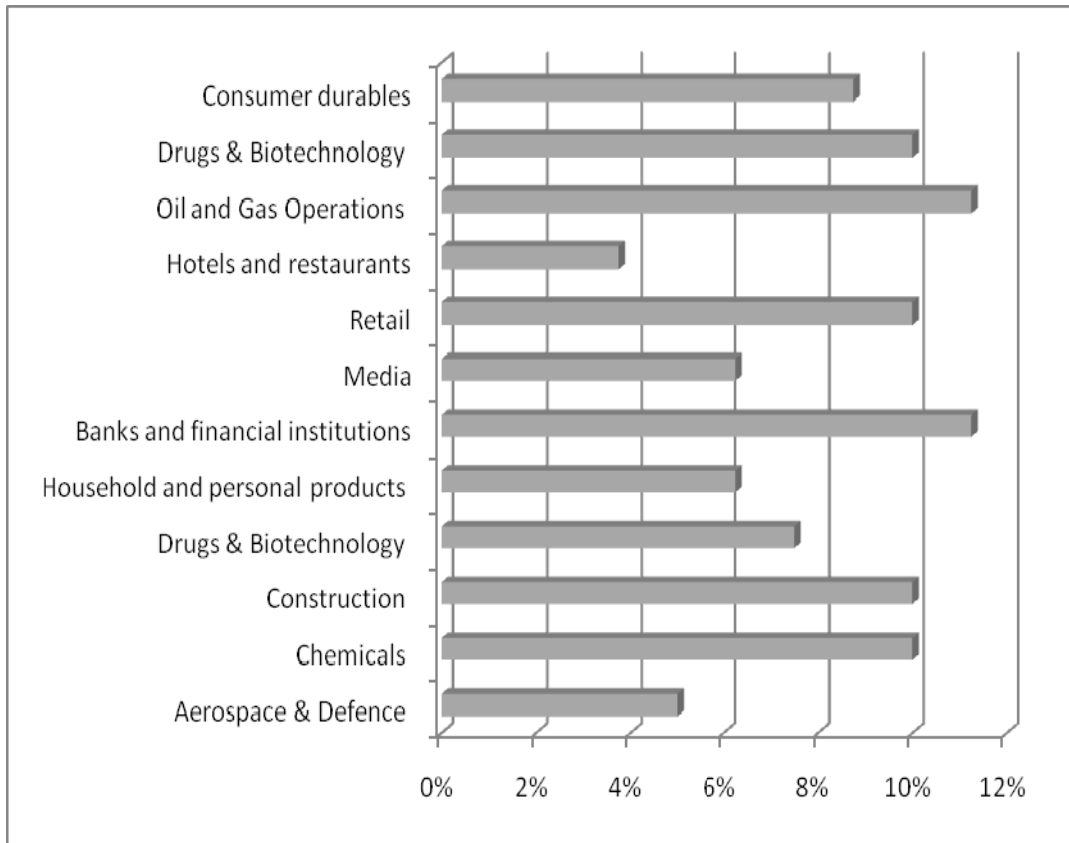


Figure 1. FTSE 100 sample
(source: own work)

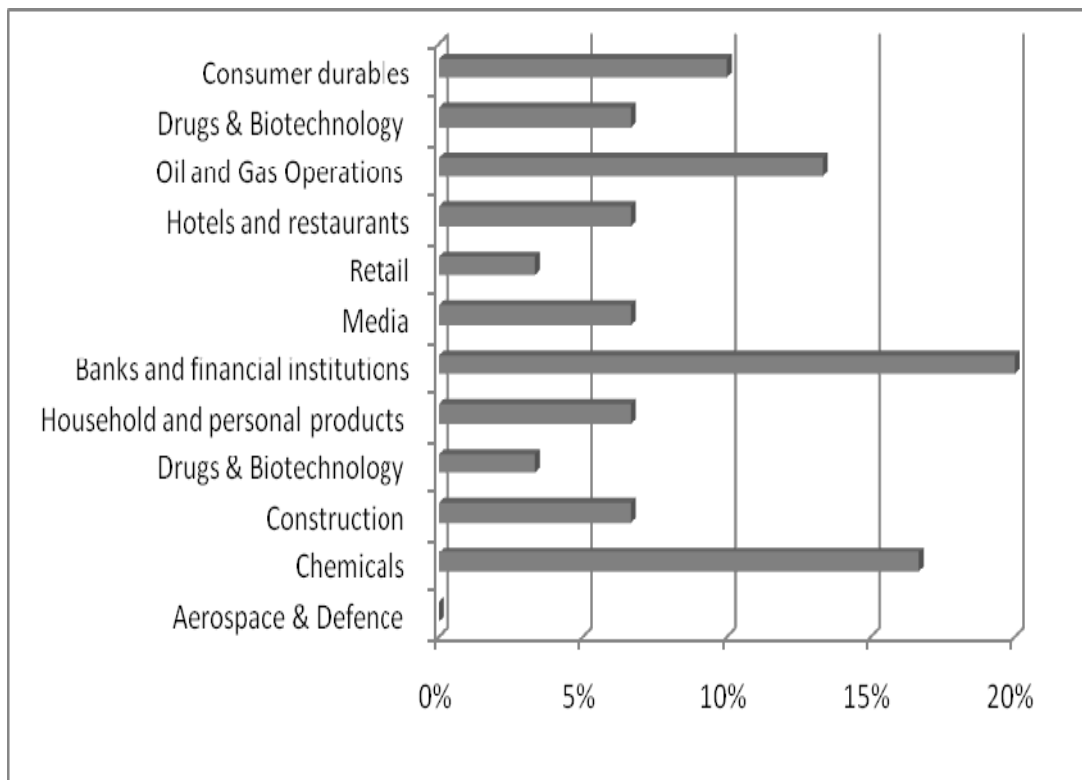


Figure 2. WSE sample structure
(source: own work)

In all three models compensation (remuneration) is considered as dependant variable. Compensation is the total of cash pay and share own by CEO (director).

5 Data collection and findings

At first 130 from companies has been considered for this study, but the final sample contains only 110 listed companies as some of the companies have not disclosed necessary information over investigated period. 80 companies have been randomly chosen from FTSE 100. The companies have been investigated for the period two periods: 2007-2008 and 2009-2010. The structure of the sample is presented in Fig. 1.

50 companies have been randomly selected from firms listed on Warsaw Stock Exchange. Only 30 were considered for the analysis as only those companies provide information about directors' remuneration. The structure of the sample is presented in Fig. 2. Descriptive statistics for each variable has been calculated for the purpose of data analysis. To point out the inter correlation among various measures Pearson's Correlation has been used. To verify the significance of the relation between CEO compensation and various measures, linear regression has been used. Regression

models have been applied to identify relations between CEO compensation and selected factors.

Within investigated UK listed companies, the minimum full compensation was £900,000 as the highest £8,9m. At the same time the average basic salary of CEO reached £981,000. Within Polish listed companies the minimum full compensation was PLN 2,8m as the highest PLN 9,88m. At the same time the average basic salary of CEO reached PLN 865,000. The data has been obtained through content analysis of annual reports of selected companies.

Table 1, Table 2, Table 3 and Table 4 present correlation matrix between director's compensation, firm size (total assets), accounting factor (ROE) and market factor (Tobin's Q).

The research shows (see Table 1) that CEO compensation of UK based companies between 2007 and 2008 is positively related with accounting factor (0,020) and market factor (0,035), but negatively related with firm size (-0,15). Similar results have been obtained for 2009-2010. It shows that CEO remuneration is positively related with accounting factor (0,022) and market factor (0,035) though the relation with market factor is slightly lower than in previous years.

Table 1. Correlation matrix British companies for 2007-2008
(source: own work)

| Factor | Statistic | Remuneration (total pay) | Firm size (total assets) | Accounting Factor (ROE) | Market factor (Tobin's Q) |
|------------------------------|---------------------|-----------------------------|-----------------------------|----------------------------|------------------------------|
| Remuneration (total pay) | Pearson Correlation | 1 | -0,015 | 0,020 | 0,035 |
| | Sig. (2-tailed) | - | 0,823 | 0,783 | 0,628 |
| | N | 80 | 80 | 80 | 80 |
| Firm size (total assets) | Pearson Correlation | -0,015 | 1 | -0,024 | -0,215* |
| | Sig. (2-tailed) | 0,823 | - | 0,793 | 0,003 |
| | N | 80 | 80 | 80 | 80 |
| Accounting Factor (ROE) | Pearson Correlation | 0,020 | -0,024 | 1 | -0,038 |
| | Sig. (2-tailed) | 0,783 | 0,793 | - | 0,598 |
| | N | 80 | 80 | 80 | 80 |
| Market factor (Tobin's Q) | Pearson Correlation | 0,035 | -0,215* | -0,038 | 1 |
| | Sig. (2-tailed) | 0,628 | 0,003 | 0,598 | - |
| | N | 80 | 80 | 80 | 80 |

*correlation is significant at the 0,01 level (2-tailed)

Table 2. Correlation matrix British companies for 2009-2010
(source: own work)

| Factor | Statistic | Remuneration (total pay) | Firm size (total assets) | Accounting Factor (ROE) | Market factor (Tobin's Q) |
|------------------------------|---------------------|-----------------------------|-----------------------------|-------------------------------|------------------------------|
| Remuneration (total pay) | Pearson Correlation | 1 | -0,023 | 0,022 | 0,045 |
| | Sig. (2-tailed) | - | 0,892 | 0,754 | 0,666 |
| | N | 80 | 80 | 80 | 80 |
| Firm size (total assets) | Pearson Correlation | -0,023 | 1 | -0,032 | -0,240* |
| | Sig. (2-tailed) | 0,892 | - | 0,777 | 0,003 |
| | N | 80 | 80 | 80 | 80 |
| Accounting Factor (ROE) | Pearson Correlation | 0,022 | -0,032 | 1 | -0,040 |
| | Sig. (2-tailed) | 0,754 | 0,777 | - | 0,578 |
| | N | 80 | 80 | 80 | 80 |
| Market factor (Tobin's Q) | Pearson Correlation | 0,045 | -0,240* | -0,040 | 1 |
| | Sig. (2-tailed) | 0,666 | 0,003 | 0,578 | - |
| | N | 80 | 80 | 80 | 80 |

*correlation is significant at the 0,01 level (2-tailed)

In 2009-2010 negative relation between CEO compensation and firm size (-0,23) has been observe, which is in line with previous year's results. The impact is stronger in comparison to the first set of research and it is mainly due to the recession over the investigated period. Over the period of 2007-2008 the negative relation has been establish between company size and accounting factor (-0,024) and company size versus market factor (-0,215). Similar relation has been notice over the 2009-2010 period although the relation is slightly stronger (company size vs. accounting factor (-0,032), company size vs. market factor (-0,240). In both periods accounting factor (ROE) is negatively related with market factor (Tobin's Q) (2007-2008: -0,038; 2009-2010: -0,040).

Table 3 and 4 presents regression of CEO compensation on firm size. The results indicate that there is positive correlation between directors' compensation and company size. The increase of total assets by 1 % over the period of 2007-2008 results in 8% increase of directors' remuneration and by 11% over 2009-2010. It is rather surprising that in the second period the correlation is so strong over the economy downturn (2009-2010). T-test value of the regression coefficient of the constant is 2,213 in the first period and 3,333 in the second period. This is significant and the t-test value of the regression coefficient of the independent variable, which is firm size (total assets), in this case, is 0,212 and 0,343 respectively.

Table 3. Regression on directors' compensation and firm size UK listed companies for 2007-2008
(source: own work)

| Model | Unstandardised Coefficient | | Standardised Coefficient | t | Sig. |
|--------------------------|----------------------------|------------|--------------------------|-------|------|
| | B | Std. Error | Beta | | |
| 1 constant | 294,933 | 133,267 | - | 2,213 | ,028 |
| Firm Size (total assets) | ,000 | ,001 | ,080 | ,212 | ,823 |

Table 4. Regression on directors' compensation and firm size UK listed companies for 2009-2010
(source: own work)

| Model | Unstandardised Coefficient | | Standardised Coefficient | t | Sig. |
|--------------------------|----------------------------|------------|--------------------------|-------|------|
| | B | Std. Error | Beta | | |
| 1 constant | 256,988 | 122,277 | - | 3,333 | ,023 |
| Firm Size (total assets) | ,000 | ,01 | ,11 | ,343 | ,799 |

Table 5. Correlation matrix Polish companies for 2007-2008
(source: own work)

| Factor | Statistic | Remuneration (total pay) | Firm size (total assets) | Accounting Factor (ROE) | Market factor (Tobin's Q) |
|---------------------------|---------------------|--------------------------|--------------------------|-------------------------|---------------------------|
| Remuneration (total pay) | Pearson Correlation | 1 | -0,022 | 0,027 | 0,028 |
| | Sig. (2-tailed) | - | 0,833 | 0,773 | 0,688 |
| | N | 30 | 30 | 30 | 30 |
| Firm size (total assets) | Pearson Correlation | -0,022 | 1 | -0,028 | -0,225* |
| | Sig. (2-tailed) | 0,833 | - | 0,693 | 0,007 |
| | N | 30 | 30 | 30 | 30 |
| Accounting Factor (ROE) | Pearson Correlation | 0,027 | -0,028 | 1 | -0,033 |
| | Sig. (2-tailed) | 0,773 | 0,693 | - | 0,558 |
| | N | 30 | 30 | 30 | 30 |
| Market factor (Tobin's Q) | Pearson Correlation | 0,028 | -0,225* | -0,033 | 1 |
| | Sig. (2-tailed) | 0,688 | 0,007 | 0,558 | - |
| | N | 30 | 30 | 30 | 30 |

*correlation is significant at the 0,01 level (2-tailed)

Table 6. Correlation matrix Polish companies for 2009-2010
(source: own work)

| Factor | Statistic | Remuneration (total pay) | Firm size (total assets) | Accounting Factor (ROE) | Market factor (Tobin's Q) |
|---------------------------|---------------------|--------------------------|--------------------------|-------------------------|---------------------------|
| Remuneration (total pay) | Pearson Correlation | 1 | -0,020 | 0,022 | 0,025 |
| | Sig. (2-tailed) | - | 0,822 | 0,783 | 0,718 |
| | N | 30 | 30 | 30 | 30 |
| Firm size (total assets) | Pearson Correlation | -0,020 | 1 | -0,022 | -0,220* |
| | Sig. (2-tailed) | 0,822 | - | 0,683 | 0,004 |
| | N | 30 | 30 | 30 | 30 |
| Accounting Factor (ROE) | Pearson Correlation | 0,022 | -0,022 | 1 | -0,031 |
| | Sig. (2-tailed) | 0,783 | 0,683 | - | 0,598 |
| | N | 30 | 30 | 30 | 30 |
| Market factor (Tobin's Q) | Pearson Correlation | 0,025 | -0,220* | -0,031 | 1 |
| | Sig. (2-tailed) | 0,718 | 0,004 | 0,588 | - |
| | N | 30 | 30 | 30 | 30 |

*correlation is significant at the 0,01 level (2-tailed)

When examining the relation between CEO compensation between 2007 and 2008 of Polish listed companies (see Table 5) a positive relation with accounting factor (0,027) and market factor (0,028) can be seen but negative relation with firm size (-0,22). Similar results have been obtained for 2009-2010. It shows that Polish CEO remuneration is positively related with accounting factor (0,022) and market factor (0,025) though both relations are lower than in previous years.

In 2009-2010 negative relation between CEO compensation and firm size (-0,20) has been observe, which is in line with previous years. Over the period of 2007-2008 the negative relation has been establish between company size and accounting factor (-0,028) and company size versus market factor (-0,225).

Similar relation has been notice over the 2009-2010 period although the relation is slightly stronger (company size vs. accounting factor (-0,022), company size vs. market factor (-0,220). In both periods, accounting factor (ROE) is negatively related with market factor (Tobin's Q) (2007-2008: -0,033; 2009-2010: -0,031).

The regression of CEO compensation on firm size (see Table 7 and Table 8) shows positive correlation of 1,5% between directors' compensation and company size over the period of 2007-2008 and 4% positive correlation over 2009-2010.

T-test value of the regression coefficient of the constant is 2,111 in the first period and 2,233 in the second period. This is significant and the t-test value of the regression coefficient of the independent variable, which is firm size (total assets), in this case, is 0,213 and 0,233 respectively.

The results obtain within Polish companies are very similar to those noted when investigating British firms and are in line with outcomes of studies of Jansen et al. ([14], pp. 255-268), Baker et al. ([1], pp. 593-616) or Rosen ([22], pp. 311-323). In earlier studies, many scholars proved that CEO compensation is positively related with firm size. However, there is no clear indication about why firm size is correlated positively with CEO compensation. Jensen et al. ([14], pp. 593-616) assumed that maybe larger firms tend to give higher remuneration regardless of CEO abilities. Rosen ([22], pp. 311-323) has brought up similar conclusion. Baker et al. ([1], pp. 593-616) stress that usually there is greater pay performance sensitivity in larger firms and lesser significance of pay performance sensitivity in smaller firms. This allows to conclude there is that directors' compensation is positively related with firm size. Although it should be noted that further studies should be conducted to look for more factors underpinning this trend.

Table 7. Regression on directors' compensation and firm size Polish listed companies for 2007-2008
(source: own work)

| Model | Unstandardised Coefficient | | Standardised Coefficient | t | Sig. |
|--------------------------|----------------------------|------------|--------------------------|-------|------|
| | B | Std. Error | Beta | | |
| 1 constant | 222,113 | 122,227 | - | 2,113 | ,030 |
| Firm Size (total assets) | ,000 | ,001 | ,015 | ,250 | ,823 |

Table 8. Regression on directors' compensation and firm size Polish listed companies for 2009-2010
(source: own work)

| Model | Unstandardised Coefficient | | Standardised Coefficient | t | Sig. |
|--------------------------|----------------------------|------------|--------------------------|-------|------|
| | B | Std. Error | Beta | | |
| 1 constant | 236,111 | 111,707 | - | 2,233 | ,023 |
| Firm Size (total assets) | ,000 | ,01 | ,040 | ,233 | ,722 |

There is positive a correlation between directors pay and accounting factor within British companies (Table 9 and Table 10). The research indicate that 1% increase in return on equity (accounting factor) over the period of 2007-2008 increase directors compensation by 2%.and by 3% over the period of 2009-2010. T-test

value of the regression coefficient of the constant is 2,254 and 2,355 respectively, which is significant. The t-test value of the regression coefficient of the independent variable (accounting factor/return on equity) is 0,275 and 0,255 respectively.

Table 9. Regression on director's compensation and accounting factor within UK listed companies for 2007-2008
(source: own work)

| Model | Unstandardised Coefficient | | Standardised Coefficient | t | Sig. |
|-------------------------|----------------------------|------------|--------------------------|-------|------|
| | B | Std. Error | Beta | | |
| 1 constant | 284,916 | 126,431 | - | 2,254 | ,025 |
| Accounting Factor (ROE) | 34,447 | 125,193 | ,020 | ,275 | ,783 |

Table 10. Regression on director's compensation and accounting factor within UK listed companies for 2009-2010
(source: own work)

| Model | Unstandardised Coefficient | | Standardised Coefficient | t | Sig. |
|-------------------------|----------------------------|------------|--------------------------|-------|------|
| | B | Std. Error | Beta | | |
| 1 constant | 277,116 | 132,331 | | 2,355 | ,022 |
| Accounting Factor (ROE) | 24,117 | 121,281 | ,03 | ,255 | ,753 |

Table 11. Regression on director's compensation and accounting factor within Polish listed companies 2007-2008
(source: own work)

| Model | Unstandardised Coefficient | | Standardised Coefficient | t | Sig. |
|-------------------------|----------------------------|------------|--------------------------|-------|------|
| | B | Std. Error | Beta | | |
| 1 constant | 254,916 | 133,431 | | 2,154 | ,029 |
| Accounting Factor (ROE) | 14,447 | 123,182 | ,010 | ,225 | ,755 |

Table 12. Regression on director's compensation and accounting factor within Polish listed companies 2009-2010
(source: own work)

| Model | Unstandardised Coefficient | | Standardised Coefficient | t | Sig. |
|-------------------------|----------------------------|------------|--------------------------|-------|------|
| | B | Std. Error | Beta | | |
| 1 constant | 263,618 | 123,233 | - | 2,554 | ,026 |
| Accounting Factor (ROE) | 15,336 | 133,812 | ,015 | ,233 | ,761 |

The results of Polish firms show similar results (see Table 11 and Table 12). Positive relation has been established between directors pay and accounting factor. Each increase in accounting factor by 1% impacted directors' compensation with the increase of 1% over the 2007-2008 and 1,5% over 2009-2010. T-test value of the regression coefficient of the constant is 2,154 and 2,554, which is significant and the t-test value of the regression coefficient is 0,225 and 0,233 respectively.

The results within both countries are in line with outcomes obtained by Shim et al. ([25], pp. 93-116) within high-tech and low-tech firm over the period of 1999-2001.

When looking at the links between directors' compensation and market factor it can be noted that a positive correlation exists between Tobin's Q and directors' remuneration within UK companies (Table 13 and Table 14).

Table 13. Regression on director's compensation and market factor within UK listed companies 2007-2008
(source: own work)

| Model | Unstandardised Coefficient | | Standardised Coefficient | t | Sig. |
|---------------------------|----------------------------|------------|--------------------------|------|------|
| | B | Std. Error | Beta | | |
| 1 constant | 157,484 | 292,984 | - | ,538 | ,592 |
| Market Factor (Tobin's Q) | 223,626 | 460,142 | 0,040 | ,468 | ,628 |

Table 14. Regression on director's compensation and market factor within UK listed companies 2009-2010
(source: own work)

| Model | Unstandardised Coefficient | | Standardised Coefficient | t | Sig. |
|---------------------------|----------------------------|------------|--------------------------|------|------|
| | B | Std. Error | Beta | | |
| 1 constant | 155,484 | 272,777 | - | ,558 | ,583 |
| Market Factor (Tobin's Q) | 244,262 | 433,111 | 0,040 | ,466 | ,658 |

Table 15. Regression on director's compensation and market factor within Polish listed companies 2007-2008
(source: own work)

| Model | Unstandardised Coefficient | | Standardised Coefficient | t | Sig. |
|---------------------------|----------------------------|------------|--------------------------|------|------|
| | B | Std. Error | Beta | | |
| 1 constant | 144,444 | 272,977 | - | ,511 | ,555 |
| Makter Factor (Tobin's Q) | 209,222 | 401,421 | 0,020 | ,488 | ,633 |

Table 16. Regression on director's compensation and market factor within Polish listed companies 2009-2010
(source: own work)

| Model | Unstandardised Coefficient | | Standardised Coefficient | t | Sig. |
|---------------------------|----------------------------|------------|--------------------------|------|------|
| | B | Std. Error | Beta | | |
| 1 constant | 1614,321 | 267,121 | - | ,577 | ,572 |
| Makter Factor (Tobin's Q) | 222,343 | 422,333 | 0,025 | ,488 | ,599 |

The increase of Tobin's Q by 1% increased director pay by 4% in 2007-2008 and stay at the same level for 2009-2010. T-test value of the regression coefficient of the constant is 0,538 and 0,558 respectively and is significant. The t-test of the regression coefficient of the independent variable which is market factor (Tobin's Q) in this case, is 0,48 and 0,466 respectively.

For Polish companies the situation demonstrates the same trend. The increase of Tobin's Q by 1% boost director pay by 2% in 2007-2008 and 2,5% 2009-2010. T-test value of the regression coefficient of the constant is 0,511 and 0,577 respectively, which is significant. The t-test value of the regression coefficient of the independent variable, which is market factor (Tobin's Q), in this case, is 0,488 and 0,511(see Table 15 and Table 16).

The achieved results from Polish and British sample are consistent with findings of Kato et al. ([15], pp. 1-19) research on Japanese firms or Randøy et al. ([21], pp. 57-81) on Norwegian and Swedish firms. All this studies conclude positive that CEO compensation is positively related with market performance.

6 Conclusions

Looking at the area of directors' compensation the question is always raised how remuneration is related to directors' impute. How remuneration package needs to be structure to maximise shareholders wealth. In most cases CEO payment are correlated with companies' performance and size. This research established positive correlation between directors' payment and companies' size (book asset value) in both British and Polish listed companies. Furthermore, positive correlation has been found between firms return on capital and directors remuneration in both samples. Directors' compensation is also positively associated with market performance for both British and Polish firm. All three factors are much stronger correlated with directors remuneration within British companies. This can be associated with more developed economy, different structure of directors' remuneration, or British directors having stronger position when negotiating payment packages. All findings are consistent with the results obtained by scholars conducting research in this field.

British companies are obliged to disclose information about director's remuneration. It is strongly regarded as an element of enhancing the transparency of corporate

governance. It was disappointing that many Polish listed companies do not publish information about directors' remuneration. This force researcher to limit the study to thirty companies only. It is hoped that in the future Polish companies disclose more information about directors' remuneration and it would be possible to conduct wider analysis in this field.

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THE DEVELOPMENT OF PRODUCTION MANAGEMENT CONCEPTS

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Abstract: The aim of this paper is the analysis of contemporary concepts used in production management in relation to the paradigms which accompanied their appearance and development. The first chapter contains a definition of the term ‘paradigm’, discusses the importance of the paradigms for the development of a scientific approach to management and lists examples of paradigms relevant to production management. In the second chapter such management concepts as LM, Kaizen, TOC, TQM, TPM, Six Sigma and BPR are presented, along with their respective old and new paradigms, main goals, fundamental rules and tools (methods and techniques). Some less popular concepts are also dealt with. The last chapter is devoted to an analysis of interactions between the analyzed concepts, with an emphasis on their mutual compatibility and complementarity, which can be of benefit in the process of their implementation.

Key Words: Lean Management, Theory of Constraints, Kaizen, Total Quality Management, Six Sigma, Business Process Re-engineering, Agile Manufacturing, Mass Customization, management paradigms, production knowledge, management by projects.

1 Introduction

Each field of science develops through both revolutionary and evolutionary processes. Groundbreaking discoveries alternate with periods of gradual improvement and consolidation of methods, techniques, research and implementation tools. This is also the case in the field of management. From time to time concepts emerge which break with the old paradigms or modify them substantially.

S. Nowosielski describes management concepts as “(...) recipes for, or ideas of, management, which are the result of interpretation and generalization of practical experience, coming from a certain area of an organization’s activity. They encompass a “soft” aspect, related to the general idea (philosophy) and a “hard” aspect, describing specific tools for realizing the company’s vision” ([36], p. 10).

The aim of this paper is to describe the key concepts used nowadays in production management:

- LM – Lean Manufacturing,
- TOC – Theory of Constraints,
- TQM – Total Quality Management,
- Six Sigma,
- TPM – Total Productive Maintenance,
- Kaizen – continuous improvement,
- BPR – Business Process Reengineering.

