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Using Fuzzy Logic to Evaluate the Relationship between Designing Training Program and Level of Creativity and Innovation

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ABSTRACT: This paper describes the relationship between the designing training program and the level of creativity and innovation by using the fuzzy logic as a suitable tool to evaluate the linguistic variable.
The researchers used the Fuzzy Logic (FL) to analyze the collected data of questionnaires, they used MatLab 6.5 to calculate the FL equations in addition to Excel.
The researchers concluded that there are many different relations between creativity and innovation and the main items of designing the training program.

KEYWORDS: Training program, Fuzzy logic, Creativity, Innovation.

1 INTRODUCTION

Managers are beginning to realize that it's important for their staff to be developed. For that they are always searching for the best ways to increase the level of their staff and to encourage them to create and innovate.

According to the previous studies, many researchers believed that the best way to develop the staff is by the good training program, in addition training makes employees feel that they are part of company family, demonstrates that the organization is interested in its employees' professional development or skill enhancement. As well when employees realize that the organization is investing in them, they reciprocate with loyalty. Ongoing training helps to create the reputation of a great place to work and results in fewer wage demands, less absenteeism, and a longer list of job applicants, on the other hand the training programs can help to increase the level of innovation and creativity.

2 THE TRAINING

2.1 THE CONCEPT OF TRAINING :

Training means changing behaviour pattern , it is the art of doing the job a correct , effective and efficient manner , training has been defined by many authors and scholars as :

1. The process of transmitting and receiving information related to problem solving[1] .
2. The organized procedure by which people learn knowledge and/or skill for a definite purpose[2] .
3. The systematic development of the knowledge, skills and attitudes required by an individual to perform adequately a given task or job[3].

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2.2 THE NEED FOR TRAINING

The efficiency of any organization depends on directly on how well its member are trained. Newly hired employees almost always need some training before they can take up their work, while older employees require training both to keep them alert to the demands of their jobs and to fit them for transfers and promotions[4].

Every organization should provide training to all the employees irrespective of their qualifications and skills. Specifically the need for training arises because of following reasons[5]:

1. Environmental changes: Mechanization, computerization, and automation have resulted in many changes that require trained staff possessing enough skills. The organization should train the employees to enrich them with the latest technology and knowledge.
2. Organizational complexity: With modern inventions, technological upgradation, and diversification most of the organizations have become very complex. This has aggravated the problems of coordination. So, in order to cope up with the complexities, training has become mandatory.
3. Human relations: Every management has to maintain very good human relations, and this has made training as one of the basic conditions to deal with human problems.
4. To match employee specifications with the job requirements and organizational needs: An employee's specification may not exactly suit to the requirements of the job and the organization, irrespective of past experience and skills. There is always a gap between an employee's present specifications and the organization's requirements. For filling this gap training is required.
5. Change in the job assignment: Training is also necessary when the existing employee is promoted to the higher level or transferred to another department. Training is also required to equip the old employees with new techniques and technologies.

2.3 THE CONSIDERATIONS FOR TRAINING PROGRAM

The considerations for developing a training program are as follows[6] :

1. Needs assessment and learning objectives : This part of the framework development asks you to consider what kind of training is needed in your organization. Once you have determined the training needed, you can set learning objectives to measure at the end of the training.
2. Consideration of learning styles : Making sure to teach to a variety of learning styles is important to development of training programs.
3. Delivery mode : What is the best way to get your message across? Is web-based training more appropriate, or should mentoring be used? Can vestibule training be used for a portion of the training while job shadowing be used for some of the training, too? Most training programs will include a variety of delivery methods.
4. Budget : How much money do you have to spend on this training?
5. Delivery style : Will the training be self-paced or instructor led? What kinds of discussions and interactivity can be developed in conjunction with this training?
6. Audience : Who will be part of this training? Do you have a mix of roles, such as accounting people and marketing people? What are the job responsibilities of these individuals, and how can you make the training relevant to their individual jobs?
7. Content : What needs to be taught? How will you sequence the information?
8. Timelines : How long will it take to develop the training? Is there a deadline for training to be completed?
9. Communication : How will employees know the training is available to them?
10. Measuring effectiveness of training : How will you know if your training worked? What ways will you use to measure this?

