Selecting the best Robotic Kits in Term of Increasing Creativity

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Abstract**—** There has been an increased offer of robot kits over the last decade, which is the result of a fats developing market of cheap electronic and mechanical devices. It is important to highlight the fact that the ways of shopping, paying and transport have been highly simplified, which has affected superfluous amount of both manufacturers and consumers. This clearly leads to the final confusion over the right choice of a robot kit. Although we can say that the usage and increment of creativity has been the main aim in choosing the right robot kit, the process of acquiring complex technical knowledge should definitely be easy and stimulating.

The aim of this paper is to highlight the parameters that have to be taken into consideration in the choice of robot kits by using the Fuzzy Analytic Hierarchy Process (FAHP), which can eventually result in the biggest increase of creativity among users.

Keywords **—** Fuzzy Analytic Hierarchy Process, Fuzzy logic, AHP, Robot, Robot Kits, Learning.

I. Introduction

EXPERIENCE has shown that learning through play, fun and a lot of positive energy leads to an intensive creativity development and it gives spectacular results. The young necessarily need those features as a completion to a school programme which does not have a practical dimension. Studying hard and the creative use of free time for children and the young affect the technical culture and contribute to contemporary conditions of technical development and improvement.

Therefore, that was one of the main reasons for establishing the Centre of Technical Culture (CTK). CTK is a place for young people with a predisposition for natural sciences and technology. The main goal of the CTK is to enable those young generations the access to practical knowledge in electronics, robotics and informatics and in that way help them become creative experts.

The Centre of Technical Culture organizes creative electronics workshops in which starters can learn the basics of electronic components and useful assemblies. With a constitution of modular elements, actuating motors, pneumatic cylinder and sensors, it is possible to make a plenty of different robots – for detouring and overcoming obstacles, simulating the work of real machines...

The aim of this paperwork is to help the Centre of technical culture in choosing the robot kit which can eventually result in the biggest increase of creativity among users.
Comparing several chosen robot kits, parameters that have to be taken into consideration in choosing the right robot kit will be highlighted. In this paper we will use FAHP method.

Analytic hierarchical process (AHP) is one of the most frequently used methods for multi-criteria decision-making. It is one of the most famous methods and in the recent years it has been mostly used for decision-making when the process of decision-making, actually the selection of one of the given alternatives or their ranging is based on more attributes which have different importance and which are expressed using different scales. AHP method provides flexibility of the decision-making process and helps decision-makers to make priorities and make a qualitative decision considering qualitative and quantitative aspects of the decision-making [8][9]. It is due to its characteristics which have been additionally improved using fuzzy logic, it is a very important tool with which we can eliminate disadvantages and lacks of the SWOT analysis, which provides a systematic analysis of the external and internal environment of a particular organization.

Fuzzy AHP method is often used in literature for solving many complex problems related to decision-making. Van Laarhoven and Pedrcyz [2] suggested the first studies using fuzzy logic in AHP (FAHP). Chang [3] introduced a new approach for working with the FAHP, actually he introduced triangular fuzzy numbers in the scale used for comparing pairs of elements and using prolonged synthetic analysis. Ataei [4] used multi-criteria decision-making in selecting location of facilities for aluminate cement.

Lee and Lin [5] combine fuzzy AHP with SWOT in order to calculate relations of the international distribution centers in Asian-Pacific region. Kahraman [6] used FAHP in the SWOT analysis for calculating and defining alternative strategies for using e-government in Turkey. Kangas, Kangas, J., Pesonen, M., Kurttila, M. and Kajanus [7] wrote about the integration of the SWOT analysis with the AHP.

II. ANALYSIS OF COMMERCIAL AND OPEN SOURCE ROBOTICS KITS

We will generalize several categories of the term robot kits. The given list is the result of the internet browser Google and it is presented in the order that appears on the listing. The list has been reduced for reasons of abundance, and because, according to the opinion of the authors of this paper, some products should not be included. We also know that the order of search in the browser Google is based on popularity, which helps the user narrow the choice.

