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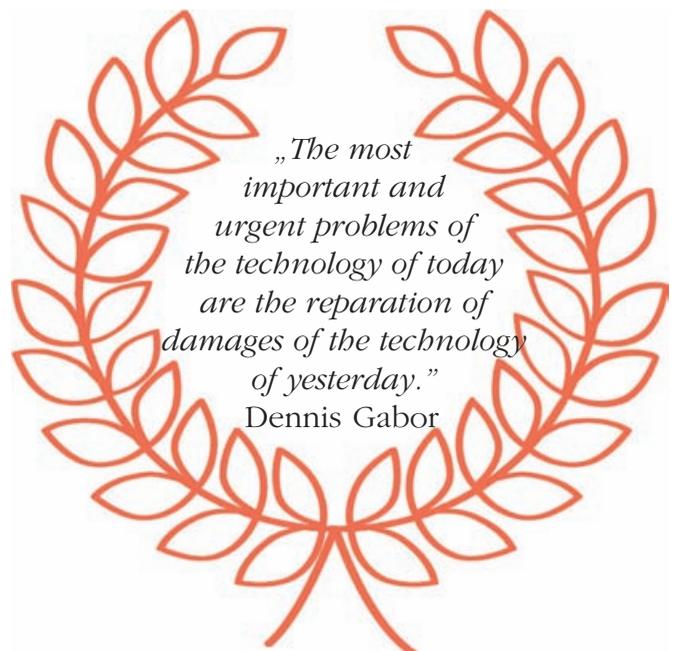
A Business Accelerator – The Technology

A management law states that the organization of production (and business) processes are in line with the adopted technological process. But the technological process is the result of technology and developing a product (a business) requires a mix of technologies. For this reason, the management schools registered a high number of requests for technology management topic. Not everybody understands technology; many companies are reluctant to use and apply technology. Others, though they do not understand technology, they will apply it, driven by the flow of change, as a must-have of the season, to be modern. This approach is not a successful one.

Technology is a set of knowledge, attributes available to be used for practical purposes in a certain area/domain. There is a materials technology, but also a design technology, manufacturing, management, research, etc. including a teaching technology. Unlike technology, the technological process is a set of operations to transform resources into results.

The development of technology is like creating a product that follows the stages of making technology (when realized); testing (the first application for assessment); launch (technology available on sale). This is where the *life cycle starts*, with embryonic technologies (not yet outlined), emerging (first steps of application), evolutionary (with awareness, but not generalized); mature, obsolete (with no longer added value). Technology is losing its novelty in 8-12 years.

Organizations, they have a portfolio of technologies at different stages of their lifecycle. A.D. Little classifies them as basic technologies (widespread, necessary, but not offering an advantage); key technologies (determines competitive position, ensures differentiation) and auxiliary technologies (are useful but not fundamental). Technologies, classified by *the degree of formalization* (the extent to which exceptions affect the procedures defined by C. Perow) are artisanal technologies, rigid technologies, flexible technologies. By *degree of interdependence* (how departments depend on one another, from technology point of, defined by J. Thompson) are mediating technologies (the product is made in a department through collaboration between producer and customer); sequential technologies (the process





is done in a department through a succession of operations); intensive technologies (departments use technologies bespoke, as per requirements).

Technology, as a product, must be continuously innovated and developed; the outcome of these activities is technological innovation. In democratic societies, the technological innovation takes place and ensures their development, but in dictatorial societies development is based on known technologies, it is limited, and it is not continuous.

The assignment of industrial property rights to technology is made through specific *technology transfer* contracts. There are often limitations on the markets on which it will be sold, or on the quantity produced. Choosing the proper technology can be difficult and there could be some limitations. There it has been found a technological determinism, choosing a technology prevents some future alternatives.

The process of finding new technologies requires the existence of *technological watch*, a search for information about what other companies do or discover scientific novels, inventions, and B.A.T. (Best Available Technology) or BACT (Best Available Control Technology). But the recommendation of such technologies discourages innovation.

Sorin Ionescu
Editor-in-Chief



Decisions in Material Technology

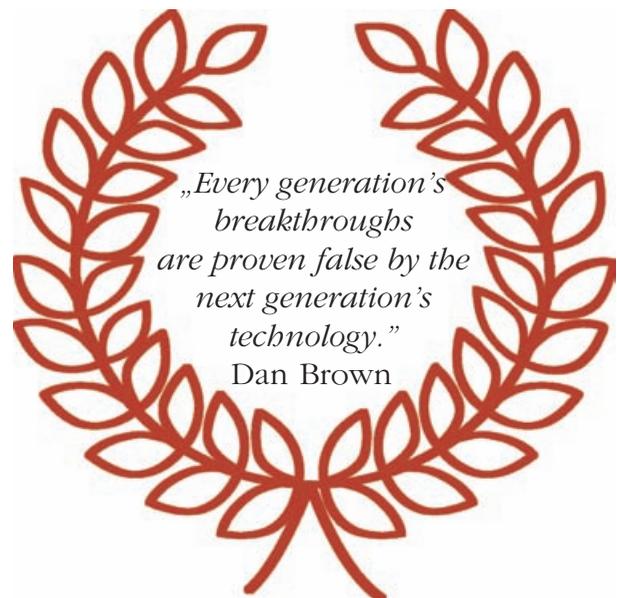
Mariana Ciurdaș, Alina Daniela Necșulescu

University POLITEHNICA of Bucharest, Romania

Abstract

In material science, engineering design and industrial application, the material selection, always was an important issue for processing „new materials”, especially composite materials for different industries like: aeronautics, automotive, medical (health), etc. To make the right selection of material for performance enhancement and cost reducing can use multi attribute decision making (MADM) methods such as: AHP, TOPSIS, ELECTRE, VIKOR, etc. About MADM methods we can say they are important for screening and selection of suitable materials. They provide a good data and information about material selection models in industrial application. Each of these methods has good outputs but also limitations. For a composite material, the properties and characteristics of this material influence the process selection. Also, the processing routes (powder metallurgy) are important to define the manufacturing parameters. To illustrate the application of AHP, four different types of composites materials were studied. Paper present an integrated model using a simple, flexible multi attribute decision making methods, AHP, for choosing the proper materials for given engineering design. Based on specific criteria for metal matrix composites (MMC) processing, this paper makes two contributions in composite material designing. For a concluding decision of suitable material a useful tool is Analytic Hierarchy Process for determining the relative weights of importance for a number of performance attributes with interpretation of ranking of selected materials for optimal design.

Keywords: material selection, composite, multi attribute decision



Introduction

The process of material selection is one of the important activities for defining manufacturing procedures. Selection on a suitable material like metal matrix composites (MMC) respecting the physical and mechanical properties or processing parameters (liquid or powder metallurgy route) is difficult task. Ashby (2005) considered a useful and simplest tool for material selection the material property chart. All the information and mechanical properties can be summarizing with these simple methods.

To reduce time and other costs in industrial practices, the material selection tools is very advantageous during the material selection process. During the material selection process, mechanical and physical properties data for metal matrix composites are very important (Hambali, 2010). These selection attributes include: physical properties (apparent density, powder mean size) mechanical, electrical, magnetic, chemical, manufacturing properties, material cost, product shape, performance characteristics, recycling, market trends, aplicability.

To resolve the material selection issue, in the past years many approaches had been studied. Authors (Ashby, 2004) proposed many strategies and various methods for material selection including graphical engineering selection method or the ranking method. One of these methods for ranking is AHP (Analytical hierarchy process) it is one of the widely used method of multicriteria decision making (MCDM) with many advantages: higher quality product and shorter product development process. Among the various MCDM approaches, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and Analytic Hierarchy Process (AHP) are very popular due to their simplicity, wide applicability and robustness.



Multiple-criteria decision analysis (MCDA) or Multiple-criteria decision making (MCDM) is a sub-discipline and full-grown branch of operations research that is concerned with designing mathematical and computational tools to support the subjective evaluation of a finite number of decision alternatives under a finite number of performance criteria by a single decision maker or by a group (Lootsma, 1999).

AHP is a multiple criteria method to solve many decisions making in research and academic area (Vaidya, 2006) providing subjective and objective evaluation measures, which help the team to check the consistency of the evaluation measures an alternatives alloying the organization to minimize common problems of decision making process. The implementation of the AHP in area like engineering, personal and social categories is impetuous necessary. Comparing candidate materials, ranking and choosing the best material is one of the most important stages in material selection process (Saaty, 2001). However,



At the industrial level (Kaneko, 2009) (Purohit, 2012) there are several conventional techniques for obtaining aluminum sintering products and aluminum based composites using powder metallurgy.

The most commonly used technique is elementary state powder mixing (Al, Cu, Mg) or binding matter – powder mixing with the ceramic particles, followed by (one direction, two direction or isostatic) warm pressing and thermal treatment; by powder mixing, cold isostatic press and warm extrusion/lamination with degasification and specific thermal treatment.

These techniques require specialized equipment and specific endowment. Under laboratory conditions there can be obtained composite materials by mixing the elementary state powders or by mixing the binding matter used in the pressing process with the powder, followed by cold pressing process, controlled atmosphere sintering process and thermal treatment. The obtained composite materials can be acquired at a lower price and can have specific characteristics according to the applications used for.

The studies accomplished so far regarding the obtaining process of the composite materials through the powder metallurgy based on the nature of the component materials and technologically parameters reveal the fact that there are still many unsolved problems with direct implications upon the properties of these materials. One of the problems encountered is the difficult pressing and sintering of aluminum powders and especially of Al/SiC powders comparing to pressing and sintering of other ferrous or copper powders. The process of cold one-direction pressing of the mixtures of metal-ceramics powders gives rise to densification problems because it requires pressing forces much higher than those

the use of AHP for material selection is still very limited in making the right decision.

The continuous development of aircraft and automotive industries impose new solutions for new advanced materials. Metal matrix composites represent a promising class of such materials, especially aluminum composites (Prasad, 2004), (Purohit, 2012), (Hassani, 2014). The composites properties depend on the metal matrix properties and on the reinforced particles form, distribution and properties. Also, the composition and physicochemical properties of the interface between metal matrix and reinforced particles must be known. From many techniques suitable to obtain the metal matrix composites the powder metallurgy is used broadly (Clyne, 1993), (Cojocar, 2004), (Balshin, 1938).

The processing of composite materials with Al matrix represents an important and distinct field in the powder metallurgy. It allows us to obtain materials with complex properties, almost impossible to obtain through classical technological processes.



used in the case of metal-metal mixtures. Aluminum sintering is difficult because each particle of Al is covered with a thin layer of a very stable aluminum oxide which cannot be reduced during the sintering process and because of that it locks the diffusion process which is necessary for the particles binding process to take place. However, the powder metallurgy (P/M) is the most attractive techniques since it gives good mechanical properties and is an inexpensive process (Hassani, 2014).

Analytical Hierarchy Process (AHP)

State of Art. In 1980, Thomas L. Saaty (Saaty, 1980, 2001) develops a new model named AHP (Analytic Hierarchy Process) to determine the relative importance of a set of activities in a multi-criteria decision problem. The AHP provides a comprehensive and rational frame-work for structuring a decision problem for representing and quantifying its elements, for relating those elements to overall goals and for evaluating alternative solutions (Saaty, 2008). The main activities in the AHP method is to make the pair wise comparisons, both of the alternatives with respect to the criteria

(scoring) and criteria with respect to themselves to estimate the criteria weights (weighting) (Saaty, 2008). The AHP method is based on three principles: first, structure of the model; second, comparative judgment of the alternatives and the criteria; third, synthesis of the priorities.

AHP Steps. To make a decision in an organized way to generate priorities we need to decompose the decision into the following steps (Saaty, 2008):

1. Define the problem and determine the kind of knowledge sought;
2. Structure the decision hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, through the intermediate levels (criteria on which subsequent elements depend) to the lowest level (which usually is a set of the alternatives);
3. Construct a set of pair wise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it;
4. Use the priorities obtained from the comparisons to weigh the priorities in the level immediately below. Do this for every element. Then for each element in the level below add its weighed values and obtain its overall or global priority. Continue this process of weighing and adding until the final priorities of the alternatives in the bottom most level are obtained.

STEP 1. AHP has been applied to a number of applications by many researchers. The first step is to define the problem by developing the weights for the criteria by using a single pair wise comparison matrix for the criteria; multiplying the values in each row together and calculating the root of the product. The decision

elements are: criteria and decision alternatives. With the AHP, the goals, criteria and alternatives are arranged in a hier-

archical structure similar to a family tree (Figure 1).

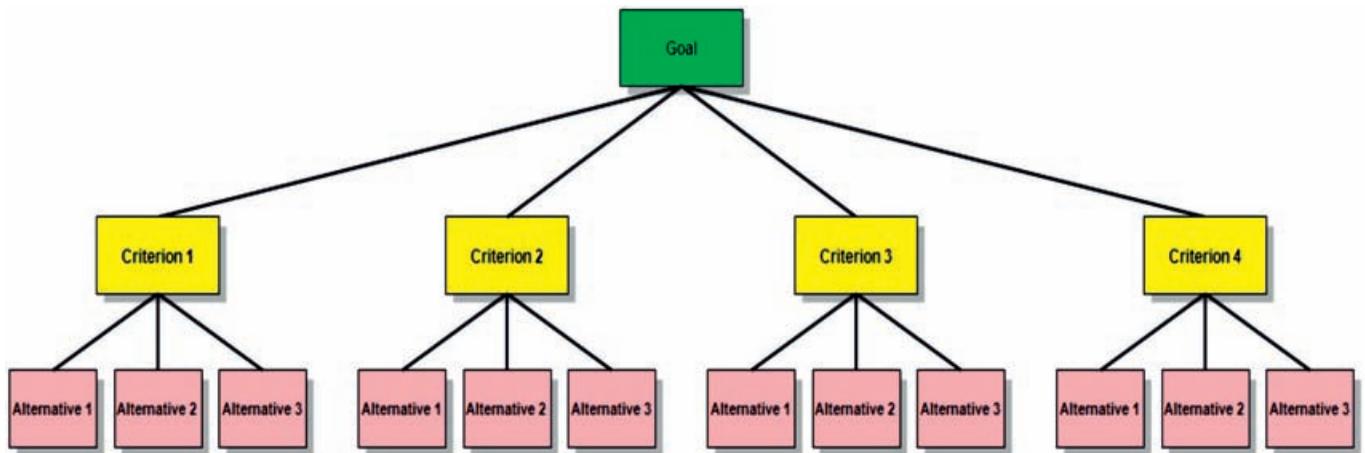


Figure 1 – A simple AHP hierarchy

(Source: Saaty, 2008)

STEP 2. Priority setting. The second step is the comparison of the alternatives and the criteria. Once the problem has been decomposed and the hierarchy is constructed, prioritization procedure starts in order to determine the relative importance of the criteria within each level. The pair wise judgment starts from the second level and finishes in the lowest level, alternatives. In each level, the criteria are compared pair wise according to their levels of influence and based on

the specified criteria in the higher level. In AHP the pair comparison is developed assigning values from 1 to 9 to express the level importance in the decision of the two element properties.

Table 1 displays the meaning of the comparison scale used in the weighting of two elements (Albayrak, 2004). The result of the pair wise comparison developed inside the AHP on „n” criteria is applied to provide a reciprocal (n x n) evaluation matrix $A = \{a_{ij}\}$.

Table 1 – Scale for pair wise comparison

Relative importance (a_{ij})	Description (i over j)
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Absolute importance
2, 4, 6, 8	Intermediate

(Source: Saaty, 2001, Hambali, 2010)

STEP 3. Calculated de weighted average rating for each decision alternative, choosing the one with highest score.

$$CR = \frac{CI}{RI} < 0,1 \quad (1)$$

$$CI = \frac{\lambda_{max} - n}{n - 1} < 0,1 \quad (2)$$

$$\lambda_{max} = \sum A \cdot W \quad (3)$$

CR (consistency ratio) is calculated with equation (1). The values for random consistency index is given by Table 2, and its value depend on the value of n (rank of the matrix).

Table 2 – Random consistency index RI

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

(Source: Saaty, 2001, Hambali, 2010)

STEP 4. Selection of the best material according to the results carried out in previous steps.

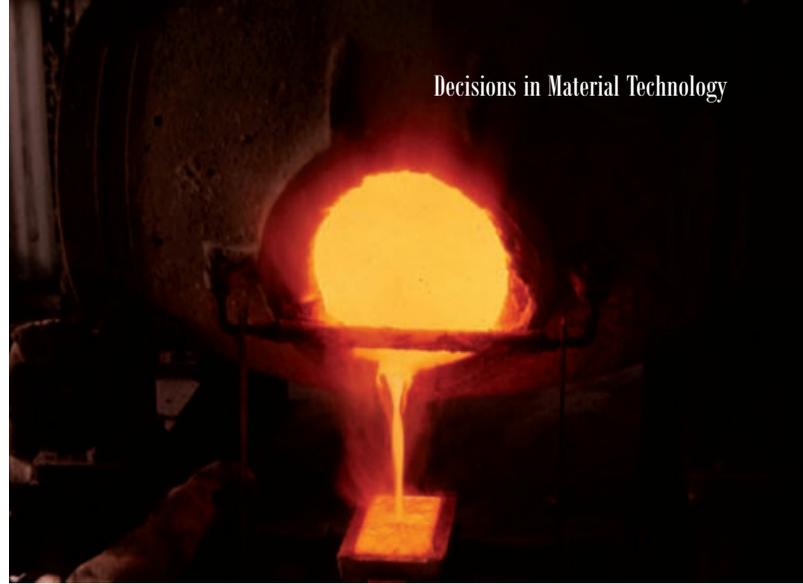
INPUT DATA. As shown in Table 3, six composites with different initial conditions were made by powder metallurgy route.

Table 3 – Preparing condition of proposed six composites

Proposed composites	SiC percentage (wt %)	Size of SiC powder (µm)	Mixing time (min)	Compressive pressure, MPa
C1	5	80	30	240
C2	5	80	30	420
C3	15	85	60	240
C4	15	85	60	420
C5	25	90	120	240
C6	25	90	120	420

Table 4 – Decision matrix for proposed composites

Candidate composites	Compressing pressure MPa	Apparent density g/cm³	Compressibility %	Porosity %
C1	240	2,44	89,70	10,3
C2	420	2,57	94,48	5,5
C3	240	2,47	89,16	10,3
C4	420	2,65	95,66	4,3
C5	240	2,49	86,70	9
C6	420	2,73	96,46	3,5



RESULTS: Data from Table 4 are represented to the pair wise comparison matrix A.

$$A = \begin{pmatrix} 1 & 2 & 4 & 3 \\ \frac{1}{2} & 1 & 5 & 2 \\ \frac{1}{4} & \frac{1}{5} & 1 & \frac{1}{5} \\ \frac{1}{3} & \frac{1}{2} & 5 & 1 \end{pmatrix} \quad (4)$$

The sum of the columns of matrix A = (2.08 3.7 15 6.2)

The aim of this work is to select the composite which have the best combination of physical properties using AHP method. We considered four criteria in order to study the

compressibility and porosity in composite material (Table 4). Using the importance description from Table 1 we can summarize the most significant criteria in pair wise comparison shown in Table 5.

