Improving the model of the European Foundation for Quality Management by applying the radar and fuzzy logic approaches (143- 160)

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Abstract:

In the present day's fast-paced and competitive business world, managers attempt to distinguish their firms from the competition. The most common strategy for accomplishing this objective is consistently increasing performance standards. The European Foundation for Quality Management (EFQM) Excellence Model is the most reliable and relevant tool for monitoring a company's progress towards organizational excellence. The European Foundation for Quality Management established this notion. This study employs the EFQM model to provide a novel, unified strategy for boosting the firm's overall performance. The Iraqi Oil Tanker Company conducted a case study to demonstrate the applicability of the proposed technique. This significance was proved by identifying strengths and development opportunities using a European Foundation for Quality Management technique. In the case study, the RADAR method and the proposed fuzzy logic technique were applied (EFQM). Matlab software was utilized to execute the proposed design.

Keywords: EFQM, Fuzzy Logic, RADAR.

INTRODUCTION

Many businesses in today's interconnected global economy benefit from the rapid pace of technological progress and the persistent nature of economic and social problems [1]. They are innovative, ethical, and customer-centric, making the most of existing and emerging technologies to create first-rate products and services. To pinpoint the company's strengths and weaknesses, it's important to have a consistent framework for assessing individual functions. They can organize priorities and find areas that can be recovered. An organization's potential for greatness can be unlocked through employee involvement [2].

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Many businesses have adopted quality management to better their operations and maintain a market advantage. In most cases, these methods adhere to predetermined criteria for assessment [3]. Excellence in the workplace, when properly executed, produces fruitful results and ensures continuity. Organizations use comparative data from the outside to boost their competitiveness and allocation of resources [4]. [5][6]. Analyzing a company's performance helps it achieve its strategic objectives. Effective performance assessment systems have been the focus of a number of research [7]. Institutional success is facilitated by performance analysis. Exemplary practices in the institution are promoted.

Three models determine quality, financial success, and institutionalization. Deming's Model, the Baldrige Performance Excellence Criteria, and the European Foundation for Quality Management can all be used to assess the effectiveness of an institution. When it comes to improving a business' quality, EFQM is unrivalled. Human resource management, skill development, and staff autonomy are all components of the European Foundation for Quality Management [8]. Employees, customers, processes, strategies, value creation, and long-term viability are all part of EFQM.

Organizations can implement Total Quality Management Principles with the aid of EFQM and eventually reach the pinnacle of success [9]. The European Foundation for Quality Management (EFQM) hastens development in both production and service. Product and service quality are enhanced. The TQM methodology and management excellence paradigm promoted by EFQM is widely adopted [10]. The European Foundation for Quality Management (EU). European Foundation for Quality Management (EFQM) Excellence Model [11] was developed in 1992 for the European Quality Award. Its fame extends beyond the borders of Europe. The societal and economic impacts of a company and its customers' satisfaction are all part of EFQM's excellence model. This idea promotes quality management in organizations across Europe. [12]. TQM and EFQM are used by businesses to strive for excellence. Improved levels of customer satisfaction, employee dedication, international trade, new product development, and knowledge management result from using

EFQM. [13] These outstanding features boost the business's ability to compete. The EFQM Management Toolkit creates a system-oriented model of a company's performance by combining financial and non-financial data.

