What Skills Should a Management Scientist Consultant Possess?

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Abstract

The aim of this article is to examine how much the Management Science (MS) models and methods are applied in companies in a certain developing country—the Republic of North Macedonia—what effects have been achieved by their application and which skills MS consultants should have with regard to being engaged in solving the problems that companies face. The survey was conducted through a questionnaire given to senior managers of state and private companies in the country. The total number of analyzed questionnaires is 219, out of which 68 were filled out by senior managers of state companies and 151 by private companies. Most of the respondents (151) answered that there is a need for MS support and that in the future they plan to hire an MS consultant. The skills that an MS consultant should have are divided into two categories: fundamental and ancillary practical skills. On the basis of the estimated average grade of importance of the fundamental skills, the MS consultant that is able to look at the problem has the highest average grade. Ancillary practical skills are divided into five fields: marketing, selling, formal communication and reporting, skills in interacting with the client and facilitating, and computing, and the average grade of importance for each skill in these fields is presented and analyzed. Based on the obtained results for the skills in each category, an AHP model is developed. The solution of the model can serve companies as a recommendation when choosing a management science consultant.

Keywords: Management Science, MCDM, AHP, Consultant, Skills.

1. INTRODUCTION

Companies must adapt to changes and make investments in employee education if they want to thrive in this dynamic and complex world. Companies' management, through the choices they make, should get the company closer to accomplishing the objectives. Management should place a strong emphasis on the use of quantitative analysis in addition to the knowledge, abilities, and experience they have.

At the heart of the discipline of operational research (OR)/management science (MS), also known as the science of better, is data, so the question posed here is how to get from data to information that will be valuable to those leading companies. By developing a quantitative model for the real problem situation and applying the most appropriate OR/MS method, an optimal or best solution is provided, serving as a recommendation to the management of companies in making better decisions.

Most of the MS methods allow solving problems whose aim is to find the best solution in relation to one criterion (Anderson, Sweeny, Williams, Camm, & Martin, 2012), but most of the real

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problems involve more than one criterion. Masud and Ravindran (2008) explain that when it refers to a decision-making problem with one criterion, the best solution is defined in terms of an optimal solution for which the value of the objective function is either minimized or maximized, and whenconsidering multiple criteria that are most often conflicting, there is usually no optimal solution, so deciding in a multi-criteria problem is usually about choosing the best compromise to the solution.

Multiple-criteria decision-making (MCDM) is one of the most important and fastest growing fields in management science. It refers to deciding when there are several criteria which are most often conflicting with each other. For more information, see Triantaphyllou (2000). Koksalan, Wallenius, and Stanley (2011) gave a detailed review of MCDM from its early history up to the present. A literature review on MCDM techniques and their application was conducted by Mardani et al. (2015). They included 393 articles published in more than 120 international peer-reviewed journals on the Web of Science database in the period 2000–2014. According to the frequency of the application of decision-making techniques (AHP, ELECTRE, DEMATEL, PROMETHEE, TOPSIS, ANP, VIKOR, etc.), the one that is used the most is the Analytic Hierarchy Process (AHP) (128 articles). When from several alternatives, there needs to be a choice of one that is the best, or to rank alternatives, considering several criteria on the basis of which the alternatives are evaluated, one of the most commonly used MCDM methods is AHP.

Taking into account the cruciality of making good decisions in companies that should lead to their further successful operation, the inclusion of management science consultants to model the problems and make recommendations for the optimal, i.e., the best solution, has a vital role. Because the selection of a consultant is based on multiple criteria, it is adequate to model it as a multi-criteria problem. In that direction, the inclusion of qualitative factors, in addition to quantitative ones, enables the multi-criteria AHP method with which we conducted a search in the SCOPUS database within the article title (TITLE), abstract (ABS), and keywords (KEY): "management scientist consultant" AND "AHP" using only articles as the document type and the entire period, and the outcome was 0 documents. This prompted our idea to build an AHP model for selecting a management science consultant, which would enrich the existing literature but at the same time help companies make the best choice of such a consultant to improve their results.