Table 5 – Weight of the criteria

	Compressing presure, MPa	Aparrent density, g/cm ³	Compresibility, %	Porosity, %
Compressing presure	1	2	4	3
Aparrent density, g/cm ³	0.5	1	5	2
Compresibility	0.25	0.2	1	0.2
Porosity, %	0.33	0.5	5	1

For checking the consistency, we made the normalized matrix N, dividing each element of matrix A by the sum of the columns.

$$N = \begin{pmatrix} 0.48 & 0.54 & 0.26 & 0.48 \\ 0.24 & 0.27 & 0.33 & 0.32 \\ 0.12 & 0.05 & 0.06 & 0.03 \\ 0.16 & 0.13 & 0.33 & 0.16 \end{pmatrix} \quad (5)$$

The weights for each criteria is summarize in matrix W. It can calculate with average of each row of the normalized matrix N.

$$W = \begin{pmatrix} w_1 = \frac{0.48+0.54+0.26+0.48}{4} = 0.45 \\ w_2 = \frac{0.24+0.27+0.33+0.32}{4} = 0.30 \\ w_3 = \frac{0.12+0.05+0.06+0.03}{4} = 0.06 \\ w_4 = \frac{0.16+0.13+0.33+0.16}{4} = 0.19 \end{pmatrix} \quad (6)$$

The sum of weights is $\sum W_i = 1$

The next step is to check for the consistency, calculating the Eigen value (λ_{max}) using equation (3) where

$$A \cdot W = \begin{pmatrix} 1 & 2 & 4 & 3 \\ \frac{1}{2} & 1 & 5 & 2 \\ \frac{1}{4} & \frac{1}{5} & 1 & \frac{1}{5} \\ \frac{1}{3} & \frac{1}{2} & 5 & 1 \end{pmatrix} \cdot \begin{pmatrix} 0.45 \\ 0.30 \\ 0.06 \\ 0.19 \end{pmatrix} = \begin{pmatrix} 1.86 \\ 1.20 \\ 0.27 \\ 0.79 \end{pmatrix} \quad (7)$$

The maximum Eigen value is:

$$\lambda_{\max} = \sum A \cdot W = (1.86 + 1.20 + 0.27 + 0.79) = 4.12$$

close to the criteria (n) so is considered consistent.

The next step is calculating the Consistency index using equation 2.

$$CI = \frac{4,12 - 4}{4 - 1} = 0.04 \quad (8)$$

Consistency ratio is calculated with equation (1).

$$CR = \frac{0.04}{0.99} = 0.04 \quad (9)$$

Since $CR \leq 0.1$, the consistency of A is acceptable.

Table 6 – Alternative priorities

Composite	1	2	3	4	5	6		
	0.121	0.158	0.162	0.224	0.212	0.172	x	$\begin{bmatrix} 0.45 \\ 0.30 \\ 0.06 \\ 0.19 \end{bmatrix} = \begin{bmatrix} 0.1540 \\ 0.1781 \\ 0.1535 \\ 0.1449 \\ 0.1858 \\ 0.1733 \end{bmatrix}$
	0.212	0.167	0.171	0.119	0.121	0.160		
	0.121	0.160	0.161	0.224	0.212	0.172		
	0.212	0.172	0.173	0.093	0.121	0.162		
	0.121	0.162	0.157	0.261	0.212	0.177		
	0.212	0.177	0.174	0.076	0.121	0.162		

Table 7 – Ranking alternatives

Rank Composites	
1	C5
2	C2
3	C6
4	C1
5	C3
6	C4



Conclusions

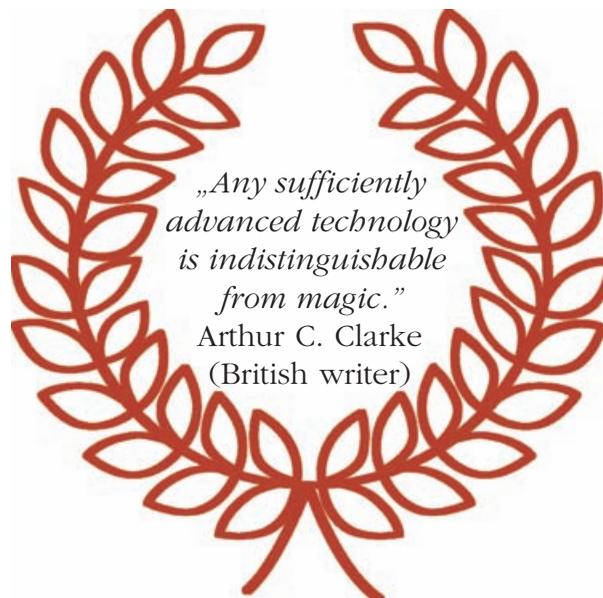
In this study, Analytical hierarchy process (AHP) method was used for determining the most desirable combination of physical properties for metal matrix composites by powder metallurgy route for aerospace and automotive industry application. The physical characteristics of the compacts were determined by measuring

and weighting. The preferred alternative for the maximum densification can be observed at 240 MPa pressure in the 25% SiC reinforced samples. Best values of density and porosity after compaction are recorded on sample Al-25 % SiC composites. In AHP methods the ranking order of the ideal solution is $C5 > C2 > C6 > C1 > C3 > C4$.

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Open Innovation in Technology Upgrading

Titu-Marius Băjenescu

La Conversion, Switzerland

Abstract

Greater world-wide solutions are needed in all areas: health care, transport, climate change, youth unemployment, financial problems, stability, prosperity, sustainability and economic growth. These challenges are an important opportunity to create a new shared value with the help of innovation. The knowledge landscape has changed and with it the rules of competition. The paradigm of Open Innovation (OI) is becoming the standard innovation process and has been already adopted by many firms, organizations and industries.

Keywords: innovation, closed innovation, open innovation, shared value, intellectual property

Introduction

Companies are increasingly rethinking the fundamental ways in which they generate ideas and bring them to market – harnessing external ideas while leveraging their in-house R&D outside their current operations. Innovation also generates value to society, even if the innovator does not capture the majority of its profits. The changing environmental, economic, political, cultural, and social conditions stress the need for different approaches to innovation.

A typical linear innovation process incorporates firms' functions in a linear manner. It starts either in the research department, goes on to the product development and prototype phase, reaches production and is put to the market. This is also known as a technology-push model. Alternatively, innovation can start with the identified



market demand which encourages researchers to develop a product and proceed with its production and marketing, i.e., a market-pull innovation model.

The traditional sequential, linear model (Figure 1) is not good enough in the era of

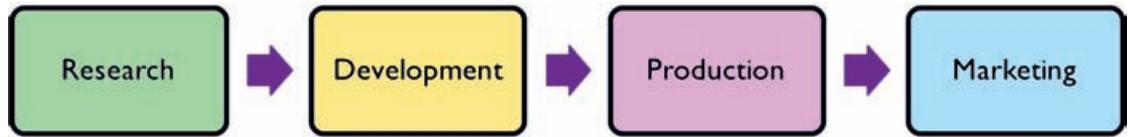


Figure 1 – *The linear model of innovation*

(Source: Kline, Rosenberg, 1986)

Open Innovation (OI) describes an emergent model of innovation in which firms draw on research and development that may lie outside their own boundaries. In some cases, such as open source software, this research and development can take place in a non-proprietary manner. To investigate this phenomenon, it is necessary to link the practice of innovation to the established body of innovation research, showing what's new and what's familiar in the process. With theoretical explanations for the use (and limits) of OI – and examining the applicability of the concept – we discover the implications for the boundaries of firms, the potential of OI to prove successful, and the implications for intellectual property policies and practices.

Closed and open innovation

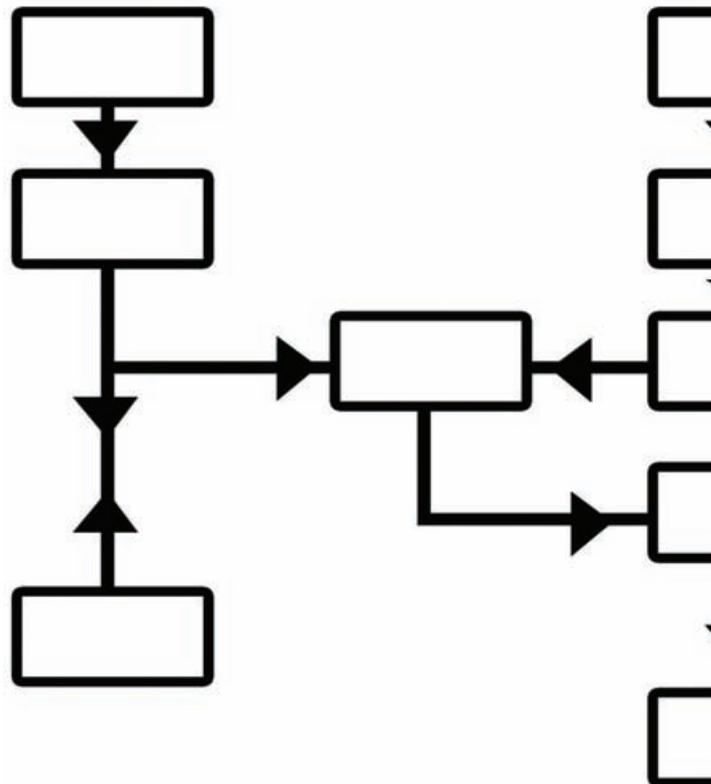
Innovation is something quite different from invention. Innovation means invention implemented and taken to market. Beyond innovation lies disruptive innovation, which actually changes social practices – the way of living, work, and learn. Really substantive innovation – the telephone, the copier, the automobile, the personal computer, or the Internet – is quite

an increased level of education, customised customer demands, mass and niche market preferences, dynamic technology, and emerging new organizational forms that allow knowledge to reside within networks, stressing their core competencies.

disruptive, drastically altering social practices (Brown, Hagel, 2002).

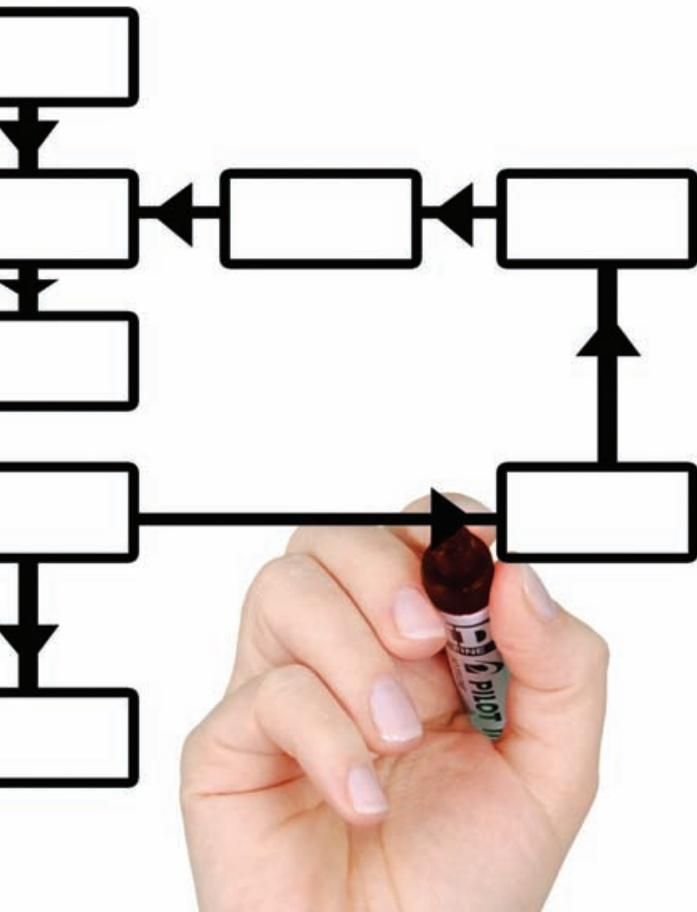
Companies are increasingly rethinking the fundamental ways in which they generate ideas and bring them to market – harnessing external ideas while leveraging their in-house R&D outside their current operations.

Innovation is at the heart of the development of companies and administrations.



Historically, keeping data and research secret was a way of challenging the competition. This time is over and whatever the field, it now seems essential to share, collaborate and open up in order to create added value and remain competitive on the market. Open Innovation is therefore now part of the development paths of any organization and is not limited to the use of collaborative platforms.

„Innovation is the specific tool of entrepreneurship, the means by which they exploit change as an opportunity for different business or different service. It is capable of being presented as a discipline, capable of being learned, capable of being predicted. Entrepreneurs need to search purposefully for the sources of innovation, the changes and their symptoms that indicate opportunities for successful innovation. And they need to know and to apply the principles of successful innovation” (Drucker, 1985).



The logic of **closed innovation** (CI) created a virtuous cycle (Figure 2). Companies have invested in internal research and development, which has led to many discoveries. The findings have allowed these companies to bring new products and services to the market, to make more sales and higher profit margins due to these products and then to reinvest into more R&D activities, which has led to new developments. And because the intellectual property that comes from internal research and development is reserved exclusively for this firm, others can not exploit new ideas for their own profit.

Competitiveness results from generating value propositions that differ from competitors' value propositions. Innovation increases the customers' value propositions and generates revenues for innovators or owners of innovation. Innovation also generates value to society, even if the innovator does not capture the majority of its profits.

In today's world – where product and technology life cycles have become startlingly shorter, where external knowledge workers (such as universities and research laboratories) make their research results available to a large public, and where the cost of independent R&D is rising rapidly, the attention paid to closed innovation is increasingly risky.

In the last years of the twentieth century, several factors combined to erode the underpinnings of closed innovation (CI). One factor was the growing mobility of highly experienced and skilled people. When people left a company after working there for many years, they took a good deal of that hard-won knowledge with them to their new employer. A related erosion factor was the burgeoning amount of college and post-college training that many people obtained allowing knowledge to circulate rapidly from a company to the other.

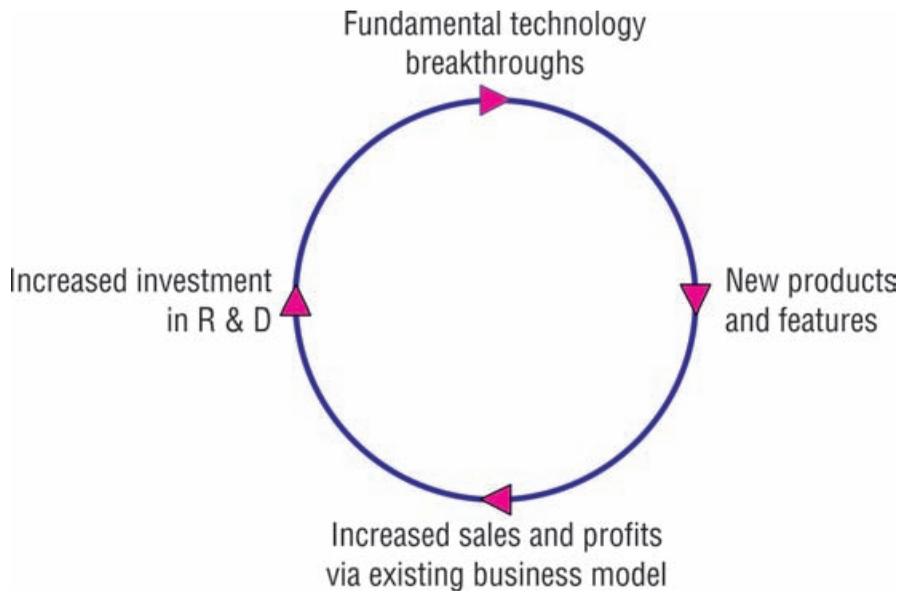


Figure 2 – *Virtuous circle*

The logic of CI was further challenged by the increasingly fast time to market for many products and services, making the shelf life of a particular technology ever shorter. Moreover, increasingly knowledgeable customers and suppliers further challenged the firm's ability to profit from their knowledge silos. And non-U.S. firms be-

came more and more effective competitors as well. When these corrosion factors have impacted an industry, the assumptions and logic that once made CI an effective approach no longer applied (Figure 3). The past success of the CI paradigm accounts for its persistence in the face of the changing landscape of knowledge.

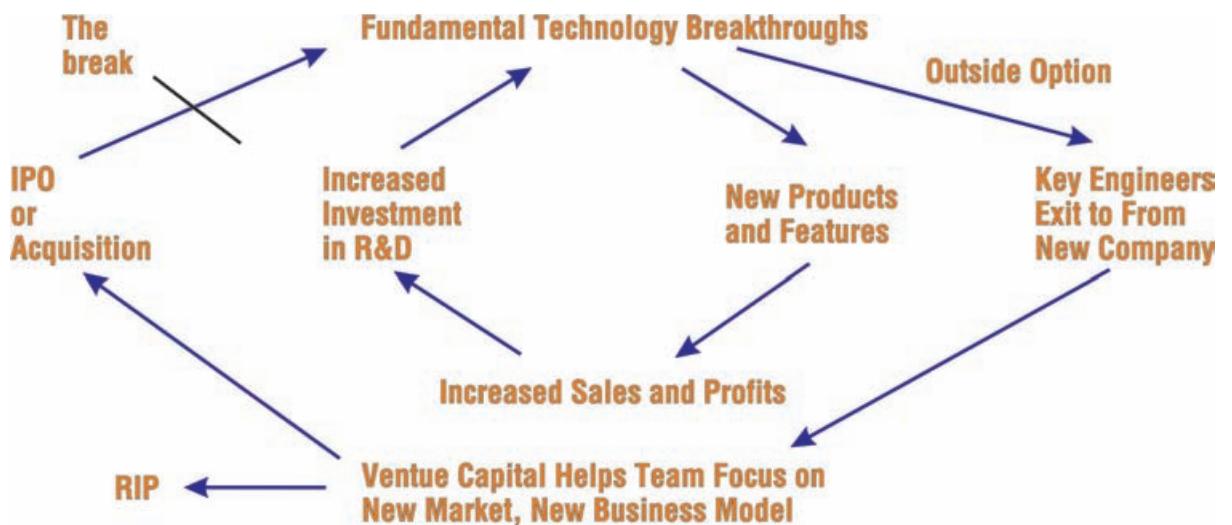


Figure 3 – *The virtuous cycle broken*

(Source: Chesbrough, 2006c)

In many industries today, the logic supporting an internally oriented, centralized approach to R&D has become obsolete. Useful knowledge is widespread in many industries, and ideas must be used with alacrity if they are not to be lost. These factors create the new logic of open innovation, which embraces external ideas and knowledge in conjunction with internal R&D. This logic offers new ways to create value, along with the continuing need to claim a portion of that value.

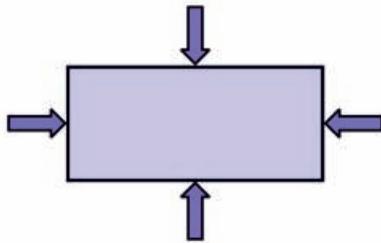
The open innovation phenomenon has developed from a small club of innovation practitioners, mostly active in high-tech industries, to a widely discussed and implemented innovation practice. Simultaneously, a small community of management researchers has recently developed into an established research field.

The term **Open Innovation** was first developed by Henry Chesbrough in 2003,

when he published *Open Innovation: The New Imperative for Creating and Profiting from Technology*. „Open innovation is a paradigm that firms can and should use external ideas, as well as internal and external ideas, as well as external ways to market, as firms would like to develop their technology” (Chesbrough 2003a, p. XXIV)

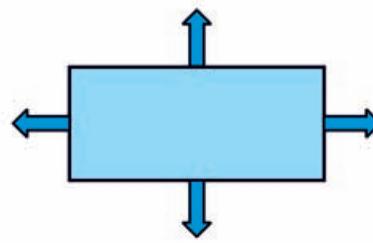
He defined the process through which an enterprise can appeal to ideas and expertise from outside it (Figure 4). Shared innovation also allows an enterprise to redistribute its ideas/licenses/ patents outside of its own markets, proposing it to other enterprises/institutions, sharing their earnings. The advantage of the enterprise is to speed up the solutions found, to broaden the perspectives with the proposed ideas and concepts, but also to lower development costs. Experts participating in this ecosystem seek to become more familiar and develop all business opportunities.