With EFQM's help, your company may achieve higher levels of performance. Organizational processes are also reviewed and tweaked in this process. [14]. the cause-and-effect relationships inside an organization can be better understood with the aid of data collected using the Excellence Framework for Quality Management. Finds and eliminates redundant data and faulty structure. [15]. [Bibliography] By providing a competitive edge to model firms, the EFQM excellence model benefits all stakeholder groups. [16]. The European Foundation for Quality Management (EFQM) is a selfassessment framework [17]. The subjectivity of the model is altered by expert judgments, reducing its usefulness. The model's score prevents us from collecting accurate data from experiments and expert opinions (language variables) [18]. The EFQM model's credibility is undermined by its ambiguous language parameters. When dealing with ambiguity and complexity, fuzzy logic can be useful. We used a fuzzy logic model to simulate this. The same linguistic form can have many meanings with fuzzy logic thanks to the 0-1 membership functions. As a result of its fuzzy nature, fuzzy logic allows for grey areas. [19] The use of fuzzy logic improves the EFQM model. The Fuzzy EFQM was developed in MATLAB's fuzzy inference editor to combine the RADAR scoring system from the traditional EFQM model with the maximum aggregate technique, allowing for a more streamlined implementation process [20]. Because of this, FEFQM was born. The "if-then" framework is central to the FEFQM paradigm. The FEFQM score of the Iraqi Oil Tanker Company was evaluated against that of the more conventional EFQM survey (IOTC).

I*:* Literature review

Literature indicates two EFQM usage. EFQM uses linguistic factors and fuzzy logic to measure quality. EFQM criteria use fuzzy multicriteria decision-making, as seen below. Fuzzy logic simplifies EFQM. This study

examines EFQM's use of RADAR. Business outcomes. Researchers are determining which fuzzy models accurately explain EFQM. Fuzzy logic should generate the most accurate EFQM results. This paper used fuzzy logic and EFQM to analyze self-performance. Abreu et al. [21] Quality Fuzzy Logic R&D This research integrate Fuzzy Logic and EFQM to improve company performance. The case study shows RADAR's Logic's application by analyzing an R&D unit's performance. EFQM uses Fuzzy Logic to identify strengths and shortcomings. Then come high-priority modifications. Alireza Khosravi et al. [22] EFQM-Fuzzy Network Data Envelopment Analysis Model for Organizational Efficiency Assessment evaluates organizational units under fuzzy settings. The proposed method for evaluating an organization's efficiency uses Fuzzy Network Data Envelopment Analysis and EFQM. O. Uygun et al. [23] Fuzzy multicriteria decision-making for EFQM-driven institutionalization. Fuzzy multicriteria decision-making is used to examine EFQM criteria. Fuzzy DEMATEL determines EFQM criteria interactions. A fuzzy analytic network procedure is used to produce sub-criteria weights based on Fuzzy DEMATEL's relationship diagram. Mimi Fotini [24] Fuzzy-set-based self-evaluation. Using fuzzy control systems technology, a self-evaluation mechanism translates language approximation into an automated control plane. The Quality mentioned above Model features are linguistic variables. They use fuzzy LR intervals. Jamal Ezzabadi Hosseini et al. [25] A novel integrated approach based on the EFQM paradigm that integrates fuzzy logic, an AHP, and OR can increase organizational excellence by evaluating business performance and identifying high-priority improvement activities. Yousef Same et al. [26] A quality function deployment (QFD) approach for selecting effective management tools in establishing EFQM. Researchers intend to create a new way to select management tools based on QFD, which has been utilized to create new commodities. Adopting the house of quality (HOQ) to improve management tool selection procedures and corporate satisfaction with excellence achievement is the focus of this research. Fuzzy logic is used because the suggested HOQ requires ambiguous qualitative language evaluations.

A. EFQM Excellence Model

EFQM is available to any business. Operations, strategy, and management are all overseen by EFQM. Europeans developed it in 1988. They educate European businesses on the realities of international rivalry [27]. Good investors have high standards.

In 1991, EFQM introduced EQA to the business world. Companies that have earned the European Quality Assessment label always deliver consistent results. Prospective employees need to excel in making others happy. The use of high-quality software boosts productivity in groups. The European Commission and the European Organization for Quality both stress the importance of using the EQA logo. Cost centres (250 employees), government agencies, and SMEs. A total of twenty thousand persons use EFQM [28].