2.4 DESIGNING TRAINING PROGRAM

An effective training program is built by following a systematic, step-by step process. Training initiatives that stand alone (one-off events) often fail to meet organizational objectives and participant expectations. The five necessary steps to creating an effective program are the following[7] :

1. Assess Training Needs: The first step in designing a training program is to identify and assess needs. Employee training needs may already be established in the organization's strategic, human resources or individual development plans.

2. **Set Organizational Training Objectives:** The training needs assessments (organizational, task & individual) will identify any gaps in the current training initiatives and employee skill sets. These gaps should be analyzed and prioritized and turned into the organization's training objectives. The ultimate goal is to bridge the gap between current and desired performance through the development of a training program.
3. **Create Training Action Plan:** The next step is to create a comprehensive action plan that includes learning theories, instructional design, content, materials and any other training elements. Resources and training delivery methods should also be detailed. While developing the program, the level of training and participants' learning styles need to also be considered.
4. **Implement Training Initiatives :** The implementation phase is where the training program comes to life. Organizations need to decide whether training will be delivered in-house or externally coordinated. Program implementation includes the scheduling of training activities and organization of any related resources (facilities, equipment, etc.). The training program is then officially launched, promoted and conducted. During training, participant progress should be monitored to ensure that the program is effective.
5. **Evaluate & Revise Training:** As mentioned in the last segment, the training program should be continually monitored. At the end, the entire program should be evaluated to determine if it was successful and met training objectives. Feedback should be obtained from all stakeholders to determine program and instructor effectiveness and also knowledge or skill acquisition. Analyzing this feedback will allow the organization to identify any weaknesses in the program. At this point, the training program or action plan can be revised if objectives or expectations are not being met.

2.5 MEASURING EFFECTIVENESS OF TRAINING

After completing the training, the management wants to make sure its training objectives were met. One model to measure effectiveness of training is the Kirkpatrick model, developed in the 1950s. His model has four levels[8] :

1. Reaction: How did the participants react to the training program?
2. Learning: To what extent did participants improve knowledge and skills?
3. Behavior: Did behavior change as a result of the training?
4. Results: What benefits to the organization resulted from the training?

Figure 1 can illustrate the Kirkpatrick's four levels of training evaluation.

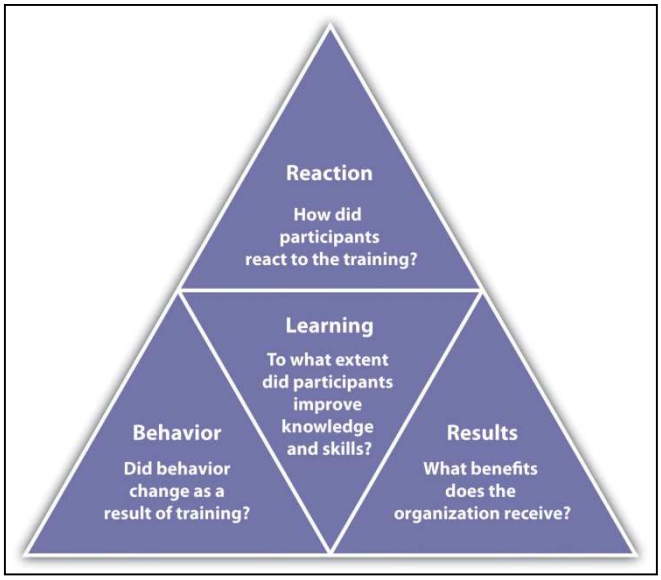

Fig. 1 : Kirkpatrick's four levels of training evaluation

3 THE CREATIVITY

3.1 THE CONCEPT OF CREATIVITY

There are many definitions of creativity. A number of them suggest that :

1. Creativity is the generation of imaginative new ideas, involving a radical newness innovation or solution to a problem, and a radical reformulation of problems[9] .
2. Creative solution, either new or recombined, must have value . A novel idea is not a creative idea unless it is valuable or it implies positive evaluation[10] .
3. Creative is imagination, which involves the generation of ideas not previously available as well as the generation of different ways of seeing events, is important to achieve creative actions[11] .