Categories:

1. Platforms with wheels, caterpillar treads or legs
2. "Robot arm" with a certain degree of freedom
3. Robots that resemble the human anatomy (humanoids)
4. Specialized kits or robots in machine models

We will mention some of the company specialized for the production/ sale of robot kits:

- RobotShop
- EZ-Robot
- Jameco Robot store
- Inovatic
- Lynxmotion
- Razor robotic
- Vexrobotics (Protobot Robot Kit, Classroom Lab Kit)
- Paradiserobotics
- Arcbotics
- Lego
- Fisher tehnic
- DIY ("Do it yourself" - all the components for a robot kit can be bought separately or all the available facilities can be used)

The most popular, i.e., the most frequent use of robot kits, according to the target group of users:

- Line tracking
- Moving in space and obstacle avoiding (ultrasound, IR)
- Pass through the maze
- Different use of a robot arm
- Throwing the opponent robot out of the given ring (perimeter)

Regardless to the high aims, shopping a robot kit usually comes down to the "fastest", "cheapest" and "most available" option. Unfortunately, the wrong choice causes an unwanted effect. Therefore, we need to pay attention to the following parameters when we choose a robot kit:

a) *Hardware package*

When buying a robot kit it is very important to pay attention to:

- The main controller: it is desirable to have a bigger number of sensor entries and exits for the actuators and motors.
- The number and type of sensor

Also in ideal case for a minimal investment we expect:

- 4 independently four independently steerable wheels through PWM signals
- 4 ultrasonic sensors
- 2 photo sensors
- 3 Axis Acceleration Sensor
- digital compass
- 4 senses of touch the micro-switches
- extendable main controller through the connectors for editing
- Communication through Bluetooth or RF

b) *Support and availability*

No matter how attractive a robot kit is, if the user is forced to use it on its own that will dampen the initial enthusiasm. The possibilities of fast acquisition and the practical use of new acquired knowledge, shared experience, fast answers to vagueness are not possible without a wide support.

The term implies:

- User community
  - Internet
  - School
  - Technical organizations
  - Friends
- Available literature in electronic format or in print
- Technical support of manufacturers (services , software updating, etc.)

c) *Programming interface(front-end - graphical (GUI) or text programming*)

The speed of understanding and acquiring knowledge of Mechatronics Principles of robotics mostly depends on the program base. The majority of companies uses for its kits the existing compilers based on C and Basic languages depending on whether the microcontroller is implanted in the controller (mostly Atmel and Microchip).

It is known that visual programming is the most accepted form of acquiring programming for children in elementary school. For example, there is a programme language Logo. The celerity of knowledge acquisition in programming is significantly more efficient in visually oriented programs rather than "classical", line programming languages. Therefore it is very desirable that there is a programming packet for a chosen robotic platform based on visual programming.

d) *Modularity*

Modularity is the possibility of extending the basic kit with extra components, usually different kinds of sensors. The most important thing is that the user can buy new additions from other suppliers, and that the electro-mechanically compatible with the existing kit.

In order to hold the buyer longer for themselves, many manufacturers use the "property" modules compatible only with their controllers. Adding other modules or components most of the time is not possible or very difficult to do. The price of those modules overpasses their real market price (up to 20 times), especially when the initial (bare) kit is sold for the “reasonable”, primary price.

Usually the development of new modules is very slow or it does not exist. This causes boredom among young users which slows the process of acquiring new skills and knowledge or even giving up.

e) *The price*

Although in practice this is not the case, a low market price does not necessarily have to affect the decision for buying a certain products. Good marketing, packaging, impatience and the buyer´s inexperience will easily disguise a bad product. When buying a robot kit it is very important to pay attention to:

- The main controller: it is desirable to have a bigger number of sensor entries and exits for the actuators and motors.
- The number and type of sensor
- The price: it should not be unreasonable. There is no point in paying hundreds of dollars for a simple footage, couple of sensors, a minimal controller and a free software.