Other concepts dealt with here include: agile manufacturing, mass customization, management through projects and production knowledge management. These concepts are still being developed in terms of the techniques and methods they employ.

Some authors point out that the increasing commercialization of management has created the necessity for a critical perspective on the methods and concepts popular these days: “management concepts marketed by business consultants and gurus have a lot of weaknesses. Accepting them uncritically is, therefore, not recommended.” ([53], p. 170).

The concepts selected for analysis in this paper have proved to be successful in many countries, have been described well in the literature and are generally recognized and applied in everyday management practices. Emphasis has been placed on the use of these concepts in production management, highlighting at the same time their universal applicability and potential for use in organization management in general, not only for manufacturing.

New management concepts appear when in a given economy new problems arise. In order to find the solution for them one has to be capable of looking at the issue at hand from a different perspective, going beyond the entrenched conventions, which results in stepping outside the current paradigm and creating a new one.

This paper defines the concept of a paradigm and presents examples of paradigms relevant in production management. Fundamental models applied in production management are described. The breakthrough which accompanied their development is illustrated by contrasting the new and the old paradigm. Each model is characterized in terms of its fundamentals and methods and techniques used.

Interrelationships between different models are shown, which result from shared methods among other things. In the conclusion, the case for simultaneous implementation of contemporary production management models is made, as the compatibility of the models creates potential for synergy.

2 Production management paradigms

The word ‘paradigm’ comes from Greek and means “pattern, example” ([28], p. 457). It is a “a thought, pattern, model, or approach generally accepted in a given field” ([28], p. 457). The notion of paradigm in the historical development of science was introduced by TS. Kuhn, who defined it as “generally recognized scientific achievements which at a given time provide

the scientific community with model problems and solutions” ([27], p. 12). Kowalczewski defines paradigm as “a model generally accepted by the scientific community of a given time and widely used” ([26], p. 24).

Many authors discuss the issue of paradigm changes in management science, particularly in relation to the novel view of organization as networked and virtual, the novel roles of directors (as leaders, coaches) ([35], p. 11), or the development of a knowledge and e-commerce based economy ([12], p. 13-14).

There are many management paradigms, which have been modified over the course of time. As a result of the world economy evolving towards globalization, it seems necessary to embrace the need for speed, agility and continuous changes. It is brought about not only by focusing on customer needs, but also by growing competition from fast developing Asian countries. Table 1 illustrates traditional paradigms and examples of new ones, with particular emphasis on production management.

The most important changes in production management paradigms will be discussed in the remainder of this paper.

Table 1. Examples of traditional and new production management paradigms
(source: self study on the basis of [18, p. 193])

| Aspects | Traditional paradigms | New paradigms |
|------------------------------|------------------------|---|
| Strategic management | 5 years | 1-2 years |
| Tactic management | 2-3 years | 6-18 months |
| Operational management | 3 months | 1 week |
| Freezed master schedule | 3 months | 1 week |
| Freezed operational schedule | 1 month | 1 day |
| Machine inspection | Once a week | Continuous monitoring |
| Equipment modernization | Once worn out | Once outdated |
| Training | On the job, irregular | Off-the-job, professional, regular |
| Roles and positions | Narrow specialization | Wide-range of employees' qualifications |
| Production flow | Continuous, sequential | Discrete, parallel |
| Planning | Adjustive planning | Reacting to market needs, adaptive, forecasting |

3 Paradigm change as the basis of concepts used in production management

3.1 Lean Manufacturing

| old paradigm | new paradigm |
|---|---|
| production effectiveness achieved through mass production (specialization, economies of scale, taylorism) | production effectiveness achieved through lean manufacturing based on waste elimination |

Lean Manufacturing is a conception which views use of resources for anything other than creating value for the customer as a waste. It allows the production of a greater amount of products while using fewer resources, hence “lean” ([44], p. 19). In contrast to the traditional approach, based on extensive use of production capacity, LM assumes that only what is needed is produced. This way system productivity, as well as product quality, and customer service improve. The main differences between the traditional and the lean approach are illustrated in Fig. 1.

Lean Manufacturing is based on five lean approach rules ([51], p. 16-26):

- 1) assessing the product’s value from the client’s needs perspective;
- 2) identifying value stream for each product;
- 3) ensuring smooth value flow in production process;
- 4) ensuring a pull production system;
- 5) striving for perfection through continuous improvement.

Their brief description as well as supportive methods and techniques are shown in Table 2.

One of the main principles of Lean Manufacturing is elimination of waste. It is possible thanks to the identification of activities ([51], p. 20):

- value adding,
- non-value adding, but necessary - indispensable to the process (muda of the Type One),
- waste - non-value adding and dispensable (muda of the Type Two).

In the literature 7 main types of waste (Jap. muda) are mentioned whose elimination results in the increase of enterprise productivity ([20], p. 75): overproduction, inventory, defects (repair/rejects), motion, processing, waiting, transportation.

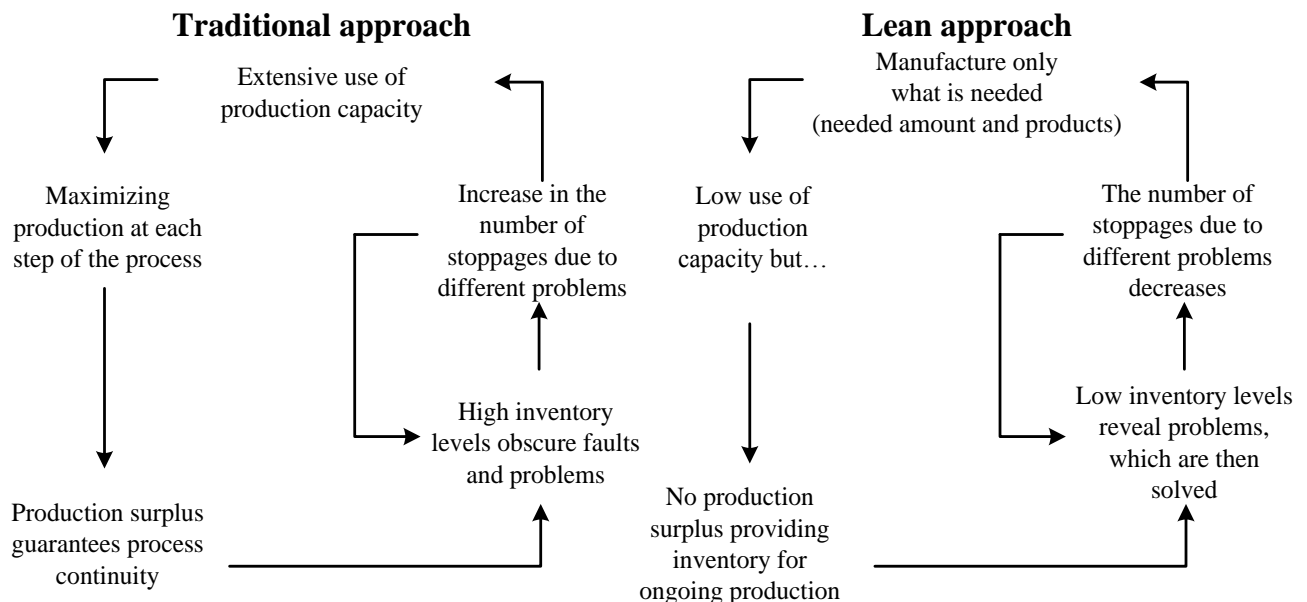


Figure 1. Traditional vs. lean approach to manufacturing (source: self study)

Table 2. Lean principles and techniques supporting them
(source: self study on the basis of ([25], pp. 67-7; [32], p. 108 and [52], p. 39)

| Principle | Description | Techniques |
|---------------------|--|--|
| 1) Value | Can be only defined by the customer. Only has a meaning when it is being considered in terms of a specific product, which fulfils customer's needs at a specific price and at a specific time. | Voice of the customer, value engineering (VE), value analysis, |
| 2) The value stream | The set of actions required to bring a product through the critical management processes of the business. | Value Stream Mapping (VSM) |
| 3) Flow | Requires a fundamental change in thinking for everyone involved, as functions and departments that once served as the categories for organizing work must give way to specific products. | One Piece Flow, SMED, Heijunka, TPM- Total Productive Mainenace |
| 4) Pull | No upstream function or department should produce a good or service until the customer downstream asks for it. | Supermarket, kanban, JIT delivery |
| 5) Perfection | Processes in the company and its organization must be improved all the time. There is always something more to do to achieve perfection which is actually unreachable. | Muda elimination, Visual Control, 5S, Poka-Yoke, self-control, SPC, standardization, problem solving, PDCA cycle |

3.2 Kaizen

| old paradigm | new paradigm |
|--|---|
| enterprise competitiveness growth mainly through innovation | enterprise competitiveness growth mainly through continuous improvement of processes by small steps using expert employees' |
| taking decisions and knowledge are the director's domain – hierarchical management | knowledge, teamwork in solving problems, delegating authority |

The Kaizen approach comes from Japan and reflects Oriental culture and way of thinking. Kaizen became widely popular in the West after the publication of Masaaki Imai's book "Kaizen: The Key to Japan's Competitive Success" in 1986.

Kaizen in Japanese means improvement (Jap. "kai" – change, "zen" – good). It denotes an approach focused on continuous improvement of the current conditions. It is done through small, gradual changes in processes, which accumulated over time make a substantive difference ([48], p. 2). Kaizen is underpinned by three main goals ([19], p. 128):

- 1) employees are the most important resource of the enterprise;
- 2) processes should evolve through gradual improvements rather than radical change;

- 3) improvements to be made are decided on the basis of a quantitative assessment of the results of particular processes.

The key principles of Kaizen are as follows ([20], pp. 2-7):

- maintaining and improving standards – maintaining relies on Kaizen activities, improving can be analyzed as either Kaizen or innovation,
- orientation towards processes – improving a process is fundamental to improving results,
- applying PDCA (plan, do, check, act) and SDCA cycles (standardize, do, check, act) – PDCA serves to establish new, better standards, SDCA is used to consolidate them and stabilize the level of results achieved,
- quality is number one priority – the main goals of the enterprise are related to quality,
- using data – referring to current data when solving a problem,
- the next process is the client – differentiation between the external client (in the market) and internal client (in the enterprise),
- engagement of all employees, management and rank-and-file employees alike.

Fig. 2 shows Kaizen and innovation concepts as well as how to achieve a radical improvement in a short time thanks to alternating between innovating and enhancing achieved standards using PDCA and SDCA cycles.

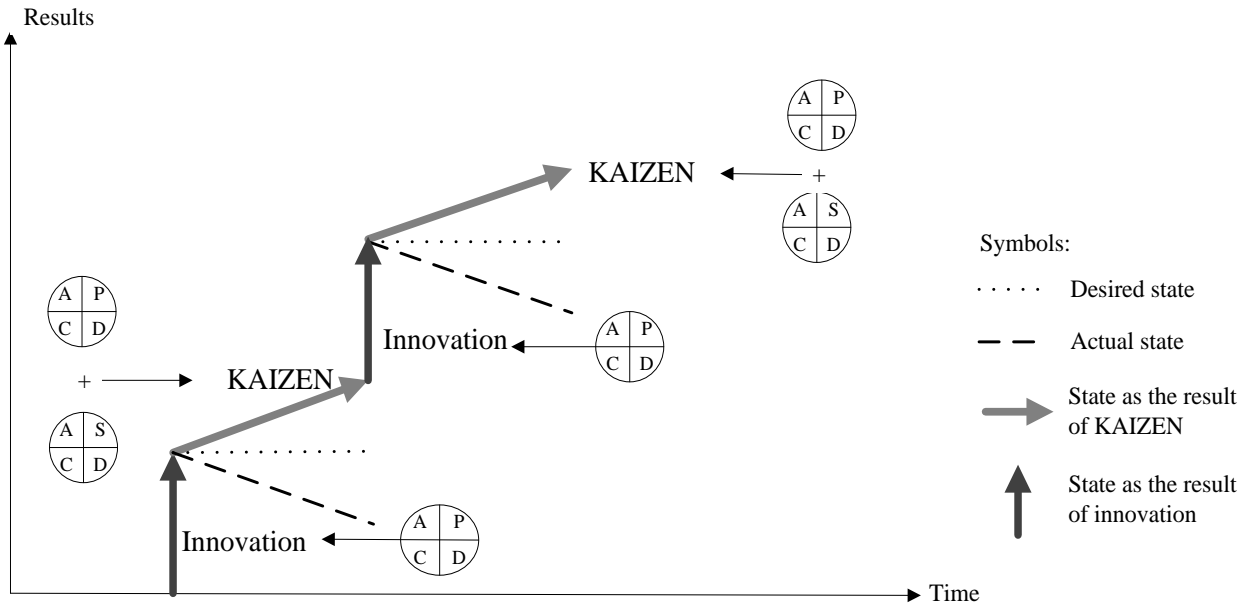


Figure 2. Innovations and Kaizen
 (source: self study on the basis of [21], p. 29 and p. 64)

The basic idea of Kaizen is to introduce small, gradual changes. The opposite is sudden radical changes called innovations (including product, process, marketing, or organizational innovations). Daily practices are aimed at maintaining the achieved level. However, in reality the level decreases due to failing to observe standards.

Kaizen allows for improvement of the achieved level through small, gradual enhancements as in the SDCA cycle. This approach complements the one based on innovations and vice versa. Thanks to using Kaizen it is possible to enhance the processes usually up to a certain level. The next improvement requires introducing completely new solutions and that is when innovation is needed. Hence, both approaches, although based on different assumptions, are mutually complementary.

The Kaizen philosophy assumes that all employees are involved in the improvement process ([21], p. 12). Rank-and-file employees are seen as the main source of knowledge about how to carry out the work in the right way, the problem and the solutions to it. They have the greatest detailed knowledge about the problem – the higher up in the management the better is the employee’s general knowledge of the situation and the less extensive their detailed knowledge. Hence the importance of increasing employee’s authority, which is linked to the increase of responsibility

and ability to take decisions in case of disturbances and clashes in the process.

Kaizen is supported by a range of methods and tools which make up the so called “Kaizen umbrella” ([21], p. 9). It includes such approaches as: Total Quality Control (TQC), suggestion system, Total Productive Maintenance (TPM), Kanban, Just-in-Time (JIT), as well as Zero Defects (poka-yoke). This shows the interdependence between Kaizen and other concepts used in production management, such as TQM (an extension of TQC), TPM and Lean Manufacturing (based on JIT).

3.3 Theory of Constraints

| old paradigm | new paradigm |
|--|--|
| every resource not used is a waste; one should strive to maximize the use of all resources | only the resource which is the constraint cannot be left unused; use of resources which are not critical does not affect throughput of the production system |

Theory of Constraints (TOC) is a concept created by E. Goldratt, which is based on the premise that the organization, like a chain, is as good as its weakest (not strongest) link. The fundamental notion in TOC is a constraint, defined as “anything which constrains

the system in achieving better results regarding its goal” ([45], p. 385).

There are three main constraints categories ([45], pp. 388-389):

- physical constraints (bottlenecks) – resource or resources, which physically constrain the achievement of the goals of the system,
- policy – rules and measurements used to manage the enterprise,
- paradigms, basic assumptions, beliefs, values and principles underpinning the conception and development of the enterprises’ policy.

The following principles of the Theory of Constraints can be formulated:

- 1) every organization has only a few constraints, elimination of which leads to radical improvement of results;
- 2) continuous system improvement is based on the POOGI (Process of Ongoing Improvement) - consisting of the following steps: what should be changed? what should be the result of the change? how should the change be made?
- 3) searching for improvements is a 5-step process:
 - (a) identifying the constraint,
 - (b) exploiting the constraint,
 - (c) subordinating all other resources and activities to the constraint,
 - (d) elevating the constraint,
 - (e) returning to step (a) to complete the cycle of continuous development.

Now the Theory of Constraints is a complex approach to organization management, covering [8]:

- 1) tools for identifying constraints and solving problems, so called logical thinking tools;
- 2) a range of area-specific applications, often computer-aided, enabling effective constraints management in such areas as:
 - (a) production management – DBR (Drum-Buffer-Rope) model,
 - (b) distribution management,
 - (c) project management – Critical Chain model,
 - (d) sales management,
 - (e) marketing;
- 3) human Resources management;

- 4) global and local measurements system, enabling financial decisions to be taken;
- 5) systematic method of creating the company’s strategy and tactics, directed at a radical improvement of results.

TOC application for production management is called Drum-Buffer-Rope. Its consecutive steps use both tools (methods and techniques) specific to TOC and tools belonging to other concepts.

Identifying the constraint is the starting point, because the constraint affects the size of the production output. The decision about the way of constraint exploitation is aimed at increasing its production capacity. At this stage all methods of enabling the increase of production flow at the bottleneck are used, e.g.: eliminating all operations involving the bottleneck which can be done using different resources, minimizing the bottleneck changeover times (e.g. by using the SMED method), prioritizing the bottleneck regarding all maintenance support, making sure that no low quality materials get to the bottleneck and so on. The result of all these activities is “the drum”, i.e. the schedule maximizing the use of the bottleneck capacity.

The buffer and the rope allow for subordinating to the constraint almost every process in the enterprise related to production planning, materials purchase, or shipment of finished products. The buffer serves to guarantee the realization of the bottleneck work schedule even when there are disturbances resulting from random fluctuations in the process, e.g. delay in the completion of the previous operation. The rope in turn is a mechanism for identifying the moment of moving the material to the first operation of the production process so that the right amount of intermediate products reaches the bottleneck in time. The concept of Drum-Buffer-Rope method is shown in Fig. 3.

Elevating the constraint should be considered only after exploiting all the potential of the constraint. When there are still possibilities of increasing sales (market is not a constraint) elevating constraint can be done through increasing its throughput, e.g. by buying a new machine. Returning to step one completes a cycle of continuous development – the same procedure is repeated for a new constraint.

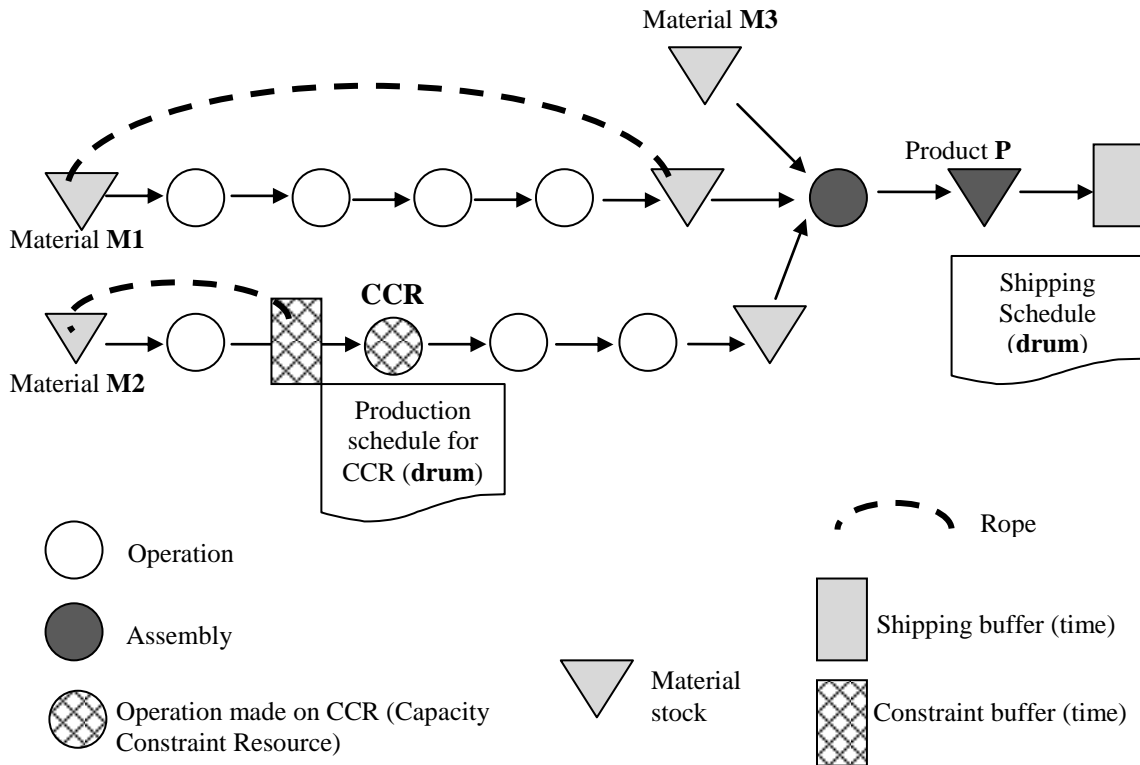


Figure 3. Drum-Buffer-Rope
(source: self study)

3.4 TQM

| old paradigm | new paradigm |
|---|--|
| product-orientated | client-orientated, identifying internal and external customers |
| the responsibility for quality is with the quality control department | the responsibility for quality is with every employee |

TQM (Total Quality Management) comes directly from the Japanese concepts of TQC (Total Quality Control) and CWQC (Company Wide Quality Control). They were adapted for the USA and then spread in the West. One of the main authors of TQM is William Edwards Deming, who created 14 principles of quality management.

TQM is an approach to enterprise management which views enterprise operations as a process in need of improvements in order to satisfy client's needs. It is possible through engaging all employees in matters of quality. In other words, TQM is an approach to the management of the enterprise as a whole in order to achieve its excellence [1].

TQM is based on 5 principles ([9], p. 30):

- 1) focusing on clients – there are external clients (the recipients of the final product) and internal clients (the organization's employees who receive the intermediate product);
- 2) continuous improvement (Kaizen) – continuous improvement of the processes to satisfy clients;
- 3) focusing on facts – decisions should be taken based on facts, which is possible thanks to the use of a constant measurement, observation, and data-collection system;
- 4) common involvement – the requirement of all the employees being involved in quality matters;
- 5) management involvement – informs and shows the employees that quality matters are of utmost importance.

Some mention as many as 8 principles relating to TQM, introduced by ISO 9000:2000 as principles of quality management. These principles are as follows ([41], p. 17):

- 1) client orientation;
- 2) leadership;
- 3) employees' involvement;
- 4) process approach;

- 5) system approach to management;
- 6) continuous improvement;
- 7) factual approach to decision making;
- 8) mutually beneficial supplier relationships.

Principles (4), (5) and (8) are those added to the traditionally recognized ones. These principles negate the so called traditional approach to quality, realized first as quality inspection, then quality control and finally quality assurance. The old and new attitudes to quality are contrasted in Table 3.

TQM is a concept relevant to both production management and quality management. It is supported by a range of methods and tools applicable to both these areas ([6], pp. 116-120):

- traditional TQM tools: 7 old quality tools, 7 new quality tools, 7 supporting quality tools,
- methods of quality planning: DOE (Design of Experiments), FMEA (Failure Mode and Effects Analysis), Taguchi method and QFD (Quality Function Deployment),
- methods of quality improvement: FMEA (Failure Mode and Effects), SPC (Statistical Process Control).

3.5 TPM

| old paradigm | new paradigm |
|---|---|
| responsibility for the technical condition of machines is with the maintenance department | responsibility for the technical condition of machines is with everyone |

TPM (Total Productive Maintenance) is a strategy of maximization of total effectiveness of machines and equipment. It prescribes continuous improvement of equipment with active involvement of employees responsible for the workplace and maintenance ([11], p. 158). In contrast to the traditional approach, in which it is the maintenance department who are responsible for the condition of the machines, TPM proposes that it is the machine operator who knows best how the machine works and how to keep it in the best condition.

The five pillars of TPM are ([46], p.11-12):

- 1) planned maintenance system, introducing three types of maintenance: preventive, modernizing and diagnostic;
- 2) autonomous maintenance done by the machine operators;
- 3) improvement activities aiming at improving the efficiency of machines;
- 4) preventing repairs through a system of designing and selecting machines;
- 5) training system for employees involved in TPM.

Progress in TPM is measured mainly by calculating OEE (Overall Equipment Effectiveness), which is a measurement linking machines availability, their performance and the quality of the manufacturing process. It is calculated by multiplying these three. OEE is improved mainly by eliminating Six Big Losses, presented in Table 4.

Table 3. The old and new approach to quality
(source: [1], p. 25)

| Factors | Old approach | New approach – TQM |
|----------------------------|--|--------------------------------------|
| Orientation | Towards the product | Towards the customer |
| Decisions | Short-term Based on intuition and beliefs | Long-term Based on facts and data |
| Focus on | Identifying mistakes | Preventing mistakes |
| Responsibility for quality | Quality control department | All employees |
| Problem solving | Managers individually | All employees as a team |
| The role of the manager | Planning, controlling, executing | Delegating authority, coaching |

Table 4. Six Big Losses in TPM
(source: self study on the basis of [50], p. 5 and [52])

| Six big losses | Category | Examples | Calculating OEE |
|-------------------------------|----------------|--|------------------------|
| Breakdowns | Down time loss | Unplanned maintenance Machine breakdowns | Availability |
| Setups and adjustments | Down time loss | Adjustments Setup/Changeover Material shortages | |
| Awaiting work and small stops | Speed loss | Obstructed component flow Delivery blocked Control | Actual efficiency |
| Reduced speed | Speed loss | Rough Running Equipment Wear Operator Inefficiency | |
| Startup rejects | Quality loss | Repairing defects Rework In-process damage Incorrect assembly | Product quality metric |
| Production rejects | Quality loss | | |

In order to support the implementation of TPM the following tools are used ([47], pp. 111-132):

- graphs showing machines performance metrics, including OEE metric, radar graphs,
- tools for identifying and solving problems: Pareto-Lorenz's diagram, Ishikawa diagram etc.,
- statistical tools, including histograms, SPC control charts,
- 5S practices,
- waste elimination,
- PDCA cycle and standardization of best practices
- visual control,
- quick changeovers: SMED,
- FMEA templates – Failure Mode and Effects Analysis.

TPM is the leading approach used in production management in enterprises in continuous operation such as energy and metallurgical plants, as well as food business operators, pharmaceutical and chemical companies, and paper manufacturers, because their productivity depends first of all on the efficiency of their machines, equipment and complex manufacturing installations.

3.6 Six Sigma

| old paradigm | new paradigm |
|--|---|
| quality assurance programs are focused on detecting and correcting defects | there are methods of carrying out processes which prevent defects from coming about |

It is very difficult to capture the essence of Six Sigma so that it can be characterized by means of one paradigm, because it is actually an extension of TQM. There are many definitions of Six Sigma, among them the following one: "Six Sigma is a complex and flexible system of achieving, maintaining and increasing success in business. It is characterized by understanding customer needs and using facts, data and statistical analysis results. It is aimed at managing, streamlining and improving solutions related to processes of the organization." ([24], p.193).