3.2 THE MAIN TYPE OF CREATIVITY

There are three main types of creativity, involving different ways of generating the novel ideas[12]:

1. The “combinational” creativity that involves new combinations of familiar ideas.
2. The “exploratory” creativity that involves the generation of new ideas by the exploration of structured concepts.
3. The “transformational” creativity that involves the transformation of some dimension of the structure, so that new structures can be generated.

3.3 THE OBJECTIVES OF CREATIVITY

Main objectives of a creative thinking process is to think beyond existing boundaries, to awake curiosity, to break away from rational, conventional ideas and formalised procedures, to rely on the imagination, the divergent, the random and to consider multiple solutions and alternatives[13].

The result of the creative thinking process is especially important for businesses. Managers and managerial decisions and actions, confronted with fast-changing and ambiguous environments in business, need to develop creative solutions and creative action-based strategies to solve problems, as they allow to increase understanding of problematic situations, to find multiple problems, to produce new combinations, to generate multiple solutions that are different from the past, to consider possible alternatives in various situations that could occur in the future and “to expand the opportunity horizon and competence base of firms”[11].

3.4 THE BENEFITS OF CREATIVITY

Creativity, through the generation of ideas with value, is needed in order to solve concrete problems, ease the adaptation to change, optimise the performance of the organisation and best practice manufacturing, and change the attitude of the staff of the organisation. Creative thought processes are also important at all stages in the R&D process. Some expected results of the creativity process are[14] :

- innovation through new product and process ideas
- continuous improvement of products or services
- productivity increase
- efficiency
- rapidity
- flexibility
- quality of products or services
- high performance

4 THE INNOVATION

4.1 THE CONCEPT OF INNOVATION

The significance of innovation is recognized at both the micro and the macro level of an economy. At a firm level, some scholars noted that "Innovation is widely considered as the life blood of corporate survival and growth"[15] . The European Commission defined innovation as a new or significantly improved product (good or service) introduced to the market or the introduction within an enterprise of a new or significantly improved process. Innovations are based on the results of new technological developments, new combinations of existing technology or the utilization of other knowledge acquired by the enterprise. Innovations should be new to the enterprise concerned; for product innovations they do not necessarily have to be new to the market and for process innovations the enterprise does not necessarily have to be the first to have introduced the process[16].

4.2 MANAGEMENT INNOVATION

Management innovation involves the introduction of novelty in an established organization, and as such it represents a particular form of organizational change. In its broadest sense, then, management innovation can be defined as a difference in the form, quality, or state over time of the management activities in an organization, where the change is a novel or unprecedented departure from the past[17].

4.3 PERSPECTIVE OF MANAGEMENT INNOVATION

There are 4 main perspectives of management innovation as following [18] :

1. The institutional perspective takes a macro level and comparatives approach to make sense of the institutional and socioeconomic conditions in which particular management innovations emerge. The institutional perspective measures innovation in terms of the discourse around particular ideologies and also at the level of specific practices or techniques. It gives no direct consideration to the role of human agency in shaping the process; instead, it focuses on the preconditions in which an innovation first emerges and then the factors that enable industries to adopt such innovations.
2. The fashion perspective focuses on how management innovations emerge through the dynamic interplay between the managers who use new management ideas and the "fashion setters" who put forward those ideas. This perspective provides a wealth of insight into how management fashions take shape, including a detailed understanding of the typical attributes of managers who buy into these fashions.
3. The cultural perspective attempts to understand how management innovation shapes, and gets shaped by, the culture of the organization in which it is being implemented. It operates at the meso level of analysis by looking at how individual attitudes toward management innovation interact with the organization level introduction of the innovation. One strand of this literature takes a critical perspective.
4. The rational perspective builds on the premise that management innovations are introduced by individuals with the goal of making their organizations work more effectively. According to this perspective, an individual puts forward an innovative solution to address a specific problem that the organization is facing, and he or she then champions its implementation and adoption.

There is also a subtheme within this perspective concerned with the links between management and technological innovation, which suggests that they may convolve[18].

4.4 THE FRAMEWORK OF MANAGEMENT INNOVATION

The framework of the process of management innovation has two dimensions. The horizontal dimension consists of four phases of the innovation process [18]:

1. Motivation is concerned with the facilitating factors and precipitating circumstances that lead individuals to consider developing their own management innovation.
2. Invention is an initial act of experimentation out of which a new hypothetical management practice emerges.
3. Implementation is the technical process of establishing the value of the new management innovation in vivo.
4. Theorization and labeling is a social process whereby individuals inside and outside the organization make sense of and validate the management innovation to build its legitimacy.