1. Openness to external competences



Subcontractors, clients, consultants, public institutions (universities, laboratories), private research centers, the large public.

2. Optimizing its intellectual property



Sale of patents and/or licenses, financing partnerships, public contributions.

Figure 4 – Schematic representations of openness to external competences and optimizing its intellectual properties

For a long time, open innovation and intellectual property rights management have been presented as contradictory approaches to innovation. It is just an apparent trade contradiction with the definitions (Dahlander, L. & Gann, D.M., 2010).

DPIs (patents, designs, copyrights) as defined by the WTO are „rights granted to

individuals on their spiritual creation. Generally, they give the creator an exclusive right to use his creation for a certain length of time.” As you can see, the notion of exclusivity is central.

The notion of individual property rights arose in 1967 with the establishment of the World Intellectual Property Organization (WIPO).



Individual property rights are designed to exclude others from using the ideas and inventions of an enterprise.

On the other hand, as we have seen, open innovation is thus defined: „Open innovation is a paradigm that implies that enterprises can and must use external ideas as well as internal ideas, but also internal and external ways to the market.” Otherwise said, it’s about to innovate with partners, sharing the risks and benefits. In this case, the emphasis is on sharing.

Although sharing does not mean giving, the difference between the notions of „exclusivity” and „sharing” is well visible.

Many authors rightly point out that intellectual property is not at the opposite of sharing, collaborative or collaborative work, but is propitious to technology sharing (Pisano, G.P. & Verganti, R., 2008). For example, the FRAND (fair, reasonable and non-discriminatory) license guarantees the licensee access to technology (reasonable and non-discriminatory), or promotes cross-license. Even outside the hypothesis of open innovation, in some cases, ac-

cess is free and protected. For example, Internet browsing systems are copyrighted, but they are freely available to everyone.

Nobody says that a business should only use open innovation; ideally, the enterprise must combine the two development techniques: when opening, when discretion. It must cultivate internal secrecy and innovation, but also an openness to other firms.

Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. Open innovation can be understood as the antithesis of the traditional vertical integration approach where internal R&D activities lead to internally developed products that are then distributed by the firm. As my definition suggests, there are two facets to open innovation. One is the „outside in” aspect, where external ideas and technologies are brought into the firm’s own innovation process. This is the most commonly recognized feature of open innovation. The other, less commonly recognized aspect is the „inside out” part, where un- and under-utilized ideas and technologies in the firm are allowed to go outside to be incorporated into others’ innovation processes (Chesbrough, H.W., 2006c).

Open innovation is an innovation process in which firms use external knowledge and external paths to market in order to advance and commercialize their technology. Open innovation has penetrated several pioneering industries, such as software, electronics, pharmaceuticals, biotechnology and telecommunication. Not only large corporations but also SMEs are adopting open innovation, strategically using their intellectual property as their main competitive advantage in the market.

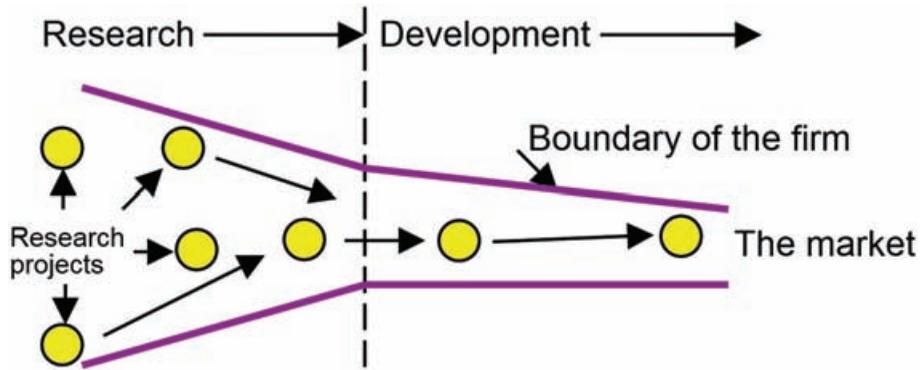


Figure 5 – *The closed paradigm for managing industrial R&D*

In figure 5, projects enter on the left at the beginning and proceed within the firm until they are shipped to customers on the right of the figure. The process is designed to weed out false positives, projects that look initially appealing, but later turn out to be disappointing. The survival projects, having survived a series of internal screens, hopefully, have a greater chance of success in the market.

Shortened product life cycles and lower costs of production have increased the success risk of new products or services (Dahlander & Gann, 2010). It has become evident that some projects are not valued in one organization but could bring value in another organizational setting. So-called 'false negatives' have led to spillovers in industrial R&D. Some organizations have begun to pick up on the notion and create new business models that view these spillovers as a new value generating possibilities (Chesbrough, 2012). Consequently, organizations have opened their inter-organizational networks, organizational structures, evaluation processes and knowledge management systems of innovation to external processes (Chiaroni, Chiesa, & Fratini, 2010) and found new value generating possibilities (Mortara & Minshall, 2011).



The differences between a closed innovation system and an open innovation system are represented in Figure 6.

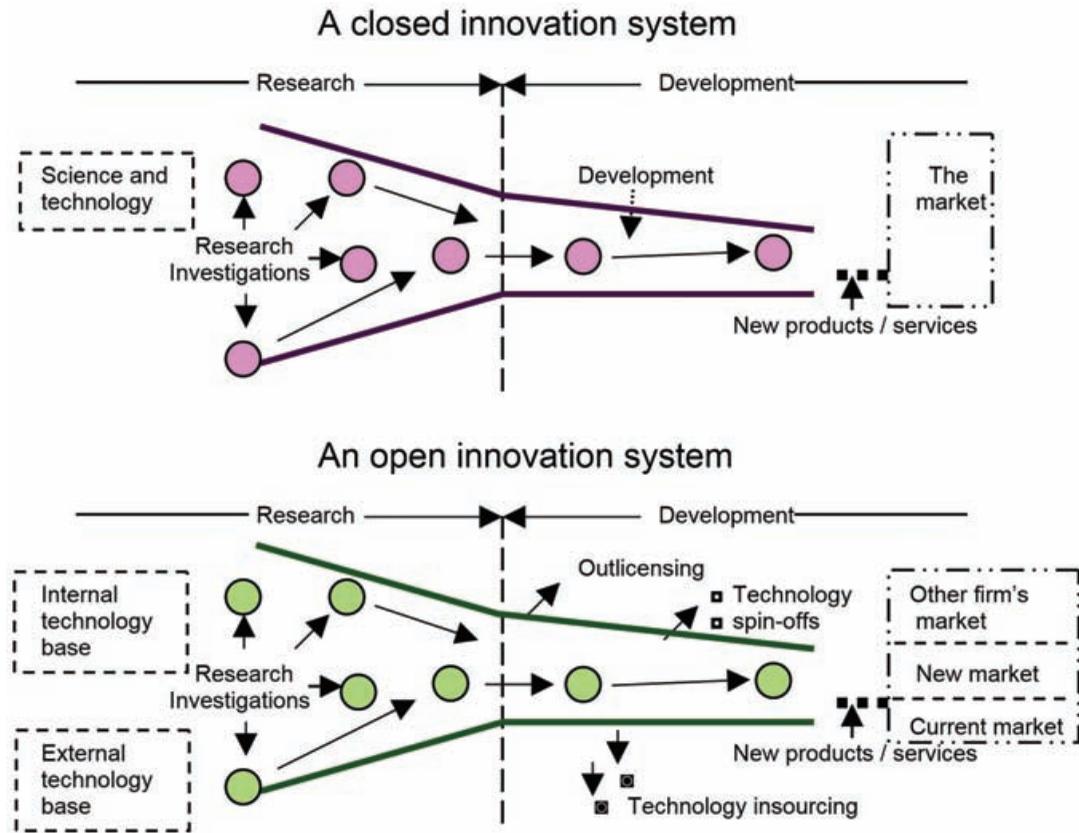


Figure 6 – *The differences between a closed innovation system and an open innovation system*

(Source: Chesbrough, 2011)

Usually, the incentives of **OI** are the limitations inherent in the closed. Open means removing boundaries. As the world is getting more competitive, organizations find themselves in an era of innovation, distinguished by its availability of venture capital. Today expertise is less scarce, and more people are educated. The mobility of knowledge workers, to new job opportunities outside of the organizations, means that desired knowledge and experience are more frequently available outside of the organization, stemming from individuals;

consumers or users who initially created value for themselves, and refined in collaborative innovation communities to viable offerings or via external experts. With new technologies for communications, the transaction costs of tapping into this knowledge are decreasing, thus resulting in a shift to user-centered innovation process, leaving traditional in-house innovation processes lagging behind.

Table 1 summarizes the main features of a closed-innovation system and an open innovation site.

Table 1 – Comparison between a closed and an open innovation system

The basics of a closed innovation system	The basics of an open innovation system
All of the company's highly-committed staff works for us	Not all of the company's dedicated staff work for us
Our company creates all devices that we need	Devices developed in other areas are useful
To take advantage of R & D, we need to find out, develop and sell our products and our services	External R & D can create value, and internal R & D use and apply this value
If we create more and better ideas, we advance	The optimal use of internal and external ideas allows us to move faster
We need to control our innovation process so that others do not take advantage of our ideas	We need to take advantage of the findings made by others and then buy the intellect of others when she serves our business model

Most of the enterprises and organizations today are aware that innovation is about access and collaboration, not ownership. There is a clear business case for recycling the abundance of technologies and outcomes of user and market experiments from adjacent industries. In the hyped start-up scene, everybody is looking to emulate asset-light companies who are leveraging the underutilized assets of others. However, even though Open Innovation (OI) is the new normal, few organizations have implemented an OI curriculum to cater to these new innovation contact aspects.

Open innovation issues

Overall, the **main benefits** of open innovation are (Docherty, 2006):

- ➔ The ability to leverage R&D developed outside;
- ➔ Extended reach and capability for new ideas and technologies;
- ➔ The opportunity to refocus some internal resources on finding, screening and managing implementation;
- ➔ Improved payback on internal R&D through sales or licensing of otherwise unused intellectual property;

- ➔ A greater sense of urgency for internal groups to act on ideas or technology;
- ➔ The ability to conduct strategic experiments with less risk and fewer resources, in order to extend the core business and create new sources of growth;
- ➔ Over time, the opportunity to create a more innovative culture from the „outside in”, through continued exposure to and relationships with external innovators.

Disadvantages of open innovation are:

- ➔ The extra costs of managing co-operation with external partners;
- ➔ The lack of control, the adverse impact on flexibility;
- ➔ The (over) dependence on external parties and the potentially opportunistic behaviour of partners;
- ➔ The growth in the outsourcing of R&D and open innovation also make the management of innovation more complex and may result in the loss of (some) technological competencies and greater dependency on external actors.
- ➔ The increased risk of leakage of proprietary knowledge and involuntary



spillovers means: the unique knowledge may be revealed to external partners that may later become competitors or may make better use of the results of the venture or the know-how.

Open innovation **implications** (Gassmann *et al.*, 2010)

- ❖ The internationalization of research, technology and product development by firms;
- ❖ An increased division of labour due to more outsourcing, more inter-firm alliances and industry-university research collaborations;
- ❖ Earlier integration of downstream users and suppliers in the innovation process to customize future products and services;
- ❖ Greater commercialization potential of the newly created technology and IP in the future;
- ❖ The generation of spill-over of proprietary knowledge via either compensation (licensing) or without compensation (open source models).

Innovation – crucial to long-term survival and business growth – is changing

(Dabic *et al.*, 2016). As not all firms have the resources to be able to innovate, they abandon their closed internal innovation model in order to open themselves outward so they can capture the new opportunities (Chesbrough, 2003b). Open Innovation allows for the strategic exploitation of sources of ideas, both internal and external (Christensen *et al.*, 2005), with the help of closed and/or open collaborations (Pisano & Verganti, 2008) partners (competing, suppliers, users, experts etc.).

However, firms trying to adopt the Open Innovation Model face a number of difficulties, particularly in terms of protecting intellectual property (IP) or sharing/assigning the value associated with them. Considered as one of the major assets of the enterprise (Chesbrough, 2003a), PI has to be protected to ensure a sufficient allocation (Pisano & Teece, 2007). This protection may prove to be difficult, or even impossible, in an open model, depending on the type of collaboration and type of partner chosen (Chesbrough H., 2006c). In addition to this defensive dimension, businesses need to seek IP valorisation (through the purchase and sale of exploitation rights) in order to exploit domestic and foreign opportunities conveniently (Chesbrough, 2003a). IP rights can, therefore, be treated as a new class of assets and not as a protection instrument (Chesbrough *et al.*, 2006d). To capture these assets, companies open their innovation process to other partners (Chesbrough, 2003 b) and/or users (Von Hippel & Von Krogh, 2003).

The concept of **Shared Innovation** (Figure 7) has changed our traditional conception of innovation; today we have to move forward, innovating innovation because innovation goes beyond creation, as it is an invented invention in an efficient market.

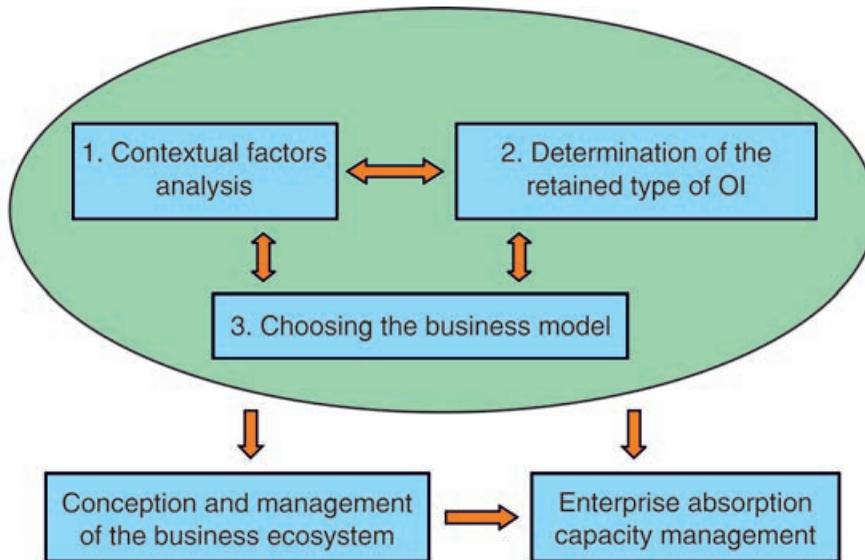


Figure 7 – Integrator model of open / shared innovation

Collaboration helps us in the creation process. In this new perspective of innovation on a particular market, businesses can no longer give up shared innovation – if they want to go further in the direction of research and development. In this way, each enterprise will benefit from intelligence and external contributions, whether they come from universities, researchers,

students, or other top-level experts. Businesses can benefit from the benefits of shared innovation to develop new products or services; we must be able to reach the market at a new angle, providing innovative products or services. The study (Dahlander & Gann, 2010) shows two sourcing and acquisition processes and two outgoing and disclosure processes (Table 2).

Table 2 – Open innovation and input and output methods of an open innovation

	Enter an innovation (outside-in)	Exit of an innovation (inside-out)
With financial compensation	Acquisition	Cession
Without financial compensation	Assignment	Disclosure

(Source: Alexander, *et al.*, 1977)

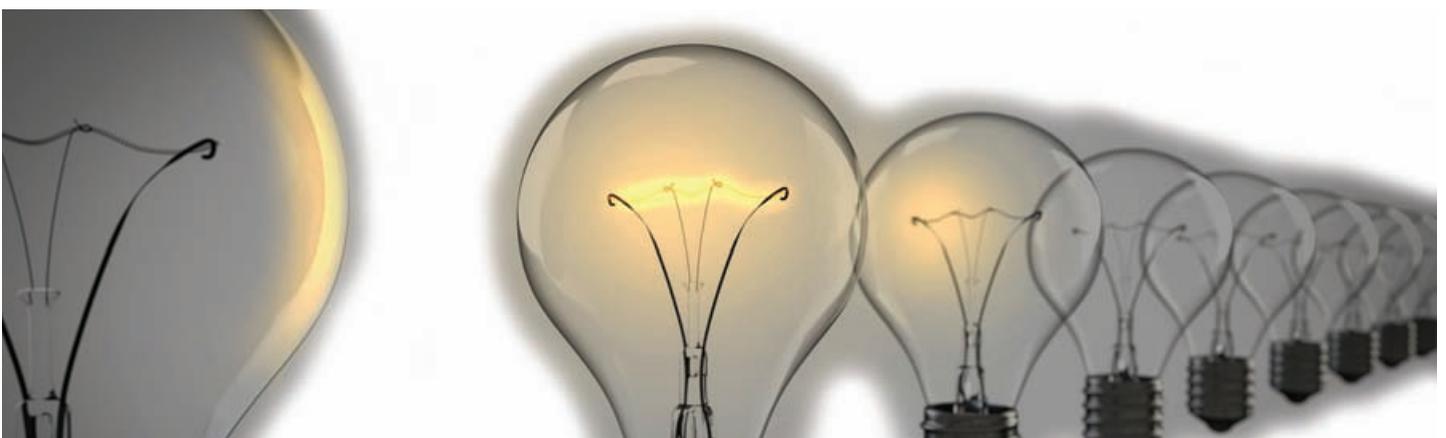


Figure 8 shows the dimensions of open/ shared innovation, its management levers and the process of adopting it. KM = Knowledge Management.

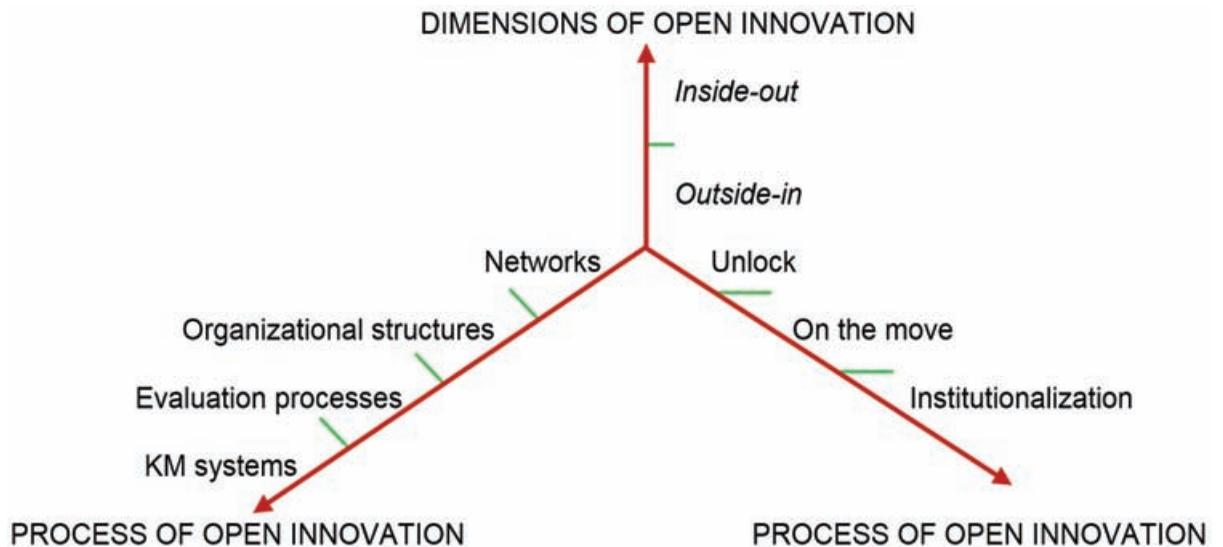


Figure 8 – Dimensions of open / shared innovation, its management levers and the process of adopting it

The concept of open innovation is gradually gaining success; however, there are numerous and significant risks, especially with regard to the difficulties in capitalizing on property rights related to collaborative innovation. Speciality literature seeks to demonstrate that there is a negative relationship between the level of openness of the innovation process and the ownership of innovation-related rights, without specifying either the type of collaboration or the nature of the partners.