The research was conducted through a questionnaire of senior managers in state and private companies in the Republic of North Macedonia, and the obtained answers serve as a basis for developing an AHP model for the selection of an MS consultant based on their fundamental and ancillary practical skills.

The article is organized as follows: In addition to the introduction to Section 1, the methodology and data are explained in Section 2. The results of the questionnaire are presented and analyzed in Section 3. The AHP method is described in Section 4, while the developed AHP model is presented in Section 5. The conclusion is given in Section 6.

2. METHODOLOGY AND DATA

The research was conducted by a questionnaire, consisting of a total of 19 questions.[1] Besides the questions related to the company's location, industry, gender, age, and level of education of senior managers, the focus of the research is the following:

- Do you think that everything can be measured?
- Are methods and models of management science used in your company?
- For the MS model, i.e., the method that is used in the company (break-even analysis, probability and probability distribution, decision analysis, game theory, regression

[1]The questionary is available by request to the authors.

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analysis, time-series analysis and forecasting, inventory models, linear programming, transportation models, assignment, integer programming, goal programming, nonlinear programming, dynamic programming, project management, waiting line models, simulation, Markov processes, and multiple criteria decision-making), they need to explain which problem it has been applied for, the effect that has been achieved, and to answer if the model has been developed and solved with the help of an analyst employed in the organization or if they have hired an MS consultant, or both.

- Does the company need MS support?
- Do they plan to engage an MS consultant in the future?
- What skills do they want the MS consultant to have? (evaluate on a scale of 1-5; 1-the lowest grade, 5-the highest grade)

The emphasis in this article is on the skills that an MS consultant needs to have to be chosen by the management of companies in the country. For this purpose, the skills (fundamental and ancillary practical) are extracted from the book "Management Science in Practice" by Terry Williams. Details can be found in (Williams, 2008, pp. 227-246).

The fundamental skills of an MS consultant are the following: they need to be able to look at the problem; to relate to the client; to comprehend the social geography of the client body; to identify opportunities for analysis in a creative manner; to structure the problem; to model it; to analyze the developed model; and to relate the results to the real situation (Williams, 2008, p. 226).

Ancillary practical skills are grouped in five fields: 1) marketing, 2) selling, 3) formal communicating and reporting, 4) skills in interacting with the client, and 5) computing). In the field of marketing, the MS consultant needs to be a marketer (to be able to look at the needs and wants of possible clients and consider which way is the best to meet their needs and wants). In addition, the MS consultant needs to be a seller (here interpersonal skills, analytical skills and knowledge are considered). Interpersonal skills are related to active listening and empathizing with the client (to be able to see the situation as the client, questioning in a way that is structured and analytic and to demonstrate insight). Analytical skills are linked with the ability to conceptualize situations and to identify problem areas that are of key importance. The MS consultant needs to have knowledge of the way that business operates, domain knowledge of the problem area and of different analytical approaches. The formal communication and reporting is linked with the style in written communications, presentations, visualization of information through figures, diagrams, charts, timetables, etc.). In the field of interacting with the client and facilitation, the skills are: to be personable, friendly, energetic, showing enthusiasm, trust and credibility as the basis of the relationship with the client, and to have necessary skills to hold workshops with a group of clients (to "facilitate" workshops) and to gain information or data from them. Last but not least is the field of computing that consists of the following skills: the ability to pick up new software packages in a quickly manner, to be comfortable to collect data from a variety of information systems, to be a programmer, and to be a software engineer.

The respondents need to evaluate each skill on a discrete scale (1 to 5, where 1 is the lowest grade of importance and 5 the highest). Besides the listed skills (fundamental and ancillary practical), if according to the respondents, an important skill is not included in any category, they need to add and evaluate it.

The survey was carried out on senior managers of private and state companies in the Republic of North Macedonia and the period was one month, i.e. in February 2018. The companies are randomly selected. The total number of questionnaires is 236. Of these, 17 are incomplete and 219 are analyzed. Out of these 219, 68 are from state companies and 151 are from private companies. A representative sample of senior managers in the Republic of North Macedonia was surveyed according to the total number of analyzed questionnaires (219).