The vertical dimension, scholars expect two groups of individuals to shape the process[19] :

1. Internal change agents, who are the employees of the innovating company proactive in creating interest in, experimenting with, and validating the management innovation in question.
2. External change agents, who, similar to management intellectuals and idea entrepreneurs, are independent consultants, academics, and gurus proactive in creating interest in, influencing the development of, and legitimizing the effectiveness and retention of new management practices.

The figure 2 illustrates the framework of the process of management innovation.

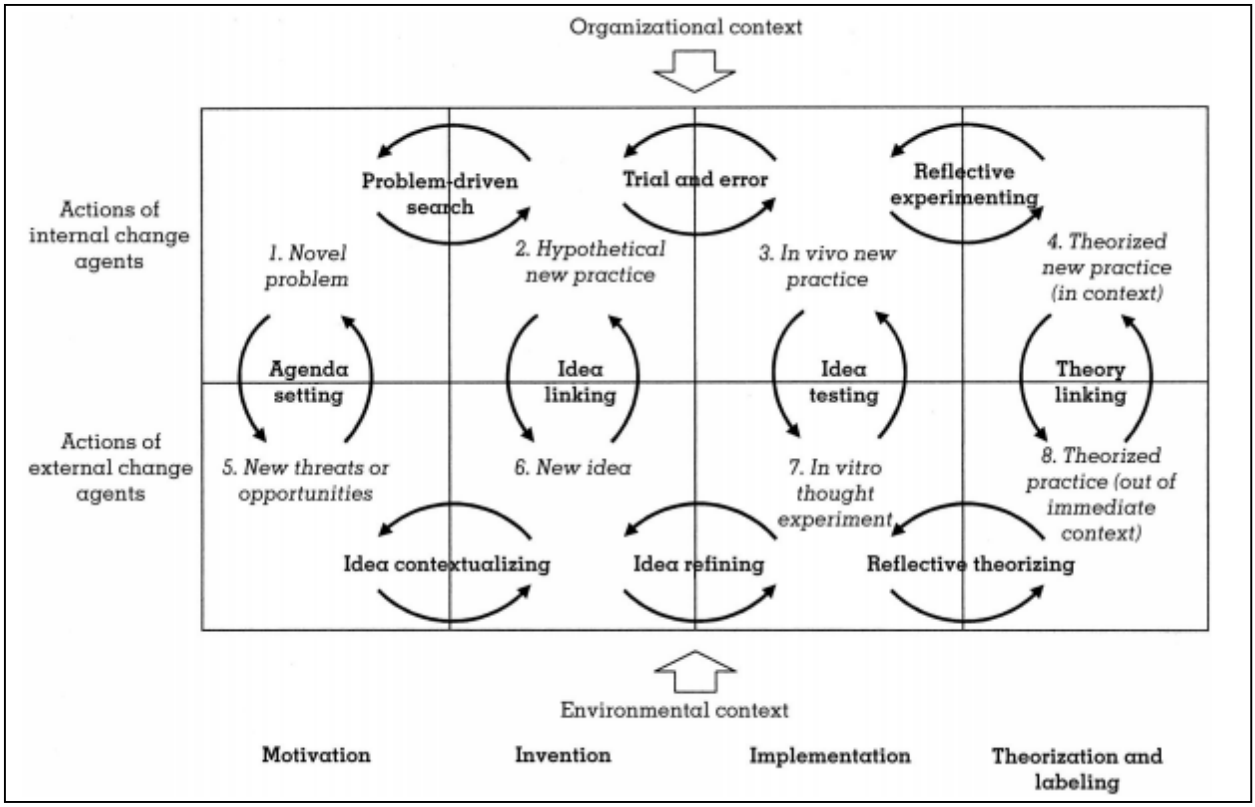

Fig. 2 : The Process of Management Innovation Framework

5 THE PRACTICAL PART

5.1 THE CONCEPT OF FUZZY LOGIC

Fuzzy logic is a form of many-valued logic; it deals with reasoning that is approximate rather than fixed and exact. Compared to traditional binary sets (where variables may take true or false values). Fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false [20].