The changing environmental, economic, political, cultural, and social conditions stress the need for different approaches to innovation. The traditional sequential, linear model is not good enough in the era of an increased level of education; customized customer demands, mass and niche market preferences, dynamic technology, and emerging new organizational forms allow knowledge to reside within networks, stressing their core competencies.

Conclusion

Companies that don't innovate die; this is one certainty for the company faces in this complex world. However, how should your company innovate? Rather than relying entirely on internal ideas to advance the business, open innovation leverages internal and external sources of ideas. Rather than restricting innovations to a single path to market, open innovation inspires companies to find the best business model – whether that model exists within the form or within an external one. Open innovation calls for revolutionary organizing principles for managing research and innovation.

Open innovation is a new paradigm built for the concept of industrial innovation in the 21st century. Open innovation is a distributed innovation process based on purely positive flows of knowledge deliberately managed within the organiza-

tion's limits, using pecuniary and non-financial mechanisms, depending on the model economic growth of each enterprise. These external knowledge streams may involve knowledge flows to the focused organization (to take advantage of external knowledge that is valued by internal processes), outflows of targeted firm knowledge (to take advantage of internal knowledge gained through external marketing processes) or using both types of knowledge flows (linking sources of external knowledge and marketing activities). In order to accelerate the understanding of this new approach, a coherent definition of open innovation needs to be adopted.

In order to stay competitive, businesses need to innovate, collaborate with other organizations/businesses to make innovation work. The advantages of open innovation have been described in detail in the literature; however, the mechanisms of how companies can be successful in using open innovations have not been well understood. More and more researchers (see the bibliography) have begun to systematically study and develop open inno-



vation to take a thorough examination of the best possibilities and the most promising topics.

In the new era of open innovation, co-engagement with other businesses can bring concrete benefits to higher education institutions, beyond patents, licenses or academic achievements.

Harmonization of open innovation activities with motives of diverse business and institutional segments to accept open innovation practices will determine the successful application of open innovation.

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Technologies for Modeling Business Processes

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Abstract

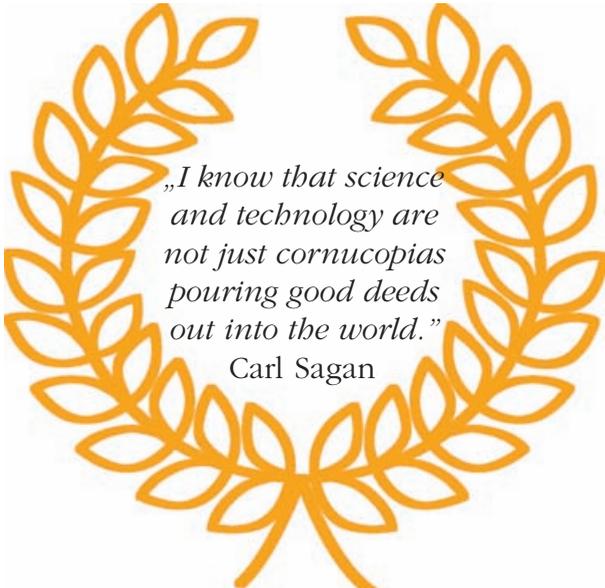
Business process modelling is a common practice in process-oriented organizations. There are a number of approaches for modelling frameworks that lead to significant process improvements. The purpose of this paper is to analyse and compare three modern modeling frameworks. In the first section, the following business process models are presented: Business Process Management (BPM), Capability Maturity Model Integration (CMMI), Business Analysis Body of Knowledge (BABOK Guide). Then, the presented frameworks are compared using criteria such as the scope of the models, the field of application, stakeholders, risk management, process complexity, process control and monitoring, continuous improvement.

Finally, the paper ends with discussion and conclusions that can be drawn from this study and research on the business modeling process frameworks.

Keywords: BPM, CMMI, BABOK, comparison, analysis

Introduction

Interdependencies between organizations, communities, countries and economies are strengthened and growing in complexity. In order to stay competitive, organizations are required to innovate and continuously improve their work. Technology developments have led to significant improvements in organizational performance. In order to adapt to the evolving market demands, organizations need to perform efficiently. Organizational goals represent future desirable states for organizations which may be achieved through organizing internal activities with the aid of processes. This brings a number of benefits



*„I know that science
and technology are
not just cornucopias
pouring good deeds
out into the world.”*

Carl Sagan



including predictability, increased work efficiency, and reducing internal risks and errors.

In the 1980s, the most popular quality control methodology for the organizations was Total Quality Management (TQM). This was followed in the early 1990s by Business Process Reengineering (BPR) promoted by Hammer and Champy (1990), as noted by Jeston and Neils (2008). The

Six Sigma approach was invented in 1986 and created process awareness and the BPR (Business Process Re-engineering) movement began, as reported by Hammer (1990). The „BPM: The Third Wave” article has created significant interest and discussion around the concept of business process management, and since then BPM is an important subject in the management field, as noted by Smith and Fingar (2006). Figure 1 outlines the evolution of the BPM concept.

In 1993, the Capability Maturity Model, originally developed as a tool for assessing the ability of government processes to implement a contracted software project, was fully defined and published, as reported by Paulk (1993). The interest in the information technology processes required organizations to document their business analysis practices and, in 2005, the first edition of the Business Analysis Body of Knowledge (BABOK) Guide was published, as noted by International Institute of Business Analysis (2009).

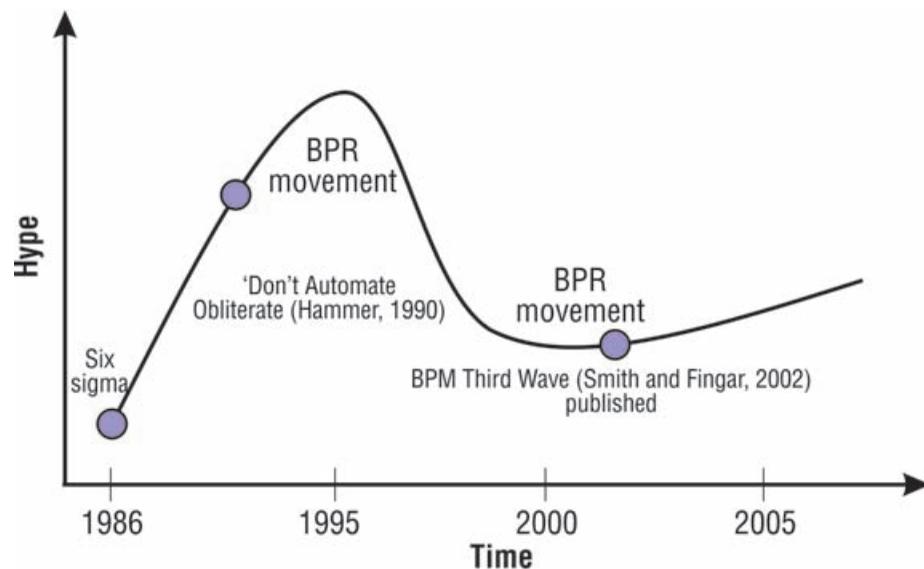


Figure 1 – *BPM concept evolution*
(Adapted from Jeston and Neils, 2008)

Theoretical Framework

Business Process Management Model. According to scientific literature, the BPM model includes ten phases and three key components for implementing the BPM approach in organizations. While some of the phases may be initially ignored, the authors stated that all organizations must eventually return and complete all stages if they adopt a process-based vision. The phases and essential elements of the BPM model are highlighted in Figure 2.

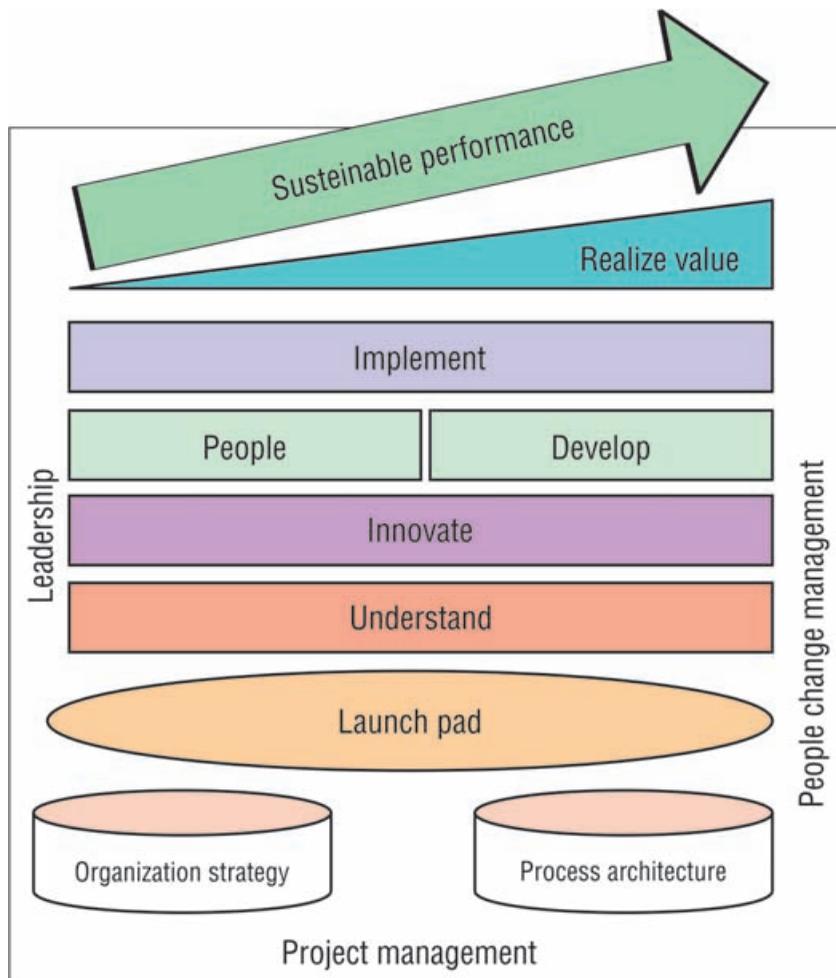
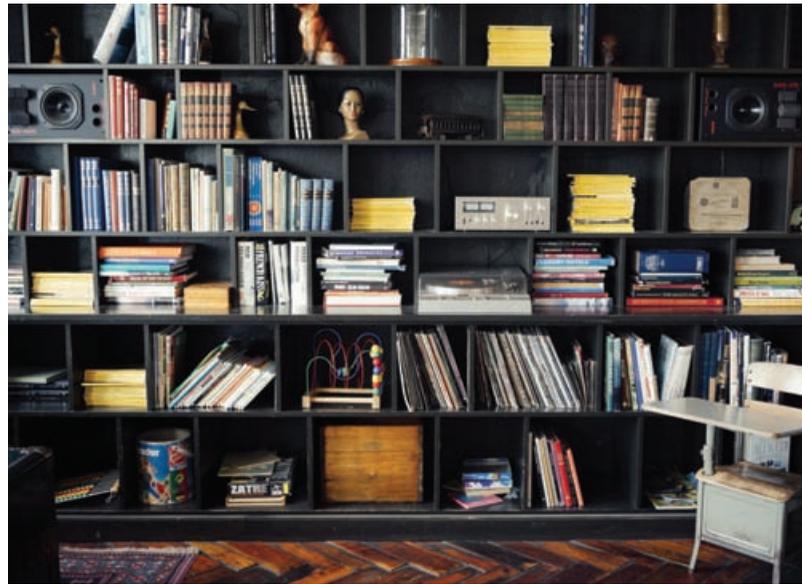


Figure 2 – BPM project framework
(Adaptation from Jeston and Neils, 2008)

Each phase of BPM implementation comprises different key activities needed to achieve the success of this approach within an organization, as follows:

- In the **organization strategy** phase, the strategy, vision, and strategic goals must be clearly understood by project team members.
- The **process architecture** phase defines how the organization sets rules, principles, guidelines, and models for BPM deployment across the organization.
- The BPM project implementation starts in the **launch** phase. This phase has three major outcomes: choosing where to begin the initial (or next) BPM project within the organization, understanding the process' objectives and/or vision once the processes have been selected, establishing the BPM project.
- In the **understand** phase, the business process environment must be understood by project team members, is essential to have basic process metrics to set the initial cost of the process.
- The **innovate** phase is the creative phase of the project, involving all relevant

stakeholders where implementation feasibility is determined to find the best options. In addition, metrics are completed to allow a comparison with the measurements made during the **understanding** phase.

- The **develop** phase consists of building all the components for the implementation of new processes. This could involve building the entire infrastructure (offices, PCs, buildings) and testing the software and hardware.
- The **people** phase is a critical phase and could put the rest of the project at risk if it is not handled well and at a high standard. The purpose of this phase is to ensure that all activities, roles and performance measurement match the organization's strategy and process objectives.
- The **implementation** phase is the phase in which all aspects of the project are implemented (launch of new processes, new technologies etc.).
- The **realize value** phase aims to ensure that the results obtained with BPM implementation are as expected.
- The last phase of the BPM model, **sustainable performance** means ensuring that improvements are sustainable.

However, the following three essential components must be taken into account to reduce the risk of the BPM implementation project within an organization: **leadership, people change management, project management.**

Capability Maturity Model Integration. Capability Maturity Model Integration (CMMI) is a set of globally recognized best practices that enable organizations to improve performance, key capabilities and critical business processes, as noted by CMMI Institute (2018). Being administered by the CMMI Institute, a subsidiary



of ISACA, the method was developed at Carnegie Mellon University (CMU), as reported by Carnegie Mellon University (2009). Maturity levels are an organized way for organizations to improve their performance and process, based on pre-defined sets of practice areas. Each level

of maturity is based on previous maturity levels by adding new functionalities. The stage representation of CMMI maturity levels along with the focus on the processes is shown in Figure 3.



Figure 3 – CMMI maturity levels and focus on processes

(Source: Adaptation from CMMI Institute 2018)

Business Analysis Body Of Knowledge Model. The BABOK Guide is the international practice standard for business analysts having the main purpose to define the content of the business analyst profession. It describes the business analysis tasks that need to be performed to understand how a solution will bring value to a sponsoring organization. Each task contributes in a certain way, directly or indirectly, to the main purpose. Business analysis is used in the information technology field, as noted by the International Institute of Business Analysis (2009).

Podeswa (2009) outlines the phases of the Software Development Life Cycle (SDLC) along with the business analysis activities:

- The objectives of the **initiation** stage are to develop the business case for the project, to determine the project and the scope of the product and to explore solutions. The business analyst supports

the project manager by identifying stakeholders, business processes and IT services affected by the project. By the end of this phase, the key function is identified.

- The main objective of the **discovery** phase is to understand the desired solution's behaviour and initial architecture.
- The main objective of the **construction** phase is to complete the analysis and design, coding, integration and testing of the software.

The main objective of the **final verification** phase is to perform final testing before the product or service is transformed into production.

- The goal of the **closure** phase is to manage and coordinate the processes, systems and functions needed to implement a product launch and to complete the project activities.

Business analysis outcomes at the end of each phase of the SDLC are presented in Table 1.

Table 1 – Business analysis outcomes at the end of each phase of the SDLC

Phase	Outcome
Initiation	Business case
Discovery	Architectural proof of concepts
Construction	Project
Final verification	Final project
Closeout	Deployment into production

Comparative Analysis

The choice of the business process model should be made after understanding the organizational goals and field of application or area of practice. Before shaping organizational processes, it is important to understand the stakeholders who will benefit from the results of the process and establish how to communicate with them.

According to a study reported in Kinetic (2015), 69% of fast-growing companies are concerned about the security risks of their organization, but only one third have the capabilities to manage these risks. In order to achieve continuous improvement, customers and stakeholders satisfaction and global strategic management within the organization, quality must be intrinsically linked to risk management. The model should provide support to risk assessment and management.

Depending on the complexity of processes, some processes are easier or harder to understand. The model should support any type of processes, regardless of their complexity and should provide support for automation if the organization needs it. Comparing the expected outcome with the results achieved and the capability to take corrective actions is the way to achieve the objective sought when implementing a model. Processes have a lifecycle and will need continuous improvement to adapt to changing requirements. The model should provide sustainable process performance and continuous improvement.

The comparative analysis of the BPM, BABOK and CMMI models (Table 2) is based on the following criteria: scope, the field of application (area of practice), stakeholders, risk management, process complexity, process control and monitoring, continuous process improvement.



Table 2 – Comparison of BPM, CMMI and BABOK models

Criteria	BPM	CMMI	BABOK
Scope	Accomplish organizational goals through business process management	Implement standard processes to strengthen the key capabilities	Deliver a solution to the stakeholders
Field of application	Any organization	CMMI-DEV, CMMI-SVC, CMMI-ACQ	IT
Stakeholders	An essential component: people change management	At the end of maturity level 1	Planning and monitoring business analysis
Risk management	Process automation and three essential components	Evaluation	Evaluation and validation of the solution
Process complexity management	Use structured tools and methods	Continuous and stage representation for different development plans	Test plan in the discovery phase of the SDLC
Process control and monitoring	Metrics in the understand and innovate phases	CMMI V2.0 Appraisals	Requirements analysis
Continuous process improvement	Sustainable performance phase	CMMI V2.0 Appraisals and continuous assessment to determine the maturity level	Solution assessment and validation

a) The scope of the model. In the organization strategy phase of the BPM model, the strategic goals are outlined and the organizations have selected the processes that were most important in meeting their customers' needs and focused on making them more efficient. In the process architecture phase, business processes architecture is aligned with strategic goals.

The CMMI model focuses on specific processes that are considered important to the organization's immediate business objectives or for which the organization assigns a high degree of risk. According to CMMI, knowing the key capabilities of the organization creates value. Employees focus on implementing standard processes to strengthen their key capabilities, as reported by Carnegie Mellon University (2009).

Business analysis helps organizations define the optimal solution for their needs, with a series of constraints under which the organization operates. A solution is a change in the current state of the organization that is made to meet a business need, solve a problem, or exploit an opportunity. The BABOK model includes business analysis activities, designed to define and validate solutions that meet business needs, ideals and goals. Business analysis can be done to understand the current state of the organization or to be the basis for further identifying business needs.

b) Field of application (Area of practice). The BPM model is used both in the industry and in information technology, production, in any organization that can be organized by business processes. For CMMI, areas of interest include

product and service development (CMMI-DEV), services (CMMI-SVC), product and service acquisition (CMMI-ACQ). The BABOK model is used in information technology organizations.

c) Stakeholders. One of the three essential components for any BPM implementation project is people change management, as stakeholders play an important role in the execution of business processes, and it is important to manage the change imposed by them. At the end of the level 1 maturity level of the CMMI, organizations must understand their stakeholders. The chapter on planning and monitoring business analyzes in the BABOK guide explains how to choose stakeholders. The chapter on enterprise analysis highlights the crucial process of keeping everyone in the loop and on the same page on the direction and progress of the project.

d) Risk assessment. BPM defines a classification and then risk management throughout all life cycle phases. Human factor risk is reduced by automating processes. The three essential components (leadership, people change management, project management) are defined to reduce the risk of the BPM implementation project.