The essence of Six Sigma is quality management based on the measurement of results ([16], p. 193). Six Sigma is focused on defining the metrics of customer satisfaction at every stage of the process. These metrics are the reference in streamlining the process. The synthetic metric of the process level is the so-called sigma value, which is related to the DPMO metric (defects per million opportunities). The process is at level 4σ if the number of defects per million opportunities is not greater than 6210 (see Table 4).

The basis for improving processes in Six Sigma is the understanding of variation and the ability to identify general and specific causes of variation. There are three main sources of variation, which are interdependent ([17], p.142):

- incorrect margin of error assumed at the stage of product and process planning (setting tolerance limits),
- variation related to intermediate products and materials provided by external suppliers,
- limited ability of own production processes to satisfy customer demands regarding critical quality parameters.

An integral element of Six Sigma is carrying out detailed measurements (by SPC, Statistical Process Control, among other methods), which allow general and specific causes of variations to be identified, and improvement projects aimed at the reduction and/or elimination of variations to be carried out.

The basis of all Six Sigma projects is data allowing changes in customer needs and demands as well as all

deviations from target values to be detected (see Fig. 4).

A commonly used and effective method of carrying out Six Sigma projects is the improvement process based on DMAIC cycle. The cycle is supported by different tools used in specific phases (see Table 6).

Recently, the Six Sigma concept has been associated with Lean Management philosophy. They have come together as the Lean Six Sigma approach focused on creating a “lean” process, free from variation, as well as customer-oriented products. Six Sigma consists of the following elements ([31], p. 7):

- Product development – covering product and process planning,
- Lean Management – focused on waste reduction and process cost cuts,
- TQM – process management and optimization,
- ISO – aimed at standardization and optimization of processes.

Table 5. The sigma quality level versus DPMO number
(source: self study on the basis of [37], p. 28)

| Sigma quality level | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---------|---------|--------|-------|-------|---------|
| The maximum number of DPMO (defects per million opportunities) | 697 700 | 308 537 | 66 807 | 6 210 | 233 | 3,4 |
| The percentage of quality criteria-compatible products in the overall number of manufactured products | 30,9 | 69,2 | 93,3 | 99,4 | 99,98 | 99,9997 |

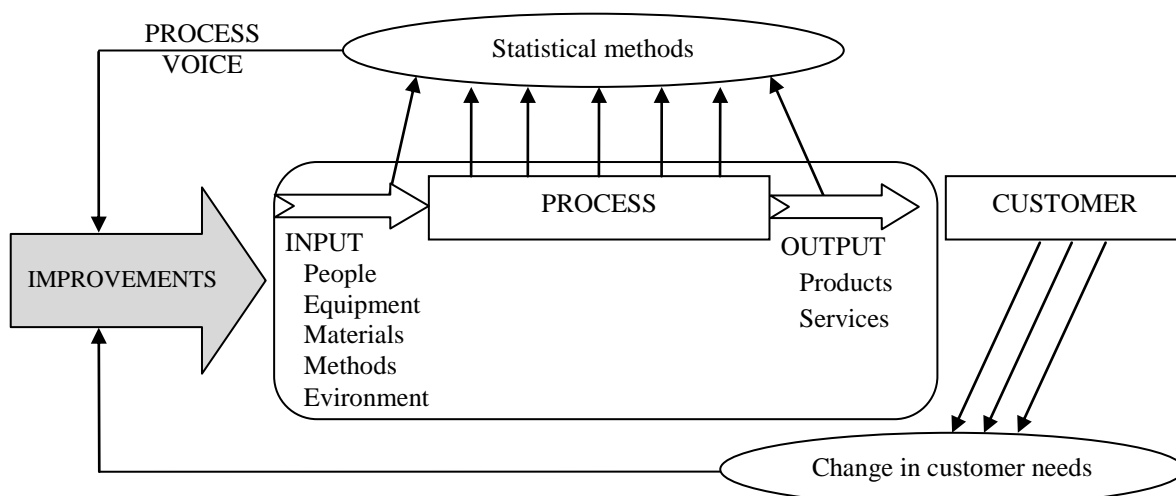


Figure 4. Six Sigma improvements process model
(source: self study)

Table 6. DMAIC cycle and its tools
(source: self study on the basis of [31])

| Cycle phase | Description | Tools used |
|-------------|---|--|
| D – define | Defining projects, problems, measurements, reference levels, aspects critical to quality. | Customer Voice Chart, Kano Model, CTQ Matrix/CTB Matrix, Cause-and-Effects (Ishikawa) Diagram, QFD, Pareto Chart. |
| M – measure | Measuring the current state of the key process, establishing and verifying the process measurement system. | Measurement Matrix, Data Source Analysis, Gage R&R, Graphs and Charts, Process Capability Calculations, Data Collection Forms, Measurement System Analysis, Statistic Plot and Parameters, Histogram, Control Chart, Scatter Plot. |
| A – analyze | Statistical data analysis allowing the most important factors affecting the defined critical aspect to be identified. | Cause-and-Effects (Ishikawa) Diagram, Process Mapping, Value-Stream Map, Spaghetti Diagram, Value Analysis, Time Analysis, DoE – Design of Experiments, Histogram, Correlation, ANOVA. |
| I – improve | Improvement in order to reduce the level of defects and deviations. | TOC, 5S, SMED, Pull System, Poka Yoke, TPM, Creativity Techniques, Tools for Selecting Solutions, Implementations Planning. |
| C – control | Controlling aimed at maintaining the achieved quality level. | Process Documentation, Monitoring/Control Charts (SPC), Reaction Plan, Checklist for the Control Phase, Project Closure |

3.7 Process approach and Business Process Re-engineering

| old paradigm | new paradigm |
|---|--|
| division of labor according to functions – optimization of results within functions and specializations | local optimization (within functions) does not lead to whole system optimization, because key results are related to interdependence among different functions |
| functional specialization leads to efficiency and quality growth | the process approach integrates product and process planning, manufacturing and after-purchase service |

Business Process Re-engineering (BPR) was created as a response to the changes in industry in the 90s: fierce competition, growing customer expectations, and technology development, especially in the IT field. M. Hammer and J. Champy, the authors of BPR, say this methodology means “The fundamental rethinking and radical redesign of business processes to bring about dramatic improvements in performance.” ([15], p. 3).

BPR assumes a transformation of functional, hierarchical structures into horizontal process structures. The changes happening within the organization are revolutionary and radical in character. This has been the reason why many attempts at BPR-based organizational transformation have actually failed. Still, BPR foregrounded the importance of the process, which led to the conception of the process approach.

The process approach, known also as horizontal or systemic, means the organization is focused on the processes within it. This approach is the opposite of the traditional approach to organization management, called vertical or functional. Rummler G. and Brache A. described a phenomenon, characteristic of the functional management approach, known as the silos effect ([43], p. 32-33). Silos – tall buildings with thick walls and no windows - appear around functional departments and make it difficult - or at lower organizational levels even impossible - to solve problems shared by more than one department.

As Rummler G. and Brache A. write ([4]3, p. 32-33): “The silo effect means that managers of a higher rank are forced to deal with problems of lower ranks and are thus driven away from tackling more serious issues connected to customers and competitors. Rank and file employees who could deal with these problems themselves do not take full responsibility for results and see their own role as merely carrying out instruction and providing information. “(...) However, optimization at the department level only leads to worsening (suboptimization) of the results of the organization as a whole.” The silo effect does not appear in organizations managed in accordance with the process approach.

Efforts made to improve quality and customer satisfaction led to a change in the approach from vertical to horizontal. It was recognized that fundamental problems appear on the border between functional departments: procurement, production, sales, quality control, and maintenance departments. This was pointed out by Rummler [43, p. 35]: “(...) the greatest opportunities to increase productivity often lie at the border between different departments – at the points where the buck (e.g. production specifications) is passed from one department to another. Problems of this kind can only be solved when process-oriented thinking is applied”.

Changes which resulted in production process-oriented thinking started at Toyota plants: the famous one-piece flow. The concept of Lean Manufacturing is in its essence a methodology of process-oriented management. The characteristics of process-oriented management can be summarized as follows ([7], p. 285-286):

- focus on process results and process management,
- restructuring (improvement) of processes regarding QCDF (quality, costs, deadlines, flexibility),
- focus on value stream, identifying operations adding value (for the customer), reduction of non-value adding but indispensable operations, elimination of waste,
- the owner of the process, processes simplified, but the tasks of individual employees more complex, enforcing human resources development,
- regulation of process operation through the introduction of the customer (external/internal) – supplier relation,
- horizontal communication, reduction of hierarchical levels, one coordinator (process owner).

Changes to process-oriented thinking should take place in the following areas ([49], p. 225):

- manufacturing processes – combining functions such as: research, development, distribution into one process,
- product development – cooperation of experts from different departments of the enterprise,
- internal and external relations – including suppliers and customers in the product development process,
- creating teams – creating interdepartmental teams to work on streamlining processes.

There is a range of methods and techniques supporting the above activities in restructuring production processes:

- Tools for process mapping, value-stream mapping “from door to door” in the factory,
- Kanban pull system,
- SPC statistical process control,
- Poka-yoka - mistake proofing,
- Deming cycle (PDCA and SDCA).

The process approach is used not only for restructuring production processes, but for changing all business processes and for all organizations, not only production enterprises.

3.8 Other concepts applied in production management

Some other concepts should be mentioned here which are less often used due to their limited applicability, or the generality of their character and lack of developed methods and specific techniques facilitating their implementation.

3.8.1 Agile manufacturing (AM)

Agile manufacturing is characterized as a strategy directed at the development of organization capacities so that the organization can function better ([42], p. 8). It is described as the next stage of development in production management methodology after LM. The biggest difference between these concepts is that while LM assumes that changes can take some years to happen and cooperation with suppliers requires time, AM authors say that changes result from strong competition on the market and should be made as soon as the need arises ([42], p. 5).

AM is based on two key principles:

- innovative alliances with suppliers, customers and other producers in order to add value for the customer,
- investing in flexible and modern production technologies.

The aim of agile manufacturing is an almost immediate delivery of small batches satisfying customer needs [14]. Hence it is applied in mass, repetitive, and serial production.

AM can use methods and techniques of other production management concepts, such as LM or TOC. However, it has its own tools as well ([42], p. 10-11):

- transactional analysis: based on research into the organization's functioning; allows gaps to be detected in the development of the enterprise and points out the direction of development,
- activity/cost chain: allows activities carried out in the enterprise to be linked with specific costs; knowing the cost allows the improvements introduced to be assessed,
- organization maps: serve to picture cooperation with suppliers; can be particularly useful when planning new products,
- key characteristics: created for high profile products; serve to specify customer demands and cater for them at the construction and production stage,
- contact chains: link key characteristics with product structure.

Agile manufacturing is very closely linked to CE (Concurrent Engineering) or SE (Simultaneous Engineering), which are methods of simultaneous development of the concept of the product, its construction, manufacturing processes, starting and adjusting production. It reduces the length of the product manufacturing process and minimizes costs. Organization-wise it means creating interdisciplinary expert teams who are responsible for quickly introducing the product to the market. These techniques cover ([10], p. 184):

- creating an innovative product concept and construction planning,
- quick prototyping and testing prototypes,
- production processes planning,
- quick manufacturing of special tools and equipment,
- quick single product manufacturing.

3.8.2 Mass customization (MC)

Mass customization is a new management concept based on the integration of mass production with production fulfilling an individual customer's expectations. It entails translating customer needs into a finished product, which is produced and delivered in a short time with production efficiency being high ([2], p. 7). It requires craft production to be combined with modern manufacturing technologies ([5], p. 2). This is achieved thanks to modular product construction and using a flexible production system. Table 7 contrasts MC with mass production.

The methods and techniques of this approach include [2] and ([3], pp. 228-229):

- voice of the customer,
- product portfolios,
- SMED – quick changeovers,
- value analysis,
- concurrent manufacturing.

It should be noted that the methods used within this approach are not fully formalized and characterized. This is a result of both the short history of AM application and attempts at adjusting known methods and techniques to use within it.

3.8.3 Management by projects

The concepts used in production management which were outlined above are relevant mainly for mass and serial production, that is production which is repetitive in a more or less regular way. There are however many enterprises which offer unique products, e.g. construction companies, shipyards, enterprises providing complex production installations, as well as IT companies providing dedicated IT systems or adjusting standard systems for the customer. Such enterprises should be managed through projects, because they simultaneously carry out a range of projects, which appear unrelated but use the same resources.

A project is characterized by carrying out a sequence of activities in order to achieve unique results in a specific timeframe ([33], p. 20-21). Projects have specific deadlines and are usually unique. "Project management" could be defined as ([23], p. 18-19): planning (what should be done), organizing (how this should be done), implementation (realization of planned activities), and control (maintaining the direc-

tion which was set out). “Management by projects” covers managing multiple projects at the same time and includes ([7], p. 333): defining values, specifying priorities, solving conflicts between projects, as well as defining organizational structure and the rules of its functioning.

The concepts of project management and management by projects evolve in time. The key change tendencies are illustrated in Table 8.

The concept of management by projects also constantly evolves. In the literature one can find characteristics of concepts linking project management with many modern management methods. In “Lean Projects Leadership” [29] the authors suggest combining the principles popularized by PMI (Project Management Institute) in PMBOK™ Guide with LM, TOC (Critical Chain application), and Six Sigma.

Table 7. Mass production versus mass customization
(source: self study on the basis of [40], pp. 47)

| Aspects | Mass production | Mass customization |
|-----------------|---|--|
| Focus | Efficiency through stability and production control | Customization through flexibility and capacity for quick reaction |
| Aim | Development, production, marketing, and shipping done so that costs and prices are kept low | Development, production, marketing, and shipping done so that variety satisfying customer needs is maintained |
| Main principles | <ul style="list-style-type: none"> - Stable demand - Vast, homogenous market - Low costs, satisfactory quality, standardization of products and services - Long product development cycles - Long product cycles | <ul style="list-style-type: none"> - Fragmented demand - Heterogeneous market - Low costs, high quality, products and services adjusted to customer needs - Short product development cycles - Short product cycles |

Table 8. Changes in project management in the direction of management by projects
(source: self study on the basis of [7], p. 318-319 and [29], p. 1.2-1)

| Aspects | From | To |
|--------------------------|--|---|
| Project size | Small | Big, complex |
| Project length | Short (a few days) | Long (a few years) |
| Production type | One-off production clearly separated from repetitive, serial production | Blurring of differences, a growth in the number of projects realized by the enterprise |
| Organizational structure | Functional, matrix | Horizontal, task-based Hierarchical structure destabilized |
| Management type | Classic | Management by projects |
| Project definition | Project as the source of over employment and fluctuation of managers | Multiple projects = complexity of management + necessity for flexibility and reactivity + autonomy |
| Project manager role | Little knowledge of project manager's function | The role of project manager is appreciated |
| Methods and techniques | Gantt and PERT graphs, CPM method, computer programs for project management (e.g. MSProject, P2Ware Planner) | Using modern techniques with emphasis on human factors. Additionally, modern tools such as Intranet and Extranet are used |
| Knowledge accumulation | Knowledge accumulates in the project manager's head Unique experiences | The necessity for capitalizing knowledge and experience through the use of IT networks and databases |
| Workplace | Chaotic | Focused on projects and their flow |

3.8.4 Production knowledge management

The classic strand of management was underpinned by the assumption that an enterprise can be managed as an object, a collection of human and material resources. Knowledge management is focused on the immaterial resource of knowledge and is a response to changing business conditions such as virtualization of business activities and increasing importance of information processes.

Knowledge management ([22], p. 20) is understood as a process of acquiring, developing, codifying, distributing and using information, knowledge, and experience, allowing for future growth of the enterprise drawing

on its technological and human resources. It is widely applied in production enterprises thanks to the potential of project, process, and organizational innovation that it offers.

For the sake of this paper the focus is on a specific type of knowledge identified by production enterprises – production knowledge. This knowledge is used mainly at the operational and tactical level, and to a lesser extent at the strategic level. Production knowledge is knowledge about products, production systems and processes, as well as ways of manufacturing. These elements of production knowledge are stored either in a structured form as, among other things, plans, instructions, procedures, and standards, or in an unstructured form. Production knowledge includes knowledge about the best practices in production preparation and planning, in particular in the areas of planning, organizing, leading, and controlling production. The production management process, including production knowledge resources, can be presented as in Figure 5.

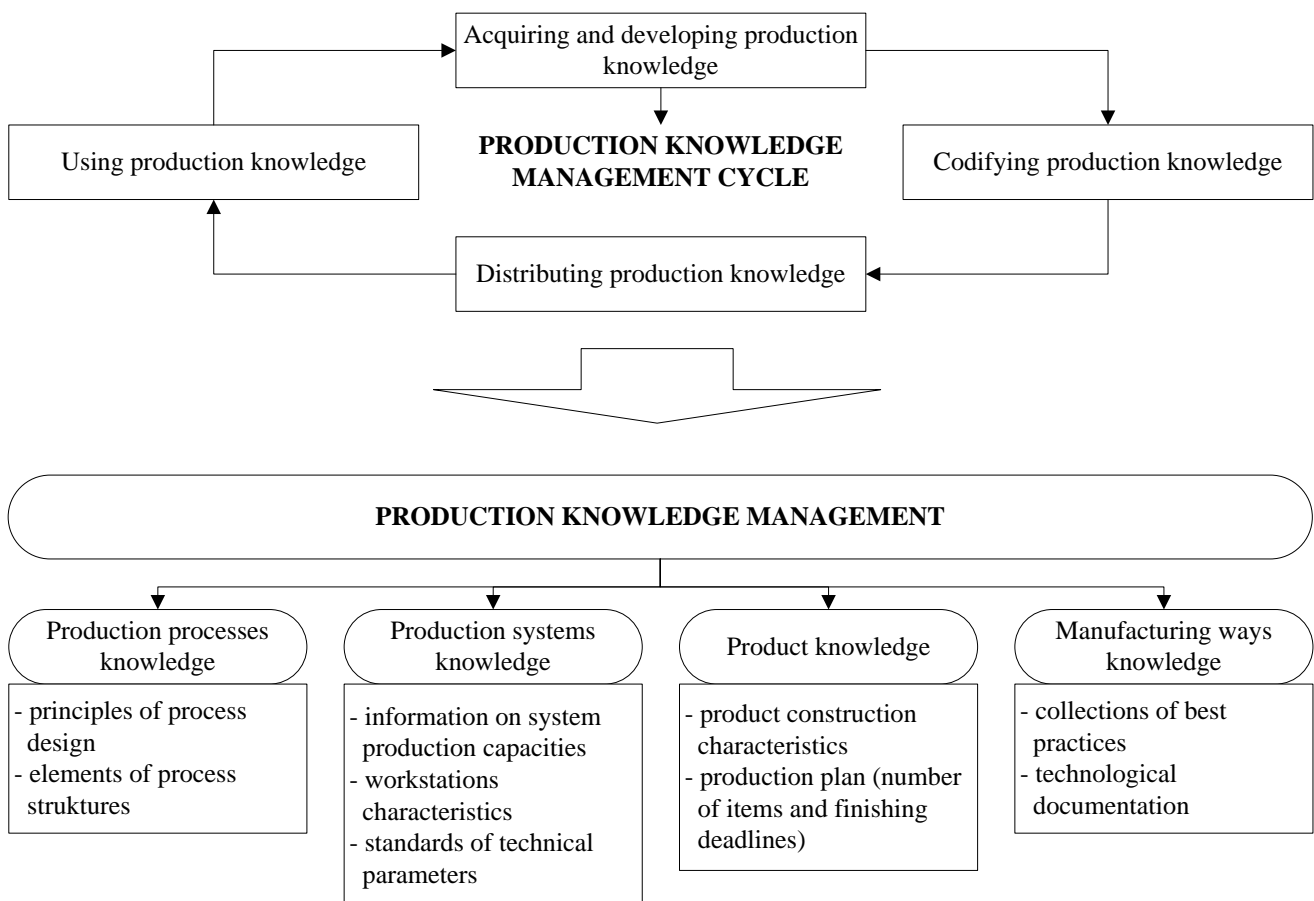


Figure 5. Production knowledge management cycle
 (source: self study on the basis of [22], p. 20 and [39], p. 372)

The importance of knowledge management is recognized by the managers of production enterprises. This is linked to the appreciation of such characteristics of knowledge as the fact that it ages, quickly becomes outdated and is at risk of being losing. At the same time knowledge is a resource which increases with time. In production organizations two fundamental types of knowledge are identified:

- explicit knowledge – clearly defined, systematized, coherent, objective, rational and presented formally,
- tacit knowledge – intuitive, subjective, experiential, not formalized ([38], p. 45-46).

Tacit knowledge is difficult to manage, because it is the individual knowledge of each employee. It is possible to transform knowledge from tacit to explicit ([13], p. 79-80), which facilitates management processes.

Production knowledge management is a concept which supports other concepts of production management and is based on them. The experience acquired while streamlining production processes and the documents created when applying particular methods enrich production knowledge. Table 9 shows tools used at particular stages of knowledge management.

4 Interactions between modern management concepts

Many authors [34, 36, 4 and 11] point out the dynamic development of management tools, their interchangeability, complementarity, and the need for systematization.

Table 9. Tools for production knowledge management
(source: self study)

| Stages of production knowledge management | Tools for production knowledge management |
|---|---|
| Acquiring and developing production knowledge | <ul style="list-style-type: none"> - Tools for examining process sequence: Process Chart, Material Flow Chart, Process Flow Chart, Team Activities Chart, Two-Handed Process Chart, Working Day Photography Sheet, Snapshot Observations Sheet, Standardized Work Sheet, Standardized Work Combination Table, Production Capacity Chart, - Tools for examining flow: Spaghetti Diagram, Value-Stream Map, - Tools for process analysis: Cause-and-Effects (Ishikawa) Diagram, Pareto Chart |
| Codifying production knowledge | <ul style="list-style-type: none"> - Standardized Work Documentation (Standardized Work Sheet, Standardized Work Combination Table, Production Capacity Chart, Operator Balance Chart, Failure Mode and Effects Analysis), - Value-Stream Map, - Instructions (workstation, cleaning, Total Productive Maintenance) - Check Lists - Operation sheets - Construction documentation |
| Distributing production knowledge | <ul style="list-style-type: none"> - Internal training based on instructions - Work based on Standardized Work Sheets - Process visualization - Team work |
| Using production knowledge | <ul style="list-style-type: none"> - Learning by doing - Solving problems based on production documentation |

This problem is noted also by J. Lichtarski ([30], p. 167), who talks about “the jungle of management theories” and the need for systematizing it. He introduces the notion of “orientation”, defining it as “[...] theoretical-methodological direction of thinking and its results in management science, as well as consulting activities and practical applications which accompany it and are based on a particular idea expressed in values, leading paradigm, principles of this/these direction(s). [...] Implementation of these orientations is done by applying methods, tools, and concepts specific for them, and is gradual and evolutionary in character.” Lichtarski distinguishes the following modern orientations in management: market orientation, quality orientation, results orientation, human orientation, strategic orientation, process orientation, change orientation, and knowledge orientation. The values, principles and guidelines specific for each orientation can be introduced to the enterprise through different concepts, methods and tools, which is illustrated in Table 10.

Most often these philosophies are implemented independently, or in a way only incidentally linked, which is pointed out by, among others, S. Nowosielski ([36], p. 10). The interaction between them as well as their shared methods and techniques are not taken advantage of as they should be. These concepts are so closely

related that it is sometimes hard to tell whether a given solution is implemented as part of TQM or LM. Recently one can hear more and more often about Lean Six Sigma [31], a system combining LM and Six Sigma, or even about TLS – a combination of TOC, LM and Six Sigma. Many methods and techniques are used in different approaches. For example, 5S practices and continuous improvement philosophy are present in all systems, SMED is considered a tool of LM and TPM, and statistical process control is seen as an element of TQM, Six Sigma, and Lean Manufacturing as well. Table 11 illustrates the chosen methods, approaches and tools present in different concepts, and their interdependence and complementarity.

Approaching existing management models separately from each other results in creating separate organizational structures, documentation systems, training programs etc. The lack of coordination makes organization management system very complicated and means that the potential for synergy, coming from the fact that a lot of methods and specific techniques are common for different models, is squandered. Additionally, uncoordinated implementation of different concepts often fails if implementing more advanced tools is not preceded by using less advanced methods.

Table 10. Relations between orientations in enterprise activity and management concepts
(source: self study)

| Orientation | Management concepts | | | | | | |
|-------------|---------------------|-----|--------|-----|-----------|-----|-----|
| | LM | TOC | kaizen | TQM | Six Sigma | TPM | BPR |
| market | √ | √ | | √ | √ | | √ |
| quality | √ | | √ | √ | √ | | |
| results | √ | √ | | √ | √ | √ | √ |
| human | √ | | √ | √ | √ | √ | |
| strategic | √ | √ | | √ | √ | √ | √ |
| process | √ | √ | | √ | √ | | √ |
| change | √ | √ | √ | √ | √ | √ | √ |
| knowledge | √ | | √ | √ | | √ | |

Table 11. Chosen methods and tools used in key methodologies of production management
(source: self study)

| Methods and tools | Management concept | | | | | | |
|------------------------|--------------------|--------|-----|-----|-----|-----------|-----|
| | LM | Kaizen | TOC | TQM | TPM | Six Sigma | BPR |
| Process approach | | | ● | ● | | ●● | ● |
| Continuous improvement | ◐ | ● | ● | ● | ● | ● | ● |
| Value engineering | ● | ◐ | | | | ● | ◐ |
| Process mapping | ● | | ◐ | ● | | ● | ● |
| One piece flow | ● | | ◐ | | | | |
| Waste elimination | ● | ● | | ● | ● | | ● |
| Pull system | ● | | ● | | | | |
| Supplier collaboration | ● | | ● | ◐ | | ● | ◐ |
| 5S | ● | ● | ● | ● | ● | ● | ● |
| Poka-Yoke | ● | | | ● | | ● | ● |
| Visual control | ● | ● | | ● | ◐ | | |
| SPC | ◐ | ● | | ● | | ● | ● |
| Standardization | ● | ● | | ● | ● | ● | ● |
| PDCA/SDCA cycle | ◐ | ● | | ● | ◐ | ● | ● |
| SMED | ● | | ● | | ◐ | | |
| Heijunka | ● | | | | | | |
| Kanban | ● | ◐ | | | | | ● |
| FMEA | ● | | | ● | ● | ● | |

The symbols mean that the given concept uses methods/techniques:

◐ partly, ● fully

5 Conclusion

In this paper the key modern concepts used in production management were characterized along with the paradigms which accompanied their development. It is worth noting that concepts and methods used in management have a life cycle of their own, similarly to a product on the market, from its inception to growing popularity to maturity and finally decline when the managers turn to new tools.