III. THE IDEAL ROBOTS PLATFORM

In the ideal case for a minimal investment we expect:

- Hardware
    - 4 independently four independently steerable wheels through PWM signals
    - 4 ultrasonic sensors
    - 2 photo sensors
    - 3 Axis Acceleration Sensor
    - digital compass
    - 4 senses of touch the micro-switches
    - extendable main controller through the connectors for editing
    - Communication through Bluetooth or RF
- A large number of addenda compatible with the basic controller, more suppliers and the possibility for DIY
- A lower price and simpler supply of additional components (online shopping, PayPal paying, cheap transport)
- Quality support
- That there are two versions of programming interface - GUI and a textual, and that they are free

In that case we will use the following platform for the evaluation:

- MAKE Rovera 4WD Arduino Robot Kit
- Boe-Bot Robot (Paralax)
- RobotShop RB-Dfr-16 + DFRobot controler
- Pololu 3pi
- DIY platform

MAKE Rovera 4WD Arduino Robot Kit (Make magazine)

Compatible with the Arduino robot platform It consists of two well known, mutually connected Arduino controllers „Arduino UNO“ and „Motor shield“ (in some parts). There is a minimal set of sensors that comes with the kit, which is sufficient for the elementary applications. It is laudable to mention the fact that the kit has to be composed and the creativity is emphasized by the fact that the Motor shield has to be brazed. It has the same programming characteristics as the arduino robot kit. It is interesting that a book with complete instructions for composition has been written for this kit. Besides, all the other components can easily be bought in many places (e-bay, dealextreme) for very reasonable prices.

Boe-Bot Robot (Paralax)

“The plume” of a solid and experienced player on the field of microcontrollers, based on the educational platform for BasicStamp. The setting of breadboard as a electronics device is very laudable, because it instigates the users to connect it all by themselves. The offered list of sensors could be better, but it is clear that the manufacturer considers it is better for the user to find everything on its own. The support is based on BasicStamp controllers, which is not so meaningless, according to the time that has been on the market. Still, the price is too high, especially if we take into consideration that a better platform could be found only for a couple of dollars more

RB-Dfr-16 + DFRobot controler (RobotShop)

Robot Shop is a specialized shop of robot components. From the offer we have taken out the combination of a standard platform with 4 wheels and a specialized controller based on Atmel 328 MCPU. The controller is a bit improved Arduino Uno, with rebuilt exits for motors, connectors for communication and a set of keys. The software aliment is already described in the „Arduino robot“ platformi, and it is magnificent. There is not a single sensor that comes with this kit which actually is not so unusual, especially taking into consideration the reasonable price. Therefore there is a wide list of additions from the Arduino arsenal provided by a vast list of Chinese suppliers.

Pololu 3pi (Pololu)

Pololu is also a specialized shop of robot components and electronics. This unusual robot is, by description, designated for line tracking and for passing through the maze

Except for four optical sensors on the bottom, there are not additional sensors (neither the possibility of adding additional) so it is not very clear how the robots manage to pass the maze. The controller is based on the processor Atmel 328p and the programme support is based on the C language (Atmel Studio 4), with a restrained set of library routines.

There is a modest LCD and some keys. Additional creativities are not possible with this platform. Taking into consideration that the applications are limited and the hardware is very simple, the price could be even lower.

DIY platform

A platform out of competition in every sense. Every listed kit could be bought, made or found in the garbage. The enormous list of available components, literature, user community is very hard to ignore. Only with this platform, creativity is restrained by time and imagination. A creative boom, in the last couple of years it started an open-source „Arduino“ platform with free software, a big list of cheap additions, suppliers, applications, and so on. We have already described some kits based on this platform.

It is possible to compose a robot kit with all the components from the above-mentioned ideal platforms, based on the controller „Arduino Mega“ (the best of all the described. But also we have to mention that there is additional effort for the buyer to assembly working robot. The buyer must have expert knowledge to buy every part for assembly. Aditionaly we don’t have a support and any guarantee for our custom robot

IV. AHP AND FAHP

The AHP is a flexible, quantitative method for selecting among alternatives based on their relative performance with respect to one or more criteria of interest. The AHP resolves complex decisions by structuring the alternatives into a hierarchical framework. The hierarchy is constructed through pair-wise comparisons of individual judgments rather than attempting to prioritize the entire list of decisions and criteria simultaneously. This process generally involves six steps:

- Describing the unstructured problem,
- Detailed criteria and alternatives,
- Recruiting pair wise comparisons among decision elements,
- Using the eigenvalue method to predict the relative weights of the decision elements,
- Computing the consistency properties of the matrix,
- Collecting the weighted decision elements. The AHP techniques form a framework for decisions that use a one-way hierarchical relation with respect to the decision layers. The hierarchy is constructed in the middle level(s), with decision alternatives at the bottom, as shown in Fig. 1.