3. ANALYSIS OF THE SURVEY RESULTS

3.1 Demographic Results and Analysis

According to the obtained results from the 219 questionnaires, most of the companies are located in the capital of the country, Skopje (154 companies, or 70.32% of the companies). Based on the National Classification of Activities – NCA Rev. 2 (National Classification of Activities, 2013), the highest number of companies (40) belongs to the manufacturing industry, then follows: wholesale and retail trade; repair of motor vehicles and motorcycles (25), information and communications (24), professional; technical, and scientific activities (19), transportation and storage (18), etc. (Figure 1).

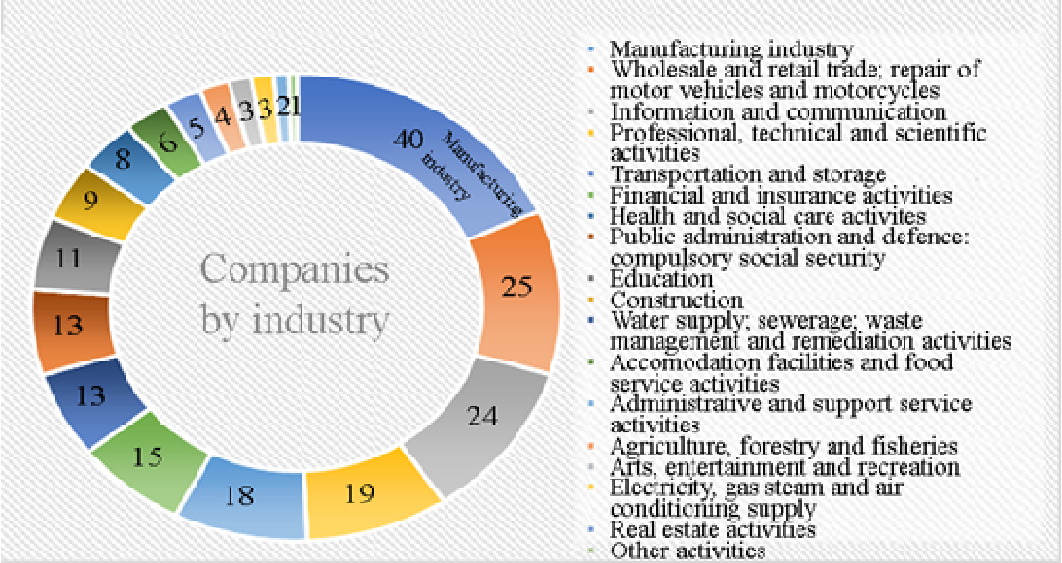

FIGURE 1: Companies by industry.

According to gender, 113 respondents are male and 106 are female.The average age is 43 years. According to the level of education, 143 respondents have higher education; 34 are M.Sc., 25 have completed secondary education, 8 have higher vocational education, 6 PhD's, and 3 don't want to answer this question.

3.2 Results and analysis of MS models and methods used

For the question on whethercompanies thought that if anything could be measured, 115 confirmed, while 104 answered negatively. Methods and models of management science are used in 33 companies (25 private and 8 state), while 186 companies (126 private and 60 state) do not use them. The most commonly used are: break-even analysis (21 respondents), decision analysis (12), time series analysis and forecasting (10), etc. (Table 1).

No.	Used MS models and methods	No. of respondents who listed the model, the method
1.	Break-Even Analysis	21
2.	Decision Analysis	12
3.	Time Series Analysis and Forecasting	10
4.	Project Management	9
5.	Inventory models	8
6.	Probability and Probability Distributions	5
7.	Simulation	5
8.	Transportation Models	5

9.	Assignment	4
10.	Linear Programing	2
11.	Regression Analysis	2
12.	Game Theory	1
13.	Goal Programing	1
14.	Markov Processes	1
15.	Multiple Criteria Decision-Making	1

TABLE 1: Used MS models and methods.