New management concepts are usually accompanied by groundbreaking publications or articles characterizing the principles of new concepts, which was highlighted in the paper. At the development stage the concept is gradually acquiring a range of methods and techniques, which allows its leading principles

to be implemented. That has also been pointed out in this paper. Consulting companies offer trainings and implementation support services related to the new methods. These new methods also make their way into university curricula.

At the maturity stage using a given concept becomes a must for the successful enterprises. Companies share their experience and achievements, the scientists do research into the concept, its applications and methods related to it and numerous academic and popular publications devoted to it appear. Z. Martyniak ([32], p. 341) calls this phase a "great diffusion". At the decline stage the popularity of the concept decreases and the attention shifts onto new ideas, which often take over some of the methods and techniques used in older management methodologies.

Regarding the lifecycles of particular concepts it could be argued that TQM is currently in the maturity phase, while Six Sigma is at the stage of dynamic development, and that Six Sigma uses to a great extent tools developed within the TQM framework. The situation is similar with Lean Manufacturing and Constraints Theory, which uses LM techniques. That is why Agile Manufacturing was not classified as a key concept used in production management – it appears to be still in the initial phase. It has not yet developed its own tools (methods and techniques) and it is difficult to foresee whether it will become a more permanent element of management practice.

A new paradigm accompanying the new concept is fully evident only at the stage of concept maturity, when the synthesis at a higher level of generality is possible. It is often very difficult to formulate the paradigm so that the essence of the new concept and the change in the way of thinking it represents is captured.

Changes in the production management paradigms play a key role in the development of modern management frameworks. They result from the changes in the external environment. New production management paradigms are compatible with the present economic conditions, in which the key success factors are thought to be customer satisfaction, flexibility in reacting to the change in customer needs and market situation, high product and customer service quality, as well as productivity of the owned resources.

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PRINCIPALS OF FINANCIAL MODELLING

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Abstract: The financial statements submitted by each company annually reflect their financial performance in the past but are also utilized to forecast the future results in quantitative and realistic frames. The aim of the following elaboration is to thoroughly research all the issues related to financial modelling. The author step by step introduces the reader with theoretical and practical assumptions related to forecasting of respectively, the profit & loss account, balance sheet account and cash flow statement. All of the issues are illustrated with excel spreadsheets that were prepared exclusively for this article purposes.

Key words: financial model, input module, output module, calculation module, profit & loss account, balance sheet, cash flow statement.

1 Introduction

The main objective of preparing a financial model is to reflect the forecasted financial performance of the company. The main areas of utilisation the financial model are as follows:

- compilation of financial projections for the company being valued using Discounted Cash Flow (DCF) approach,
- compilation of financial projections for the company (no valuation involved).

The above mentioned are just the two general (indirect) areas of model utilisation. The direct objectives might vary depending on the company needs and might include e.g. profitability analysis, cost analysis, sensitivity analysis and impairment tests [13].

It is however important to analyse the objective of preparing the financial model before the analytical work begins. The financial model of a company prepared for valuation purposes shall differ from the one prepared for cost analysis purposes as an example.

The types of the financial models might be split with respect to two main criteria: consolidated/standalone basis or valuation approach being used (see Table 1).

Other approaches include primarily usage of the financial models for e.g. leverage buy-out analysis, synergy effect analysis and other specific analysis.

Before the assumptions concerning key inputs are plugged into the financial model the thorough analysis and reconciliation of historical performance of the valued entity must be performed. The history reconciliation is performed for both balance sheet and profit and loss account, but excluding cash – flow statement.

Table 1. Possible applications of different types of valuation models based on types of financial statements
(source: self study)

| | Free Cash Flow to Equity | Free Cash Flow to Firm | Dividend Discount Valuation | Other approaches |
|--------------------|--------------------------|------------------------|-----------------------------|------------------|
| Standalone basis | √ | √ | √ | √ |
| Consolidated basis | √ | √ | √ | √ |

Illustrative Valuation of ABC Company as of 31 December 2003**Macroeconomic assumptions**

| | Unit | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---------|-------|-------|-------|--------|--------|--------|--------|
| <u>Poland</u> | | | | | | | | |
| Inflation rate (December to December) | [%] | 1.10% | 2.00% | 2.00% | 19.00% | 19.00% | 19.00% | 19.00% |
| Average inflation | [%] | 2.30% | 1.55% | 2.00% | 10.50% | 19.00% | 19.00% | 19.00% |
| Nominal corporate income tax rate | [%] | 27.0% | 19.0% | 19.0% | 19.0% | 19.0% | 19.0% | 19.0% |
| <u>E/X</u> | | | | | | | | |
| F/X rate PLN/EUR at the end of the period | PLN/EUR | 4.00 | 4.00 | 4.01 | 4.69 | 5.49 | 6.43 | 7.52 |
| Average F/X rate PLN/EUR in the period | PLN/EUR | 4.00 | 4.00 | 4.01 | 4.35 | 5.09 | 5.96 | 6.97 |
| <u>Interest rate</u> | | | | | | | | |
| 3 month WIBOR | [%] | 9.1% | 6.3% | 5.7% | 4.7% | 4.6% | 4.6% | 4.6% |
| Bank rate for deposits | [%] | 6.9% | 4.8% | 4.2% | 3.2% | 3.1% | 3.1% | 3.5% |
| 52-week Treasury Bills | [%] | 8.4% | 5.9% | 5.2% | 4.3% | 4.1% | 4.1% | 4.1% |

Figure 1. Macroeconomic assumptions
(source: self study)

It is crucial that the breakdown of all profit and loss (revenues, costs) and balance sheet captions for the historical period is identical to the one of forecasted period. Therefore before the history reconciliation is performed the general structure of the financial model, the key-drivers and information-flow shall be identified. Items that affect the company's performance and which may be the subject of sensitivity analysis should be broken out, while other items might be presented on aggregated basis [6, 3].

While performing the historical data reconciliation it is always recommended to compare the company's past performance with forecasted by the management future results of the company. Generally past performance can be a good indicator of future performance. Therefore, any significant changes in financial performance (e. g, EBIT margins increases, sales volume or price increases) shall be verified on case-by-case basis. This is often called the 'hockey stick' effect, and can undermine the credibility of the projections [8]. A very effective means of checking the model can be to study the year-to-year performance of the company and look for dramatic or unexplained shifts in performance

The general principles how to structure financial model are presented below:

- the financial model should have a modular structure and should be consist of three main modules:
 - input module,
 - calculation module,
 - output module,

- the financial model should be flexible, permitting to extend financial projections period; Moreover financial model should be structured to allow testing of a variety of assumptions,
- the model should adhere as rigorously as possible to accounting fundamentals; on the other hand some reclassifications and aggregative approaches that do not have material impact on the valuation results are possible e.g. division of fixed assets into 4 main categories and estimating average depreciation rate for each of the category,
- the financial model should not be more complex than the requirements of the analytical problem it is designed for.

2 Input module

Input module consists usually of three different spreadsheets:

- Macroeconomic assumptions

The data plugged on this spreadsheet include all the factors that refer to the forecasted performance of the economy that might affect either the performance of the valued company or the valuation specific parameters e.g. discount rates. Therefore macroeconomic assumptions might be usually split into three categories: market specific factors (market growth, saturation); GDP and inflation; Interest rates (T-Bills, WIBOR, LIBOR, deposit rates).

Illustrative Valuation of ABC Company as of December 31 2003
Operating assumptions

| | Unit | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|------------|-------|-------|-------|-------|-------|-------|
| Increase of total number of cards embossed | | | | | | | |
| Company | [%] | 1.0% | 2.0% | 2.0% | 2.0% | 0.0% | 0.0% |
| Bank A | [%] | 1.0% | 2.0% | 1.0% | 1.0% | 0.0% | 0.0% |
| Bank B | [%] | 1.0% | 2.0% | 1.0% | 1.0% | 0.0% | 0.0% |
| Structure of the cards embossed | | | | | | | |
| Debit cards | [%] | 40.0% | 40.0% | 40.0% | 40.0% | 40.0% | 40.0% |
| Credit cards | [%] | 60.0% | 60.0% | 60.0% | 60.0% | 60.0% | 60.0% |
| Total transactions per card | | | | | | | |
| Company | [number] | 100 | 100 | 100 | 100 | 100 | 100 |
| Bank A | [number] | 110 | 110 | 110 | 110 | 110 | 110 |
| Bank B | [number] | 120 | 120 | 120 | 120 | 120 | 120 |
| MARK-UP ASSUMPTIONS | | | | | | | |
| Cardholder management | | | | | | | |
| Bank A debit cards | [%] | 20% | 20% | 20% | 20% | 20% | 20% |
| Bank B debit cards | [%] | 20% | 20% | 20% | 20% | 20% | 20% |
| Bank A credit cards | [%] | 20% | 20% | 20% | 20% | 20% | 20% |
| Bank B credit cards | [%] | 20% | 20% | 20% | 20% | 20% | 20% |
| Cards transactions | | | | | | | |
| Bank A catrd transations | [%] | 20% | 20% | 20% | 20% | 20% | 20% |
| Bank B catrd transations | [%] | 20% | 20% | 20% | 20% | 20% | 20% |
| CAPITAL EXPENDITURES | | | | | | | |
| | ['000 PLN] | 810 | 1210 | 1210 | 1210 | 1210 | 1210 |
| Intangibles | ['000 PLN] | 400 | 600 | 600 | 600 | 600 | 600 |
| Land | ['000 PLN] | 200 | 200 | 200 | 200 | 200 | 200 |
| Buildings and constructions | ['000 PLN] | 200 | 400 | 400 | 400 | 400 | 400 |
| Other fixed assets | ['000 PLN] | 10 | 10 | 10 | 10 | 10 | 10 |
| WORKING CAPITAL TURNOVER | | | | | | | |
| Trade receivables - dometic | ['000 PLN] | 30 | 30 | 30 | 30 | 30 | 30 |
| Trade receivables - export | ['000 PLN] | 45 | 45 | 45 | 45 | 45 | 45 |
| Trade payables - domestic | ['000 PLN] | 30 | 30 | 30 | 30 | 30 | 30 |
| Trade payables - export | ['000 PLN] | 45 | 45 | 45 | 45 | 45 | 45 |
| Inventory | ['000 PLN] | 10 | 10 | 10 | 10 | 10 | 10 |

Figure 2. Operating assumptions
 (source: self study)

In case of the financial projections in current prices, all the profit and loss captions shall be adjusted for the year-average inflation and balance sheet captions shall be adjusted for December – December inflation, it is recommended to presented the both inflation ratio on the spreadsheet with macroeconomic assumptions [1].

The exemplary screenshot of spreadsheet with macroeconomic assumptions is presented in Fig. 1.

- Operating assumptions

The data plugged on this spreadsheet include all the factors that refer to the forecasted performance of the company. The structure and complexity of the operating assumptions shall be considered on case-by-case and might vary significantly with respect to different projects. In general operating assumptions might be split into five vogue categories: sales as-

sumptions (volume increases, real price increases); operating costs assumptions (margins, unit costs of materials); capital expenditures, working capital (turnover of receivables, payables, inventory and operating cash); other assumptions (dividend payout ratio, provision for receivables) [11].

The exemplary screenshot of spreadsheet with operating assumptions is presented in Fig. 2.

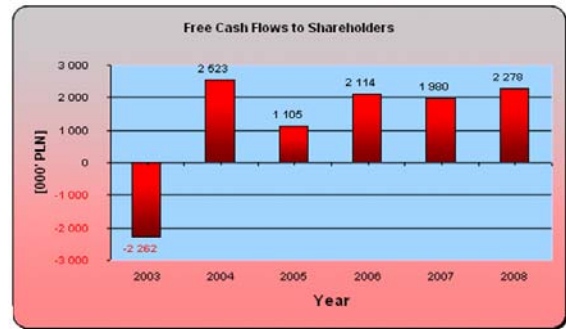
- KVD spreadsheet

The data presented on this spreadsheet include primarily the results and the key drivers of the sensitivity analysis. The structure and complexity of KVD shall be considered on case-by-case and might vary significantly with respect to different projects.

The exemplary screenshot of KVD spreadsheet is presented in Fig. 3.

Illustrative Valuation of ABC Company as of 31 December 2002
KVD - Sensitivity Analysis

| | | 2004 | 2005 | 2006 | 2007 | 2008 |
|--------------------------------------|-----|------|------|------|------|------|
| Change in contract revenues | [%] | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Change in non-contract revenues | [%] | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Change in costs of external services | [%] | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Change in Other costs - other | [%] | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Change in cost of equity | | 0.0% | | | | |



| | | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | Valuation as of 31 December 2003 | Implied multiples - residual value |
|--|-----------|--------|--------|--------|--------|--------|--------|----------------------------------|------------------------------------|
| Sales revenues | [000 PLN] | 68 260 | 64 625 | 56 536 | 53 619 | 56 212 | 58 956 | Value 2003-2008 | P/S |
| EBIT | [000 PLN] | -1 491 | 3 518 | 5 276 | 3 616 | 3 978 | 4 299 | Residual Value | P/EBITDA |
| Net profit (loss) | [000 PLN] | -1 438 | 3 317 | 4 246 | 2 606 | 2 870 | 3 105 | TOTAL | P/EBITDA |
| Average employment | [osoby] | 696 | 560 | 490 | 465 | 465 | 465 | Excess cash | P/E |
| Average working capital | [000 PLN] | 5 240 | 5 222 | 4 486 | 4 025 | 3 985 | 4 178 | EQUITY VALUE | |
| Average excess cash | [000 PLN] | 3 077 | 3 208 | 5 022 | 6 631 | 8 678 | 10 807 | | |
| Average equity | [000 PLN] | -1 628 | -895 | 2 707 | 6 133 | 8 871 | 11 858 | | |
| Average overdraft | [000 PLN] | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Free cas flow to equityholders | [000 PLN] | -2 262 | 2 523 | 1 105 | 2 114 | 1 980 | 2 278 | | |
| Payroll and related charges | [000 PLN] | 51 786 | 41 962 | 30 557 | 29 337 | 29 938 | 30 540 | | |
| Increase of payments per employee (real terms) | [%] | | 6.0% | 2.3% | 1.7% | 0.5% | 0.5% | | |

Figure 3. Exemplary screenshot of KVD
(source: self study)

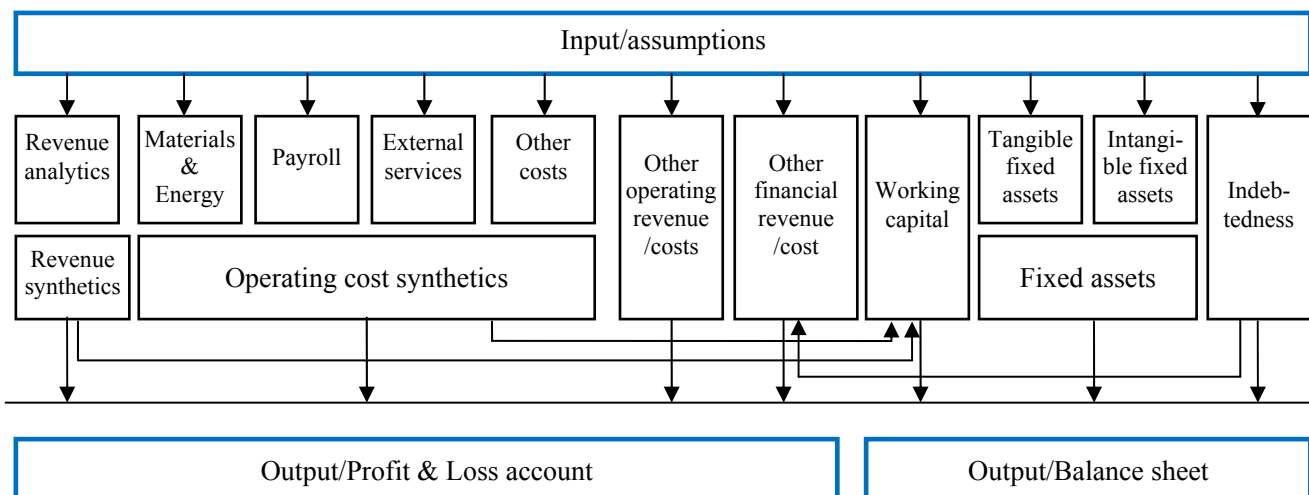


Figure 4. The exemplary structure of the calculation module included in the financial model
(source: self study)

3 Calculation module

The number of the spreadsheets in the calculation module depends on the business specific factors and shall be considered on project-by-projects basis. The exemplary structure of the calculation module included in the financial model of a commercial company is presented in Fig. 4.

In case particular areas are subject to simplified approach these might be calculated on one spreadsheet e.g. fixed assets. On the other hand, if particular areas

require thorough analysis, these might be modelled using several spreadsheets e.g. cost of materials and energy or production process flow. The general rule governing all financial models shall be the hierarchical data flow: input – calculation – output.

- Analytics vs. synthetics

The most common approach is to present the aggregated data on the top of the spreadsheet (see Fig. 5) if only possible. The detailed calculation presented in the bottom of the spreadsheet shall be followed by the aggregated data.

Illustrative Valuation of ABC Company as of 31 December 2003**Sales of products and services**

| | Unit | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|----------------------|------------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Sales revenue | '000 PLN] | 40 914 | 44 062 | 47 474 | 51 101 | 54 819 | 56 381 |
| Product 1 | ['000 PLN] | 19 258 | 20 740 | 22 346 | 24 053 | 25 803 | 26 539 |
| Product 2 | ['000 PLN] | 12 582 | 13 549 | 14 599 | 15 714 | 16 857 | 17 338 |
| Product 3 | ['000 PLN] | 9 074 | 9 772 | 10 529 | 11 334 | 12 158 | 12 505 |
| Product 1 | '000 PLN] | 19 258 | 20 740 | 22 346 | 24 053 | 25 803 | 26 539 |
| Retail | ['000 PLN] | 4 622 | 4 355 | 4 469 | 4 570 | 5 419 | 5 573 |
| Wholesale | ['000 PLN] | 11 555 | 12 444 | 12 961 | 13 229 | 13 160 | 13 004 |
| Distribution network | ['000 PLN] | 1 926 | 2 489 | 3 128 | 4 089 | 4 903 | 5 308 |
| B2B | ['000 PLN] | 1 156 | 1 452 | 1 788 | 2 165 | 2 322 | 2 654 |
| Product 2 | '000 PLN] | 12 582 | 13 549 | 14 599 | 15 714 | 16 857 | 17 338 |
| Retail | ['000 PLN] | 2 642 | 2 710 | 2 920 | 3 143 | 3 709 | 3 814 |
| Wholesale | ['000 PLN] | 6 920 | 7 452 | 7 883 | 8 328 | 8 429 | 8 669 |
| Distribution network | ['000 PLN] | 629 | 813 | 1 022 | 1 257 | 1 686 | 1 907 |
| B2B | ['000 PLN] | 2 391 | 2 574 | 2 774 | 2 986 | 3 034 | 2 947 |
| Product 3 | '000 PLN] | 9 074 | 9 772 | 10 529 | 11 334 | 12 158 | 12 505 |
| Retail | ['000 PLN] | 1 815 | 2 052 | 1 369 | 1 700 | 1 945 | 2 001 |
| Wholesale | ['000 PLN] | 4 537 | 5 766 | 7 370 | 7 027 | 6 809 | 6 502 |
| Distribution network | ['000 PLN] | 635 | 1 759 | 1 579 | 2 380 | 3 161 | 3 751 |
| B2B | ['000 PLN] | 2 087 | 195 | 211 | 227 | 243 | 250 |

Figure 5. Aggregated data
(source: self study)

- Sales revenue

Sales revenue shall be categorized in order to distinguish between the groups of products/services with different profitability. Profitability is usually determined as contribution, margin or mark-up realised on the product/service group. While working over the analytics of the sales revenue the two objectives shall be followed:

- the number of different groups of products/services shall be minimised,
- the total sum of the variances of groups of products/services shall be minimised [10].

The criteria used in revenue categorisation shall be assessed on project-by-project basis. In valuation practise the two dimensions of revenue seem to be very useful:

- product/service group,
- distribution channel.

- Depreciation and amortisation

Depreciation and amortization shall be calculated on pre-formatted Microsoft Excel spreadsheet with respect to different groups of fixed assets. Valuation practice proves that fixed assets are usually split into

four groups: intangibles; building and construction, machinery and equipment and other fixed assets (all remaining tangible fixed assets) [3].

For the purposes of compilation of financial projections the weight average economic depreciation rates estimated for different groups of assets shall always be applied. The estimate of depreciation rate might be performed based on historical financial statements (unless there is no evidence that accounting depreciation rates differ significantly from economic depreciation rates) or using the management assumption concerning the asset utilisation [12, 4].

In case there is a significant difference between the accounting and economic depreciation rates the adjustment to the historical depreciation rate is necessary.

4 Output module

The output module consists usually of several spreadsheets that present the data on the aggregated level. These are the spreadsheets that include the results and the summary of the analyses performed in the financial model.

Table 2. The basic drivers to profit & loss captions
(source: self study)

| | Driver I | Driver I derivatives | Driver II | Driver II derivatives |
|-------------------------|--------------------------------|---|--|---|
| Sales revenue | growth | $\frac{\text{inflation}}{\text{real growth}}$ | sales revenue | calculated |
| | volume output | $\frac{\text{output growth}}{\text{market share}}$ | price of product/ services | $\frac{\text{inflation}}{\text{real growth}}$ |
| Materials & Energy | assumed % | | sales revenue | calculated |
| | unit material/ energy usage | $\frac{\text{constant (history)}}{\text{real growth}}$ | unit price of material/ energy | $\frac{\text{inflation}}{\text{real growth}}$ |
| External services | assumed % | | sales revenue | calculated |
| | assumed % | | operating costs | calculated |
| | assumed % | | production output/ material volume e.g. transport | calculated |
| | assumed % | | other parameters e.g. employment e.g. subcontractors | calculated |
| Payroll | assumed % | | sales revenue | calculated |
| | number of employees | $\frac{\text{increases/decreases}}{\text{constant}}$ | average salary | $\frac{\text{inflation}}{\text{real growth}}$ |
| Depreciation | depreciation rate - % | constant | gross fixed tangible assets | calculated |
| Amortisation | amortisation rate - % | constant | gross fixed intangible assets | calculated |
| Other operating revenue | constant | $\frac{\text{nil}}{\text{constant}}$ | | |
| Other operating cost | constant | $\frac{\text{nil}}{\text{constant}}$ | | |
| | assumed % | $\frac{\text{provision for receivables}}{\text{real growth}}$ | sales revenue | calculated |
| Financial revenue | interest rates on deposits | | average operating cash (valuation) | calculated |
| Financial expense | interest rates on loans | | average indebtedness | calculated |

Illustrative Valuation of ABC Company as of 31 December 2003

Profit and loss accounts

| | Unit | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Sales | ['000 PLN] | 43 568 | 47 532 | 51 207 | 55 213 | 59 217 | 60 901 | 62 118 |
| Sales of goods bought for resale | ['000 PLN] | 40 914 | 44 062 | 47 474 | 51 101 | 54 819 | 56 381 | 57 508 |
| Sales of services | ['000 PLN] | 2 654 | 3 470 | 3 733 | 4 113 | 4 398 | 4 520 | 4 610 |
| Operating expenses | ['000 PLN] | 39 409 | 44 003 | 47 875 | 51 981 | 55 089 | 56 542 | 57 673 |
| Cost of goods and materials sold | ['000 PLN] | 26 795 | 29 821 | 32 528 | 35 796 | 38 249 | 39 148 | 39 931 |
| Energy and other materials | ['000 PLN] | 659 | 682 | 707 | 731 | 754 | 776 | 791 |
| External services | ['000 PLN] | 4 042 | 5 647 | 6 012 | 6 496 | 6 884 | 7 077 | 7 218 |
| Payroll and related charges | ['000 PLN] | 5 251 | 5 336 | 5 478 | 5 630 | 6 163 | 6 484 | 6 613 |
| Depreciation & amortisation | ['000 PLN] | 1 145 | 981 | 845 | 853 | 431 | 409 | 417 |
| Other costs | ['000 PLN] | 1 518 | 1 537 | 2 305 | 2 475 | 2 608 | 2 649 | 2 702 |
| Gross profit / (loss) on sales | ['000 PLN] | 4 159 | 3 529 | 3 332 | 3 232 | 4 127 | 4 359 | 4 446 |
| <i>as percentage of sales</i> | <i>[%]</i> | <i>9.5%</i> | <i>7.4%</i> | <i>6.5%</i> | <i>5.9%</i> | <i>7.0%</i> | <i>7.2%</i> | <i>7.2%</i> |
| Other operating revenues | ['000 PLN] | 1 033 | 829 | 2 744 | 606 | 606 | 606 | 619 |
| Other operating expenses | ['000 PLN] | 973 | 799 | 816 | 835 | 853 | 861 | 878 |
| EBIT | ['000 PLN] | 4 220 | 3 558 | 5 260 | 3 004 | 3 881 | 4 104 | 4 186 |
| <i>as percentage of sales</i> | <i>[%]</i> | <i>9.7%</i> | <i>7.5%</i> | <i>10.3%</i> | <i>5.4%</i> | <i>6.6%</i> | <i>6.7%</i> | <i>6.7%</i> |
| Financial revenues | ['000 PLN] | 787 | 63 | 60 | 58 | 53 | 48 | 49 |
| Financial expenses | ['000 PLN] | 1 412 | 2 081 | 647 | 567 | 348 | 226 | 231 |
| Profit / (loss) on ordinary activities | ['000 PLN] | 3 595 | 1 540 | 4 673 | 2 495 | 3 586 | 3 926 | 4 005 |
| <i>as percentage of sales</i> | <i>[%]</i> | <i>8.3%</i> | <i>3.2%</i> | <i>9.1%</i> | <i>4.5%</i> | <i>6.1%</i> | <i>6.4%</i> | <i>6.4%</i> |
| Extraordinary gains | ['000 PLN] | 98 | 0 | 0 | 0 | 0 | 0 | 0 |
| Extraordinary losses | ['000 PLN] | 94 | 0 | 0 | 0 | 0 | 0 | 0 |
| Profit / (loss) before taxation | ['000 PLN] | 3 598 | 1 540 | 4 673 | 2 495 | 3 586 | 3 926 | 4 005 |
| <i>as percentage of sales</i> | <i>[%]</i> | <i>8.3%</i> | <i>3.2%</i> | <i>9.1%</i> | <i>4.5%</i> | <i>6.1%</i> | <i>6.4%</i> | <i>6.4%</i> |
| Taxes | ['000 PLN] | 1 713 | 886 | 1 427 | 856 | 1 116 | 1 194 | 1 218 |
| Corporate income tax | ['000 PLN] | 1 713 | 886 | 1 427 | 856 | 1 116 | 1 194 | 1 218 |
| Profit / (loss) after taxation | ['000 PLN] | 1 885 | 654 | 3 246 | 1 639 | 2 470 | 2 732 | 2 786 |
| <i>as percentage of sales</i> | <i>[%]</i> | <i>4.3%</i> | <i>1.4%</i> | <i>6.3%</i> | <i>3.0%</i> | <i>4.2%</i> | <i>4.5%</i> | <i>4.5%</i> |

Figure 6. The exemplary screenshot of spreadsheet presenting profit & loss accounts
(source: self study)

The two main groups of spreadsheets categorised upon its objective might be distinguished for the concern of this document:

- Spreadsheets that present the final results on the aggregated level in the form of financial statements. These comprise of the spreadsheets such as profit and loss account, balance sheet and cash flow statement.
- Spreadsheets that present the additional measures of financial performance. These comprise of all the spreadsheets that present the additional results of the analysis performed by the financial model e.g. sales and operating costs analysis or ratio analysis.