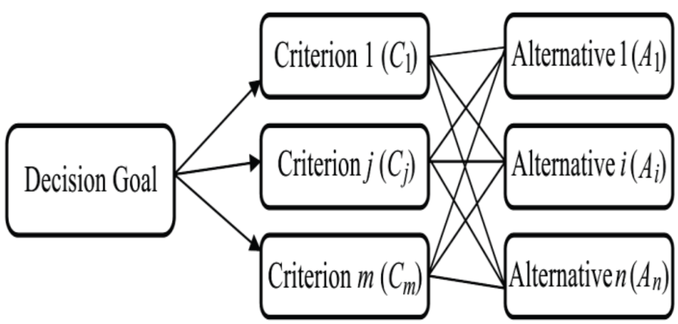

Fig. 1: Hierarchy for a typical three-level MCDM problem

The AHP method provides a structured framework for setting priorities on each level of the hierarchy using pair-wise comparisons as demonstrated in Fig. 2:

Linguistic scale	Explanation	TFN	Inverse TFN
Equal importance	Two activities contribute equally to the objective	(1,1,1)	(1,1,1)
Moderate importance	Experience and judgment slightly favor one activity over another	(1,3,5)	(1/5,1/3,1)
Strong importance	Experience and judgment strongly favor one activity over another	(3,5,7)	(1/7,1/5,1/3)
Very strong importance	An activity is favored very strongly over another, its dominance	(5,7,9)	(1/9,1/7,1/5)
Demonstrated importance	The evidence favoring one activity over another, is highest possible order of affirmation	(7,9,11)	(1/11,1/9,1/7)

Fig. 2: Linguistic scale and corresponding triangular fuzzy numbers

The AHP has been widely used to solve MADM problems. However, due to the existence of vagueness and uncertainty in judgments, a crisp, pair-wise comparison with a classical AHP may be unable to accurately represent the decision-makers' ideas.

Even though the discrete scale of AHP has the advantages of simplicity and ease of use, it is not sufficient to take into account the uncertainty associated with the mapping of one’s perception to a number. Therefore, fuzzy logic is also introduced into the pair-wise comparison to deal with the deficiency in the classical AHP, referred to as FAHP.

FAHP is an efficient tool to handle the fuzziness of the data involved in deciding the preferences of different decision variables. The comparisons made by experts are represented in the form of Triangular Fuzzy Numbers (TFNs) to construct fuzzy pair-wise comparison matrices.

FAHP Algorithm:

The extent of FAHP is utilized in four steps (Chang, 1996), as stated below:

Let $X = \{x_1, x_2, x_3, \ldots\ldots, x_n\}$ be an object set, and

$G = \{g_1, g_2, g_3, \ldots\ldots, g_m\}$ be a goal set. According to the method of Chang’s extent analysis, each object is taken and extent analysis for each goal, g_i, is performed, respectively. Therefore, m extent analysis values for each object can be obtained with the following signs:

$M^1 gi, M^2 gi, \ldots, M^m gi, \; i=1, 2, \ldots, n$

Where, all of the $M^j gi$ ($j = 1, 2, \ldots, m$) are TFNs. Followings are the steps of Chang’s extent analysis:

Step 1:

The value of fuzzy synthetic extent with respect to the i-th object is defined as:

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} * \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} \quad (1)$$

To obtain the $\sum_{j=1}^{m} M_{gi}^{j}$, we perform the fuzzy addition operation of m extent analysis values for a particular matrix such that:

$$\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j\right) \quad (2)$$

Obtaining the $\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1}$, we perform the fuzzy addition operation of

$$M_{gi}^{j} (j = 1,2, \dots, m)$$

values such that:

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i\right) \quad (3)$$

Compute the inverse of the vector above, such that:

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right) \quad (4)$$

Step 2:
As $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$ are two TFNs, the degree of possibility of

$$M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$$

defined as:

$$V(M_2 \geq M_1) = \sup_{y \geq x}\left[\min\left(\mu_{M_1}(x), \mu_{M_2}(y), \right)\right] \quad (5)$$

This can equivalently be expressed as:

$$V(M_2 \geq M_1) = hgt(M_1 \cap M_2) = \mu_{M_2} = \begin{cases} 1 & if\ m_2 \geq m_1 \\ 0 & if\ l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & otherwise \end{cases} \quad (6)$$

Step 3:

The possibility degree for a convex fuzzy number to be greater than *k* convex fuzzy numbers can be defined by:

$$V(M \geq M_1, M_2, \dots, M_k) = V[(M \geq M_1) and\ (M \geq M_2) and \dots and\ (M \geq M_k)] = \min(M \geq M_i),\ \ i = 1,2,3, \dots, k \quad (7)$$

Assume that $d(A_i) = minV(S_i \geq S_k)$
for the $k = 1,2, \dots, n;\ \ k \neq i$,
the weight vector is given by:

$$W' = \left(d'(A_1), d'(A_2), \dots, d'(A_n)\right)^T \quad (8)$$

Wherein, $A_i (i = 1,2, \dots, n)$ are n elements.
Fig. 3. illustrates the Equation (9), where d is the ordinate of the highest intersection point between μ_{M1} and μ_{M2}. To compare M1 and M2, we need both of the values of $V(M_1 \geq M_2)$ and $V(M_2 \geq M_1)$

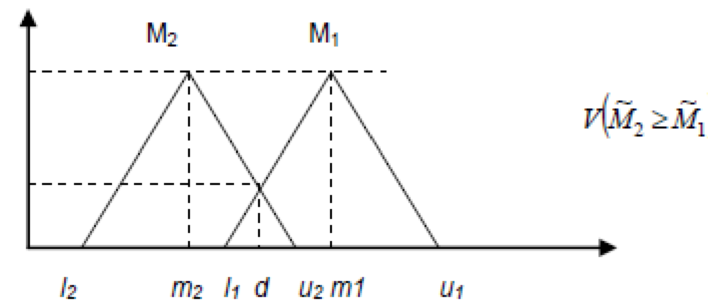

Fig. 3: The intersection between *M1* and *M2*

Step 4:
Via normalization, the normalized weight vectors would be:

$$W = \left(d(A_1), d(A_2), \dots, d(A_n)\right)^T \quad (9)$$

Where W is a non-fuzzy number.

In our analysis we are going to take following attributes as criterias:

Table I: Criteria

Criteria	
C1	*Hardware package*
C2	*Support and availability*
C3	*Programming interface*
C4	*Modularity*
C5	*The price*

Also we are going to use following robot kits as alternatives:

Table II: Alternatives

Alternatives	
A1	Pololu 3pi (Pololu)
A2	RB-Dfr-16 + DFRobot controler (RobotShop)
A3	Boe-Bot Robot (Paralax)
A4	MAKE Rovera 4WD Arduino Robot Kit
A5	DIY platform

V. EXPERIMENTAL STUDY

After we defined main criterias we make pairwise fuzzy comparison using linguistic scale.

Table III: Fuzzy pairwise comparison of criteria

	C1	C2	C3	C4	C5
C1	1,1,1	1,3,5	1/5,1/3,1	1/5,1/3,1	1/5,1/3,1
C2	1/5,1/3,1	1,1,1	1/5,1/3,1	1/5,1/3,1	1/7,1/5,1/3
C3	1,3,5	1,3,5	1,1,1	1/5,1/3,1	1/5,1/3,1
C4	1,3,5	1,3,5	1,3,5	1,1,1	1/5,1/3,1
C5	1,3,5	3,5,7	1,3,5	1,3,5	1,1,1

Weights of all criteria have been determined by Chang analysis. Synthetic values are first calculated:
Based on the equation: (2)

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i\right)$$

it is calculated:

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = (18.943, 40.20, 66.333)$$

Based on the equation:

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right)$$

it is calculated:

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = (0.053, 0.025, 0.015)$$

After (3) and (4) it can be calculated that the synthetic value of each factor equation is:
(5)

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} * \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1}$$