In state companies the most used are: transportation models, inventory models, decision analysis, and project management. The use of MS methods and models helped them in: accuracy of games of chance, procurement of articles, planning of transport capacity, planning of shorter driving lines, lack of garbage vehicles, project structure, simulating new opportunities for modern service, conflict analysis, optimizing the operating process, judicial procedures, support in the planning process, budget analysis. However, in private companies the most used are: break-even analysis, decision analysis, and time series analysis and forecasting. The use of MS models and methods helped them in: determining the price of a product, determining how many products are to be produced, determining which products to produce, the tendency of reducing the selling price, introducing a new product, the frequency of product delivery, portfolio profitability analysis, estimation of reserves, allocation of insurance admission limits, modeling of exposure from catastrophic risks, insurance risk, preparation of application, development of projects, warehouse operation, projecting income by classes of insurance, predicting the number of customers, assignment of a certain client to an employee, time delivery, increasing quantity of products in stock that cannot be sold, thus the income is lower, procurement of commodities, analysis of entrance into a new market (region), determining the annual budget for each sector, assigning a co-worker at a suitable job, determining what to invest in, managing new projects, planning the sales volume, and determining the optimal level of inventory.

All respondents stated a material effect, and one of them stated both material and non-material effects. Some of the respondents from private companies have described the effects as reduced costs; reduced costs with combined transport and change in the transport route; change in sales prices; variable costs per unit; volume of production and sales; reduced time to perform a service.

The MS model has been developed and solved with the help of: an analyst employed in the organization (24 respondents), an MS consultant (5 respondents), and both (4 respondents).Respondents from 151 companies answered that they need MS support, while 68 answered that they do need this kind of support. Also, 151 respondents plan to engage an MS consultant in the future, while 68 do not plan to engage one.

3.3 Results and analysis of fundamental skills

The respondents have not added additional skills. The average grades of importance for the fundamental skills of an MS consultant are given in Table 2. The highest average grade of importance is given to the MS consultant to be able to look at the problem ($\bar{x}$ = 4.81), followed by the skill to relate the results to the real situation, to structure a problem, etc., while the least important is to comprehend the social geography of the client body, whose average grade of importance is below four ($\bar{x}$ = 3.84). (Table 2)

No.	Fundamental skill	Average grade of importance
1.	to be able to look at the problem	4.81
2.	to relate the results to the real situation	4.77
3.	to structure a problem	4.59
4.	to analyze the model	4.53
5.	to relate to the client	4.40

6.	to model the problem	4.35
7.	to creatively identify opportunities for analysis	4.26
8.	to comprehend the social geography of the client body	3.84

TABLE 2: The results of the survey – importance of fundamental skills.

3.4 Results and analysis of ancillary skills

The respondents have not added additional skills. According to the obtained results for the ancillary practical skill in the field of marketing, the average grade of importance that an MS consultant needs in order to be a marketer is 4.05. In the field of selling, i.e., to be a seller has gained an average grade of importance 4.35 (knowledge has the highest grade of importance ($\bar{x}$= 4.51), followed by analytical skills ($\bar{x}$= 4.41) and interpersonal skills ($\bar{x}$= 4.14)). Skills in the field of formal communicating and reporting have gained an average grade of importance 4.50. The most important skill in the field of interacting with the client, and facilitation, is the relationship with the client to be based on trust and credibility ($\bar{x}$= 4.73), while the least important is for them to be energetic ($\bar{x}$= 4.31). (Table 3)

No.	Ancillary practical skill (field: interacting with the client, and facilitation)	Average grade of importance
1.	the relationship with the client to be based on trust and credibility	4.73
2.	to be personable	4.56
3.	to have the skills necessary to hold workshops with groups of clients (to "facilitate" workshops) and gain the required output (information or data from them)	4.52
4.	to show enthusiasm	4.43
5.	to be friendly	4.40
6.	to be energetic	4.31

TABLE 3: The results of the survey – importance of ancillary practical skills in the field of interacting with the client, and facilitation.