Profit and loss account is the financial statements that shall be established at the beginning of the process to construct financial model (the exception to this rule refer to the models of financial institutions e.g. banks, insurance companies).

Profit and loss account seems to be a backbone of the financial model as it determines the company

future profitability. The forecasted results of the company performance presented in profit and loss statements (EBIT, EBITDA, net profit) derive the value of the company in greatest part. Many of the balance sheet and cash flow items vary as a function of income statement items such as revenue or costs. The basic drivers to profit & loss captions are presented in Table 2.

It is important to remember that all the profit and loss captions shall be calculated based on year-average balances e.g. operating cash balance or indebtedness balance and year-average inflation rates [13].

In the majority of financial models, it is the cost drivers' identification that seems to be the most challenging task. The first step in analysing costs shall be categorising them into: fixed costs, semi-variable and variable costs. The further steps shall usually be considered on case-by-case basis.

It is worth noticing that relating all the costs to revenue captions is oversimplification that often causes a significant bias on the valuation results.

Illustrative Valuation of ABC Company as of 31 December 2003

Balance sheets

| | Unit | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Fixed assets | ['000 PLN] | 6 291 | 5 762 | 5 633 | 5 080 | 4 979 | 4 910 | 4 959 |
| Intangibles | ['000 PLN] | 256 | 240 | 411 | 317 | 214 | 166 | 168 |
| Tangible assets | ['000 PLN] | 6 035 | 5 521 | 5 222 | 4 764 | 4 765 | 4 744 | 4 791 |
| Current assets | ['000 PLN] | 17 248 | 13 773 | 14 909 | 16 182 | 17 332 | 17 799 | 17 977 |
| Inventory | ['000 PLN] | 5 957 | 4 902 | 5 347 | 5 884 | 6 288 | 6 435 | 6 500 |
| Trade receivables | ['000 PLN] | 10 362 | 7 992 | 8 629 | 9 312 | 10 017 | 10 320 | 10 423 |
| Other receivables | ['000 PLN] | 441 | 363 | 363 | 363 | 363 | 363 | 367 |
| Operating cash | ['000 PLN] | 488 | 516 | 569 | 623 | 664 | 680 | 687 |
| Excess cash | ['000 PLN] | 0 | 0 | 0 | 0 | 139 | 2 704 | 0 |
| Total Assets | ['000 PLN] | 23 538 | 19 535 | 20 542 | 21 263 | 22 450 | 25 413 | 22 936 |
| Equity | ['000 PLN] | 3 826 | 4 480 | 7 725 | 9 365 | 11 834 | 14 566 | 17 352 |
| Subscribed share capital | ['000 PLN] | 3 098 | 3 098 | 3 098 | 3 098 | 3 098 | 3 098 | 3 098 |
| Capital reserve | ['000 PLN] | 2 237 | 2 237 | 2 237 | 2 237 | 2 237 | 2 237 | 2 237 |
| Accumulated profit / (loss) form previous year | ['000 PLN] | -1 803 | -1 509 | -855 | 2 390 | 4 030 | 6 499 | 9 231 |
| Profit / (loss) after taxation for the current financial year | ['000 PLN] | 294 | 654 | 3 246 | 1 639 | 2 470 | 2 732 | 2 786 |
| Indebtedness | ['000 PLN] | 4 475 | 2 642 | 3 639 | 1 906 | 0 | 0 | 0 |
| Overdraft | ['000 PLN] | 2 960 | 2 242 | 3 639 | 1 906 | 0 | 0 | 0 |
| Other debt | ['000 PLN] | 1 515 | 400 | 0 | 0 | 0 | 0 | 0 |
| Short term liabilities | ['000 PLN] | 10 626 | 8 151 | 8 811 | 9 625 | 10 248 | 10 479 | 5 126 |
| Trade accounts payable | ['000 PLN] | 9 422 | 7 353 | 8 021 | 8 826 | 9 431 | 9 653 | 5 126 |
| Other short term liabilities | ['000 PLN] | 1 204 | 798 | 790 | 799 | 817 | 826 | 0 |
| ZFRON | ['000 PLN] | 4 611 | 4 262 | 368 | 368 | 368 | 368 | 368 |
| Total liabilities | ['000 PLN] | 23 538 | 19 535 | 20 542 | 21 263 | 22 450 | 25 413 | 22 936 |

Figure 7. The exemplary screenshot of spreadsheet presenting balance sheet
(source: self study)

Cost accounting is a complex discipline on its own, and in most cases it is unrealistic to expect to model all costs (and their relationship to inventory). It is important to understand the cost structure of the business and make sure that it is appropriately reflected in the base model and in all alternative scenarios.

The exemplary screenshot of spreadsheet presenting profit and loss accounts is presented in Fig. 6.

Balance sheet account is the financial statements that shall be established mainly based on information derived from profit and loss accounts (the exception refers to the models of financial institutions e.g. banks, insurance companies where the balance sheet shall be constructed as the first financial statement).

The basic drivers to the balance sheet captions are presented in the Table 3.

The exemplary screenshot of spreadsheet presenting balance sheets is presented in Fig. 7.

Every year of the financial projections' period implemented in the financial models period must satisfy the general accounting condition that total assets equal

total liability. In other words the balance sheet must always balance.

From financial modelling perspective balancing the balance sheet requires implementing a circular into the financial model. The explanation of this issue is presented in Fig. 8.

The overdraft and excess cash balances with the inflow and outflow of cash during each year of the financial projections period making the balance sheet balance. Changes in overdraft and excess cash make the net interest to fluctuate as the interest expense and interest revenues are affected by the changes of overdraft and excess cash, respectively. The fluctuations in net interest affect the company's net income on annual basis. Net income of the year, stripped of dividends is recorded as retain earnings on the liability side of the balance sheet. Change on the liability side of the balance sheet requires rebalancing the balance sheet again using overdraft and excess cash balances. As profit and loss and balance sheet captions are each other logically dependent the circular links are necessary.

Table 3. The basic drivers to the balance sheet captions
(source: self study)

| | Driver I | Driver I derivatives | Driver II | Driver II derivatives |
|-------------------------|-------------------------------|----------------------|--------------------------|-----------------------|
| Intangible fixed assets | capital expenditures | assumptions | amortisation | assumptions/constant |
| Tangible fixed assets | capital expenditures | assumptions | depreciation | assumptions/constant |
| Inventory | inventory turnover ratio | assumptions | selected operating costs | calculated |
| Trade receivables | receivables turnover ratio | assumptions | sales revenue | calculated |
| Trade payables | payables turnover ratio | assumptions | selected operating costs | calculated |
| Operating cash | operating cash turnover ratio | assumptions | sales revenue | calculated |
| Excess cash | balancing figure | | | |
| Overdraft | balancing figure | | | |
| Debt | repayments | assumptions | issuing | assumptions |
| Issued capital | issues | assumptions | buy-backs | assumptions |
| Retained earnings | dividend payout ratio | assumptions | net profit | calculated |

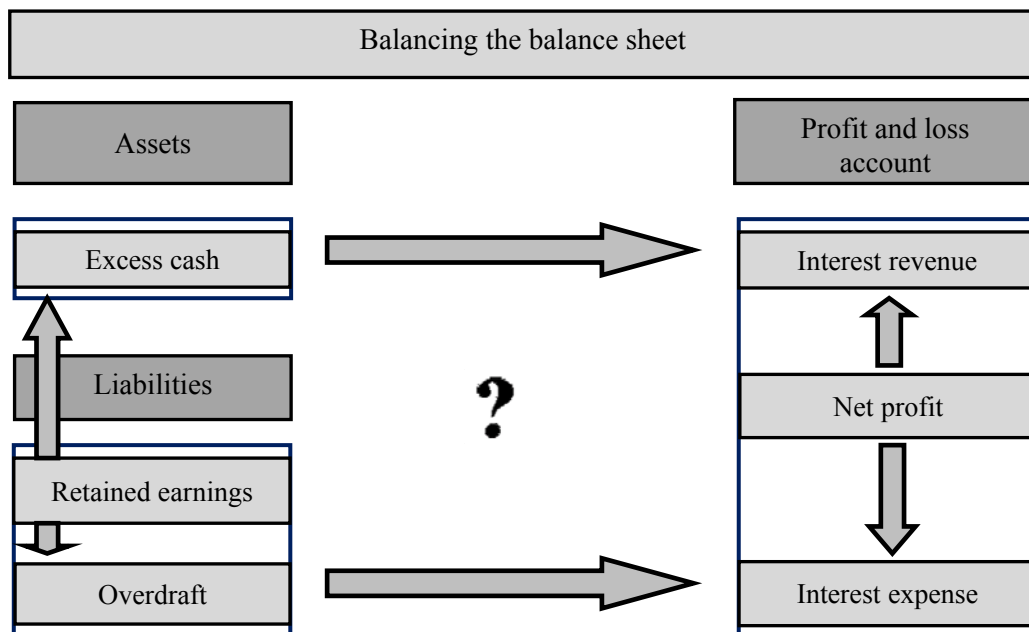


Figure 8. Balancing the balance sheet
(source: self study)

Table 4. The basic drivers to cash flow captions
(source: self study)

| | Status | Source/spreadsheet | Impact on cash-flow* |
|------------------------------------|------------|--|----------------------|
| Cash from operating activities | | | |
| Adjusted EBIT | calculated | profit & loss | positive |
| Corporate Income Tax paid | calculated | profit & loss/balance sheet | negative |
| Depreciation & amortisation | calculated | profit & loss or fixed assets (separate) | positive |
| Working capital changes | calculated | balance sheet | negative |
| Changes in other assets | calculated | balance sheet | negative |
| Changes in other liabilities | calculated | balance sheet | positive |
| Cash from investing activities | | | |
| Capital expenditures | assumption | input or fixed assets (separate) | negative |
| Proceeds from sale of fixed assets | assumption | input or fixed assets (separate) | positive |
| Cash from financing activities | | | |
| Change in indebtedness | calculated | balance sheet or indebtedness | positive |
| Net interest | calculated | profit & loss | negative |
| Issued capital | calculated | balance sheet | positive |

* direct impact of the increase of the item on cash-flow statement

The supporting assumptions used while balancing the balance sheet are as follows:

- in case company needs more cash as of the balancing date, it is incurring overdraft – additional short term financing., the company repays as soon as excess cash appears on its balance sheet,
- in case company has excess cash of the balancing date it retains it in the balance sheet (retained earnings); for the valuation purposes the changes in excess cash, adjusted for increases in shareholders capital and dividend payouts are treated as free cash flow to equity/firm.

It is assumed that balancing procedure is recorded in visual basis language using goal seek function implemented. These are implemented for each of the years of the financial projections period [7, 14].

In extraordinary circumstances, when implementing circular links in the financial model seem inappropriate, there is a possibility to balance the balance sheet on one of the following simplified assumption:

- no interest rate expense/revenue are calculated based on overdraft and excess cash,
- the interest rate expense/revenue are calculated based on the prior year's balances.

In both of these cases circular links are avoided. However, removing circular links increases the risks of calculating inaccurate interest expense/revenue figures if there are wide fluctuations in debt and cash balances.

The more sophisticated approach to balance the balance sheet is applicable while preparing the financial model of a bank.

Illustrative Valuation of ABC Company as of 31 December 2003

Cash flow statements

| | Unit | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|
| EBIT | ['000 PLN] | 0 | 10 689 | 28 006 | 33 510 | 36 009 | 35 824 |
| Corporate income tax | ['000 PLN] | 0 | -2 893 | -7 569 | -9 056 | -9 732 | -9 684 |
| Depreciation & amortisation | ['000 PLN] | 8 405 | 6 479 | 6 479 | 4 319 | 0 | 0 |
| Gross cash flow | ['000 PLN] | 8 405 | 14 274 | 26 916 | 28 773 | 26 277 | 26 140 |
| Change in working capital | ['000 PLN] | -4 634 | 1 897 | -1 703 | -430 | 88 | 6 |
| Operating cash | ['000 PLN] | -593 | -88 | -279 | -155 | -62 | -10 |
| Trade receivables | ['000 PLN] | -5 926 | -884 | -2 794 | -1 550 | -620 | -95 |
| Other receivables | ['000 PLN] | 0 | 0 | 0 | 0 | 0 | 0 |
| Other receivables | ['000 PLN] | 1 884 | 2 869 | 1 371 | 1 275 | 770 | 111 |
| Change in other assets and liabilities | ['000 PLN] | 332 | 127 | 317 | 61 | -33 | -3 |
| Operating cash flow | ['000 PLN] | 4 102 | 16 298 | 25 531 | 28 404 | 26 331 | 26 143 |
| Capital expenditures | ['000 PLN] | 0 | 0 | 0 | 0 | 0 | 0 |
| Cash flow before financing | ['000 PLN] | 4 102 | 16 298 | 25 531 | 28 404 | 26 331 | 26 143 |
| Financing | ['000 PLN] | 0 | 27 | 26 | 32 | 36 | 41 |
| Change in indebtedness | ['000 PLN] | 0 | 0 | 0 | 0 | 0 | 0 |
| Net interest | ['000 PLN] | 0 | 27 | 26 | 32 | 36 | 41 |
| Free cash flow to equityholders | ['000 PLN] | 4 102 | 16 325 | 25 557 | 28 436 | 26 367 | 26 184 |
| Changes in subscribed share capital | ['000 PLN] | 0 | 0 | 0 | 0 | 0 | 0 |
| Changes in excess cash | ['000 PLN] | 4 102 | 16 325 | 25 557 | 28 436 | 26 367 | 26 184 |

Figure 9. The exemplary screenshot of spreadsheet presenting cash flow statements
(source: self study)

Because the dividend discount model is recommended for bank valuation purposes both capital adequacy ratios and the dividend payout shall be additionally considered in balancing procedure.

Cash flow statement is critical for making each of the financial models. The cash flow statement records all cash inflows and outflows affecting balance sheet accounts, and determines the company's year-end cash and debt balances. Each line item on the cash flow statement should correspond to a year-to-year change in a line item on the balance sheet. The fact that every account which changes on the balance sheet is reflected on the cash flow statement is the necessary condition of the logical correctness of the financial model. Meeting this condition allows the balance sheet to balance.

The basis cash flow statement implemented in the financial model shall include three sections:

- Cash from operating activities

This is the fundamental cash flow of the business, derived from its net income corrected for non-cash income or expense items and for changes in working capital. It defines the cash available to make necessary investments and to satisfy the interest and dividend obligations of the business.

- Cash from investing activities

This reflects all of the capitalised investments of the business, in fixed assets or in intangibles. It also includes the proceeds from any sale of assets.

- Cash from financing activities

This reflects the business's decisions concerning external financing: repayment/issuing of debt. It also includes the effect of the financial revenues and financial expenses paid. The distinction and level of complexity of each of the sections shall be considered on project-by-project basis e.g. if the objective of the financial model is to assess the optimal future investment schedule than investing and financing sections of cash flow statements shall be cover in details.

The basic drivers to cash flow captions are presented in Table 4.

As presented above the majority of the cash flow captions shall derive direct from balance sheet captions. In modelling practise it is recommended to link cash flow captions direct to the balance sheet captions e.g. change in indebtedness shall be linked to changes in debt on 'Balance Sheet' spreadsheet, rather than on changes in debt balances calculated on 'Indebtedness' spreadsheet.

Illustrative Valuation of ABC Company as of 31 March 2003 / Discounted Cash Flow Approach - Free Cash Flow to Equity

| | Unit | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|--------------|--------|--------|--------|--------|-------|-------|-------|-------|--------|
| <u>Estimation of Beta for the equity of the company</u> | | | | | | | | | | |
| Tax rate | [%] | 8.7% | 7.6% | 7.6% | 7.6% | 7.6% | 7.6% | 7.6% | 15.2% | 15.2% |
| Unlevered beta | [number] | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 |
| D/E ratio for the Company | [%] | 159.0% | 180.2% | 171.9% | 135.4% | 97.3% | 61.9% | 30.8% | 8.1% | 0.0% |
| Beta levered | | 2.82 | 3.07 | 2.98 | 2.59 | 2.18 | 1.81 | 1.48 | 1.23 | 1.15 |
| <i>[Beta levered = Unlevered Beta x (1 + (1 - T) x (D/E))]</i> | | | | | | | | | | |
| <u>Estimation of cost of equity for the Company</u> | | | | | | | | | | |
| Average risk free rate [Rf] | [%] | 5.9% | 6.1% | 5.1% | 4.7% | 4.6% | 4.6% | 4.6% | 4.6% | 4.6% |
| Beta (levered) | | 2.82 | 3.07 | 2.98 | 2.59 | 2.18 | 1.81 | 1.48 | 1.23 | 1.15 |
| Long-term risk premium [Rp] | [%] | 5.90% | 5.90% | 5.90% | 5.90% | 5.90% | 5.90% | 5.90% | 5.90% | 5.90% |
| Cost of equity [Ce] | [%] | 22.5% | 24.2% | 22.6% | 20.0% | 17.4% | 15.2% | 13.3% | 11.8% | 11.3% |
| <i>[Ce = Rf + Beta x Rp + Sp]</i> | | | | | | | | | | |
| <u>Free cash flow to equity valuation</u> | | | | | | | | | | |
| Change in excess cash | ['000 PLN] | 134 | 210 | 340 | 560 | 780 | 840 | 1 023 | 1 109 | 1 340 |
| Shange in subscribed share capital | ['000 PLN] | -47 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dividends | ['000 PLN] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Free cash flow to equityholders [FCFtE] | ['000 PLN] | 87 | 210 | 340 | 560 | 780 | 840 | 1023 | 1109 | 1340 |
| Cost of equity [Ce] | [%] | 22.5% | 24.2% | 22.6% | 20.0% | 17.4% | 15.2% | 13.3% | 11.8% | 11.3% |
| Nominal semi-year rate of return | [%] | 10.7% | 11.4% | 10.7% | 9.5% | 8.4% | 7.3% | 6.4% | 5.7% | 5.5% |
| Discount rate | [%] | 10.7% | 23.4% | 23.4% | 21.3% | 18.7% | 16.3% | 14.2% | 12.5% | 11.6% |
| Discount factor | [number] | 0.903 | 0.811 | 0.810 | 0.824 | 0.842 | 0.860 | 0.875 | 0.889 | 0.896 |
| Cumulative discount factor | [number] | 0.903 | 0.732 | 0.593 | 0.489 | 0.412 | 0.354 | 0.310 | 0.276 | 0.247 |
| Present value of FCFtE in period 2004 - 2012 as of 31.12.2003 | ['000 PLN] | 79 | 154 | 202 | 274 | 321 | 298 | 317 | 306 | 331 |
| Assumed long-term growth rate after projeciton period | [%] | | | | | | | | | 0.0% |
| Residual value as of 31 December 2012 | ['000 PLN] | | | | | | | | | 12 228 |
| Cumulative discount rate for residual rate | ['000 PLN] | | | | | | | | | 0.247 |
| Net present value of FCFtE in period 2004 - 2012 as of 31.12.2003 | ['000 PLN] | 2 281 | | | | | | | | |
| Discounted residual rate | ['000 PLN] | 3 020 | | | | | | | | |
| Excess assets (cash) as of 31 December 2003 | ['000 PLN] | | | | | | | | | |
| Value of equity as of 31 December 2003 | ['000 PLN] | | | | | | | | | 5 302 |

Figure 10. The exemplary screenshot of spreadsheet presenting valuation results performed using FCFE approach (source: self study)

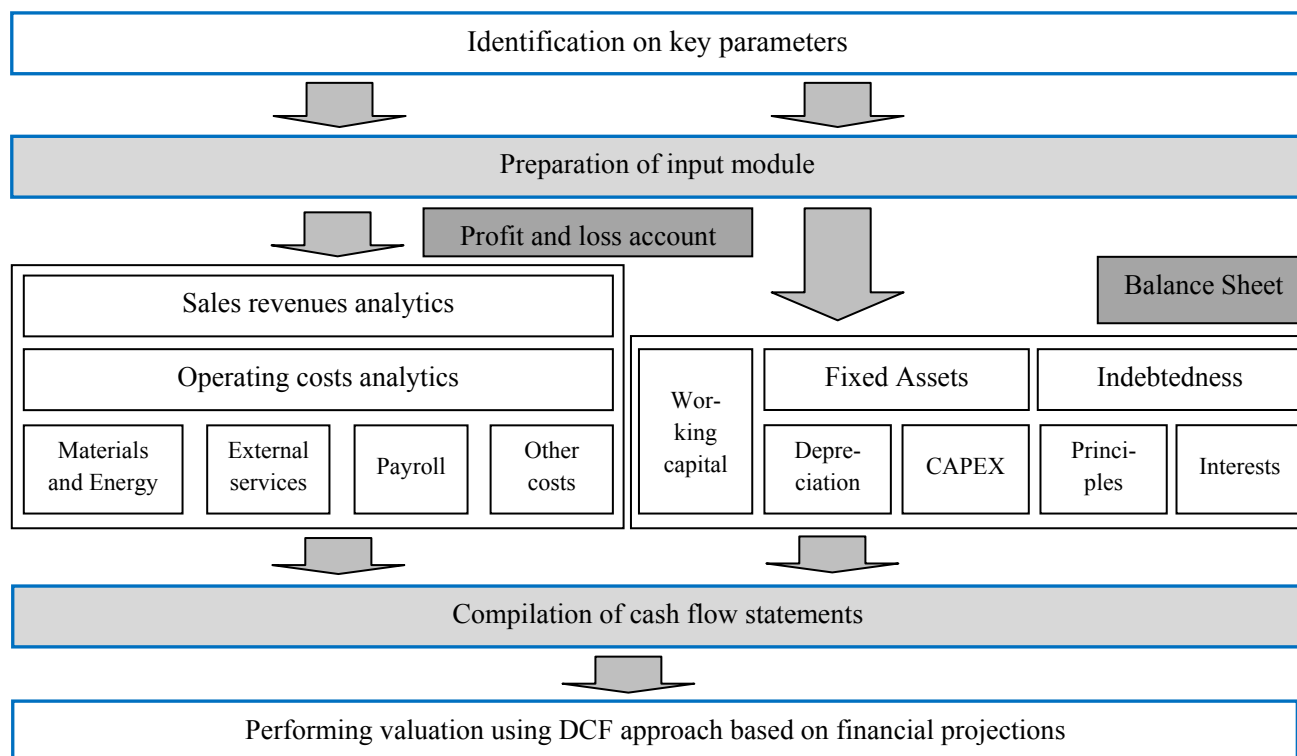


Figure 11. The major steps in building a financial model for the purpose of valuing the company (source: self study)

This approach simplifies the control procedure, increases the transparency of the financial model and reduces the possibility of committing an error [8].

The only problem that might arise while preparing cash-flow statement is the appropriate sign of the differences between the closing and opening balances of particular assets and liabilities.

The general rules must always be applied:

- Increase in asset balances reflects cash outflow

The increase in asset balances might be perceived as a use of cash e.g. purchasing new inventory (increase in inventory balances) or allowing the clients to extend the payment period (increase in trade receivables balances). On the contrary decrease in asset balances is recorded as a source of cash e.g. selling the inventory for cash (decrease in inventory balances).

- Increase in liability balances reflects cash inflow

The increase in liability balances might be perceived as a source of cash e.g. extending the payment periods to suppliers (increase in trade payables balances). On the contrary decrease in liability balances is recorded as a use of cash e.g. repayment of debt (decrease in debt balances). The exemplary screenshot of spreadsheet presenting cash-flow statements is presented in Fig. 9.

5 Valuation spreadsheet

The valuation spreadsheet shall be prepared at the final stage of preparing the financial model. The major issues connected with valuation spreadsheet are presented below:

- estimation of the cost of equity/capital for the company,
- calculation of free cash flows to equity holders/firm,
- calculating the present value of free cash flow to equity holders/firm within the financial projections period and present value of residual value,
- addition and presentation of summary results [4, 2].

In practise, spreadsheets presenting valuation results are enclosed to the financial model at the final stage, depending on the valuation approach being used. Therefore it is possible that all three valuation results (FCFF, FCFE, DDM) are included in one financial model.

The exemplary screenshot of spreadsheet presenting valuation results performed using FCFE approach is presented in Fig. 10.

Important considerations that might be useful while preparing valuation result's spreadsheet is listed below:

- the effective tax rates and debt/equity ratios calculated on annual basis shall be applied while leveraging betas,
- free cash to flow to equity shall always be adjusted for the dividends paid and increases in subscribed shareholders capital,
- the discount rate shall always be calculated on semi-annual basis. Moreover, the discount factor within the first interval of financial projections shall always be calculated assuming that the cash flow occur in the middle of the interval [11, 7, 5, 10 and 9].

6 Summary

The major steps that shall be taken while building a financial model for the purposes of valuing the company using discounted cash flows approach are presented in Fig. 11.

The Fig. 11 presented steps are just an exemplary approach. The sequence of the steps in preparing a financial model depends in greatest part on the project specific issues and availability of input data.

Generally constructing down to the operating income line is usually the first and most important step in the construction of the model.

Most of the items in the cash flow and balance sheet are derived from the income statement. The main exceptions are depreciation, an element of cost and cash flow that is generally calculated separately on a fixed asset schedule, and net interest, derived from balance sheet information.

In summary the process of constructing financial models is long and requires to respect procedures that helps to build it in the most efficient and reliable way.

Additionally the purpose of the financial projections clearly indicates the way how the model should be constructed.

10 References

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LOYALTY PROGRAMS EFFECTIVENESS

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Abstract: An increasing number of loyalty programs is one of the most common phenomena observed in the practice of marketing companies on the market today. Objectives and tasks of loyalty programs determine the type of use of marketing instruments affecting the attitudes and behaviours of customers, which is aimed at the program. The diversity of factors influencing the effectiveness of loyalty programs should set the scope and object of empirical research. As the results of studies to evaluate the effectiveness of loyalty programs mainly on the B2C market is diverse in terms of the criteria. This article presents the essence of loyalty programs and the factors influencing their effectiveness.