S_{c1}=(2.6,5,9)*(0.053,0.025,0.015)=(0.039,0.124,0.475)

S_{c2}=(1.743,2.2,4.333)*(0.053,0.025,0.015)=(0.026,0.055,0.229)

S_{c3}=(3.4,7.667,13)*(0.053,0.025,0.015)=(0.051,0.191,686)

S_{c4}=(4.2,10.333,17)*(0.053,0.025,0.015)=(0.063,0.257,0.897)

S_{c5}=(7,15,23)*(0.053,0.025,0.015)=(0.106,0.373,1.214)

These fuzzy values are compared by the equation: (6)

$$V(M_2 \ge M_1) = hgt(M_1 \cap M_2) = \mu_{M_2} = \begin{cases} 1 & \text{if } m_2 \ge m_1 \\ 0 & \text{if } l_1 \ge u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & \text{therefore} \end{cases}$$

we get the following values:

$V(S_{c1} \ge S_{c2})$ =1 $V(S_{c3} \ge S_{c1})$ =1
$V(S_{c1} \ge S_{c3})$ =0.865 $V(S_{c3} \ge S_{c2})$ = 1
$V(S_{c1} \ge S_{c4})$ = 0.756 $V(S_{c3} \ge S_{c4})$ =0.904
$V(S_{c1} \ge S_{c5})$ = 0.598 $V(S_{c3} \ge S_{c5})$ = 0.761
$V(S_{c2} \ge S_{c1})$ = 0.731 $V(S_{c4} \ge S_{c1})$ =1
$V(S_{c2} \ge S_{c3})$ = 0.566 $V(S_{c4} \ge S_{c2})$ =1

$V(S_{c2} \ge S_{c4})$ = 0.450 $V(S_{c4} \ge S_{c3})$ =1
$V(S_{c2} \ge S_{c5})$ = 0.279 $V(S_{c4} \ge S_{c5})$ = 0.872
$V(S_{c5} \ge S_{c1})$ = 1 $V(S_{c5} \ge S_{c2})$ = 1
$V(S_{c5} \ge S_{c3})$ = 1 $V(S_{c5} \ge S_{c4})$ = 1

Then the priority weighting vectors are defined as:

$d^{c1} = min(1, 0.865.0.756, 0.598) = 0.598$
$d^{c2} = min(0.731, 0.566.0.45, 0.279) = 0.279$
$d^{c3} = min(1,1,0.904,0.761) = 0.761$
$d^{c4} = min(1,1,1,0.872) = 0.872$
$d^{c5} = min(1,1,1,1,1) = 1$

Accordingly, weighting factors are calculated as $W' = (0.598, 0.279, 0.761, 0.872, 1)^{T}$ the normalized weighting vector

$$W_{faktori} = (0.17, 0.079, 0.217, 0.248, 0.285)^{T}$$

After compairing pairs of criterias we are also doing the comparison of alternatives to individual criteria. Weight for alternatives is calculated in a similar way as weights of criteria.

Table IV: The pairwise alternatives related to C1 (Hardware package)

C1	A1	A2	A3	A4	A5
A1	1,1,1	1/5,1/3,1	1/9,1/7,1/5	1/7,1/5,1/3	1/5,1/3,1
A2	1,3,5	1,1,1	1/7,1/5,1/3	1/7,1/5,1/3	1,1,1
A3	5,7,9	3,5,7	1,1,1	1/5,1/3,1	3,5,7
A4	3,5,7	3,5,7	1,3,5	1,1,1	1,3,5
A5	1,3,5	1,1,1	1/7,1/5,1/3	1/5,1/3,1	1,1,1

Table V: The pairwise alternatives related to C2 (Support and availability)

C2	**A1**	**A2**	**A3**	**A4**	**A5**
A1	1,1,1	1/7,1/5,1/3	1/9,1/7,1/5	1/7,1/5,1/3	1/5,1/3,1
A2	3,5,7	1,1,1	1/5,1/3,1	1/7,1/5,1/3	1,3,5
A3	5,7,9	1,3,5	1,1,1	1/5,1/3,1	5,7,9
A4	3,5,7	3,5,7	1,3,5	1,1,1	3,5,7
A5	1,3,5	1/5,1/3,1	1/9,1/7,1/5	1/7,1/5,1	1,1,1