In the field of computing, the most important skill is to be comfortable to collect data from a variety of information systems ($\bar{x}$= 4.45), then follows the ability to pick up new software packages very quickly ($\bar{x}$= 4.34), while the other two skills (to be a programmer and to be a software engineer) have gained an average grade of importance that is below four. (Table 4)

No.	Ancillary practical skill (field: computing)	Average grade of importance
1.	to be comfortable collecting data from a variety of information systems	4.45
2.	to be able to pick up new software packages very quikly	4.34
3.	to be a programmer	3.16
4.	to be a software engineer	3.03

TABLE 4: The results of the survey – importance of ancillary practical skills in the field of computing.

Based on the estimated average grades of importance for fundamental and ancillary practical skills, one fundamental, and two ancillary practical skills have an average grade that is below four, and they will be not part of the multicriteria decision model (AHP), while the other skills will serve as input in this model (described and presented in Section 5).

4. THE METHOD OF AHP

Thomas L. Saaty developed the analytic hierarchy process in the late seventies of the twentieth century (Saaty, 1977; 1980). The analytic hierarchy process allows for the complex MCDM problem to be decomposed into the following components: goal, criteria, sub-criteria, and alternatives, so that they are represented hierarchically. Once the hierarchical model is developed, its constituent elements are compared in pairs. According to cognitive psychologists, people make two kinds of comparisons: absolute and relative comparisons. In the first type of comparison, alternatives are compared with a standard, while relative comparisons occur when in pairs. Alternatives are compared according to the attribute which is common to them, and the AHP method can also be used for absolute and relative comparisons (Saaty & Vargas, 1994).

The decision-maker should compare in pairs the elements at each level of the hierarchical structure and express their preferences using the fundamental scale of Saaty. This scale can be found in Saaty and Vargas (2012, p. 6). At one level there need to be 7 ± 2 elements (Triantaphyllou & Mann, 1995). The sum of the weights of the elements at each level of the hierarchical structure should be 1, and a mathematical model needs to be used to calculate the weights of the criteria and the priorities of the alternatives. Details can be found in Cvetkoska (2022).
The analytic hierarchy process allows to monitor whether the decision-maker was consistent in pairwise comparisons of the elements of the hierarchy by computing the Consistency Index (CI):

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (1)$$

where n represents a number of criteria, i.e. alternatives, and is the largest eigenvalue of matrix A (matrix of pairwise comparisons). The consistency index allows for the Consistency Ratio (CR) to be measured: CI = CI/RI, where RI is a random index, whose values are given in Saaty (2006, p. 229). An inconsistency that is not greater than 10%, i.e. CR ≤ 0.10 is accepted.

AHP can be applied to solve a number of problems, such as (Saaty & Vargas, 1991, p. 16): setting priorities; generating a set of alternatives; choosing the best alternative to politics; determining requirements; resource allocation; predicting results (time dependency) - risk assessment; performance measurement; designing a system; ensuring system stability; optimization; planning; conflict resolution, etc.

For the application of the analytic hierarchy process, Vaidya and Kumar (2006) have made a literature review. Additionally, the AHP method can be integrated with other tools, and it can also serve as their support. A review of the application of the AHP method with other methods has been made by Ho (2008).

Emrouznejad and Marra (2017) give a literature review of the development of AHP by using the social network analysis (SNA) and scientometrics. Their analysis is based on 8.441 published works (4.721 articles, 3.362 conference proceedings, 211 articles and proceeding articles, 19 editorial pieces, and 128 of other document types) extracted from the largest citation-based academic database ISI WoS. The observed period is 1979 – 2017 (up to January 2017). The number of publications has increased the last ten years, so that in the period 2013-2015 there have been identified more than 800 published works. In their article a basic statistic on AHP journals and research is given, and there are presented the main topics and applications of AHP and integrated AHP with other methodologies, such as AHP and TOPSIS, AHP and DEAHP, AHP-DEA and TOPSIS, AHP and SWOT analysis, AHP and quality function deployment (QFD), AHP and sensitivity analysis.

The focus of this article is to develop an AHP model that will help the management of companies in the Republic of North Macedonia when choosing an MS consultant based on fundamental and ancillary practical skills. In the existing literature there has not been found a similar reference, which leads to the conclusion that this is the original application of AHP.