Keywords: loyalty program, customer loyalty, factors for the effectiveness of loyalty program.

1 Development of loyalty programs

Visible and dynamic development of loyalty programs reflects the increasing prevalence of relationship marketing philosophy in current business practice. Moreover, discussed phenomenon also reflects a host of vibrant changes that take place in global business arena and can be exemplified by the following trends discussed in numerous research studies:

- observed increasing competitiveness of various markets,
- increasing market awareness demonstrated by customers and escalating customers' expectations,
- decreasing homogeneity of existing customer groups.

Dynamic increase in the numbers of customers that willingly participate in various loyalty programs clearly suggests that such programs in the recent years have been steadily developing and have been widely accepted in the global marketplace. "Between 2000 and 2006 the number of North American customers that participated in various loyalty programs increased by 35,5% and reached unprecedented 1,5 billion" (Ferguson et al. [9], p. 1).

Moreover, increasing popularity of loyalty programs resulted in common acceptance of a thesis, which states that "the implementation of loyalty program by a modern business enterprise is not motivated by the enterprise's drive to strengthen and develop relationships

with its key customers. The implementation of discussed marketing tool is inevitable in a market, where all direct competitors invite customers to participate in their own loyalty programs and where inability and unwillingness to introduce similar tools might lead to significant defections in existing customer base." (Ferguson et al. [9], p. 2; Meyer-Waarden et al. [24], pp. 72).

Current loyalty programs are largely based on Advantage Programme, the first fully functional loyalty scheme implemented by American Airlines in 1981. In this initiative, American Airlines customers were invited to collect virtual air miles, which later could be redeemed for free flights. Historical development of loyalty schemes in different sectors of global economy is illustrated in Fig. 1.

Currently loyalty programs are mostly implemented by companies from global economy sectors. It is estimated that in the world's most developed markets, more than half adult population is enrolled in at least one loyalty program (Kivetz [11], p. 726).

The development of loyalty programs they apply to the following types (Rudawska [25], pp. 100-103):

- marketing clubs,
- loyalty cards,
- reward loyalty programs,
- participation programs (programs continued).

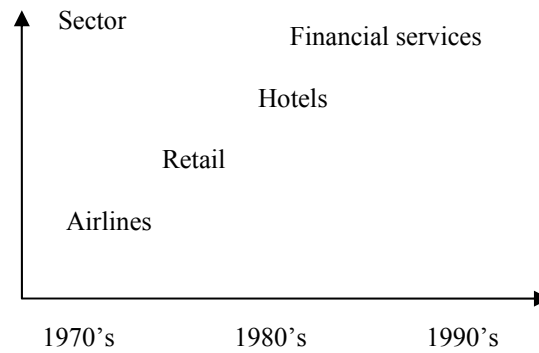


Figure 1. Historical development of loyalty schemes
(source: own work)

According to the criterion of the form of a loyalty program is distinguished by the following types (Kwiatk et al. [16], pp. 323-324):

- 1) programs based on the idea of participation (clubs):
 - a) pure clubs:
 - based on a loyalty card (card recognition) that provides a discount when purchasing products or services provided by the company organizing the club,
 - based on the added value of the brand,
 - operating on the basis of membership fee,
 - b) mixed clubs:
 - focus on ideas, not on the particular brand,
 - focus on brand and partners of the club;
- 2) programs based on the idea of collecting:
 - c) based on the traditional technique,
 - d) based on electronic technology.

Increasing popularity of loyalty programs can be explained by observed changes in today's marketplace, where the customer enjoys unprecedented freedom to choose from a wide variety of suppliers of seemingly homogenous goods. Such market is characterised by a large number of competitors offering marginally different goods and fighting for the attention of similar customers. Described market circumstances place previously underappreciated consumer in a new, privileged position and create a set of previously unidentified challenges for any business striving to develop and strengthen relationships with its most valued buyers.

Based on presented arguments it can be concluded, that today's customers relatively seldom declare their willingness to form lasting relationships with any goods and services provider who fails to present them

with a host of attractive incentives. Such conclusion may explain why loyalty programs, have currently been viewed as a key marketing tool, which promotes and drives customer relationship building. Moreover, while implementation of loyalty programs inevitably generates certain amount of costs, ultimately it should lead to increased turnover and strengthened profitability of a business enterprise. Well - devised and properly operated loyalty program is one of the main competitor's factors that may differentiate a company from its direct competitors.

Developments in information technology facilitates the management of loyalty programs, implementation of which leads to the maintenance of existing customers and acquire new, changing their purchasing preferences and to increase sales. The software makes it easy to carry out marketing activities in the following areas:

- definition of loyalty programs - setting the rules for their activities, methods to reach customers and to participate in the program,
- transactions loyalty - the award credits calculation or rebates based on purchases made or enforcement actions by the customer bonus,
- to collect marketing information about customers' habits - the ability to track customer response to the action undertaken,
- marketing and management actions to carry out their analysis - the possibility of defining marketing campaigns and run them directly through the results,
- creation of a sustainable relationship with customers - using the contact center and customer portal as a form of maintaining communication with the customer,
- marketing strategy - including a loyalty program to the overall strategy for the company.

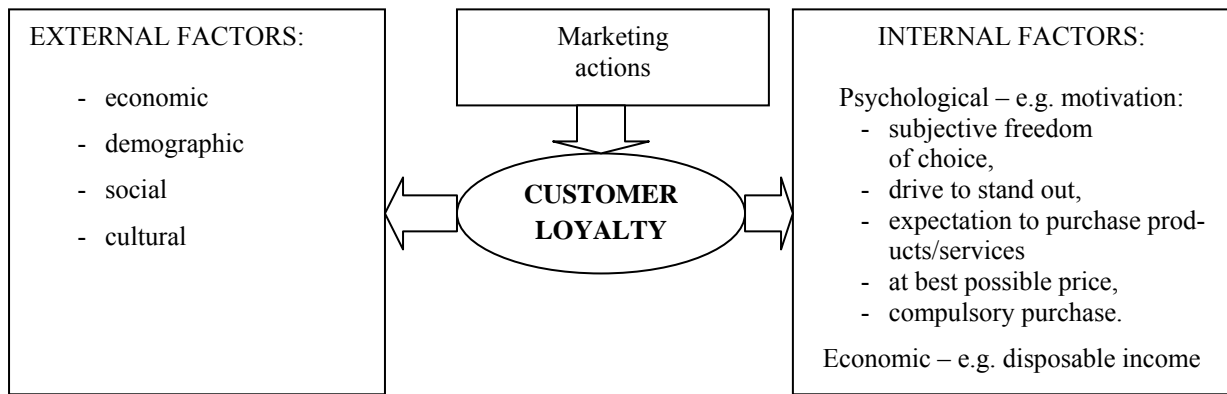


Figure 2: Factors of customer loyalty
(source: own work)

Moreover, a robust loyalty programs usually weakens customers' drive to switch goods and services provider, and therefore increases company's competitive advantage over its closest market rivals. In conclusion, to presented deliberations on the nature of current, dynamic development of loyalty programs, it must be stressed that any implemented, they should lead to increased volume of business as well as other, unquantifiable benefits, which viewed and analysed together will form the very basis for the assessment of loyalty program efficiency.

2 Customer loyalty

From viewpoint of praxeology, customer loyalty can be defined as a constant and positive attitude towards an object (i.e. brand or business enterprise). Marketing definition of loyalty traditionally covered two aspects of the phenomenon: behavioural aspect and attitudinal aspect. Behavioural loyalty explained customers' actions, which included repeat purchases, their proneness to be attracted by competitors' marketing efforts as well as their willingness to engage in word – of-mouth marketing.

Without a doubt, the classic approach to customer loyalty ignored factors affecting the attitudes and behaviour and does not include themes of loyalty. Taking into account categories such as income or lack of alternatives to choose from, we can say that the nature of economic factors determine the customer loyalty. If, however, will be included in the analysis of the determinants of market, demographic, or cultural, it reveals a broad context for consideration of the factors influencing and shaping the loyalty of company's customers.

Based on presented discussion, one must question the validity of loyalty whenever displayed loyal behaviour (i.e. repeat purchase) stems from barriers imposed by the goods provider, such as any limitations included in business contract. Customers' passive attitude caused by objective (e.g. transaction characteristics) as well as subjective (e.g. customer's indifference) factors teamed up with their repeat purchases inevitably leads to a conclusion that such scenario may not be perceived as one exemplifying loyalty. So, it seems clear that in order to discuss loyalty we must take into account a certain degree of emotional engagement displayed by a customer.

On the one hand, such statement highlights the need to examine the levels of emotional engagement displayed by customers. On the other hand, voiced need to examine customers' emotional engagement widens the scope of any discussion on loyalty as well as any marketing activity designed and implemented by a business enterprise. Any discussion on loyalty cannot fail to include careful examination of customer satisfaction levels, which are shaped by customer's subjective evaluation of purchased product/service, received value, and overall interaction with a company. The structure of the generic factors that shape customer loyalty presented in Fig. 2.

Wide variety of factors affecting customer loyalty makes it nearly impossible to present a straightforward and complete definition of the discussed term. Any inconsistencies, in the meaning of loyalty should be clarified by the overview of accepted definitions of the term presented in the following table (see Table 1).

Table 1. Overview of customer loyalty definitions
(source: own study based on Urban et al. [30], pp. 11-14; [33];
Bloemer et al. [3], pp. 499-513)

| Author | Definition |
|------------------------------------|--|
| The Global Loyalty Agency | all the feelings or experiences that would incline a customer to consider the re-purchase of a particular product, service or brand or re-visit particular company, shop or website |
| Newnan J.W., Werbel R.A. | repeat purchase of a particular brand, without considering purchase of any other available brand |
| Jacoby J., Chestnut R.W., Day G.S. | customer's predisposition towards the brand as a function of psychological processes |
| Storbacka K., Lehtinen J.R. | intention to act and willingness to interact with others |
| Bloemer J., de Ruyter K. | customers' non-incident and intentional actions displayed over a long period of time towards a particular service/product supplier which operates among numerous and similar service/product suppliers |
| Olivier R.L. | deeply-term engagement and product/service/brand re-purchase intention displayed toward a particular product, service or brand |
| Reichheld F.F. | willingness to invest in further product/service/brand relationship development |
| Dick A.S., Basu K. | Function of attitude manifested in behaviour |
| Zawadzka A.M. | the result of rational-functional motivation teamed up with emotional-symbolic motivation |

As shown in the loyalty definitions overview, most academic discussions on the topic take into account behavioural and psychological loyalty drivers. As a result, for a considerable period of time loyalty was predominately perceived as a regular re-patronage or re-purchase driven by intentional, premeditated customer's actions and accompanied by positive attitude. Consequently, most presented loyalty definitions were drawn on the assumption that two main sets of loyalty drivers (i.e. behavioural and psychological drivers) should be analysed separately and independently, without the need to examine any correlations existing be-

tween discussed drivers. Nevertheless, it is evident that such correlations should be taken into account and closely examined, which may help with critical classification of existing loyalty definitions (see Table 2). The examination of those correlations allows for identification of new loyalty drivers (i.e.: action - based, follow - up) which always remain closely linked and intertwined. It should be noted that the classifications omit reference to specific markets (B2B, B2G). Moreover, in varying degrees, refer to the types of objects that are the subject of loyalty (product category, personnel, place of purchase, brand and organization).

Table 2. Loyalty drivers and definitions
(source: own study based on Garbarski et al. [10], pp. 347-348; Urban et al. [30], p. 12;
Rudawska [25] p. 27; Dębski [5], p. 40)

| Driver | Definition |
|----------------|--|
| Psychological | high level of emotional attachment to company's employees, products or services |
| | combined role of psychological processes |
| | intention to act and willingness to engage with others |
| | strong drive to re-purchase specific brand or specific set of brands despite unfavourable circumstances |
| Action - based | systematic, intentional repurchase of a specific product/service/brand accompanied by strong conviction that selected product/service/brand is superior to other available options |
| Follow - up | the result of customers' learning process, which confirms that selected product/service/brand fulfils their needs and meets their expectations to a far greater extent than any other available product/service/brand (brings a unique and desired benefits) |

Most available literature on the discussed subject matter tends to focus on brand loyalty in B2C markets. As demonstrated in extensive research studies (Falkowski, et al. [8], p. 307):

- there is correlation between the levels of perceived satisfaction and brand loyalty (only satisfied customers declared brand loyalty),
- brand loyal customers do not always declare complete contentment with their purchase,
- satisfied customers generally declare a certain level of brand loyalty.

Those findings seem to justify why customer loyalty is often categorized based on customers' brand awareness, where brand awareness is perceived as one of key loyalty drivers. The concept of customer loyalty, particularly in marketing value, is important because to the fact that it favours formation of a combination of (Dobiegała-Korona et al. [6], pp. 225-226):

- quality (close to 0% defects),
- compliance with the expectations (close to 0% deviation),
- reliability (close to 0% failure),
- sustainability (close lifetime warranty),
- easy to maintain (cheap, fast repair),
- diagnostics (the easy identification of the customer),
- accessibility (close to 100%),
- technical features (latest technology),
- functional characteristics (colour, style, product environmentally friendly),
- a value - added properties (full safety of the product),
- future needs (the need to participate in improving the product),
- operational effectiveness,
- pre - sales services (communication, cooperation),
- after - sales services (maintenance of client contact and interest),
- delivery (in the short term, the installation of the product),
- price (less than the price competition),
- resale value (a large percentage of the purchase price),
- reputation (perceived value),
- cooperation (accountability, flexibility, sensitivity to the needs of customers, kindness),

- communication (listening skills, ease of contact, can leave feedback).

Presented discussion confirms high levels of complexity and ambiguity of customer loyalty. It seems that this very complexity makes it extremely difficult to draw a straightforward and comprehensive definition of the discussed term. The multitude of existing definitions of customer loyalty can be explained by growing heterogeneity of various markets as well as increasing range of internal and external factors affecting both, buyers and suppliers. Market characteristics (subjective, objective) and its broad determinants justify both the multiplicity and extent of use of the concept of customer loyalty.

3 The essence of loyalty program

A loyalty program should be viewed as a marketing tool, which helps to achieve general aims of accepted marketing strategy and leads to strengthened relationships with customers, as a part of customer relationship managements plan developed by an enterprise. Therefore, a loyalty scheme can be defined as a "long-term marketing initiative which allows all regular customers to collect virtual points awarded after each repeat purchase, which later can be redeemed for free products, gifts, discounts and other forms of material rewards" (Liu [21], p. 21). Described loyalty scheme is commonly applied across B2C markets but as demonstrated by extensive research studies can be utilized equally successfully across large-scale B2B markets (one of numerous examples of loyalty initiatives observed in B2B markets are customised web-based platforms which help companies to serve their most valued and profitable buyers). Therefore, it can be concluded, that any activity undertaken by an enterprise (regardless of its market size and characteristics) which aims at rewarding its customers for repeat patronage may be perceived as a loyalty program.

The main behavioural purpose of any loyalty initiative is to maximize the level of customer's relative attachment toward their favourite products or services. Such purpose is realized, through implementation of well - devised set of marketing tools, which collectively form a company's loyalty scheme. Apart from their behavioural aspects, all loyalty programs are implemented in order to achieve a set of financial and economic aims, i.e.: reduce operational costs of dealing with cus-

tomers, increase overall sales volume and profitability, and maximize the value of customer portfolio.

Regardless of the market category (B2C, B2B), implementation and utilization of a well - devised loyalty program ultimately leads to strengthened relationships with existing customers, which in turn allows a company to collect a host of previously unavailable data that can be used to improve or redesign existing loyalty tools and other marketing initiatives (e.g. re - segmentation). Therefore, it can be concluded, that operating a loyalty scheme not only improves customer relationship building capabilities of an enterprise, but also improves customer intelligence and allows for better customer information management.

Customer intelligence obtained in the process of loyalty scheme operation is also useful in “improving the perceived value of goods and services offered by an enterprise” (Bolton et al. [4], p. 98; Yi et al. [34], p. 233). Overall improvement in the appeal of goods and services offered by a company inevitably leads to improved perception of the value of such goods and services. Discussed maximization of value is one of the core conditions that allow for “initiation of a relation with a customer and form the basis for further, mutually beneficial relationship between a company and its consumers” (Sirdeshmukh et al. [28], p. 18; Woodruff [32], p. 142). The main aims and purposes of any loyalty program are as follows:

- effective encouragement of repeat patronage (repurchase behaviour),
- increased customer’s relative attachment to company’s offer, company’s values and company’s image,
- increased interactions and improved dialogue with existing customers,
- improved customer intelligence,
- improved long - term cooperation capabilities of an enterprise.

Considering the outlined purposes of any loyalty scheme, such initiatives should always aim to develop and strengthen both: attitudinal and behavioural customer loyalty. Loyalty program increases overall value perception of doing business with the firm in two complementary stages. The first stage of value enhancements is based on awarding customers with

a specific number of virtual points in exchange for their repeat purchase. Over time, customers develop internal drive to collect more virtual points and develop “positive attitude towards preferred goods or services provider. In turn, positive attitude toward preferred goods or services provider strengthens the relationship between a firm and its customers, and consequently increases the levels of customers’ behavioural and attitudinal loyalty” (Lemon et al. [19], p. 4). The number of points collected over a period of time acts as a psychological incentive, which drives the customers to repeat their purchases with preferred company. Subjectively perceived degrees of motivation to repurchase a set of goods or services, are usually defined, by the relative value of collected points (i.e. the number of points needed to claim a reward). Therefore it can be concluded, that in the case of point-based loyalty schemes, the relative value of awarded points has a direct effect on the levels of loyalty declared by a customer.

The second stage of value enhancement process begins whenever a customer decides to redeem collected virtual points for material rewards. “The free reward functions as a positive reinforcement of consumers’ purchase behaviour and conditions them to continue doing business with the firm” (Sheth et al. [26], p. 263). Psychologically, giving free rewards to customers shows the firm’s appreciation and personal recognition of its customers. Current loyalty programs are therefore aimed, at deepening consumer’s relationship with a firm over a long period, which should result in decreased customer churn, decreased costs of customer service, decreased advertising expenditure. This set of results expected from any loyalty programs are what differentiates a loyalty scheme from marketing tools associated with broadly perceived sales promotion (i.e. rewarding customers for incidental purchase of a specific product or service).

Extensive research into loyalty programs in B2C markets confirms that company’s operate two main types of discussed initiatives: program - centric loyalty schemes and customer - centric loyalty schemes. Based on that research we can clearly identify the main changes in loyalty programs that have been observed over time.

Table 3. Types of loyalty programs
(based on: Kumar [14], p. 326)

| Types of loyalty programs | |
|---|--|
| Program - centric | Customer - centric |
| Operational level - aggregate | Operational level - customer |
| Standardized program, based on usage or spending | Customized program, based on types of usage or type of spending |
| Standard and uniform reward scheme, aimed at repeat purchase | Personalized reward scheme, aimed at influencing specific behavioural change or attitudinal gratification |
| Minimal reward options | Multiple reward options |
| Reactive reward mechanism | Reactive and proactive reward mechanism |
| Tangible rewards | Tangible and experiential rewards |
| Program objective: increase market share and revenues, build behavioural loyalty through repeat purchase or usage | Program objective: link loyalty to profitability, influence behavioural loyalty, cultivate attitudinal loyalty |
| Metrics used: RFM, PCV, SOW | Metrics used: CLV |
| Technology and analytics usage: minimal | Technology and analytics usage: extensive |

The historical changes in loyalty initiatives can be followed within the set of dimensions, outlined below:

- operational level,
- program objective,
- program type,
- rewarding scheme and reward options,
- reward mechanism,
- reward type,
- metrics used,
- technology and analytics usage.

Changes in loyalty programs by criteria: operational level, the program rewards scheme, options and a mechanism for rewarding, rewards, objective indicators, the use of information technology are presented in Table 3. Introduction of loyalty programs is generally aimed, at achieving several key objectives, which fall into three main categories:

- maximization of value for customers, offering value that matches customers' expectations,

- enhancement of relationships that bond a customers with a firm,
- fulfilling loyalty program's commitments and promises.

Based on the main objectives of any loyalty program outlined above it can be concluded, that the firm's ability to maximise the value for customers with the information obtained via loyalty scheme introduction is one of the key elements that define the efficiency of loyalty initiatives from both: a customer's as well as a firm's perspectives.

4 Loyalty program tools

Depending on the degree of customer loyalty is generally applicable to change forms of their reward. An example of the relationship between forms of reward and the level of customer loyalty is shown in Fig. 3.

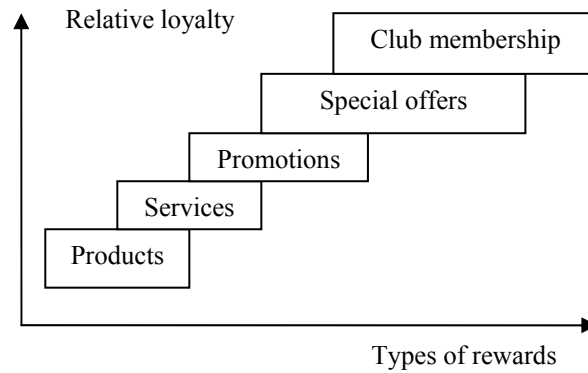


Figure 3. Observed relationship between types of rewards and levels of relative loyalty
(source: own work)

As can be seen from studies on the Polish market, B2C loyalty programs used only 51% of the surveyed companies. The most common used instruments are (www.rolandberger.com):

- bonus programs (53%) - the program offers a collection of points in exchange for using or acquiring company's products and their subsequent conversion to the prize,
- customer card (21%) - discount card loyalty that allows access to additional services,
- customer clubs (18%) - regular customers, which offers additional services (for membership of the club determines the size of their purchases and customer seniority),
- couponing (8% of respondents) - the transfer of vouchers enabling customers to purchase goods at a reduced price or free of charge under certain conditions of purchase.

The necessity to award loyal behaviour with tangible rewards is clearly justified by research, which shows, that levels of loyalty declared by customers tend to fluctuate over time. "Customers' buying behaviour is shaped by (...) a set of behavioural drivers, which affect the customers with various intensity. Customer's will to develop loyalty toward a brand is directly linked to the intensity of behavioural drivers, which the customer is exposed to" (Urban et al. [30], p. 70). Based on those findings we can outline the following key loyalty drivers:

- relationship drivers (e.g.: customer – company relationship, customer's emotional involvement with a company, etc.),

- social drivers (e.g.: customers' need to stand out from the crowd, etc.),
- value - based drivers (e.g.: most favourable value - price ratio, etc),
- external drivers (lack of alternative suppliers due to significant market barriers, etc.).

Therefore, the dynamic nature of customer loyalty justifies the need to shape the tools utilized by a loyalty scheme in accordance with the behaviour and attitudes exhibited by a targeted customer group. From a psychological viewpoint, providing the customers with free rewards for their repeat patronage validates a company's goodwill and emphasizes a company's positive attitude towards its customers. Upon receipt of a free reward, a customer feels important and valued by a firm and is therefore more likely to continue his relationship with a favourite goods or services provider. As shown by extensive research, rewarding customers for repeat patronage serves two important purposes:

- provides customers with free-of-charge access to sought-after goods and services, which are often perceived as luxurious (Kivetz [11], p. 728),
- enhances customer engagement in a firm's everyday operations (Dowling et al. [7], p. 73), and therefore improves the relationships between customers and goods or services provider.

Results of research carried out in Europe and the U.S. support use, according to the criterion of time, two types of reward: immediate and deferred. The types of awards are presented in Table 4.

Table 4: Types of rewards
(source: Kwiatek [15], p. 90)

| Specification | Immediate reduction of prices (%) | Awards postponed (%) | The electronic wallets (%) |
|---------------|-----------------------------------|----------------------|----------------------------|
| Retail Trade | 63 | 72 | 7 |
| Services | 56 | 17 | 3 |
| Total | 58 | 41 | 5 |

Those findings further justify the need to shape loyalty - building tools in accordance with targeted customer group expectations, which in turn will result in enhanced levels of customer loyalty. Moreover, both tangible and intangible rewards claimed by the customers enrolled in a loyalty scheme create a feeling of excitement among consumers, which should improve firm's overall image and enhance the perceived value of a company's offer. It is also worth noting, that discussed loyalty program tools may fulfil various objectives, which are outlined below:

- sales improvement objective – increased sales volume, increased sales value,
- data collection objective – estimation of repeat purchase probability,
- psychological objective – enhancement of a firm's image, relationship building,
- market objective – competitive advantage improvement,
- economic objective – efficiency valuation, sales profitability estimation.

Moreover, careful analysis of the relationship between individual loyalty scheme tools and the way they affect customer behaviour, seem to be at the very core estimation of the overall loyalty program effectiveness. Such exercise may involve path analysis studies, a statistical method of finding cause and effect relationships, which allow a description of the dependencies among a set of variables.

5 Factors affecting loyalty program effectiveness

Loyalty program effectiveness is defined by the degree with which a scheme fulfils a set of clearly outlined objectives. Each program may have its own unique set of success measures depending on its intended objectives, which complicates an unbiased assessment of scheme effectiveness, especially in highly competi-

tive markets. Many of today's customers take advantage of numerous loyalty programs, often provided by company, which are in direct competition. Therefore,

it can be assumed, that loyalty scheme success depends not only on the program itself but also on other facilitating and inhibiting factors present in a company's internal and external environment. Program - related factors, which explain a company's internal strategies that can contribute to the success of loyalty scheme, include the following:

- program participation requirements (convenience of participation, cost of participation),
- program point structure (point issuance and point collection convenience),
- program reward structure (points value, variety of reward options, choice and availability of rewards, brand - reward congruence, reward form: cash versus free products),
- program management (capturing and analysing consumer intelligence, organizational support, position of loyalty program in a firm's overall marketing strategy).

Success factors that are present in a firm's external environment, and therefore cannot be fully controlled include the following:

- consumers' needs and expectations (consumer's usage levels, consumer's need to stand out, etc.),
- consumers' generic traits and characteristics (demographics, current and expected shopping orientation, variety seeking, price sensitivity),
- competitive environment characteristics (firm's market position, product sustainability and expandability, market segmentation),
- competitive loyalty programs characteristics (loyalty program saturation, loyalty program differentiation, loyalty program awareness).