1992's EFQM. Honour effectiveness, lifespan, and durability [29]. Executives require weight indications. EFQM pinpoints blind spots and overlooked possibilities. Methods for assessing the efficacy of a program's leadership, management, and other components [30]. The EFQM can analyze correlations and find correlations between causes and effects. Business greatness is fueled by learning, relocating resources, expanding knowledge, and creating new services. EFQM takes into account both immediate and plans, and it also draws attention to potential weak spots [31]. Nonstandard procedure. Enabling connections, means, procedures, products, and services. Customers, communities, and results all come together. Contributors to productive outcomes. 500 total for facilitators and outcomes [32]. True. Eight fundamental sections. The EFQM standards include five enablers and four outcomes. The EFQM diagram for RADAR.

B. Why is the EFQM model a useful self-evaluation tool

Recently, connections grew. In this context, a business must improve and innovate to compete. EFQM helps managers focus on stakeholders and improve performance. Regular, detailed selfassessment identifies an organization's potential, restrictions, issue areas, and resource reallocations [33]. Self-evaluation improves performance [34]. Selfassessment drives company greatness.

Self-many evaluation's truth moments make measuring and assessing it challenging. EFQM helps managers identify problems and improvement opportunities [35]. EFQM has four levels. Five hundred points each for

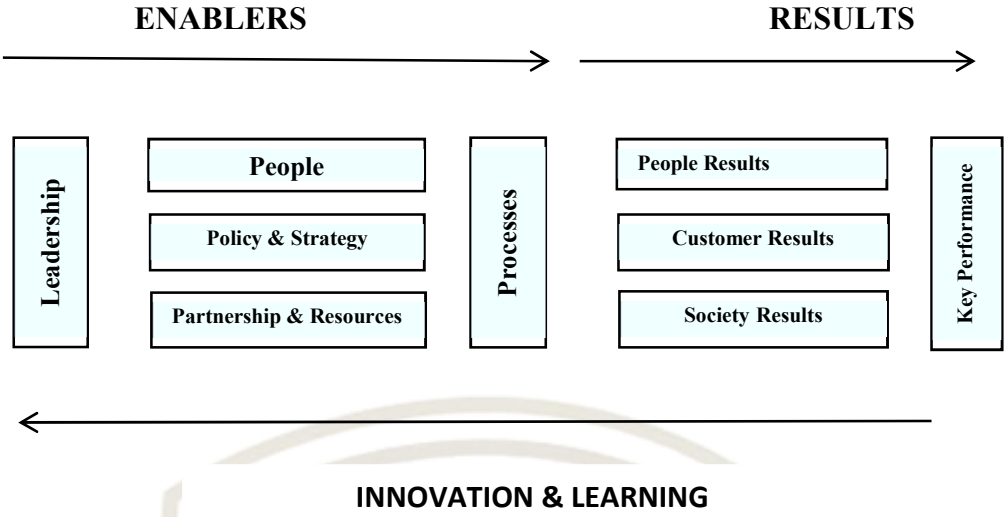
enablers and results. Each sub-attribute and sub-criterion is scored [36]. This research builds an EFQM model for IOTC. Each criterion is scored against EFQM. Data help conclude. The evaluation feeds EFQM's performance standards.

C. The criteria

The first and second sections of EFQM are depicted in this diagram. Leadership, strategy, people, partnerships, resources, procedures, products, and services contribute to a company's bottom line. The satisfaction of the clientele, employees, and the general public are essential outcomes. The application of enabling criteria can be seen in the criteria for results. Facilitators and outcomes analysis provides insight into the organization [37]. Surveys, matrices, workshops, pro formas, and prize simulations are all examples of EFQM assessment methodologies. Half of the EFQM points [38] are allocated to Enablers and the other half to Results. Consumers, employees, and the community benefit from policies, strategies, resources, and processes [39]. There are a variety of methods available for maintaining high standards of performance. When leaders make their policies and strategies a reality through their teams, networks, assets, and processes, they generate outstanding outcomes for their organizations' customers, workers, and society as a whole.