5. AHP BASED MODEL FOR MANAGERIAL DECISION MAKING IN THE PROCESS OF SELECTION OF A MANAGEMENT SCIENCE CONSULTANT

In our country, the application of methods and models of management science is at a low level. The management is not familiar with the benefits of using them, and the first author of this article has introduced multiple criteria decision-making in certain courses at the Ss. Cyril and Methodius University in Skopje, thus noting an enormous interest in its application by the students at undergraduate, Master, and PhD level.

The process of selection of a management science consultant can be considered an MCDM problem that can be decomposed into three components: goal, criteria, and alternatives. In order to determine the importance of individual elements that are mainly of a qualitative nature, AHP was chosen as the most appropriate method.

The elements of the AHP model for the selection of the most appropriate MS consultant by the management of the companies in the Republic of North Macedonia are:

- The goal is to select the most appropriate MS consultant;
- Two categories: fundamental skills and ancillary practical skills.
- In the first category, there are 7 criteria: the MS consultant is to be able to look at the problem, to relate the results to the real situation, to structure a problem, to analyze a model, to relate to the client, to model the problem, and to identify opportunities for analysis in a creative manner;
- In the second category, i.e., ancillary practical skills, the criteria are grouped into the following five groups: marketing, selling, formal communication and reporting, interacting with the client, and computing. The 3 criteria for selling are the following: The 6 criteria for interacting with the client are: the relationship with the client must be based on trust and credibility; to be personable; to hold workshops with a group of clients and gain the required output (data, information); to show enthusiasm; to be friendly; and to be energetic; and the 2 criteria in computing are: to be comfortable collecting data from a variety of information systems (IS), and to be able to pick up new software packages.
- Alternatives: candidates that will apply as MS consultants;

The hierarchy for criteria of the selection of a MS consultant is shown in Figure 2.