The CMMI model defines the evaluation as an activity that identifies the strengths and weaknesses of the organization's processes and examines how closely processes are related to the best practices. Evaluations are typically conducted to determine how well the organization processes compare with CMMI best practices and identify areas where improvements can be made. Evaluation activities can help organizations at any stage of adopting CMMI. The CMMI assessment method gives reliable,



clear, consistent and actionable attention to performance improvements that will have the greatest impact on business and will help build and improve capacity. Evaluation allows the organization to plan an organization improvement strategy to prioritize the most important performance improvements. This reduces the risk of purchasing, developing, delivering and monitoring products and services. In the chapter on the evaluation and validation of the BABOK solution, the way of choosing the best solutions for the specific needs of the business, as well as assessing how the chosen solution worked after its implementation, is detailed. This chapter helps to understand the risks, dependencies and limitations that need to be identified before proposing a solution.

e) Process complexity, BPM recommends analysing processes using structured tools and methods that are advantageous for large and complex processes.



V2.0 Appraisal Method Definition Document describes four types of CMMI V2.0 Appraisals: Benchmark, Sustainment, Evaluation, and Action Plan Reappraisal, as noted by CMMI Institute (2018). Benchmarking appraisal identifies opportunities for organizations to improve how they implement processes and their overall business performance

A sustainable appraisal can be made two years after the benchmark to determine whether the organization maintains its level of appraisal. The action plan reappraisal is a second chance for organizations that have failed to reach the level of assessment specified in a previous appraisal. The evaluation appraisal is used to help organizations prepare for evaluation and determine opportunities for improvement.

The chapter on requirements analysis in BABOK describes how business analysts prioritize and develop progressively stakeholders' requirements and solutions to enable the project team to implement a solution that meets the needs of the stakeholders.

g) Continuous process improvement, the BPM sustainable performance phase implies redesigning and improving the process, flexibility and process improvement is the main objective. CMMI aims to set goals and priorities that help improve the performance of an organization or project. The main purpose is to arrive at the highest maturity level, 5 – Optimized. The four types of CMMI V2.0 Appraisals are used to describe the strengths and weaknesses organization's processes based on CMMI best practices.

The chapter on assessment and validation of the solution from the BABOK guide details how business analysts assess the proposed solutions to determine which solution best suits your business needs, identify gaps and shortcomings

CMMI involves two ways of representation that allow for the development of different development plans. Continuous representation offers maximum flexibility, only improves certain areas of deficient processes and is used by a mature organization. Stage representation is done at the organization level, being an incremental way of improvement and used by organizations with little experience. In the discovery phase of SDLC within BABOK, the business analysis performs a test plan that will be performed to control and verify parts of the solution and the complete solution.

f) Process control and monitoring, BPM has a powerful process control and monitoring capability. Once launched, in the understand phase, basic metrics for the processes are set. Later on, in the innovate phase, metrics are compared to determine the best options. Within CMMI, process evaluation is ongoing, organizations are constantly assessed internally and externally to monitor the maturity level. The CMMI

Conclusions

The comparative analysis of the BPM, CMMI and BABOK models shows that there is no model that offers more advantages than the other, but that the model should take into account the purpose of its application within the organization. This comparative analysis helps organizations chose a suitable business process framework according to their needs. For example, if an IT software consultancy organization, which focuses on delivering a customized solution for stakeholders wants to

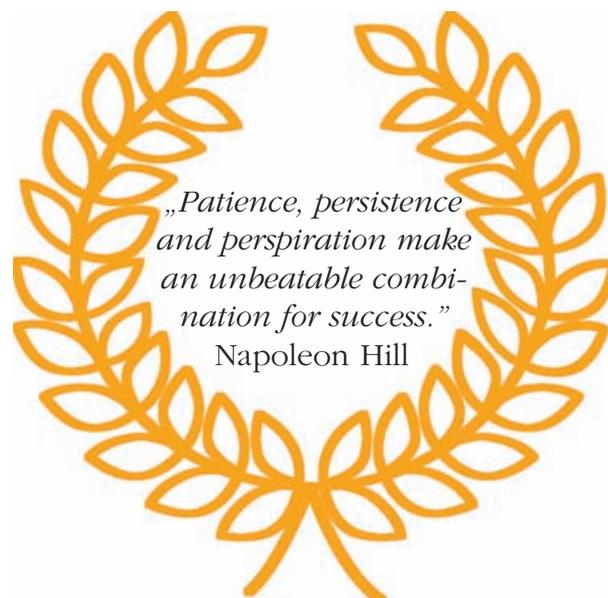
implement a business process framework, with the field of application and scope defined, it can choose the BABOK framework. Therefore, the criteria used in the comparative analysis assist the companies into assessing their needs against the business process frameworks to choose from.

In conclusion, the present paper outlines the BPM, CMMI and BABOK models, detailing their phases, focus and outcomes to provide an overview. The models are then compared according to different criteria and results are summarized.

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A New Technology to Research Consumer Behavior

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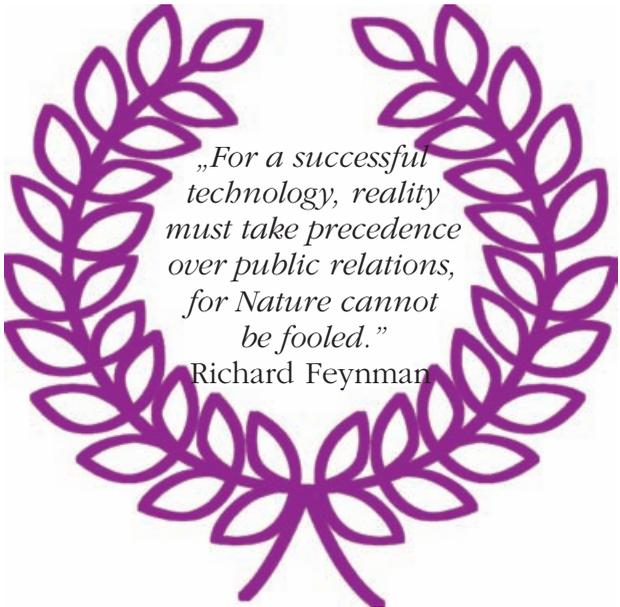
Abstract

The environment in which the consumer carries out his activities has changed considerably over previous years and is rapidly developing in a rapid manner due to the innovation and proliferation of the Internet. Customers have a formidable power, as they can get an unprecedented amount of information. Digital innovations such as social media platforms, complex operating phones, and storage of information on online servers have led to a high level of consumer understanding when it comes to searching, selecting and purchasing products. The purpose of this paper is to identify a behavioural pattern of the online consumer and to determine what elements of the actual conversion result. Based on the secondary research of online acquisitions, the results lead to a clear understanding of online consumer behavior and can provide companies in different areas with opportunities to design new strategies that will lead to customer satisfaction and loyalty in the online environment.

Keywords: online consumer, online consumer behavior, purchase decision, online acquisition

Introduction

A survey conducted in 2017 suggests that users with a positive attitude towards the purchase of products via the Internet use a large proportion of informational, impersonal sources and depend on the opinions of other consumers. There is a susceptibility to the purchase of goods due to social influence, and through the use of the Internet, it is proven that the main factor that causes an individual to turn to the online environment is the amount of information made available. According to Gallant, subjective knowledge positively influences the time spent on online searches



*„For a successful
technology, reality
must take precedence
over public relations,
for Nature cannot
be fooled.”*

Richard Feynman



using personal information sources (Gallant, 2014). Therefore, the main characteristics of the online consumer are determined by its connectivity, attention to detail, level of circumspection, the confidence that it acquires through the distribution of information, its expectations of personal interaction, the need to compare the products between them, the desire to interact with a receptive enterprise, the confidence he/she has in the targeted product reviews, and the power to manipulate the experience he/she desires through searches, explorations, and online distribution.

Analysis of Online Consumer Behaviour

As digital gains ground, customers have more and more expectations of online experience and business responsiveness. As a result of the research undertaken by the authors of the present paper, the following characteristics of the online consumer have been identified:

- Connectivity – to keep up-to-date information, customers carry out most of their daily online activities through computers, phones and tablets;
- Attention to detail – by comparing prices, reading reviews of products and searching for authentic materials;
- Caution – they are distrustful of the slightest sign of non-compliance with

the rules imposed on the market; According to WU, online consumers are becoming increasingly sceptical about traditional marketing, with confidence declining drastically in relation to television commercials (24% decrease), magazines (down 20%) and newspapers (a decline of 25 %). Less than 50% of customers remained confident in the commercials served by traditional marketing channels, while the digital promotion is increasing every day (Wu, 2016).

- The desire to share information – modern consumers can also be defined as being vocal, wanting to share experiences about the good or service consumed; With the growth of marketing channels and the number of social platforms, it has become normal for the views formed by the purchase of a product to be easily spread. Although for many businesses this may intimidate, at the same time a variety of opportunities for traders are emerging, harnessing consumers' opinions for the benefit of their businesses. According to Chawla, it has been estimated that this method of spreading information through customer communication generates sales sums that are twice as high as those invested in marketing campaigns (Chawla, 2015). Thus, investing in a digital system that allows the distribution of information becomes vital from the perspective of the rate of return on investment.

With the evolution of online communication, customers are more easily viewing different brand advertising campaigns, and the purchasing process of a product driven by online consumer behaviour can be described in three steps:

1. The first step is communication, where attention is focused on comments and reviews that indicate the best source of purchase. At this stage, the design of the site and the way it is organized is of major importance in order to determine the visitors to maintain their interest and then to buy the product.
2. The second step is the acquisition, in which it is decided which product is the preferred one by the customer according to the product range, the sales service, the quality of the products being the decisive factor in most cases.
3. The third step defines the behaviour of each consumer. Many of them become worried about the product you order and there is a desire to make a change or to return it. Therefore, the return service must be responsive and efficient.

The Internet has gained its status as a dynamic business platform, becoming more than a rich source of communication. With

its help, the complexity of the simple purchase act was defined. „Google” has become a generic term for „searching for information,” and the traditional purchase of goods by individuals took the form of a mix of stores, malls, television, the Internet and mobile shopping. Not only the developed Western and Asian countries but also those with poor infrastructure and low Internet penetration rates, choose to take on the practice of online purchases. An analysis of published online purchases shows that a wide range of topics has been explored and that there is no rich theoretical framework in the form of models. At present, the representative model for consumer behaviour is needed identification, information search, alternative evaluation, effective acquisition and post-acquisition assessment. In addition, the stages defined by the online consumer behaviour can be divided into setting the attitude, intent, adoption and continuation of online purchase. According to Criteo network data, in general, most consumers use search engines for the information search stage, but when it comes to purchasing a product, 60% of them say they prefer to start the process directly from sites retail (Figure 1).

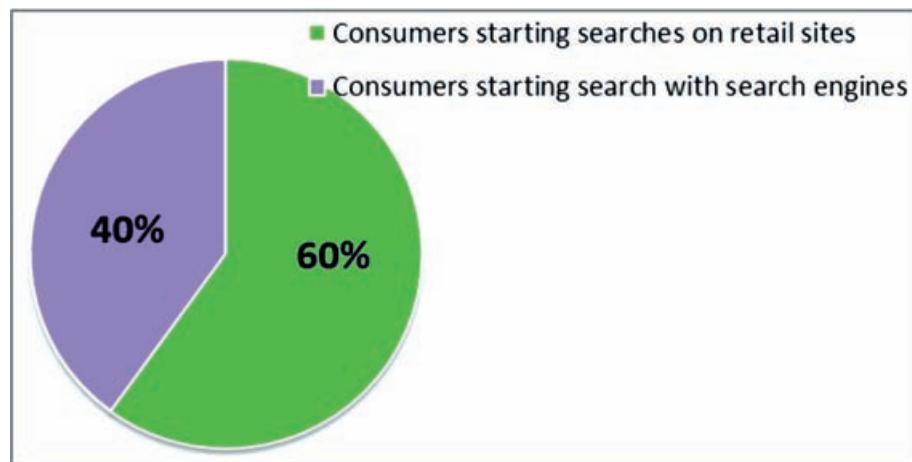


Figure 1 – *Ways to search for options by the consumer*

(Source: UK Criteo Online Shopper Survey, May 2016)

According to Criteo data, the number of retail sites shoppers browse is related to the product category (Table 1). Shoppers look over more sites for Electronics, Home and Furniture. Electronics have high consideration products that tend to have higher price points, so more shopping around.

Home and Furniture products are often a reflection of personal taste – and many also have higher price points. Health & Beauty and Apparel & Accessories, which typically have high brand intent, tend to be the category with most site-loyal browsers.

Table 1 – *Browsing habits across websites*

Product category	Interest growth percentage of users after navigating 2+ retail sites	Average visits made after browsing 2+ retail sites
Electronics	43%	3.0
Home	37%	3.1
Furniture	37%	3.1
Toys&Games	35%	2.8
Baby Care	31%	2.8
Apparel and accessories	25%	2.6
Health and beauty	22%	2.6

(Source: Criterion network data, March 2016)

Consumers can be segmented by the amount of focus they display regarding their purchases (Figure 2).

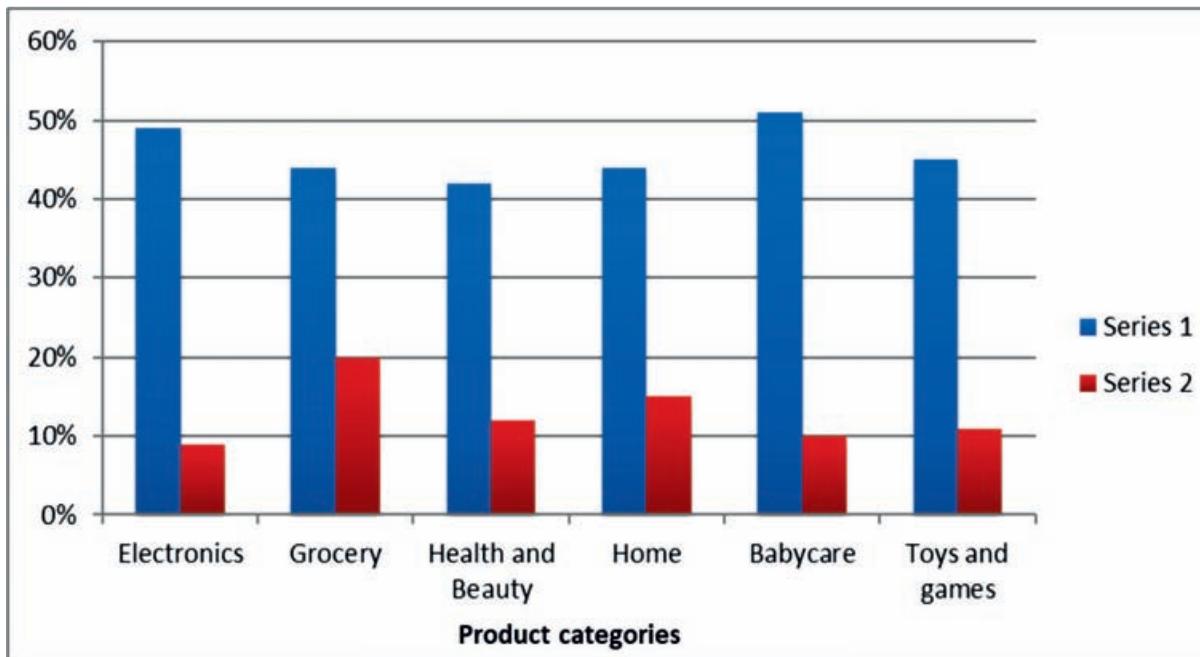


Figure 2 – *Browsing habits within websites*
 (Source: UK Criteo Online Shopper Survey, May 2016)



According to data from the Criteo survey, two – thirds of consumers on average (66%) say they have a specific product in mind and look for just that. Forty-one per cent of shoppers say they tend to browse different products on the same website to compare. A separate 13% on average is putting products into shopping carts without purchasing them right away, which they probably do as some sort of comparison shopping tool.

When you break this data down by category, Baby Care buyers are the ones most likely to browse for multiple products on the same site. The lifestyles of the young family bring many new types of products to households which these shopping patterns attest to. In categories like Food/Grocery, almost 20% of shoppers report putting products into their shopping carts without purchasing them right away. They are probably building their carts over time for a weekly or bi-weekly purchase.

Customer Satisfaction and Loyalty

The rapid growth of online transactions in the service industry has helped shape out questions about levels of satisfaction and loyalty in the online environment and the relationship between online satisfaction and loyalty. With as many customers as possible from traditional shopping to

online shopping, there is a steadily rising rate of online retailers on the Romanian market, becoming a major challenge for SME managers to attract new customers, turning them at the same time loyal customers. The more access to information and once a buying experience, the Romanians' online shopping habits are evolving. The new generation of young people is more familiar with online technology, with more experience in using the internet and is more willing to face perceived risks.

In the international context of the digital communication era, online commerce has become an important part of business systems. It is a business model that has a major impact on the whole of society. According to Celuch, once the Internet has become a tool used for communications, promotion and transactions, new platforms for competitive strategies have been developed (Celuch, 2007). E-commerce includes any form of commercial transaction in which the parties interact in a digital environment. The most important contribution made by e-commerce was the creation of new distribution channels. Retail companies are currently benefiting from these opportunities to interact with consumers around the world, with lower costs.

The reasons for the online purchase, according to Richard et Charlesworth, can be justified by the plethora of offers and benefits for this type of shopping: accessibility without time or space restrictions, the convenience of services, product selection, better bids resulting from searches products and price comparisons (Richard et Charlesworth, 2007). One of the most important reasons behind the customer's determination to adopt online purchase is the convenience of the purchase process. Jiang's study (2013) investigated the convenience of online shopping and identified

important dimensions such as convenience of access, the convenience of searching, convenience assessment, the convenience of the transaction, possession/convenience of the post-acquisition stage. This research also shows a positive correlation between the convenience of online shopping and the intention to repeat the online acquisition process: „the more perceived comfort in the search process, the transaction and the possession/convenience of the post-acquisition stage, the greater is the opportunity to make another purchase and to be recommended by a customer” (Jiang, 2013, p. 207). Customers who buy via the internet mention the advantage of lowering sales costs. When users choose a particular website, the e-services, branding and reputation of online merchants are criteria for making the purchase decision.

Online buyers are determined to remain loyal due to two attachments based on the desire to purchase and the desire to have a personalized good. Online loyalty can be defined, according to Anderson and Srinivasan, as a „consumer friendly attitude towards online businesses, reflected in a defined purchase behaviour” (Anderson et Srinivasan, 2003, p. 125) or the subjective probability that a client to make a purchase on the same site in the near future. Although marketing theories and consumer psychology support the existence of four dimensions of loyalty, most studies deal with behavioural or attitude issues. Only a few of these studies suggest behavioural cognitive, affective and behavioural behaviour patterns, less applied in online sales research in Romania. Limbu et Hashemi argues that online loyalty is approached in most cases as a one-dimensional construction (Limbu, 2011; Hashemi, 2013) and, more rarely, as a two-dimensional one. Harris and Goode have proposed a sequential loyalty

model, taking into account satisfaction, trust, perceived value and quality of service as determinants. Repeated online purchase intent refers to the reason why an online customer finally chooses certain sites and is defined as „the consumer’s desire to make repeated purchases within a site” (Blanchard, 2011). Blanchard’s research (2011) highlighted that online purchasing intentions are influenced by the following variables: interest, personalized information, perceived interactivity, consumer satisfaction and consumer attitudes.