Furthermore, when linguistic variables are used, these degrees may be managed by specific functions. Irrationality can be described in terms of what is known as the fuzzjective [21].

The term "fuzzy logic" was introduced in the 1965 proposal of fuzzy set theory by Lotfi A. Zadeh. Fuzzy logic has been applied to many fields, from control theory to artificial intelligence [22].

In fact, Zadeh made the following statement in his seminar paper of 1965 : The notion of a fuzzy set provides a convenient point of departure for the construction of a conceptual framework which parallels in many respects the framework used in the case of ordinary sets, but is more general than the latter and, potentially, may prove to have a much wider scope of applicability, particularly in the fields of pattern classification and information processing . Essentially, such a framework provides a natural way of dealing with problems in which the source of imprecision is the absence of sharply defined criteria of class membership rather than the presence of random variables [23].

5.2 THE BENEFITS OF FUZZY LOGIC

There are many benefits of using fuzzy logic, such as [24] :

1. Fuzzy Logic describes systems in terms of a combination of numerics and linguistics (symbolic). This has advantages over pure mathematical (numerical) approaches or pure symbolic approaches because very often system knowledge is available in such a combination.

2. Problems for which an exact mathematically precise description is lacking or is only available for very restricted conditions can often be tackled by fuzzy logic, provided a fuzzy model is present.
3. Fuzzy logic sometimes uses only approximate data, so simple sensors can be used.
4. The algorithms can be described with little data, so little memory is required.
5. The algorithms are often quite understandable.
6. Fuzzy algorithms are often robust, in the sense that they are not very sensitive to changing environments and erroneous or forgotten rules.
7. The reasoning process is often simple, compared to computationally precise systems, so computing power is saved This is a very interesting feature, especially in real time systems.
8. Fuzzy methods usually have a shorter development time than conventional methods.

5.3 FUZZY LOGIC METHODOLOGY

In this section, the results of conducted FL method are highlighted. In the research, we focused mainly on the managers opinions to develop the training program by evaluating their opinions according to the questionnaire.

The researchers distributed 50 questionnaires with 20 questions to 50 managers in Algerian companies. The questionnaire divided to 3 parts, the first part was about the main information of the respondents, the second part contained 25 questions about the measurements of choosing the suitable training program, and the third part contained 25 questions about the relation between the effectiveness of training program and the level of innovation and creative.

All the answers were linguistic variables, so that the FL is the best method to analyze the results.

To analyze the results of the questionnaires by FL. The results are processed by fuzzy logic function, built in Matlab ver. 6.5 according to the following steps:

1. Determining the required ratios of the results.
2. determining the weights of ratios and **questions**
3. Calculating all the ratios, based on the data of the questionnaires.
4. Calculating all the ratios according to their weights which resulted from step 3.
5. Calculating the rate of the linguistic variables by assuming a rated value to each linguistic variable by dividing the weight of each ratio into the number of linguistic variables.
6. Calculating the rate of triangular fuzzy numbers by using the function of fuzzy logic in MatLab ver.6.5.
7. Computing the weighted rates of triangular fuzzy numbers.
8. Determining the fuzzy Distance of each ratio by using the equation (1) and (2) [25].

$$D^2(\tilde{X}, M) = (b-M)^2 + {}^1\!/_3\,(b-M)[(c+a)-2b] + {}^1\!/_{18}\,[(c-b)^2 + (b-a)^2] - {}^1\!/_{18}\,[(c-b)(b-a)]\,f(\alpha) \approx \alpha \ldots . (1)$$

$$D^2(\tilde{X}, M) = (b-M)^2 + {}^1\!/_2\,(b-M)[(c+a)-2b] + {}^1\!/_9\,[(c-b)^2 + (b-a)^2] - {}^1\!/_9\,[(c-b)(b-a)]\,f(\alpha) \approx 1 \ldots . (2)$$

Table 1 shows the results of analysis:

Table 1. Fuzzy Logic Analysis Results

Vr.	Level of innovation	Level of Creativity	Impact	The correlation
Training Program	24%	31%	70%	83%
Choosing Trainers	32%	30%	77%	77%
Choosing Trainees	40%	51%	67%	88%
Content of Program	33%	29%	80%	85%

Fig. 3, 4, and 5 illustrate the results of analysis by bar chart to show the clear view for scholars about the relationship between (content of training of program, choosing the trainees, choosing trainers, and methods of training program) and (innovation and creativity).