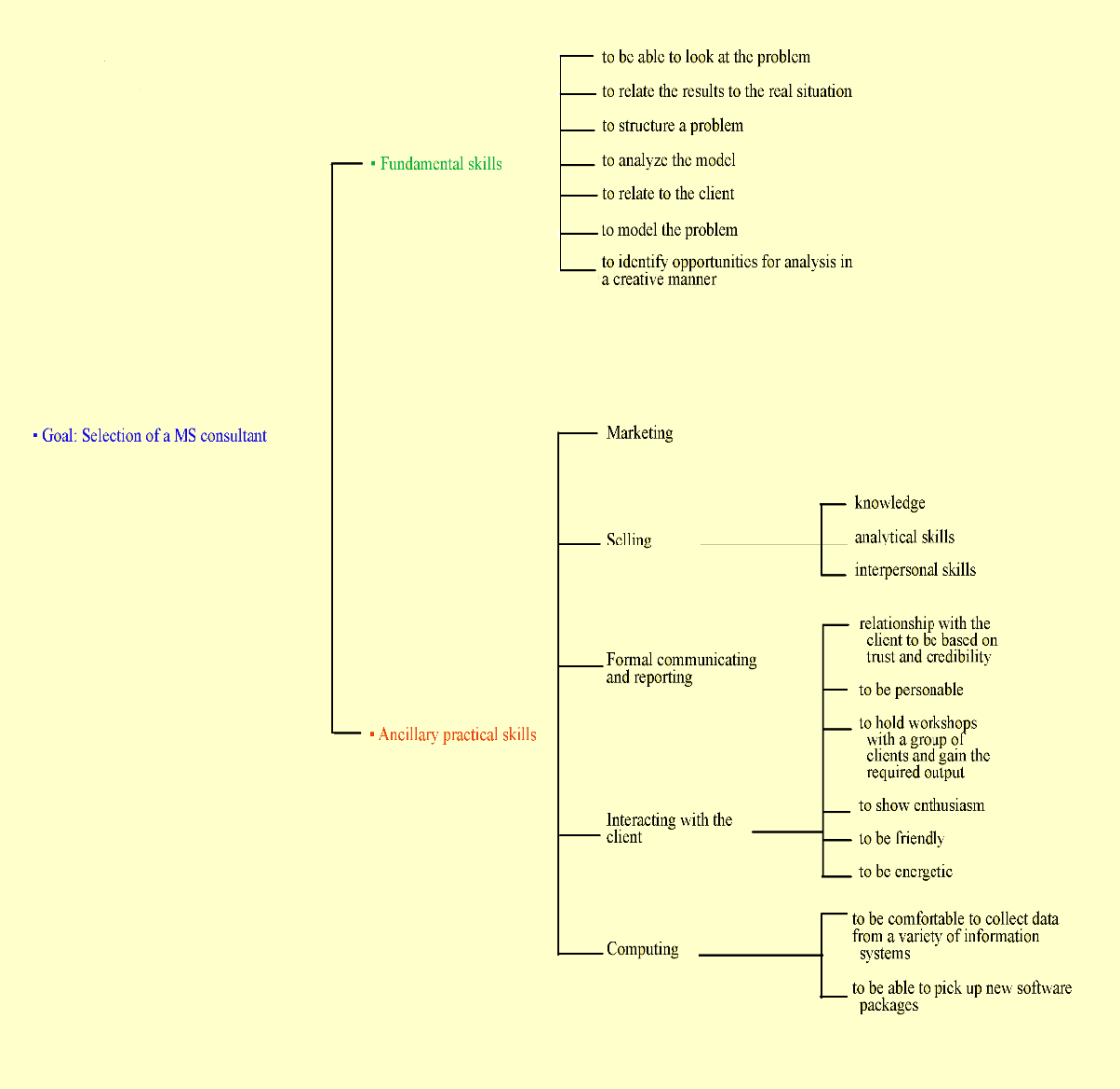

FIGURE 2: Hierarchy of the criteria for selecting an MS consultant.

The idea of the proposed model for selecting an MS consultant is to present the MCDM, i.e. the AHP method, closer to the management in our companies, so that the AHP method will be explained to them first, and the model will be described in detail, so that they can make the necessary pairwise comparisons and give their grades of importance based on the fundamental scale of Saaty, while solving the model will be done by this article's authors, until the most suitable people for this field are trained. The application of the model and the results of the companies that will apply it will be part of the next research.

6. CONCLUSION

We live in a world that is becoming more dynamic and complex, and management in companies is faced with a number of problems and challenges related to increased competition, customers that want high quality but are willing to pay as low a price as possible, limited resources, time pressures, and, of course, as part of this digital era, rapid changes in technology. With the

decisions they make, they are responsible for the results the company achieves both in the short and the long term. The change in the nature of the problems they face also means a change in the nature of the role of those who advise management in the direction of making better decisions.

For a better contribution to practice, management scientists, besides understanding the problems in companies, appropriate modeling, applying creativity in modeling, issues related to data that are the raw material of quantitative analysis, need to have many other skills related to marketing, selling, computing, formal communication and reporting (written communications, presentations, visualization of complex information), and skills in interacting with clients.

Through the research performed on senior managers of state and private companies in the Republic of North Macedonia, it can be concluded that only 15% of the analyzed companies are using the methods and techniques of management science. This low level of use is due to insufficient knowledge of MS analytical methods and techniques and the benefits of applying them. Their recommendations include expanding MS education options in the country and involving volunteers or students studying MS in companies that do not use MS in order to see the contribution of MS in their operations.

Most of the respondents (151) answered that they need MS support and that they plan to engage an MS consultant in the future. Regarding the skills that the MS consultant needs to have in order to be selected by the companies, based on the results of the questionnaire, those fundamental and ancillary practical skills that have gained an average grade of importance that is not below four are used as input for mathematical, i.e., multi-criteria modeling. We believe that this model will contribute significantly to the selection of the most appropriate MS consultants in our companies, which would help in making better and faster decisions by the top management. Those decisions are vital for the successful operation of the companies and achieving competitive advantage. The proposed AHP model will be tested in both private and state-owned companies in the country.

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