Efficient and Effective Quality Management Diagram (Figure 3). Dynamic model arrows are displayed. Changes in mindset and capability lead to better outcomes. Each organization is evaluated on how well it ticks each of the 9 boxes. None of the 9 criteria is hazy at all. Sub-criteria relevant to the current setting accompany each of the overarching criteria. Evaluations are sought in the criterion sections. Advice for each section of the criteria. These suggestions and enumerations aren't mandatory, but they illustrate the point of the criteria [40].

Fig.1. EFQM Model



D. Fuzzy Logic System

Lotfi Zadeh developed the FL decision-making method in 1965 [41]. The communication between humans and computers is boosted through fuzzy logic. Zadeh refined Aristotle's zero-one logic and established the concept of membership functions [42]. Membership in fuzzy sets can be between 0 and 1 [43]. Fuzzy systems cover many topics, from fuzzy sets to logic to algorithms to control. It is used in all "fuzzy domains," or areas where accuracy is uncertain. It offers a smooth, continuous, and steady change from 0 to 1, rather than a sudden jump [44].

Discrete values can be dealt with in classical set theory and logic. Members of regular sets (crisp sets) can be classified in just two ways. Standard logical assertions can either be true (represented by 1) or untrue (represented by 0). (expressed by 0). Fuzzy systems introduce a new dimension to research by allowing for a greater degree of nuanced accuracy. Particularly in isolated areas, fog constantly persists [45].

FL can be used to collect data from embedded microcontrollers to massive multichannel networked PCs or workstations [46]. One of its strongest points is the deft way it deals with incomplete, erroneous or unclear input. Rules such as IF X AND Y THEN Z are used instead of mathematical modelling [47]. This mapping takes in multiple input data sets and returns a single value. Components of an FL system include a fuzzifier, a rule base, an inference engine, and a defuzzifier [48].

II: Proposed approach

This study utilized fuzzy logic to EFQM's RADAR rating system. RADAR separates inputs and outputs. RADAR's input criteria (Sound, Integrated, Applied, Systematic, Measure, Learn, Create, Improve, and Innovate) Using input models, each entrance criterion is compared. The proportion of results is determined by (trends, goals, comparison, reasons, and scope). Standardization is necessary. In the EFQM Excellence Model, a score of 5 (0 to 100) is critical. A points system. Fuzzy logic is ML's AI. MATLAB used fuzzy logic to implement EFQM. Matlab's Fuzzy Logic Toolbox implements fuzzy logic (FLT). FLT structures the fuzzy inference system. We programmed the radar's components using fuzzy logic; you can do the same in Matlab or by coding directly into the system.

Fuzzy system development requires Fuzzy Logic Toolbox. Matlab basics "Evaluating Enabling Factors" and "Assessing Outcomes" RADAR tables are used to score the EFQM model. The model score is 1000. Input and results each get 50% of the points. The organization's performance affects its results. The company's performance hopes to keep rising. EFQM uses weighted criteria to evaluate organizations. Standard weights exist. Table1 (a& b) shows the current standard weights. Nine major standards are weighed.

To compute sub-criteria weights, divide 100 main-criteria points by the number of sub-criteria. Example: 100 pips, 10% weight on the above, and 25% weight on each sub-criteria. Only two criteria have as much weight.

Table 1. (a) Criterion Weights

	Criterion Weight	Criteria	Lower Criterion	Sub Criterion weight
enablers Criteria 50%	10%	(1) Leadership	1. a	20
			1. b	20
			1. c	20
			1.d	20
			1. e	20
	10%	(2) People	2. a	20
			2. b	20
			2. c	20
			2. d	20
			2. e	20
	10%	(3) Policy & Strategy	3. a	25
			3. b	25
			3. c	25
			3.d	25
	10%	(4) Partnership and resources	4. a	20
			4. b	20
			4. c	20
			4. d	20
			4. e	20
	10%	(5) Processes	5. a	20
			5. b	20
			5. c	20
			5. d	20
			5. e	20