Table VI: The pairwise alternatives related to C3 (Programing interface)

C3	**A1**	**A2**	**A3**	**A4**	**A5**
A1	1,1,1	1/7,1/5,1/3	1/7,1/5,1/3	1/9,1/7,1/5	1/9,1/7,1/5
A2	3,5,7	1,1,1	1,3,5	1/5,1/3,1	1,3,5
A3	3,5,7	1/5,1/3,1	1,1,1	1/7,1/5,1/3	1/7,1/5,1/3
A4	5,7,9	1,3,5	3,5,7	1,1,1	1,3,5
A5	5,7,9	1/5,1/3,1	3,5,7	1/5,1/3,1	1,1,1

Table VII: The pairwise alternatives related to C4 (Modularity)

C4	**A1**	**A2**	**A3**	**A4**	**A5**
A1	1,1,1	1/9,1/7,1/5	1/7,1/5,1/3	1/9,1/7,1/3	1/11,1/9,1/7
A2	5,7,9	1,1,1	1,3,5	1,1,1	1/5,1/3,1
A3	3,5,7	1/5,1/3,1	1,1,1	1/5,1/3,1	1/7,1/5,1/3
A4	5,7,9	1,1,1	1,3,5	1,1,1	1/5,1/3,1
A5	7,9,11	1,3,5	3,5,7	1,3,5	1,1,1

Table VIII: The pairwise alternatives related to C5 (The price)

C5	**A1**	**A2**	**A3**	**A4**	**A5**
A1	1,1,1	1/5,1/3,1	3,5,7	5,7,9	1/7,1/5,1/3
A2	1,3,5	1,1,1	3,5,7	5,7,9	1/5,1/3,1
A3	1/7,1/5,1/3	1/7,1/5,1/3	1,1,1	3,5,7	1/9,1/7,1/5
A4	1/9,1/7,1/5	1/9,1/7,1/5	1/7,1/5,1/3	1,1,1	1/11,1/9,1/7
A5	3,5,7	1,3,5	5,7,9	7,9,11	1,1,1

VI. Results and Conclusion

After implementing of FAHP, as well as Chang analytic method, we get the following results:

Table IX: Weiglting values of alternative strategies

Criteria	**Weighted priorities**	**Alternative strategies**				
		A1	**A2**	**A3**	**A4**	**A5**
C1	0,170	0,000	0,097	0,361	0,347	0,195
C2	0,079	0,000	0,221	0,346	0,353	0,081
C3	0,217	0,000	0,260	0,134	0,334	0,272
C4	0,248	0,000	0,250	0,119	0,250	0,380
C5	0,285	0,243	0,310	0,013	0,000	0,434
Weights		**0,069**	**0,241**	**0,151**	**0,221**	**0,317**

Results can be shown from the chart:

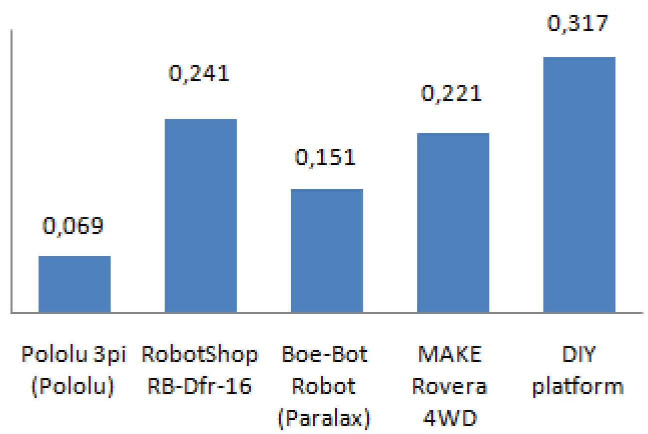

Fig. 4: Weiglting values of alternative strategies

Comparing several chosen robot kits, we get the parameters that have to be taken into consideration in choosing the right robot kit. After implementing of FAHP, as well as Chang analytic method, we get that DIY platform is the best robot kit which can eventually result in the biggest increase of creativity among users.

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