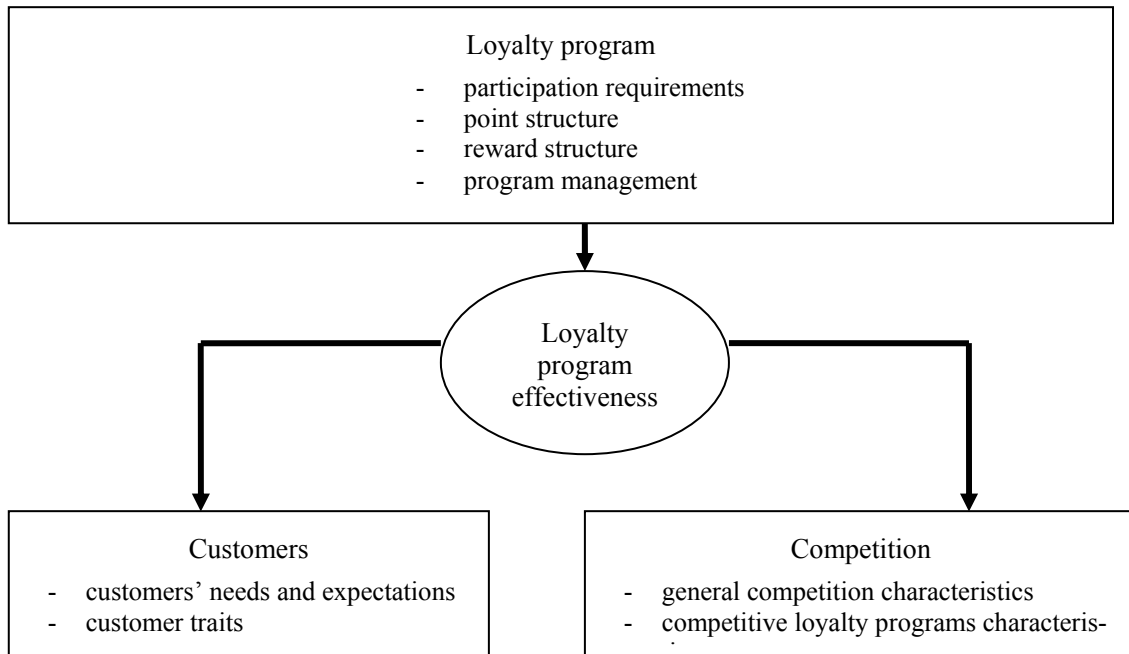


Figure 4. Factors affecting loyalty program effectiveness
(source: own work based on: Liu et al. [22], p. 95)

Results of research on the Polish market B2C show that the main causes of failure in loyalty programs include (www.rolandberger.com):

- lack of involvement in the program of all departments,
- too few rewards for program participants,
- slow implementation of promised benefits (awards, services, privileges),
- too complicated way of communicating about the program,
- expectation of immediate benefits from the program.

Key factors affecting loyalty program effectiveness are illustrated in Fig. 4.

As shown in Fig. 4, a loyalty program should be devised based on all, available information on a firm's external environment. Each element of such program must account for the dynamic nature of the environment and make best possible use of all the available data on existing loyalty programs (especially programs offered by a firm's direct competition). Process of preparation loyalty program must also make use of detailed consumer data, which can be obtained from existing, consumer database.

6 Research on loyalty program effectiveness

Loyalty program effectiveness defined by the degree with which a scheme fulfils a set of clearly outlined objectives depends largely on proper customization of all program's elements. Effectiveness of customer - centric schemes as well as program - oriented schemes can be considered from two independent perspectives:

- short - term effects of the scheme on consumers' repurchase behaviour and their attitudes towards firm's products,
- long - term effects of the scheme on consumers' buying behaviour and their attitudes towards firm's products.

Moreover, for each group of factors identified as affecting customer loyalty, a firm should devise an appropriate set of measures, which will enable correct assessment of loyalty - related marketing activity effectiveness. A set of properly devised analytical measures of loyalty program effectiveness allows identification of all scheme's attributes, which are likely to be strongly affected by any changes that take place in a firm's external environment.

Moreover, regular use of such measures enables collection of most suitable consumer data, which in turn can be used for ongoing loyalty scheme improvement.

To improve existing loyalty programs, company should also conduct ongoing studies into customer responsiveness to current marketing activities, which will allow for better customization of all marketing tools devised for future implementation. Loyalty program effectiveness can also be assessed based on changes in existing customers' lifetime value (CLV). In the financial terms, customer lifetime value means "the difference between discounted future profit margin from a customer and total costs of generating the revenue, which can be calculated using the following formula" (Kołczyński [12], p. 369):

$$CLV = [\sum (M_a - K_a) r^{(a-1)} / (1 + i)^a] - KP \quad (1)$$

where:

CLV- Customer Lifetime Value,

a - number of the successive customer activity period,

M - gross profit contribution per customer per period a,

K - customer service cost per customer per period a,

R - retention rate,

i - average forecasted interest rate,

KP - customer acquisition cost.

Customer lifetime value can also be calculated using net cash flow parameter (the difference between total revenue generated by a customer and total costs of customer acquisition, retention and relationship development) and discount rate parameter (e.g.: total cost of all activities aimed at a customer).

Financial efficiency of existing loyalty program can be measured with customer equity model, which fundamentally equals returns on acquisition plus returns on retention plus returns on add-on selling across a firm's entire customer portfolio over time (Blattberg [2], p. 201). Despite relatively common use of loyalty programs, there is limited evidence on the long-term financial and marketing effects of such programs and their effectiveness is not well established. Available research data, mainly from B2C markets, focuses on three key areas:

- comparison of loyalty programs across competitors (multiple company's),
- comparison of the behaviour of loyalty program members with that of non-members,
- studies of the loyalty program members' behaviour across time.

Research into loyalty programs run by major airlines showed significant short-term increase in the interest in airline offer across majority of program members (Kopalle et al. [13], p. 23). Comparison studies of loyalty program members and non - members behaviour among customers of North American and European financial institutions conducted in 2000 and 2003 (Bolton et al. [4], p. 95; Verhoef [31], p. 32) suggest that participation in a firm's loyalty program makes consumers likely to stay with the firm and encourages them to expand their business with the company. The same studies also find that program members weigh negative experience less in their re - patronage decisions than non - members, which is consistent with the proposition that loyalty programs allow company to enjoy their customers more exclusively and are less likely to experience significant customer churn due to customer's negative experiences. On the other hand, discussed studies do not find significant main effect of loyalty program membership on long-term customer retention.

It is also worth noting that a large number of studies suggest that loyalty programs have minimal or no impact on consumer's loyalty behaviour. Those studies are based on assumption that the increase of re - patronage rate does not stem from consumer loyalty and loyalty development techniques implemented by company but rather from consumers' generic traits. Furthermore, discussed studies divide all consumers into two major groups (Lewis [20], p. 283; Verhoef [31], p. 32):

- consumers reluctant or unwilling to switch suppliers,
- consumers who actively search for most favourable offer and are indifferent to loyalty - building tools implemented by suppliers.

Studies of the loyalty program members' behaviour across time conducted in the retail sector support the positive impact of loyalty building tools on consumer's increased spending their re - patronage rates (Lal et al. [17], p. 180; Taylor et al. [29], p. 294). They do not support the hypothesis that such techniques help to develop significant bonds between consumers and brands (i.e. loyalty).

Discussed studies suggest that loyalty program members exhibit loyalty toward the program itself, mainly due to potential rewards offered by the scheme and do not declare significant loyalty toward a firm or a brand.

Table 5. Results of loyalty programs
(source: own work based on: Kwiatek [15], pp. 95-99)

| Company | Results |
|---------|---|
| Lisner | <ul style="list-style-type: none"> - exceeded the expected value quantitative objectives, - there has been the effect of so - called full shelves before beginning of television campaign. |
| Amica | <ul style="list-style-type: none"> - enhancing the image, - establishing relationships with key market participants, - increased sales by 15% per annum, - increase in market share does not cause decrease in the value of profitability ratios. |

Researchers also identified temporary shock in spending as consumers increased their purchase levels to qualify for a reward; however, they also found that after the reward, was obtained the positive change in behaviour tended to dissipate.

Similar insignificant impact of loyalty programs, on true loyalty among consumers, was shown, in research studies conducted in 2005 among over 57 thousand US loyalties - card program members (Allaway et al. [1], p. 317). Extensive research also supports the hypothesis, that limited impact of loyalty programs on true loyalty among consumers results from overcrowding the market with homogenous (or nearly homogenous) loyalty-building schemes, which most frequently have been devised based on wrong assumptions regarding consumers' needs and expectations. On the other hand, a number of published studies confirm the positive effect of discussed initiatives on loyal attitudes among consumers, which are exhibited in their everyday spending patterns (e.g.: Lewis [20], p. 282; Verhoef [31], p. 32). Therefore, it can be concluded, that available empirical studies provide mixed support for loyalty programs, and there is still much controversy over whether the loyalty program is an appealing marketing tool. Results of loyalty programs, made by companies on the Polish market illustrated in Table 5. One of the main variables that describe the capacity of existing loyalty programs to produce a set of desired effects is the loyalty program effectiveness rating. The focal variable of such rating used in studies that compare loyalty programs across competitors (multiple company) is share of wallet (SOW), which describes:

- amount of the customer's total spending that a firm captures in the products or services that it offers,
- increase or decrease in market share that is being recorded by a firm over a set period of time.

Studies conducted in 2003 (Magi [23], p. 98) using consumer panel data of grocery purchases find mixed support for the positive effect of loyalty programs on share of wallet. Discussed studies reveal increased share of wallet for four of seven analysed programs and offers support for the use of accumulated rewards in loyalty programs. Moreover, recorded increase in share of wallet was supported only on chain level, not at the individual store level. Similarly, the studies conducted in 2006 among French grocery retailers seem to confirm ambiguous effect of loyalty programs on retailers' profitability and their popularity among consumers (Meyer-Waarden et al. [24], p. 86).

Reviewed results of numerous studies clearly signify that loyal behaviour among consumers is triggered by a host of internal and external factors. Based on discussed studies it may also be concluded that failure to identify major loyalty drivers usually results in less than satisfactory effects of implemented loyalty scheme on a firm's key customers. For this, very reason implementation of a loyalty program, should be proceeded by extensive research into customers' needs and expectations as well as careful analysis of existing loyalty schemes and other elements of a firm's external environment. It is important to note, that available research data tends to focus on short-term effectiveness of loyalty programs, and their long-term effects on consumers as well as competitors remain largely unstudied. This clearly signifies an existing knowledge gap in the field of loyalty building activities and justifies the need to conduct further research into:

- detailed characteristics of customer segments enrolled in loyalty programs,
- key factors that affect loyalty program effectiveness,

- types and levels of costs associated with loyalty program preparation, implementations and maintenance,
- general effectiveness of existing loyalty programs.

Due to prevalent use of loyalty programs in recent years and the role they play in everyday practice of marketing management, such studies should be conducted in both, B2C and B2B markets.

7 Conclusions

Loyalty programs are viewed as one of the key elements and one of the key tools of a firm's customer relationship management system. Preparation, implementation and maintenance of a loyalty program generate significant costs, and therefore should be approached as long - term commitment and an integral part of a long - term marketing strategy. Numerous companies, especially in the markets, which are saturated with similar loyalty schemes, perceive the implementation of such programs as part of their defensive strategy, which helps to retain most valued customers and creates considerable barriers against customers' switching suppliers. Viewing loyalty program as an instrument of defensive marketing strategy usually results in a costly investment, which fails to fulfil its potential and impact the profitability of a business. The empirical studies reviewed in the article seem to confirm, that most loyalty programs are devised as reactive measures and their authors fail to consider a host of factors that may affect the effectiveness of the scheme in its operative stages.

Failure to analyse the entire market (i.e. consumers and competition) in the development stages of loyalty program preparation results in a scheme that lacks expected effectiveness and adds to general disappointment with commonly used relationship marketing techniques. Therefore, it can be concluded that a newly devised loyalty program should provide any business with two key benefits:

- competitive benefit – a loyalty program should be viewed as an element of firm's most valuable assets, which plays a major part in building long-term competitive advantage,
- value benefit – a loyalty program aids a firm's data mining capabilities and therefore should help with providing customers with desired value.

From the customer's viewpoint, a loyalty program provides a host of unique, tangible and intangible benefits (e.g.: discounts, rewards, gifts) and so can be wrongly perceived as a self - sufficient entity, which in the case of improperly devised schemes results in fostering loyalty toward the program rather than a particular brand or firm. Furthermore, in markets saturated with similar loyalty programs such scenario may lead to fostering loyalty toward rewards offered by the scheme and erosion of existing, true loyalty toward any particular brand or firm. In order to prevent further disappointment with the effectiveness of loyalty programs, marketers should adopt a new approach to loyalty scheme development. It is important to recognize that loyalty programs do not operate as separate entities in an isolated environment, and so their development, should be preceded, by careful examination of existing loyalty schemes run, by direct competitors as well as customers' needs and expectations.

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MULTICRITERIA DECISION MAKING MODEL FOR THE NEW TEAM MEMBER SELECTION BASED ON INDIVIDUAL AND GROUP-RELATED FACTORS

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Abstract: This paper presents a novel approach to the team building emphasizing group-related attributes of potential candidates instead of focusing on their individual characteristics during the recruitment process. The main assumption is that the teamwork capabilities are equally if not more important than individual skills or competences when selecting new team member. Myers-Briggs Type Indicator is used for analyzing teamwork capabilities and multicriteria decision making model will be developed as a final solution.

Key words: team, teamwork, personality types, MBTI, cognitive proximity, recruitment process.

1 Introduction

There is no doubt that nowadays teamwork is a key factor of the successful company. Teamwork can be defined as a collaboration of two or more people on a common task [13] and it improves innovativeness of the company [20]. According to Hayes teamwork encourages people to be more professional and responsible [12]. It also helps to empower employees and gives the opportunity of making decision to the people who perform the tasks [17]. Very often teams are used for in order to manage change, reduce costs, increase effectiveness and productivity [2]. Unfortunately gathering a group of people and just calling them a team is not a solution. It is important to note that there is a significant difference between group and team and is related to the way that group and team achieve their goals as well as to the evaluation of their

performance. Members of the group are responsible and accountable for individual work products and in the same way is measured their performance whereas team's performance is measured as a function of individual and collective efforts and results as all members share individual and mutual accountability [16]. The main differences between the group and the team are described in Table 1. and it is a base for defining the main problem described in Section II.

There are two important differences in the table above that have solid consequences for the work results. Team members' mutual accountability and collective work products lead to the fact that team's performance is directly impacted by cooperation capabilities and relationships between team members. This does not exist in a group as group's members are treated individually.

Table 1. Group vs. Team
(source: [16])

| GROUP | TEAM |
|--|--|
| Strong, clearly focused leader | Shared leadership roles |
| Individual accountability | Individual and mutual accountability |
| The group's purpose is the same as the broader organizational mission | Specific team purpose that the team itself delivers |
| Individual work products | Collective work products |
| Runs efficient meetings | Encourages open-ended discussion and active problem-solving meetings |
| Measures its effectiveness indirectly by its influence on others (such as financial performance of the business) | Measures performance directly by assessing collective work products |
| Discusses, decides, and delegates | Discusses, decides, and does real work together |

But in case of a team if team members are not able to cooperate and their professional relations are below the sufficient level such team will not be successful even though all individuals are very competent [8]. Sometimes very competent experts are selected based solely on their professional skills which do not include social and communication attributes and that may not have suitable personalities for team work [17]. Team composition is an important issue for a team success and includes such factors as composition of member's personality, team leadership or communication and coordination within a team [10]. It was noted already in the beginning of 19th century by the Polish economist, engineer and management science researcher Karol Adamiecki that besides two types of harmony that are crucial for effectiveness of collective work – harmony of choice and harmony of doing – there is also a third one, the harmony of spirit which deals only with human factors and should connect all people working together [1].

This paper focuses on a team as defined by Katzenbach and Smith [16]: “A team is a small number of people with complementary skills who are committed to a common purpose, set of performance goals, and approach for which they hold themselves accountable” and elaborates on a team building method using individual (technical) and group (human) related factors with a main assumption taken from a software project teams that when talking about better team performance human attributes of team members are more important than their technological skills [10]. There are different types of teams: sales team, project teams, sport teams, R&D teams, service teams, management teams, etc. In this paper IT Service Team is discussed. The role of such team within IT organization is to deliver and maintain IT services according to the Standard Level Agreement between the service provider (IT Service Team) and the customer (i.e. Global F&C Team). Despite service delivery tasks discussed team also transforms into project team where all resources are used in the project mode, meaning the team provides unique end result in a limited time with limited cost. In the next sections when the problem is stated or the solution proposed described above IT Service Delivery team is meant.

This paper is organized as follows. In Section II a practical problem of recruiting a new member to the already existing and well performing team is described. Different aspects of selecting the optimal candidate from

group-related and individual perspective are listed. Then a novel approach to the team building process with a focus on social and team working capabilities of potential candidates is proposed in Section III. The model as such is not created yet but its components are described. Section IV provides an illustrative example of the problem and its solution. Last two sections provide information on possible further research and conclude the paper with a short summary.

2 The problem

Having well organized team with competent members is a goal that many managers want to achieve. Such team when well managed will perform excellent using the synergy effect coming from complementary characteristics of its members. However in today's dynamic and turbulent environment in the most of the companies the only thing that is constant is a change. Enterprises change their strategies, goals and of course organizational structures. These changes lead many high performing teams to lose their members and the question arises of who should be hired in order to keep the team's performance on a sufficient level. Building a successful team of experts who will creatively and willingly cooperate with each other is a big challenge. Admittedly, a company success depends on its employees, their experiences, codified and tacit knowledge, competences and - above all – mutual cooperation, sharing information, trust, sympathy, understanding, etc. When observing sport teams (i.e. football) it can be easily seen that many times team consisting of players with “average” skills but cooperating and “feeling” each other on the field can outperform the team of “stars”. The same applies to the business teams. When building a high performing team the cooperation ability of team members is more important than their individual attributes. But analyzing Human Resources Management literature it can be found that the most popular recruitment techniques and tools are based only on individual characteristics of candidates. Some of the most popular selection's techniques are references, interview, professional tests, intelligence tests, Assessment Center [15], applications analysis, bio-data analysis, 360-evaluation, executive search [18], education, academic results [3].

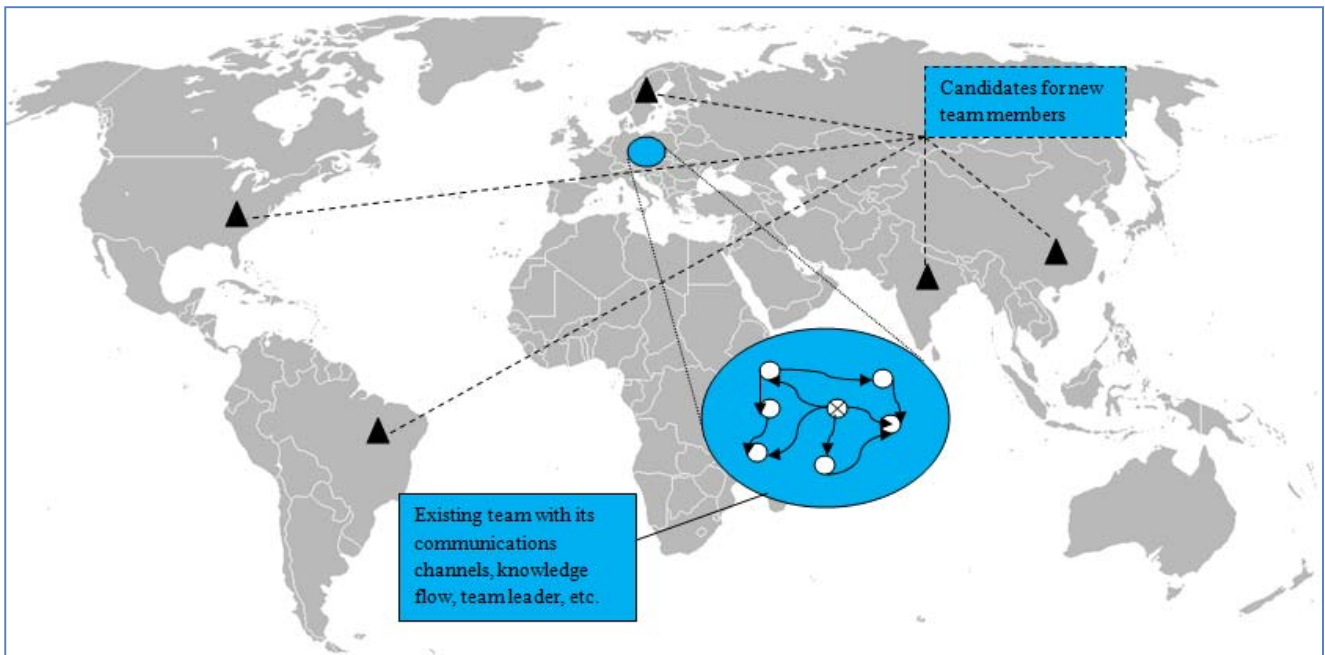


Figure 1. Recruitment Problem
(source: self study)

This is confirmed by a small survey performed on 31 international companies – mainly from IT and ICT sector but not limited to – that were asked whether during the recruitment process they check the candidate's fitness into the team he or she will work in. Only five companies answered positively, meaning that prior to the recruitment process they evaluate and analyze existing team and based on that try to find a proper new team member. The rest of the companies recruit new employees using one or many from the methods listed above. Such techniques can answer a question whether a candidate is a leader type of person or prefers to be led however regardless of their sophistication; they are mostly focused only on the candidate's individual attributes without any reference to the team. Some authors mention about techniques that evaluate candidate's fitness into overall company's strategy or even the capability of creating human relations [3] however there is no mention about fitness into particular team. One of the main factors influencing team effectiveness is communication. It plays significant role in every type of teams and becomes crucial with a growing number of team members. The problem is how to choose the candidate for the existing team in order to maximize its performance based on candidate's skills and competences, teamwork capabilities and fitness to the team and last but not least geographical location. Fig. 1. illustrates the recruitment problem.

There is a IT Service Team (small circles) that possesses well established communication and knowledge-flow channels (arrows between the circles) and has its solid structure with formal leader (crossed circle), subject matters experts, support personnel. This team due to the organizational changes is forced to increase the number of its members by selecting one from the pool of candidates (triangles) that are dispersed geographically and poses different levels of competence, skills, experience and interpersonal capabilities.

In the next chapter a solution based on multicriteria decision model for the recruitment problem is proposed.

3 Proposed solution

The proposed solution is based on the assumption that team-working skills and cooperation capabilities of candidate are equally if not more important factors than his individual characteristics. It is based on a multicriteria decision model using two sets of criteria: individual and group related with emphasis on Myers-Briggs Type Indicator and Cognitive Proximity. In order to make a team more effective such diversities as cognitive style, team role preferences or values must be smartly organized and managed [14]. One of the factors for a successful team is communication.

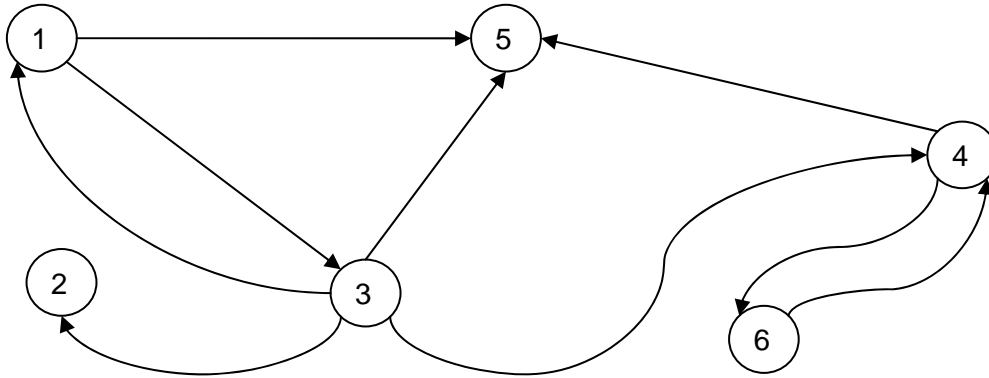


Figure 2. Knowledge flow between team members
(source: self study)

In Opt and Loffredo’s work can be found that introverts tend to be socially disadvantaged because of their communication preference and they see themselves as poor communicators [19]. That may have negative impact on the team’s communication. However knowing the communication’s preference of team members can increase tolerance and acceptance of those who are not feeling well with expressing externally [19] and thus improve the overall quality of team communication. In James Stapelton’s research it can be found that there is a significant difference in the decision performance of teams if MBTI functions of team members taken into consideration [22]. Cognitively heterogeneous pairs of members in Sensing-Intuition MBTI function are outperforming only sensing pairs in decision performing but not homogenous intuitive pairs of members [9].

In a first stage the existing team is analyzed in order to determine communication channels and knowledge flows. This can be done by performing simple survey asking team members i.e. ‘whom do they communicate with most often’ or ‘whom do they ask for an advice’. Results of the survey are represented by a digraph or by its matrix. An illustration of the example answer for the question of ‘whom do you ask for an advice when performing daily work tasks’ is presented on Fig. 2. Such question identifies the subject matter experts and the knowledge transfer within the team.

In above graph vertices represent team members and arcs the knowledge flow between the members. Subject matter experts and their level of importance in the knowledge transfer within a team is defined

by the node’s outdegree value ($deg^+(v)$) ordered from highest to lowest. In our example:

- $deg^+(3) = 4$
- $deg^+(1) = 2$
- $deg^+(4) = 2$
- $deg^+(6) = 1$
- $deg^+(2) = 0$
- $deg^+(5) = 0$

That means that member (3) serves as a knowledge source for most of the team members and should be considered as main contact point for a new member in a process of induction into new tasks and responsibilities. The following team members with lower outdegree values should be treated accordingly.

Second stage of the team analysis will be based on the Myers-Briggs Type Indicator concept. It is based on Carl Jung's theory of psychological type. It assumes that every person has natural preference in perceiving the world and making decisions in the same way like with preference of using right hand over the left – or vice versa [6]. This preference is defined by four pairs of dichotomous attributes: Extroversion/Introversion, Sensing/iNtuition, Thinking/Feeling and Perceiving/Judging [5]. Combination of one attribute from each pair creates sixteen psychological types that a person can be described by and they are listed in Table 2.