Each organization allocates resources and time to identify and understand the characteristics of customers and their needs. It is a beneficial reaction to the company when consumers’ wishes, and expectations have been met or exceeded during the service experience. Most retailers are trying to gain a competitive advantage by considering customer responses and trying to overcome the situation where the consumer is „only content” and to reach the situation where „overcoming expectations” is achieved. It is expected that customer



satisfaction will be achieved when the value of the service provided meets or exceeds consumers' expectations. A consequence of a customer's dissatisfaction may be that the service provider may be susceptible to attacks by competitors who are pre-

pared to provide customers with a higher value.

Long-term customer satisfaction represented by a Venn chart can be useful to companies in designing an effective marketing strategy (Figure 3).

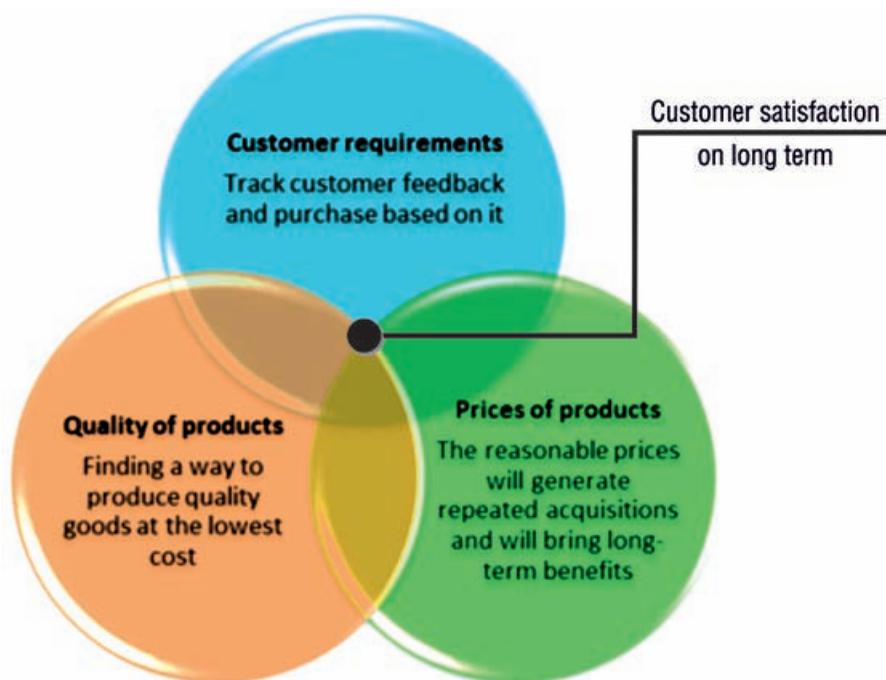


Figure 3 – *Venn Diagram of Customer Long-Term Satisfaction*

(Sursa: Customer Satisfaction Venn Chart Template, 2018)

Thus, online loyalty can be maintained by paying attention to existing customers and implementing loyalty programs, understanding the difference between reward for purchases and reward for loyalty. The first step in retaining a customer can be simply thanked for the purchase, followed by requesting permission to return with information about new products or offers. The third step is to define the behavioural characteristics of the client, followed by providing an incentive that constantly generates conversions. Social platforms are heavily used to interact and increase consumer confidence in a brand, helping customer retention rates. Palconi asserts in

2012 that the successful business relationship lies between the company and the client (Palconi, 2012).

Conclusions

- Online shopping has become an integral part of consumers' daily habits.
- The objectives of the companies, in terms of customers and online purchasing behaviour, are to establish confidence in online navigation and shopping, as trust leads to changing customer attitudes, which in turn influences the online acquisition intention. One of the most important issues omitted

by a considerable number of traders is to maintain the interest of existing customers to create the possibility of a repeat purchase.

- Although customer preferences and trends are constantly changing, the almost instinctive reactions that underlie their behaviour remain unchanged. The desire to consume, seek, compare and obtain the ideal product will remain the same. The marketing team/team should be informed about the theoretical basis of consumer behaviour and take into account new trends in order to have a clear picture of how the activity and performance level of the company will be affected, which they are targeting.
- In a global economy developed within a highly competitive market, consumer orientation is no longer a trend, but a necessity for business success.

- Consumer online behaviour is still an intriguing topic for researchers and business.
- As for the preferences of online buyers, Romanians mostly buy electronic products, video games, clothing, beauty and personal care products.
- Consumers are increasingly blind to banners and rejecting them – especially on mobile devices. Native product ads built on consumer relevance data are your best opportunity for driving sales and enticing consumers with a format that engages rather than annoys.
- Brands should ensure that product descriptions in terms of dimensions, fabrications, use and care are as complete as possible. Retailers should encourage their most loyal customers to write reviews and make them as visible as possible.

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Customers' Perception of Telecommunication Services

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Abstract

Customers' Perception of telecommunication companies is an important factor for service providers to enhance their services and seek advantages in a competitive market to gain customers' trust and loyalty. This paper represents a study of customer's perception for the three leading Mobile Service Providers „Zain”, „Ooredoo” and „Viva” in Kuwait's telecommunication market. Statistical analysis was done, using MINITAB and SPSS Software, to show the distribution of customers for the three mobile service providers and to form an idea about the perception of customers for the three providers. Different statistical techniques have been used and the results showed that Zain leads the market for the Network Quality, Viva has more advantage in customer service, and Ooredoo offers more services for customers. In addition, we have found that Age has a significant effect of which younger people prefer to use Viva, Gender, as well as the interaction between Gender and Age, has no significant effect on choosing the Mobile Service Provider, which gives an indication for the Mobile service providers about their targeted group age of customers.

Keywords: mobile service providers, customers' perception, network quality, value for money, customer services



Introduction

Improving telecommunication services start from knowing customers' need and their perception for the provided service. Customers are the hearts of any industry and Customers' evaluation of current services helps Mobile Service Providers to get a clear idea about the area they have to work on, to increase the level of satisfaction of customers and hence improve customers' retention and loyalty. „Nowadays, the Kuwait telecom industry is relatively mature and advanced, with high penetration rates and per spending capita” (Monteiro, 2011).

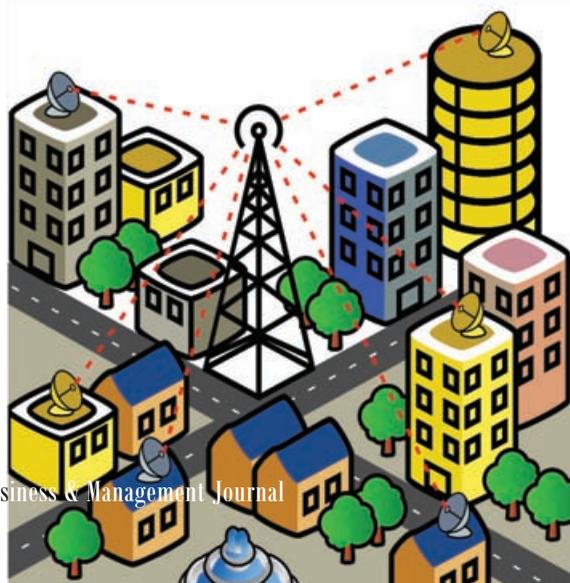
„The network quality has the highest impact on customer satisfaction and Yemeni telecom mobile companies must consider about superior network quality as perceived service quality from customers to judge the quality of services in telecom mobile network.” (Al-Hashedi, Abkar, 2017). „The higher or lower satisfaction of a consumer will depend upon the quality of brand characteristics that offered by a company” (Gerpott, Rams, Schindler, 2001). „Price is also determined by what a buyer is willing to pay, a seller is willing to accept and the competition is allowing to be charged. Price is the key element for customer satisfaction. A good price is a major

contributor to satisfaction.” (Khan, Ashfeen, 2012).

„Customer services impact customer satisfaction regarding any service provider. The customer services staff should be good enough to handle the customers' complaint regarding any service” (Popli and Madan, 2013). „The duties of the customer service staff is to clearly communicate with customers, to manage their problems regarding product or service, to transfer the appropriate information, to analyze the customer need and wants, to inform about new offerings, and to manage the length of the call. Handling customer-complaint effectively leads to customer satisfaction” (Khan, Ashfeen, 2012).

In this study, we tried to get an evaluation of Network Quality, Internet Quality, Reliability, Value for money and the wide range of services offered. Moreover, we studied the effect of Gender and Age on customers when choosing their main mobile service provider.

A representative sample of 2500 Kuwait telecommunication customers was selected and data were collected based on face-to-face interviews from customers of the three leading telecommunication companies „Zain”, „Ooredoo” and „Viva” of Kuwait. SPSS and MINITAB statistical software have been used to represent and analyze the collected data. Different statistical techniques have been applied in this study such as descriptive statistics to summarize the customers' demographic as well as customers' evaluation to make easier to analyze and interpret. Chi-square test of association was used to check whether Gender and Mobile Service Provider are associated with each other, Analysis of Variance (ANOVA), including post-hoc analysis, was used to test whether the mean age of customers differs from each other and whether



the group age could be classified into categories with respect to the mobile service provider. Moreover, Analysis of Covariance (ANCOVA) was used to test whether the interaction between Age and Gender has an effect on the Mobile service provider, as one can check the effect of each variable separately and then study the effect of their interaction.

Results and Discussions

Demographic and Customers' Perception. „The analyses appropriate for single-

categorical-variable data almost all involve proportions of the various categories that comprise the variable. These proportions are often pictures in a pie chart but simple tables are good or bar charts” (Deakin n.d.).

As a general overview, the majority of mobile customers are in the group age of 25 to 34 years with a 41% followed by 26% to the group age 35 to 44 then 19% for the group age 15 to 24 and only 14 % for those whose age is at least 45 (Table 1). Histogram for Age of customers is presented in Figure 1.

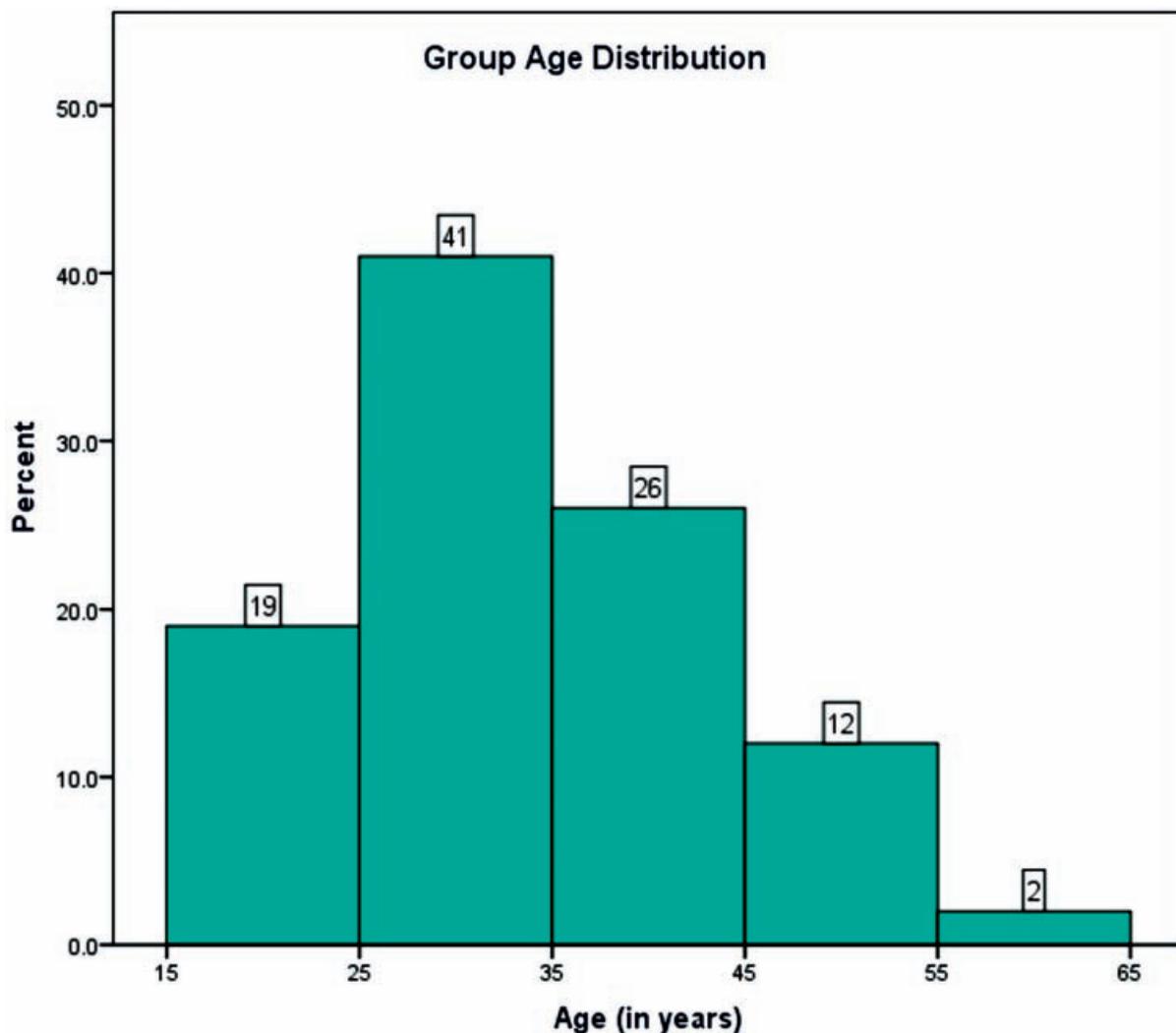


Figure 1 – Distributin of age group

Table 1 – Age group distribution

Age Group	Percent
[15-25]	19%
[25-35]	41%
[35-45]	26%
[45-55]	12%
[55-...]	2%

Telecommunication customers in Kuwait are subscribed in one or more than one of the following three Mobile Service Providers: Zain, Ooredoo and Viva. When we asked the customers about their Main Mobile Service Provider, that is, the one that you make most of your calls through (Figure 2), showed that „Zain” has the highest number of subscribers with 37%, followed by Ooredoo (35%), then Viva (28%).

Subscribers of Mobile Service Providers in Kuwait

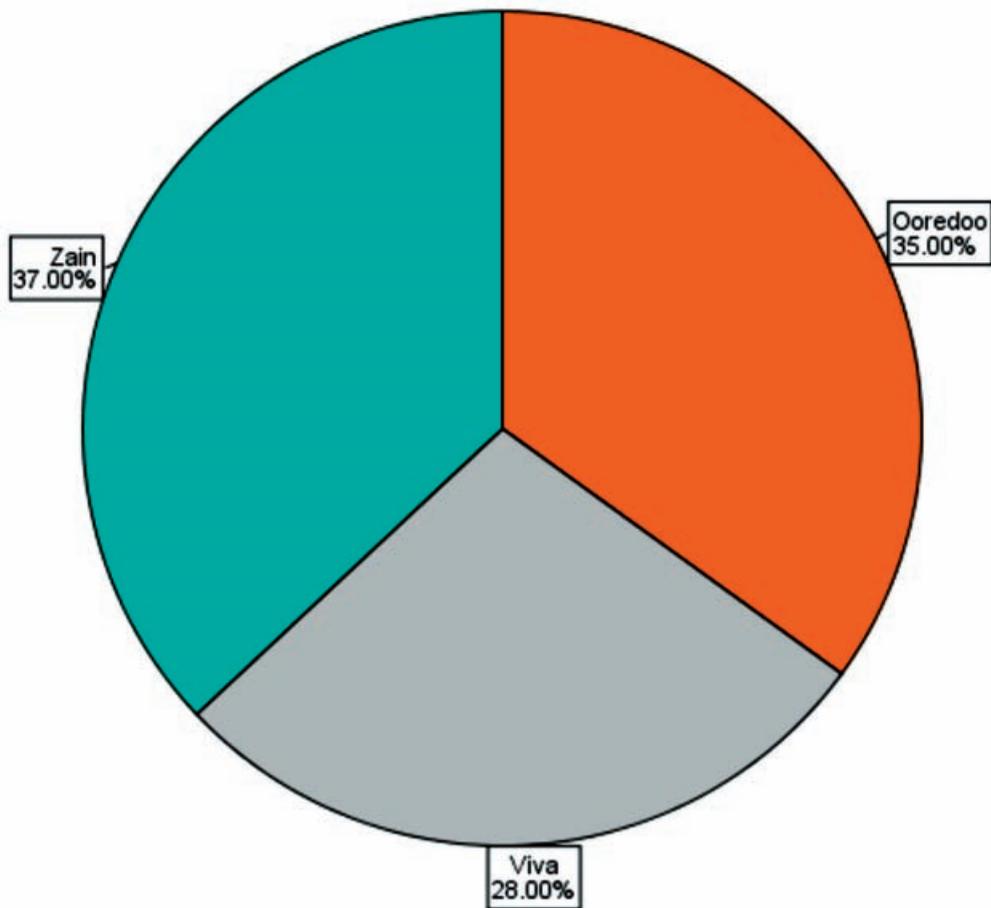


Figure 2 – Distribution of telecommunication customers

We can also conclude (Figure 3), the chart that the distribution of customers on the different group ages is the same for the three companies. However, the percentage

of customers in each group is almost similar for the three companies except for the group age 45-54 where Zain has double customers than Viva.