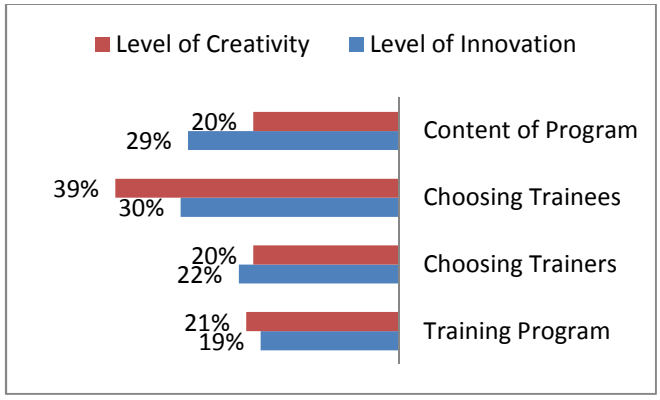

Fig. 3: Fuzzy Logic analysis bar chart

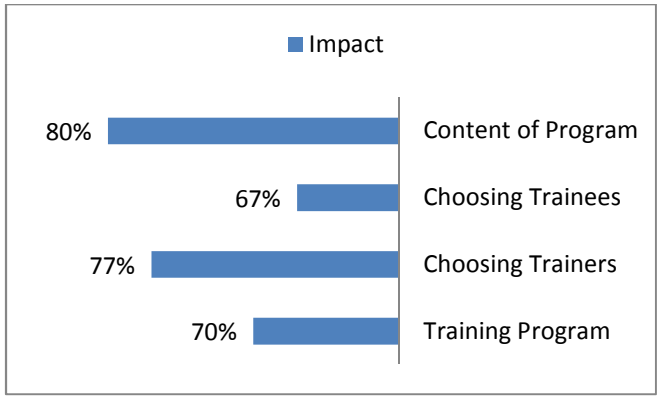

Fig. 4: Fuzzy Logic analysis bar chart

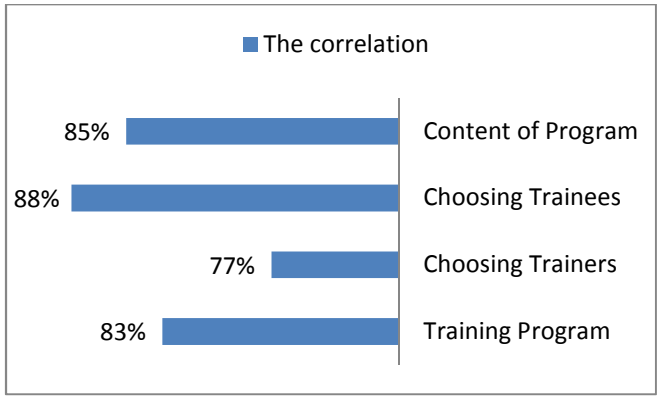

Fig. 5: Fuzzy Logic analysis bar chart

6 CONCLUSION

In this paper the results of Fuzzy Logic analysis of the questionnaires indicate the following:

- Choosing trainees (39%) is the most influential factor on creativity in the organization, and both of the content of program (20%) and choosing trainers (20%) are the least influential factor on creativity.

- Innovation significantly influenced by choosing trainees (30%) and influenced a little by a training program (19%).
- The most important factor that can make a great change in the levels of innovation and creativity jointly is the content of training program (80%), and the least important one is choosing trainees (67%).
- According to the result of correlation coefficient calculation, the strongest relationship is happened between (innovation and creativity) and choosing trainees (88%), and the weakest on is happened between (innovation and creativity) and choosing trainers (77%).

Finally, the proposed algorithm has the capability to deal with similar types of the same situations such as: ranking the best decisions to be dealt with, the best financial ratio in the bank, choosing the best applications in environmental sustainability, etc. therefore, the proposed method provides accurate selection and can be used easily in many sectors.

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