Table 2. Psychological types
(source: [5])

| | | | |
|------|------|------|------|
| ISTJ | ISFJ | INFJ | INTJ |
| ISTP | ISFP | INFP | INTP |
| ESTP | ESFP | ENFP | ENTP |
| ESTJ | ESFJ | ENFJ | ENTJ |

Table 3. Attribute relations
(source: [24])

| | | | | | |
|----------|----------|----------|----------|----------|----------|
| | E | I | | S | N |
| E | + | n | S | n | + |
| I | n | - | N | + | n |
| | T | F | | J | P |
| T | n | + | J | + | - |
| F | + | n | P | - | + |

Each type shows such preference. For example a person characterized by type ISTJ is rather introvert that collects data by sensing makes decision by logical analysis and prefers systematic and planned way of acting. Then each of the MBTI types is decomposed in single attributes and those attributes are valued from the perspective of cooperation capabilities [24]. The pair of introvert vs. extrovert is quite easy to define as extroverts are outer world oriented and teamwork stimulates them. Such relation will be positive for cooperation. On the other hand it will be very difficult for two introverts to cooperate as they draw their energy from the focus on concepts and ideas and they need quiet time alone. And thus such relation will be negative. Relation between introvert and extrovert will be neutral from the teamwork perspective. People characterized by iNtuition attribute are able to create a vision from the scratch and set a future goal whereas Sensing team members will put this vision into realistic frame and make it happen [5]. Such relation is complementary and positive. Relations S-S and N-N are neutral as such people see the world in the same way and often

such relation does not bring any creative impulse. The same rule applies to Thinking-Feeling relation. In case of Judging and Perceiving pairs the situation is different. J-J and P-P people share the same vision of the world and agree on the same values and norms. This is why such relations will be positive. On the other and J-P people will not be able to understand each other and foresee what the other is going to do [7, 8]. This relation will be negative from the cooperation perspective. Above relations are summarized in Table 3. by assigning “+” for positive relation, “n” for neutral and “-” for negative relation. Relations between single attributes of different dichotomies, i.e. Extrovert vs. Intuitive are not valued as they operate on different domains and are incomparable.

In Table 4. Saaty’s fundamental scale for pairwise comparison is presented. It is used in order to quantify described attributes’ relations. Explanation of the intensity of importance from the scale ideally fits to the purpose of valuing different types of relations between MBTI attributes.

Table 4. Fundamental scale
(source: [21])

| Intensity of importance | Definition | Explanation |
|--------------------------------|---|--|
| 1 | Equal importance | Two elements contribute equally to the objective |
| 3 | Moderate importance | Experience and judgement slightly favor one element over another |
| 5 | Strong importance | Experience and judgement strongly favor one element over another |
| 7 | Very strong importance | One element is favored very strongly over another, its dominance is demonstrated in practice |
| 9 | Extreme importance | The evidence favoring one element over another is of the highest possible order of affirmation |
| 2,4,6,8 | Intermediate importance | Used in case of need of compromise |
| Reciprocals | If activity <i>i</i> has one of the above values in comparison to activity <i>j</i> , then activity <i>j</i> has reciprocal value when compared with <i>i</i> | |

Table 5. Values of attribute relations
(source: [24])

| | | | | | |
|----------|----------|----------|----------|----------|----------|
| | E | I | | S | N |
| E | 5 | 1 | S | 1 | 5 |
| I | 1 | 0 | N | 5 | 1 |
| | T | F | | J | P |
| T | 1 | 5 | J | 5 | 0 |
| F | 5 | 1 | P | 0 | 5 |

Table 6. MBTI types relations matrix
(source: [24])

| | ESTJ | ISTJ | ESFJ | ISFJ | ESTP | ISTP | ESFP | ISFP | ENTJ | INTJ | ENTP | INTP | ENFJ | INFJ | ENFP | INFP |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| ESTJ | 12 | | | | | | | | | | | | | | | |
| ISTJ | 8 | 7 | | | | | | | | | | | | | | |
| ESFJ | 16 | 12 | 12 | | | | | | | | | | | | | |
| ISFJ | 12 | 11 | 8 | 7 | | | | | | | | | | | | |
| ESTP | 7 | 3 | 11 | 7 | 12 | | | | | | | | | | | |
| ISTP | 3 | 2 | 7 | 6 | 8 | 7 | | | | | | | | | | |
| ESFP | 11 | 7 | 7 | 3 | 16 | 12 | 12 | | | | | | | | | |
| ISFP | 7 | 6 | 3 | 2 | 12 | 11 | 8 | 7 | | | | | | | | |
| ENTJ | 16 | 12 | 20 | 16 | 11 | 7 | 15 | 11 | 12 | | | | | | | |
| INTJ | 12 | 11 | 16 | 15 | 7 | 6 | 11 | 10 | 8 | 7 | | | | | | |
| ENTP | 11 | 7 | 15 | 11 | 16 | 12 | 20 | 16 | 7 | 3 | 12 | | | | | |
| INTP | 7 | 6 | 11 | 10 | 12 | 11 | 16 | 15 | 3 | 2 | 8 | 7 | | | | |
| ENFJ | 20 | 16 | 16 | 12 | 15 | 11 | 11 | 7 | 16 | 12 | 11 | 7 | 12 | | | |
| INFJ | 16 | 15 | 12 | 11 | 11 | 10 | 7 | 6 | 16 | 11 | 7 | 6 | 8 | 7 | | |
| ENFP | 15 | 11 | 11 | 7 | 20 | 16 | 16 | 12 | 11 | 7 | 16 | 12 | 7 | 3 | 12 | |
| INFP | 11 | 10 | 7 | 6 | 16 | 15 | 12 | 11 | 7 | 6 | 12 | 11 | 3 | 2 | 12 | 7 |

Table 7. Normalized matrix
(source: [24])

| | ESTJ | ISTJ | ESFJ | ISFJ | ESTP | ISTP | ESFP | ISFP | ENTJ | INTJ | ENTP | INTP | ENFJ | INFJ | ENFP | INFP |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| ESTJ | 0,60 | | | | | | | | | | | | | | | |
| ISTJ | 0,40 | 0,35 | | | | | | | | | | | | | | |
| ESFJ | 0,80 | 0,60 | 0,60 | | | | | | | | | | | | | |
| ISFJ | 0,60 | 0,55 | 0,40 | 0,35 | | | | | | | | | | | | |
| ESTP | 0,35 | 0,15 | 0,55 | 0,35 | 0,60 | | | | | | | | | | | |
| ISTP | 0,15 | 0,10 | 0,35 | 0,30 | 0,40 | 0,35 | | | | | | | | | | |
| ESFP | 0,55 | 0,35 | 0,35 | 0,15 | 0,80 | 0,60 | 0,60 | | | | | | | | | |
| ISFP | 0,35 | 0,30 | 0,15 | 0,10 | 0,60 | 0,55 | 0,40 | 0,35 | | | | | | | | |
| ENTJ | 0,80 | 0,60 | 1,00 | 0,80 | 0,55 | 0,35 | 0,75 | 0,55 | 0,60 | | | | | | | |
| INTJ | 0,60 | 0,55 | 0,80 | 0,75 | 0,35 | 0,30 | 0,55 | 0,50 | 0,40 | 0,35 | | | | | | |
| ENTP | 0,55 | 0,35 | 0,75 | 0,55 | 0,80 | 0,60 | 1,00 | 0,80 | 0,35 | 0,15 | 0,60 | | | | | |
| INTP | 0,35 | 0,30 | 0,55 | 0,50 | 0,60 | 0,55 | 0,80 | 0,75 | 0,15 | 0,10 | 0,40 | 0,35 | | | | |
| ENFJ | 1,00 | 0,80 | 0,80 | 0,60 | 0,75 | 0,55 | 0,55 | 0,35 | 0,80 | 0,60 | 0,55 | 0,35 | 0,60 | | | |
| INFJ | 0,80 | 0,75 | 0,60 | 0,55 | 0,55 | 0,50 | 0,35 | 0,30 | 0,80 | 0,55 | 0,35 | 0,30 | 0,40 | 0,35 | | |
| ENFP | 0,75 | 0,55 | 0,55 | 0,35 | 1,00 | 0,80 | 0,80 | 0,60 | 0,55 | 0,35 | 0,80 | 0,60 | 0,35 | 0,15 | 0,60 | |
| INFP | 0,55 | 0,50 | 0,35 | 0,30 | 0,80 | 0,75 | 0,60 | 0,55 | 0,35 | 0,30 | 0,60 | 0,55 | 0,15 | 0,10 | 0,60 | 0,35 |

Based on the above scale following values were applied to the MBTI relations:

- for negative relation – value 0 – in order to avoid negative numbers,
- for neutral relation – value 1,
- for positive relation – value 5.

It must be stated here that the above values are chosen in a subjective way in order to emphasize the difference between the relations and to simplify further calculations.

Quantified attributes' relations are presented in Table 5. Individual attributes' relations are extrapolated to the whole types and MBTI types' relations matrix is created. This matrix is presented in Table 6. In order to simplify further calculations above matrix is normalized by dividing it by maximum value. Normalized matrix is presented in Table 7.

Above matrix can be read in following way: the best combination of types for cooperation is a pair with the highest value in the matrix. In our case the highest value equals 1 for pairs (ENFJ, ESTJ), (ENTJ, ESFJ), etc. On the other hand the worst combination of types for cooperation are pairs with lowest value in the matrix. In our example these are (INFP, INFJ), (INTP, INTJ), etc with value 0, 1. This table is used as follows. All members of existing team are MBTI analyzed and each member has one out of sixteen MBTI types assigned. The same applies to all candidates. Now candidates will be compared pairwise with previously subject matter experts of the team in order to find the highest values for such comparison. This will be the first group-related criterion for the final model.

Second group-related criterion is a competence level of candidate in relation to other team members. For that purpose Walukiewicz's concept of Cognitive Proximity will be used. Cognitive proximity called also technological proximity defines the cognitive distance between actors working on a particular problem [23]. It consists of codified and tacit knowledge related to the problem being solved as well as problem-related experience, differences and similarities of the actors. Cognitive proximity facilitates their creative cooperation and stimulates innovative processes involved in the act. It makes their communication easier and simplifies the learning process as well. In order to quantify our research and analysis, we introduce the utility measure u of cognitive proximity (similar measure is used for oth-

er proximities as well) that is expressed by a binary function below

$$u(\text{CP}, E, H, t) = \begin{cases} 1 & \text{if expert E is cognitively able} \\ & \text{to co-operate with expert H} \\ & \text{during time t} \\ 0 & \text{otherwise} \end{cases}$$

where u means utility function, CP – cognitive proximity, E and H are actors working on a specific Virtual Production Line and t is a time period during which E and H cooperate. This function should be understood as follows: if two experts E and H are cognitively able to cooperate, that is to say, their codified and tacit knowledge levels allow them to cooperate on a specified problem during time t , our utility function yields the result of 1. Cognitive proximity is direct in a sense that we are interested both in actors and direct cognitive relations between them and that they have influence on that proximity. One could think that two actors working together should be as cognitively close to each other as possible, however too much cognitive proximity may be detrimental to learning and innovation [4].

Therefore another measure d for expressing cognitive distance between actors that could be understood as difference in knowledge – tacit and codified, relevant to the problem – is introduced. The utility function curve in relation the distance has a shape similar to the bell curve, as shown in the Fig. 3. To achieve optimal productivity of two actors working on a problem, their cognitive proximity should look as shown. As cognitive proximity is very dependent on the problem being solved, the shape of the curves will vary accordingly, nevertheless the idea is that optimal utility will always be achieved at a similar point. Cognitive proximity is asymmetric which means that the knowledge absorption capacity of actor E is not the same as that of actor H, i.e. actor E may understand or even anticipate the ideas of actor H faster than actor H ideas of actor E [11].

Properties of utility and distance of proximity:

$$d(\text{CP}, E, H, t) \in [0, 1] \tag{1}$$

$$d(\text{CP}, E, H, t) = 1 \Rightarrow u(\text{CP}, E, H, t) = 0 \tag{2}$$

$$d(\text{CP}, E, H, t) = 0 \Rightarrow E = H \Rightarrow u(\text{CP}, E, H, t) = u(\text{CP}, H, E, t) = 0 \tag{3}$$

$$u(\text{CP}, E, H, t) \neq u(\text{CP}, H, E, t) \tag{4}$$

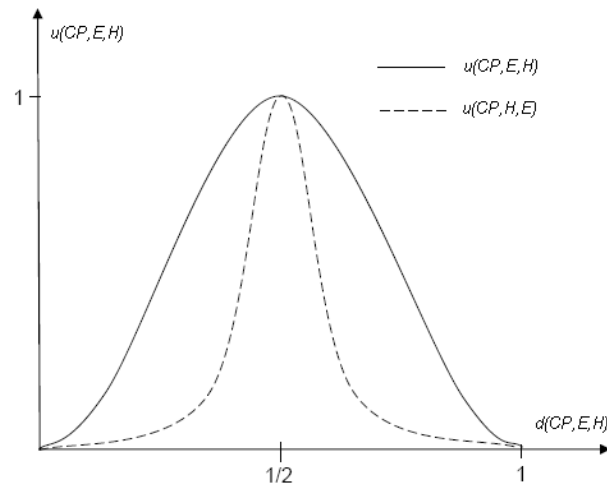


Figure 3. Utility measure of cognitive proximity in a given time t
(source: [23])

And they mean that distance between actors E and H is expressed as a value between 0 and 1. If distance d equals 1, then our previously defined utility measure equals 0, meaning that those actors are not able to cognitively cooperate. If distance equals 0, then actors E and H are “cognitively the same” for a particular problem and their cooperation will not bring any synergy, so the utility function value will be 0. Asymmetry is represented on Fig. 3. by two curves: solid one describing the distance between actor E and H and dotted describing cognitive distance between H and E.

The goal of cognitive proximity is to define and select an optimal group of actors working together from the perspective of creative problem being solved or, in other words, from the perspective of knowledge absorption and productivity, and innovation creation.

These are the two main group-related criteria that are used in the team member selection model. They are complemented by the analysis of individual criteria like education, experience, academic results, age, language skills, interpersonal capabilities, etc. Individual attributes of the existing team member have a minor influence on the model as they are already incorporated in the current performance of the team.

Next stage in the selection model deals with an analysis of potential candidates and it starts with the MBTI analysis. Then it is followed by the analysis of individual attributes of candidates including geographical location. It is not a surprise that currently many organizations consider outsourcing as a cost cutting strategy thus they are more willing to hire new employ-

ee in such countries like China, India or Brazil than in Germany, Finland or US where labor costs are much more higher. For the decision making process this criterion will be combined with the competence factor in order to provide the correct answer for the choice to be made. We can assume situation that there is two candidates from which one is located close to the base team with a higher level of competency but with also with a higher costs and the second located in a different time zone with a lower level of competency but also with a much lower costs. At this point it should be decided whether it is more profitable to hire more competency for the higher long term costs but with quicker ROI as collocated team member with higher initial skills will be able to perform his daily job quite fast.

On the other hand hiring someone in the different time zone with lower level of competency might seem to be unreasonable decision however long term costs of outsourced employee are so much lower that it might be profitable to higher such person and for the initial months collocate such member within the team for the faster knowledge transfer and afterwards sending back. Crucial issue here that will determine the choice is the knowledge transfer pace for temporary collocated new team member and thus such collocation time that influence the total cost of employee.

Above five stages of analysis form a base for new team member selection model using group-related and individual characteristics of existing team members and potential candidates. The whole model is presented in Fig. 4.

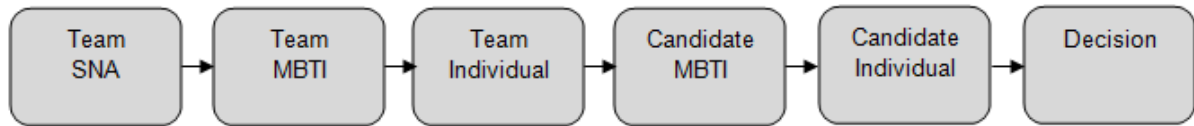


Figure 4. New team member selection mode
(source: self study)

First stage of the model identifies existing team structure, communication channels and knowledge flows. It is followed by the typological analysis of team members using Myers-Briggs Type Indicator modified in order to quantify cooperation relations between different types. Last stage of the team analysis is related to the individual attributes of its members. Then potential new team members are analyzed starting with MBTI type identification and followed by individual attributes analysis including geographical location, experience and competence. In the final stage multicriteria decision is made based on the group-related and individual attributes emphasizing cooperation and social characteristics of both team members and candidates.

Such model for a new team member selection based on group-related and individual attributes can be used for example in global telecommunication companies which have plans to outsource some of their operational tasks, i.e. IT support, marketing, etc. After outsourcing these tasks will be performed jointly by internal resources and external consultants depending on the criticality of the tasks. The company that wants to outsource is sending out requests for proposals for outsourcing services and providers are proposing delivery of the services including human resources allocated for the tasks being performed. Then requesting company can use such model for the selection of optimal external candidates to be working with an internal team in order to achieve the highest possible quality of the service to be provided. In the next chapter an illustrative example of the problem and solution proposed is presented.

4 Illustrative example

Let us consider a team consisting of 8 members. Due to the new responsibilities acquired the team must hire one additional person. Five candidates answered for the recruitment request. The first step of the method is Team SNA. Let’s define M as a set of existing team members.

$$M = (M_1, M_2, M_3, M_4, M_5, M_6, M_7, M_8)$$

Matrix representing knowledge flow between team members is showed in Table 8.

Table 8. Knowledge flow in Team M
(source: self study)

| | M ₁ | M ₂ | M ₃ | M ₄ | M ₅ | M ₆ | M ₇ | M ₈ |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| M ₁ | X | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| M ₂ | 0 | X | 1 | 1 | 1 | 1 | 1 | 1 |
| M ₃ | 0 | 0 | X | 1 | 1 | 1 | 1 | 1 |
| M ₄ | 0 | 0 | 1 | X | 1 | 1 | 1 | 1 |
| M ₅ | 0 | 0 | 0 | 0 | X | 1 | 1 | 1 |
| M ₆ | 0 | 0 | 0 | 0 | 1 | X | 1 | 1 |
| M ₇ | 0 | 0 | 0 | 0 | 1 | 1 | X | 1 |
| M ₈ | 0 | 0 | 0 | 0 | 0 | 1 | 1 | X |

This gives following outdegree values for each of the team members:

- deg⁺(M₁) = 7
- deg⁺(M₂) = 6
- deg⁺(M₃) = 5
- deg⁺(M₄) = 5
- deg⁺(M₅) = 3
- deg⁺(M₆) = 3
- deg⁺(M₇) = 3
- deg⁺(M₈) = 2

From above it can be seen that member M₁ possesses the most knowledge in the team and is a source of knowledge for all of the team members. In the opposite the member M₈ is least skilled from the knowledge transfer point of view.

Next step in the method is Team MBTI. Each member of the team solves the MBTI auto-questionnaire that defines his or her psychological type. The example results of this step are following:

- M₁ = ISTP
- M₂ = INTJ
- M₃ = ESTJ
- M₄ = ENTJ
- M₅ = ISTJ
- M₆ = ESTJ
- M₇ = ISTJ
- M₈ = INFP

Next step in the method is Team Individual where individual attributes of the team members are identified. In our example we use only two attributes such as country of residence and job role and omit others as these are enough for understanding the method. These attributes are important for the knowledge transfer point of view. Country of residence plays significant role in the cost of employee. It is not a surprise that the cost of hiring a person in Western countries is higher than in off-shored countries. Job role defines tasks and responsibilities of a team member and his or her potential in the knowledge transfer towards new team member. The hierarchy of the job roles in our example is that Ds is a most advanced role requiring the most knowledge and experience called in general the competence, Dr is a medium role requiring lower but sufficient level of competence, and Sp is introductory role requiring basic level of competence. That also shows the possibility of knowledge transfer between team members and potential new member. Let's use the example countries F, P, S, U and example job roles Ds, Dr, Sp and identify each member by these two attributes:

$$M_1 = (P, Ds)$$

$$M_2 = (F, Ds)$$

$$M_3 = (P, Dr)$$

$$M_4 = (P, Dr)$$

$$M_5 = (S, Sp)$$

$$M_6 = (S, Sp)$$

$$M_7 = (U, Sp)$$

$$M_8 = (P, Sp)$$

Now it is time for candidate's analysis. Let's define C as a set of candidates that answered for the recruitment request for the Sp role.

$$C = (C_1, C_2, C_3, C_4)$$

Their example MBTI types are:

$$C_1 = ENTJ$$

$$C_2 = ISTJ$$

$$C_3 = ESTJ$$

$$C_4 = ENTJ$$

Last step in the method is Candidate Individual where country of residence is identified as well as required competence level. Examples countries for candidates are P, F, C, B with following allocation:

$$C_1 = F$$

$$C_2 = P$$

$$C_3 = B$$

$$C_4 = C$$

Let's define cost of hiring and keeping employee in each country and assign to it 10 points in case of the most expensive country and then a fraction of it for cheaper countries. In our example it is as follows:

$$F = 10$$

$$P = 5$$

$$C = 2,5$$

$$B = 3$$

Then let's define the required competence level as RC and its scale from 0 to 1 where 0 means minimum required competence that the candidate can be hired and 1 as maximum required competence of candidate.

The results are following:

$$C_1 = 0,8RC$$

$$C_2 = 0,5RC$$

$$C_3 = 0,3RC$$

$$C_4 = 0,3RC$$

Now it is time in the method for comparison of all identified and defined values of candidates against existing team members. Firstly we compare MBTI types using values from Table 9.

Table 9. Candidates vs. Team members MBTI comparison
(source: self study)

| | M ₁ | M ₂ | M ₃ | M ₄ | M ₅ | M ₆ | M ₇ | M ₈ |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| C ₁ | 0,35 | 0,4 | 0,8 | 0,6 | 0,6 | 0,8 | 0,6 | 0,35 |
| C ₂ | 0,1 | 0,55 | 0,4 | 0,6 | 0,35 | 0,4 | 0,35 | 0,5 |
| C ₃ | 0,15 | 0,6 | 0,6 | 0,8 | 0,4 | 0,6 | 0,4 | 0,55 |
| C ₄ | 0,35 | 0,4 | 0,8 | 0,6 | 0,6 | 0,8 | 0,6 | 0,35 |

Above matrix acts as a base for a decision making process regarding the best candidate. First, all columns will be multiplied by the weights according to the results from Team SNA – each column will be weighted by its outdegree value divided by the number of team members. The results are presented in Table 10.

Table 10. Team SNA weighted matrix
(source: self study)

| | M ₁ | M ₂ | M ₃ | M ₄ | M ₅ | M ₆ | M ₇ | M ₈ |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| C ₁ | 0,31 | 0,30 | 0,5 | 0,38 | 0,23 | 0,3 | 0,23 | 0,09 |
| C ₂ | 0,09 | 0,41 | 0,25 | 0,38 | 0,13 | 0,15 | 0,13 | 0,13 |
| C ₃ | 0,13 | 0,45 | 0,38 | 0,5 | 0,15 | 0,23 | 0,15 | 0,14 |
| C ₄ | 0,31 | 0,3 | 0,5 | 0,38 | 0,23 | 0,3 | 0,23 | 0,09 |

Then each row is multiplied by the required competence factor. The results are shown in Table 11.

Table 11. Competency weighted matrix
(source: self study)

| | M ₁ | M ₂ | M ₃ | M ₄ | M ₅ | M ₆ | M ₇ | M ₈ |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| C ₁ | 0,25 | 0,24 | 0,4 | 0,3 | 0,18 | 0,24 | 0,18 | 0,07 |
| C ₂ | 0,04 | 0,21 | 0,13 | 0,19 | 0,07 | 0,08 | 0,07 | 0,06 |
| C ₃ | 0,04 | 0,14 | 0,11 | 0,15 | 0,05 | 0,07 | 0,05 | 0,04 |
| C ₄ | 0,09 | 0,09 | 0,15 | 0,11 | 0,07 | 0,09 | 0,07 | 0,03 |

Last step in our example is multiplying each row of the above matrix by the reciprocal of the Country of Residence factor and normalizing the whole matrix. The results are shown in Table 12.

Table 12. Decision matrix
(source: self study)

| | M ₁ | M ₂ | M ₃ | M ₄ | M ₅ | M ₆ | M ₇ | M ₈ |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| C ₁ | 0,41 | 0,4 | 0,67 | 0,5 | 0,3 | 0,4 | 0,3 | 0,12 |
| C ₂ | 0,15 | 0,69 | 0,42 | 0,63 | 0,22 | 0,25 | 0,22 | 0,21 |
| C ₃ | 0,22 | 0,75 | 0,63 | 0,83 | 0,25 | 0,38 | 0,25 | 0,23 |
| C ₄ | 0,61 | 0,6 | 1 | 0,75 | 0,45 | 0,6 | 0,45 | 0,18 |

Now if we summarize the values in rows we get:

$$C_1 = 3,09$$

$$C_2 = 2,77$$

$$C_3 = 3,53$$

$$C_4 = 4,64$$

That means that in our example the best candidate for the team is C₄ which is the final decision point in the presented example.

5 Further Research

It must be stated that described example was very simple and limited only to one group related and two individual attributes. The method used simple operations as its main role was only to present the possible new method of choosing the right candidate for the existing team using jointly individual and group related attributes of both existing team members and potential new members. There are several next steps in the research that will focus on:

- 1) Further research and analysis of the MBTI instrument and its usage in the team building activities

from the team members' personality matching perspective

- 2) Research and development of the team members' competence match method based on the Cognitive Proximity concept. Initial analysis of the concept suggests the usage of fuzzy sets methods in order to get optimal competence compatibilities and complementarities that generate synergy effect.
- 3) Development of sufficient number of individual attributes used in the general selection method.
- 4) Development of the general selection method based on the multicriteria decision making process.

6 Conclusion

The common problem of today's corporations is to acquire competent and experience staff that is capable of performing well in a fast and changing environment. Typically the recruitment process takes care of individual characteristics of potential new employees without relation to existing team that new employee will work in. This can cause a situation when well skilled new team member will not fit into existing team and instead of improving its performance will negatively affect it. As a solution for this problem a novel approach to the selection process is proposed. The solution is based on multicriteria decision model taking into consideration group-related and individual characteristics of both, existing team members and candidates. The selection model consists of five analysis stages that are concluded with sixth stage of decision point. Two main criteria for group-related attributes are Myers-Briggs Type Indicator and Cognitive Proximity concept.

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- The paper at the conference:

Author(s) - *Title of the paper* [at] Title of the conference, City and the year of the conference, numbers of pages.

The example:

[5] Bonits N. - *Intellectual Capital: An Exploratory Study that Develops Measures and Models* [at] The First Management Decision Conference, London 1998, pp. 12-20.

- Internet address

Authors should avoid references to internet addresses with the exception of professional databases which contain articles and monographs.

The example:

[1] Specialty Publishing Group: *KMWorld Buyers Guide*. KMWorld Magazine, Specialty Publishing Group, www.kmworld.com/BuyersGuide/Default.aspx (accessed on 2011.03.15).

[2] Ridder H., McCandless A. - *Influences on the Architecture of Human Resource Management in Nonprofit Organizations: An Analytical Framework*. Nonprofit and Voluntary Sector Quarterly, doi: 10.1177/0899764008328182, 2008.

- The reference to the monograph or to an article in a language other than English.

The example:

[1] Schuster H.G. - *Chaos deterministyczny. Wprowadzenie (Deterministic Chaos. Introduction)*. Wydawnictwo Naukowe PWN, Warszawa - Wrocław 1995.

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