Customers' distribution of each MSP across Age Group

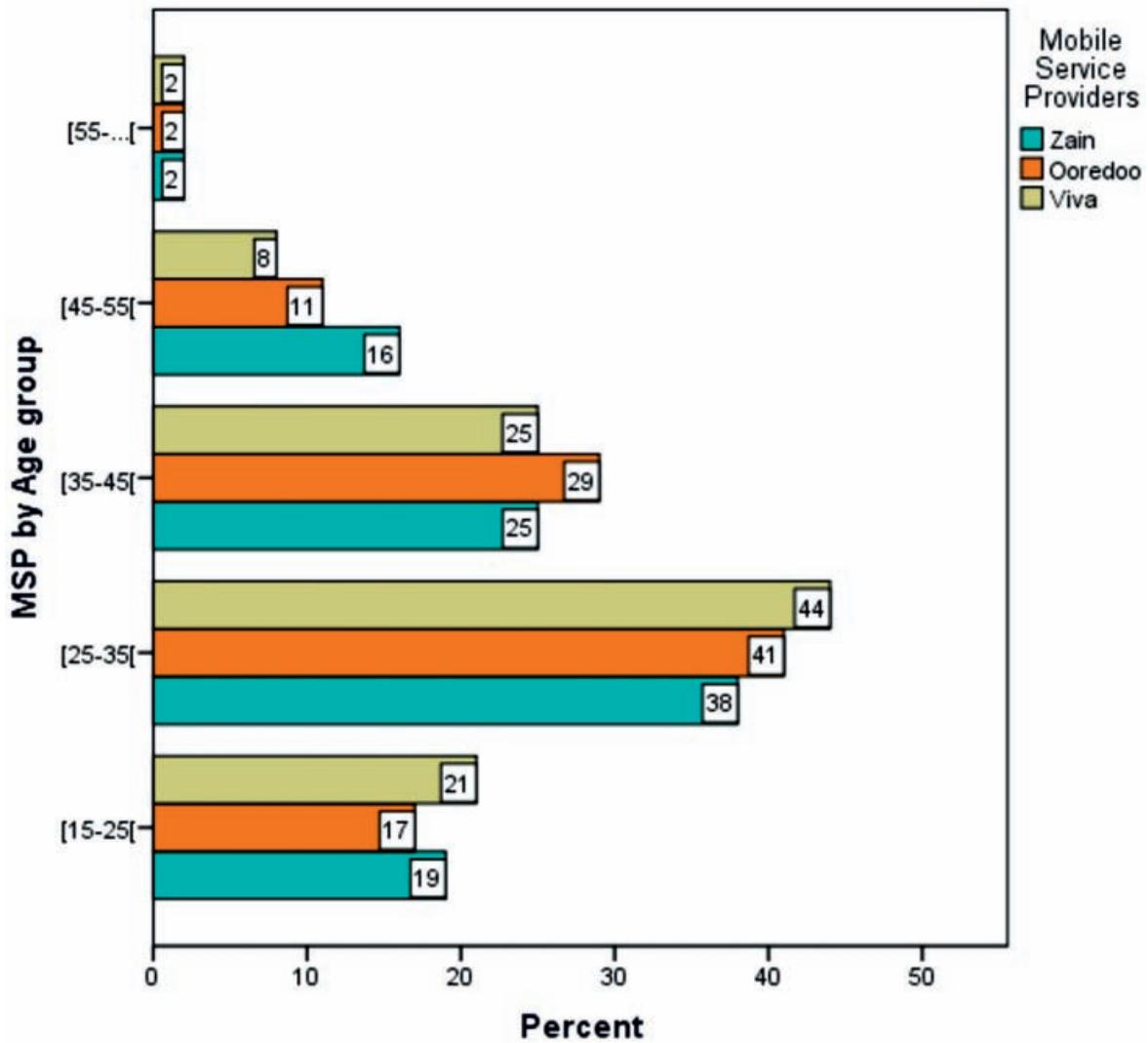


Figure 3 – Distribution per age of customers



The results in Figure 4 show that 39% of customers believe that Zain has the best Network Quality, followed by 30% and 31%, for Ooredoo and Viva respec-

tively. As for Internet Quality, we can see from Figure 5 that 36% of customers support Zain, 35% supports Ooredoo and only 29% is for Viva.

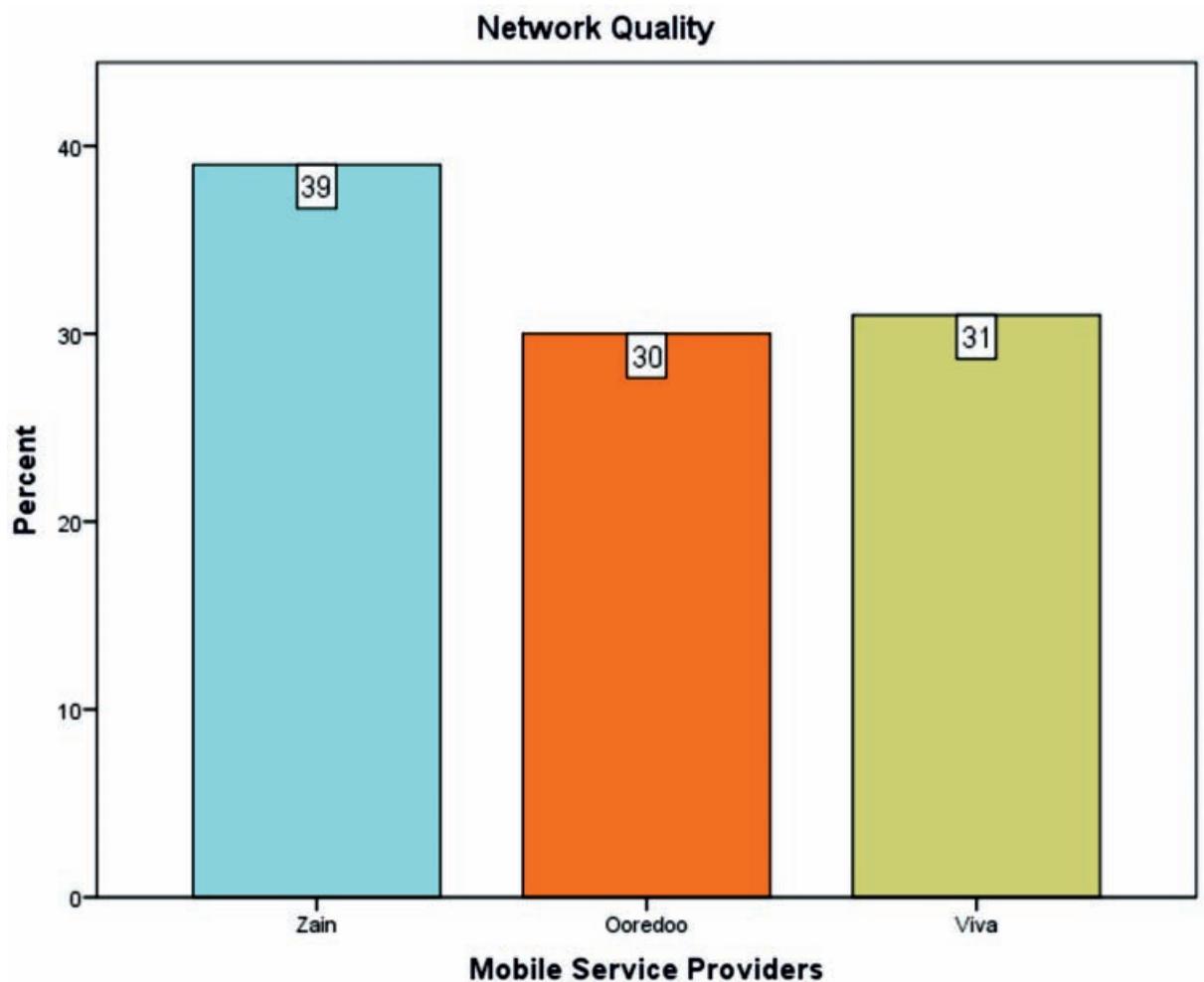


Figure 4 – *Customers' perception of network quality*

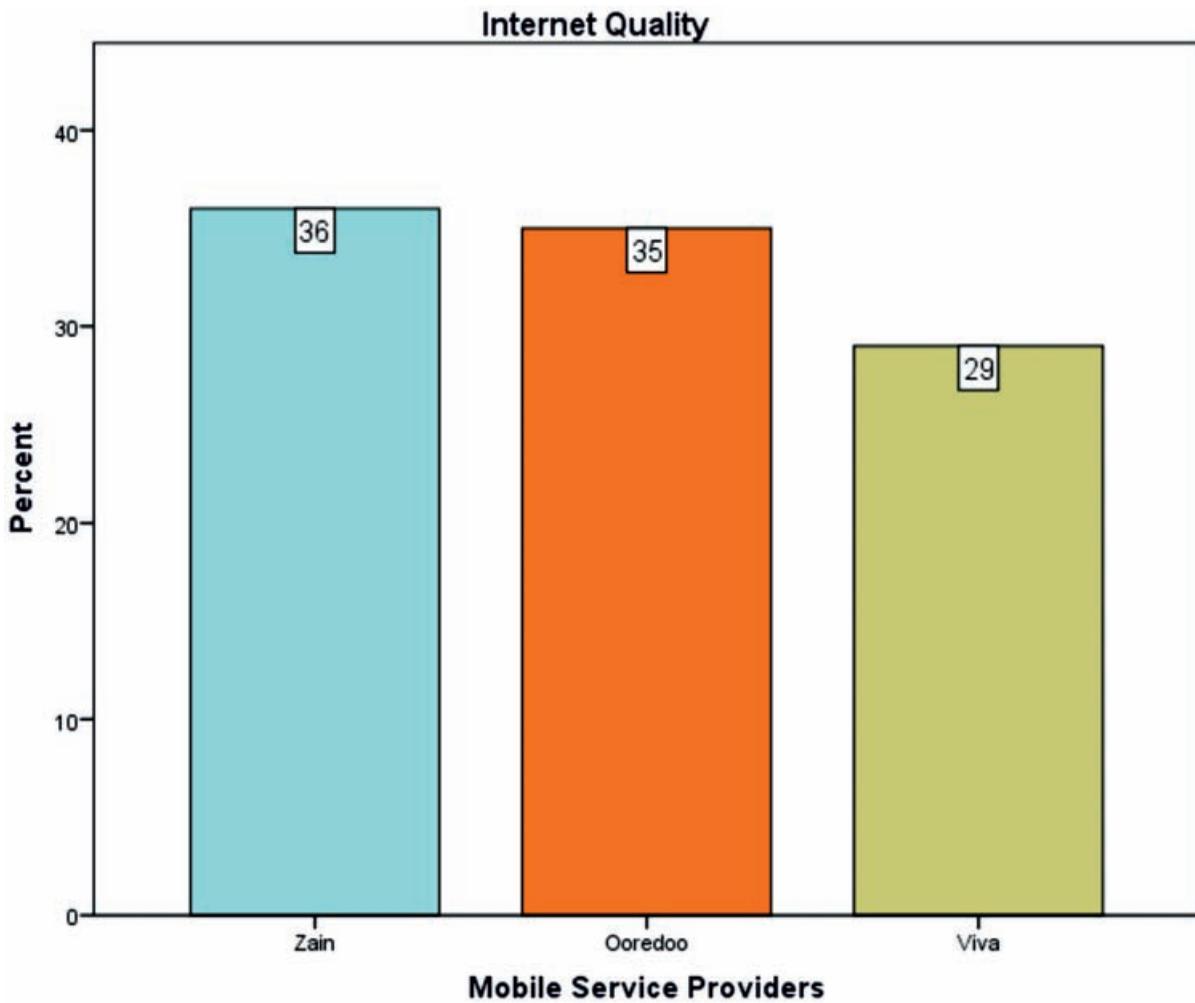


Figure 5 – Customers' perception of internet quality

Figure 6 represent the percentages that were given by customers when evaluating the customer service department of the three mobile service providers, we can see

that 35% of customers stated that VIVA has the best customer service, 33% said that Zain has the best customer service and 32% for Ooredoo.

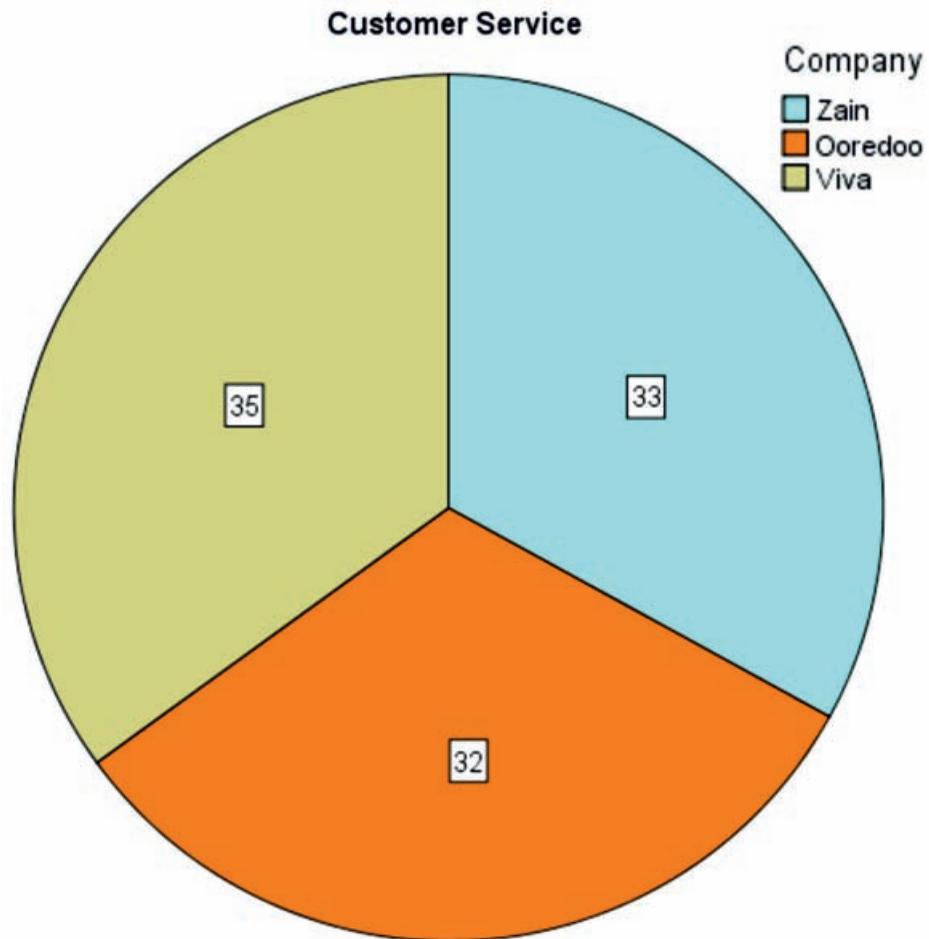


Figure 6 – Customers’ perception of customers service department

This will also tell us that customers are more familiar with the customer service offered by Viva, noting that there is not much difference between the rate given to Viva and that for Zain and Ooredoo. Hence, this is another point to be considered by these companies to enhance and get advantages on their competitors. Telecommunication customers in Kuwait consider Zain as the most reliable mobile service provider as shown in Table 2.

Table 2 – Customers’ perception

	Most reliable	A wide range of services?	Best Value for money
Zain	37%	37%	32%
Ooredoo	33%	38%	34%
Viva	30%	25%	34%

In addition, the result shows that Ooredoo leads the market for the wide ranges of services that fit customers’ needs. As for the best value for money, customers consider Ooredoo and Viva as best mobile

service providers and consider it better than Zain, even though 32% of customers have said that Zain has the best value of money.

Effect of Age and Gender on Mobile Service Provider. Analysis of variance (ANOVA) provides a statistical test of whether or not the means of three or more groups are equal, and therefore generalize the t-test to more than two groups

(Durivage, 2015). In this study, ANOVA was used to test whether the mean age of the Mobile Service Providers are significantly different from each other, as this will help the company to know more about their targeted customers. The results of ANOVA (Table 3) showed that the model is significant and so the mean age of customers is not the same in the three Mobile Service Providers.

Table 3 – ANOVA result for the age of customers

ANOVA					
Age					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1451.832	2	725.916	7.013	.001
Within Groups	258457.600	2497	103.507		
Total	259909.432	2499			

A Post-Hoc analysis (Table 4) was carried to test the homogeneous Subset using „Tukey B” test, results showed that data could be classified into two categories one for Viva and the other for Zain and Ooredoo. This means that young customers prefer Viva Mobile Service Provider.

Table 4 – Post-Hoc analysis to categorize companies according to age

Tukey B			
MSP	N	Subset for alpha = 0.05	
		1	2
Viva	700	32.13	
Ooredoo	875		33.64
Zain	925		33.96

Means for groups in homogeneous subsets are displayed.

The best test to be used in order to determine whether there is an association between two categorical variables is to apply the Chi-square test. Table 5 shows the result of the Chi-square test of asso-

ciation between Gender and Mobile Service Providers. The test sig. is 0.152 and so there is no association between gender and Mobile Service Provider, that is, Gender does not influence the Selection of the Mobile Service Provider.

Table 5 – Chi-Square test of association between gender and mobile service provider

Pearson Chi-Square Tests		
		MSP
Gender	Chi-square	3.769
	df	2
	Sig.	.152

Because Age is significant and Gender is not, we may apply the Analysis of Covariance (ANCOVA) to check whether their interaction has an effect on Mobile Service Provider. „ANCOVA always involves at least three variables: an independent variable,

a dependent variable, and a covariate. The covariate is simply a variable likely to be correlated with the dependent variable” (Huitema, 2011).

Table 6 represents the result of ANCOVA which shows that the model is significant,

Age has a significant effect but Gender and its interaction are not significant, that is we cannot conclude, as an example, that old female customers prefer Zain Mobile Service Provider.

Table 6 – ANCOVA results for studying the effect of the interaction between age and gender

Tests of Between-Subjects Effects

Dependent Variable: Age

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1458.600	5	291.720	2.815	.015
Intercept	1710691.570	1	1710691.570	16507.839	.000
Mobile Service Provider	844.969	2	422.484	4.077	.017
Gender	.179	1	.179	.002	.967
Mobile Service Provider * Gender	6.733	2	3.367	.032	.968
Error	258450.832	2494	103.629		
Total	3038065.000	2500			
Corrected Total	259909.432	2499			



Conclusion

The study was aimed to show customers' evaluation of Kuwait Mobile Service Providers. A demographic study showed that customers consist of 63% male and 37% female and that 41% of customers' age ranges between 25 and 35 years. Zain has the highest number of subscribers followed by Ooredoo then Viva.

As for Customers' evaluation, Zain has the best Network and Internet Quality as well as the most reliable company; whereas Ooredoo is considered number one for having a wide range of services that fit customers' needs. Viva has more advantages on the other companies for customer service and all three companies are very close to each other for the best value for money with a note that customers are considered Zain more expensive than other companies.

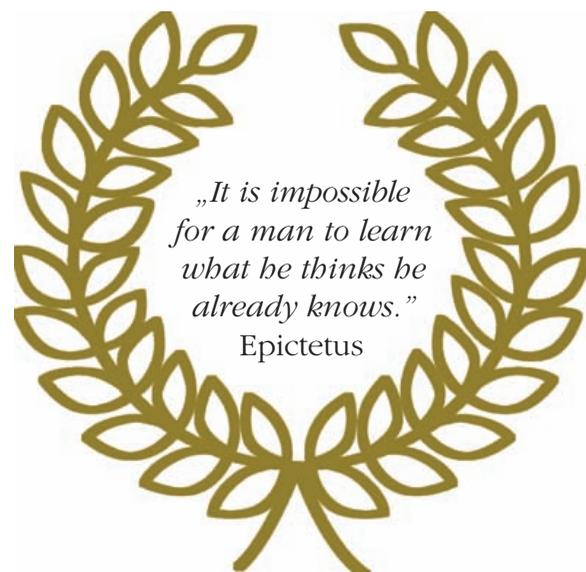
In addition, ANOVA and Post-Hoc techniques were used for Age and Mobile Service Provider; the result showed that younger customer would prefer Viva on Zain or Ooredoo. This could be for a reason that young people more care about customer service and value for money, while older people think more about the quality and range of services offered. Also, A chi-square test of association was used to check if there is no association between Gender and Mobile Service Provider and the result supported the claim and hence Gender does not have an effect on Mobile Service Provider. Moreover, ANCOVA was used to check the interaction of Age and Gender for Mobile Service Provider, which is to check whether the gender of any group age has an influence on the Mobile Service Provider, but the result obtained stated that the interaction has no effect too.

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The Gaps Between Expectations and Perceptions on Services Quality

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Abstract

The paper examines the relationship between what the organization believes it does and its customers' perception regarding gas installations design and execution services. The study is based on a SERVQUAL questionnaire research conducted among employees and customers of the organization Corola SRL. The research results show that the existing gaps between what the organization does and what the customers believe occur due to: a large number of hierarchical levels (gap 1), the insufficient management involvement in ensuring service quality (gap 2), the inadequate quality control system (gap 3), the deficiencies in communicating with the outside (gap 4). The study reveals the gaps that occurred in the gas installations design and execution field due to the fact that many apartment owners have given up the centralized heating system in favour of individual heating systems.

Keywords: quality service, customer satisfaction, SERVQUAL questionnaire

Introduction

Measuring the quality of a service can be a very difficult process. For tangible products, the customer evaluates only the final result, but as far as services are concerned, the client is able to analyze both the service delivery process and the result (Militaru, 2010). To please a customer includes replying to his expressed requirements and at the same time anticipating and satisfying his expectations about the analyzed product/service. For most types of services, customers' expectations are more numerous compared to their expressed requirements, thus having a dominant influence on customer satisfaction. Most of these



expectations differ from what a customer may express when buying a product. Therefore, when speaking of services, the concept of *quality dimensions* must be associated with customer expectations (Constantinescu, 2005).

A useful tool in analyzing customer satisfaction, well known in the services field, is the SERVQUAL questionnaire, proposed by Zeithaml, Parasuraman and Berry (1988). SERVQUAL is a complex instrument – be-

sides for evaluating customers' expectations and perceptions regarding the service, it may be used in order to improve an organization's activity or to compare the activity of different organizations. The SERVQUAL questionnaire (Yousapronpaiboon, 2014), is based on five dimensions of service quality: tangibles, reliability, responsiveness, assurance and empathy (Table 1).

Table 1 – *Definitions of SERVQUAL model's dimensions*

Dimensions	Definition / Description
Tangibles	physical facilities, equipment, staff appearance, etc
Reliability	ability to perform the service dependably and accurately
Responsiveness	willingness to help and respond to customer need
Assurance	the staff's ability to inspire confidence and trust
Empathy	the extent to which caring individualized service is given

(Source: Gibbson, 2009)

As an assessment instrument for a service's customer satisfaction, the SERVQUAL questionnaire has been successfully applied in a variety of field: higher education (Yousapronpaiboon, 2014), (Ulewicz, 2014), airlines service (Basfirinci, Mitra, 2015), certification & inspection industry (Liu *et al.*, 2015), logistics sector (Roslana *et al.*, 2015), public healthcare services (Purcarea, 2011), commercial banks (Rahaman *et al.*, 2011), social work organization (Rahaman, 2011), automobile retails (Yan, McLaren, 2010), on-line public services (Badulescu, 2008), etc.

Methodology

Corola is a small and medium enterprise (SME), established in 1993, with a broad field of activity. Since 2000, the company provides the following services: gas installations, heating and air conditioning

installations, electrical and plumbing installations (Corola Instal, 2015).

Corolla conducted research in order to identify what customers' expectations it does not respond. Customer satisfaction regarding gas installations design and execution service was evaluated. The study had two parts.

In the first part, the differences between what Corola expects and what customers perceive were identified. For this purpose, SERVQUAL questionnaires were administered to customers before and after receiving the service. In the second part, the differences between expectations and perceptions on service quality were determined in the company's management, employees and customers.

Customers' Expectations versus Customers' Perceptions. The SERVQUAL questionnaire consists of two parts. The first section,

composed of 22 statements, allows recording the specific expectations of performant companies (SERVQUAL questionnaire type A). The second section, also including 22 statements, measures the consumers' perception of the provided services (SERVQUAL questionnaire type P). Whether used for researching consumers' expectations or for evaluating their perception, the questionnaires included questions related to all service quality dimensions – see Table 2.

Table 2 – *Grouping of the questions*

Dimensions	Items
Tangibles	1 – 4
Reliability	5 – 9
Responsiveness	10 – 13
Assurance	14 – 17
Empathy	18 – 22

Table 3 – *The grading scale in the SERVQUAL questionnaire*

1	2	3	4	5	6	7
Mediocre	Weak	Little	Satisfactory	Good	Very good	Excellent

(Source: Ulewicz, 2014)

The sample size was determined by statistical methods in order to represent as clearly as possible, on a smaller scale, the entire population's characteristics. The population taken into account consisted of 170 individual customers who have benefited from „gas installations design and execution” services in the past year. For a confidence level of 95% and a confidence interval of $\pm 15\%$, 34 subjects were the resulting sample size.

The SERVQUAL score calculation required by taking several steps. The first step meant determining the average value for each statement in the questionnaire. The second step was to determine, for the entire customer sample and for each dimension

For each statement, the respondents were asked to give a mark from 1 and 7. If the customer believes that a feature is essential for the service quality, he will grant the maximum grade 7 („excellent”). If he thinks a feature is not relevant for the quality of that service, he will grant the minimum grade 1 („mediocre”). The value 4 is an average, and all the other marks are intermediate values, getting closer to the minimum or to the maximum (Table 3).

In order to collect information about customers' expectations for the research, the SERVQUAL (A) questionnaires were applied before providing the gas installations design and execution service. After providing the service, the customers filled in the SERVQUAL (P) questionnaires, which offered data on the perceived quality of the analysed service.

of service quality, the perceived and expected average values. The next phase included setting the final scores for each quality dimension by calculating the difference between the received average values and the expected average values (Yan, *et al.*, 2010). The score of service was appreciated for each quality dimension by calculating the difference between the received average values and the expected average values. Thus, the discrepancy amplitude for the five quality dimensions was obtained. The larger the gap, the lower the quality of the provided service, and the smaller the gap, the higher the quality of the service.



Service Quality Gaps. Poor quality causes for „gas installations design and execution” services were determined by using the conceptual model of service quality (Figure 1). The model shown in Figure 1 is based on the discrepancy’s analysis between expectations and perceptions on service quality from management, employees and customers. The difference between customer expectations and perceptions about service quality (gap 5) depends on four gaps, called Gap 1, Gap 2, Gap 3 and Gap 4:

$$\text{Gap5} = f(\text{Gap1}, \text{Gap2}, \text{Gap3}, \text{Gap4}) \quad (1)$$

Thus, before the company may reduce the discrepancy between the expected and the perceived service, it must first diminish the four types of discrepancies (gaps).

Gap 1. Consumer expectation – management perception, represents the difference between consumer expectations, after service delivery, and management expectations about what the clients want. Often, managers think they know what their customers want, but in many cases they are wrong. In some cases, the company may provide services that customers do not really want, while not providing other desired ones. In order to de-

termine the possible causes for discrepancies between customer expectations and management perception (gap 1), the four managers of Corola SRL filled out a standard questionnaire, part of the SERVQUAL methodology, intitled „Questionnaire for identifying causes for gaps 1 and 2 (A)”. For this specific gap, the managers needed to respond only the first nine questions, assigning marks from 1 and to 7 to each of them. Based on the marks, the SERVQUAL score was calculated, then the average score for each question and the average grade for each group of questions. Finally, the results were centralized and put in order.

Gap 2. Service quality specification is the difference between what the company’s management believes that consumers want and the set of specifications, procedures, rules or standards regarding the quality of the provided service. To measure the possible causes of the discrepancy between management perception and service quality specifications (gap 2) the same four managers at Corola SRL responded questions 10 to 20 of the same „Questionnaire for identifying causes for gaps 1 and 2 (A)”. Managers also assigned marks between 1 and to 7 for each question and the same steps were taken as for Gap 1.

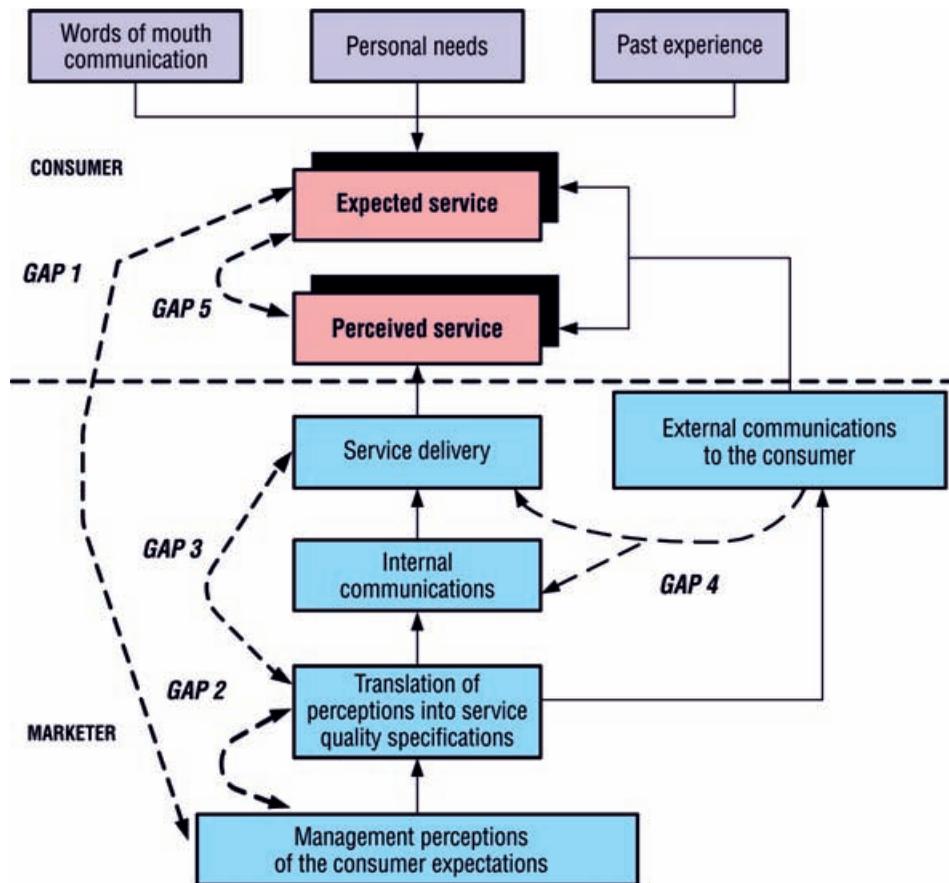


Figure 1 – *The conceptual structure of the service quality gap model*

(Source: Krishna 2010)

Gap 3. Service delivery highlights the possible differences between the set of specifications or standards regarding service quality and the actual quality of the provided service. In other words, this gap „verifies” whether the staff manages to provide the service as they were trained. To determine the possible causes of this discrepancy, the part of the staff in direct contact with the customers of the company completed the „Questionnaire for identifying causes for gaps 3 and 4 (B)”, another part of the SERVQUAL methodology. The 12 employees in permanent contact with customers responded questions 1 to 24, giving marks between 1 and 7. The results were calculated and ranked.

Gap 4. External communication gap shows any difference between the final quality of the provided service and the service quality as presented in the company’s external communications, brochures and media advertisements. The possible causes for Gap 4 were determined by analysing the responses of the staff dealing directly with customers to questions 25 to 30 in the „Questionnaire for identifying causes for gaps 3 and 4 (B)”.

Results and Discussions

Customers’ Expectations versus Customers’ Perceptions. The processing of data obtained from the SERVQUAL (A) and

SERVQUAL (P) questionnaires answered by the selected Corola customers have led to the results shown in Table 4.

Table 4 – Gaps

Dimension	Yp – Ya		Interpretation	
	Formula	Scores		
Tangibles	$Y_{Tp} - Y_{Ta}$	$5,63 - 5,65 = -0,02$	≈ 0	The perceived quality of service in terms of tangibility is the one expected
Reliability	$Y_{Relp} - Y_{Rela}$	$4,49 - 6,50 = -2,01$	< 0	The perceived quality of service in terms of reliability is below the expected level
Responsiveness	$Y_{Resp} - Y_{Resa}$	$4,43 - 6,01 = -01,58$	< 0	The perceived quality of service in terms of responsiveness is below the expected level
Assurance	$Y_{Ap} - Y_{Aa}$	$4,07 - 5,91 = -1,84$	< 0	The perceived quality of service in terms of assurance is below the expected level
Empathy	$Y_{Ep} - Y_{Ea}$	$5,87 - 5,66 = 0,21$	> 0	The perceived quality of service in terms of quality of empathy is higher than the expected quality

The positive value of the empathy dimension indicates the perceived quality is higher than the expected one. This shows that Corola understands its customers' needs and makes sure that its services are accessible to customers. The value zero for the tangibility dimension means that the company's performance meets customers' expectations. On the other hand, negative values were obtained for the quality

dimensions of reliability, responsiveness and assurance. These results indicate problems regarding financial risk and privacy. This means that either the company has not made a commitment to provide the service or its employees lack enthusiasm when providing it. In other words, the clients feel that the company's employees do not show availability and/or promptness when they come in contact with them or when providing the service.

Service Quality Gaps. The second part of the research, the one identifying gaps between customer expectations and customer perceptions on „gas installations design and execution” service quality, has led to the following results. The analysis of Gap 1 shows that the key factors accountable for discrepancies between management perception and customer requirements and expectations are: marketing research orientation, communication and management levels structure (Figure 2).



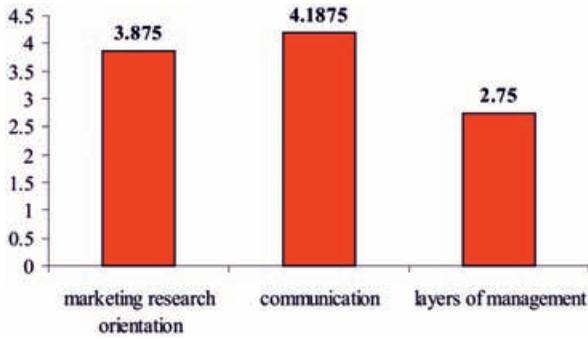


Figure 2 – Causes for gap 1



Figure 3 – Causes for gap 2

The highest score for „communication” shows there is adequate communication between the managers and the staff that interacts with customers. The lowest score (2.75) for „levels of management” highlights the existence of problems in this domain. A possible solution would be a reduction of hierarchical levels between managers and the staff interacting with customers.

The research results have allowed the organization to identify the key factors because of which the management’s perception on service quality specifications was not as expected (gap 2): management commitment to quality, setting goals, standardization of work tasks, feasibility perception on service quality (Figure 3).

Studying received scores of four possible causes for Gap 2 revealed that standardization work tasks are done appro-

priately (5.625), but that there are problems regarding target setting and management commitment to service quality, the factors which obtained the lowest scores, of 3.875 and 3.625 respectively. Figure 4 shows the key factors because of which the service quality specifications were not met by the actually provided service (gap 3).

The scores associated with these causes show that the equipment and technologies are adequate, the employees are suitable for their positions and the company management promotes teamwork. Also, the employees are clearly informed about their role in the organisation and are adequately trained for the position. The lowest value, obtained by the control system factor (3.771), may indicate the inadequacy of the control system implemented by Corola, which is exclusively oriented towards verifying the organization’s objectives.

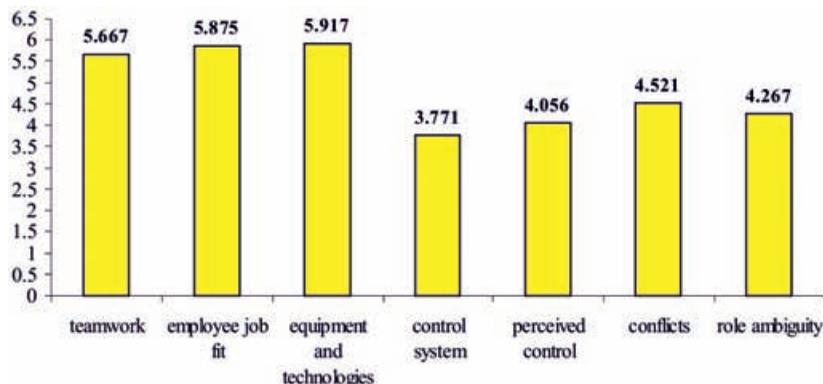


Figure 4 – Causes for gap 3

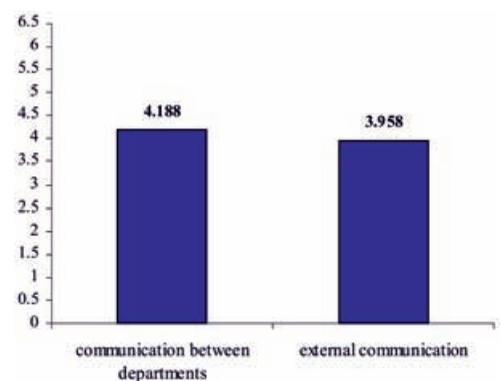


Figure 5 – Causes for gap 4

The causes that could determine important differences between internal and external communication regarding (the quality) of the service (Gap 4) are communication between the organization's departments and communication with the outside of the organization (Figure 5). The two factors obtained similar scores and are „equally guilty” for the existence of Gap 4.

Identifying the factors that caused significant differences between what the company perceives and what its customers perceive about „gas installations design and execution” is not enough. In order to reduce this difference for each analysed gap, eliminating the key factors (causes) having the lowest scores is necessary. Table 5 presents possible solutions to the causes for gaps 1-4, the ones with the lowest scores.

Table 5 – Gaps, causes, solutions

Gaps	Causes	Score	Solutions
Gap 1	marketing research orientation	3.875	<ul style="list-style-type: none"> ▪ Research customer expectations ▪ Proper use of research results ▪ Improving the interaction between managers and customers
	too many management layers	2.75	<ul style="list-style-type: none"> ▪ Reducing the number of hierarchical levels between the customer contact staff and managers
Gap 2	lack of goals	3.875	<ul style="list-style-type: none"> ▪ Setting realistic goals based on customer expectations ▪ Establishing indicators and measuring results
	inadequate management commitment to service quality	3.625	<ul style="list-style-type: none"> ▪ Management quality commitment ▪ Actual actions of tactic managers
Gap 3	inadequate control systems – exclusive orientation toward verifying the organization's objectives	3.771	<ul style="list-style-type: none"> ▪ Measuring and rewarding results ▪ Recognition of employee results
Gap 4	Inadequate external communication – an inadequate reflection of the provided service	3.968	<p>Accurate customer information:</p> <ul style="list-style-type: none"> ▪ References to the quality dimensions of the service ▪ Knowledge of customer requirements and expectations ▪ Knowledge the customer's role in the service

Within Corola customer expectations research must be conducted regularly and followed by actions aiming to improve the company's activity in relation to its clients. Correctly handled, this kind of research would bring valuable information about how the company is perceived and would allow modeling of its activity

according to customer expectations. Collecting and interpreting data should be followed by a plan including measures to be implemented until the next research. SERVQUAL questionnaires should be done regularly instead of remaining an isolated event – this is the only way „customers adapt and be content because of their

opinion counts". The top management of Corola must prove its quality commitment by communicating within the company the importance of satisfying customer requirements, by establishing quality related policies, by setting quality goals and making sure of resources availability.

Getting a high company performance is also influenced by the employee reward system. Adequate employee incentives will lead them towards the desired behaviour in the organization.

Corola must also improve its relationship with the outside. Distribution of SERVQUAL questionnaires will help identify customer expectations and the results should be monitored and translated into quality goals. Thus, the customer will understand his role in providing the service and will feel that his feedback regarding the provided service is important.

Conclusions

The paper analysed the relationship between what Corola believes it does (through

its representatives, managers and employees in direct contact with clients) and its customers' perception regarding gas installations design and execution service. The study was based on SERVQUAL questionnaire research.

Also, by applying SERVQUAL questionnaires the differences between the customers' perception and their expectations were identified. The company proves a low service quality in terms of the reliability, responsiveness and the assurance shown by employees. For these three quality dimensions, the perceived quality is lower than expected.

The four SERVQUAL gaps reflect consumer complaints that may eventually lead to the service's elimination from the market due to customers' not requesting it. Therefore, possible causes and solutions were identified for each gap.

The issue of quality evaluation is complex and essential. By knowing the consumer's response to the received service, the company may ensure effective quality control of the provided service and may make improvements, when necessary.

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