Table 1. (b) Criterion Weights

	Criterion Weight	Criteria	Lower Criterion	Sub Criterion weight
Results Criterion 50%	15%	(6) People's results	6. a	112.5
			6. b	37.5
	10%	(7) Customer results	7. a	75
			7. b	25
	10%	(8) Society results	8. a	50
			8. b	50
	15%	(9) Key performance results	9. a	75
			9. b	75

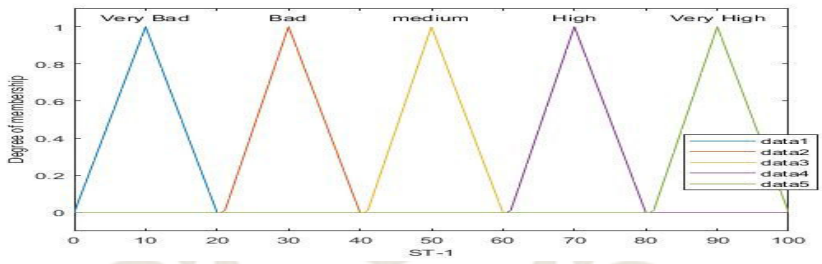
Seven sets of input members, including "sound," "integration," "implementation," "systematic," "measurement," "learning," "innovation," "improvement," and "Directing," were used to create the fuzzy system of enabling criteria.

There are five categories of inputs that contribute to the output criteria.

Examples of input and output membership pools include tendencies, objectives, comparisons, justifications, and scope. Using conventional EFQM and expert scales, you will need to evaluate the model's outputs. Thirty-two different criteria are utilized to strike a balance between competing considerations.

The membership functions' input and output parameters must be defined. The EFQM model's point values are used to input these parameters into the system. The membership function editor depicted in Figure 2

Fig.1. Membership function EFQM



After creating the membership functions, proceed to Table 2 to see the fuzzy system's membership functions and the individual parameter values for each class. To gauge quality, pick an option from "poor," "not enough," "enough," "excellent," or "very good." Possibilities and outcomes that allow this to happen follow their guidelines. A five-person EFQM evaluation team uncovered them. It Helps set the stage for success. There are certain fundamental guidelines contained in the criteria.

Table 2. Fuzzy sets and membership functions

Ne.	Fuzzy Set	Membership Function [α, β, γ]
1	(“Bad”) a small segment of regions/ No evidence	(0,10,20)
2	(“Insufficient”) limited evidence/≈ ¼ of regions	(21,30,40)
3	(“Sufficient”) remarkable evidence/ ≈ ½ of regions	(41,50,60)
4	(“Good”) strong evidence/≈ 3/4 of regions	(61,75,80)
5	(“Very Good”) complete evidence/≈ entire region	(81,90,100)

Internal assessments of the company's performance were made. The overall score and the scores for the individual subcriteria are displayed in a scoring table.

Using a simulation-based evaluation method, the Iraqi Oil Tanker Company was ranked for the EFQM Award. SelfassessmentSelfassessment reports, or the status document, were the initial step. Table3 (a& b) display the criteria used to assign the institution's overall and component grades. Afterwards, the values were recorded by radar logic and the fuzzy logic of the Iraqi Oil Tankers Company.

Table 3. (a) evaluation for (IOTC) by considering the RADAR approach

Enablers										
Criterion No.	1	%	2	%	3	%	4	%	5	%
Sub Criterion	1a	65	2a	70	3a	70	4a	70	5a	70
Sub Criterion	1b	60	2b	65	3b	75	4b	65	5b	75
Sub Criterion	1c	70	2c	70	3c	65	4c	65	5c	70
Sub Criterion	1d	70	2d	70	3d	70	4d	65	5d	70
Sub Criterion	1e	65			3e	70	4e	70	5e	70
sum		330		275		350		335		355
		÷5		÷4		÷5		÷5		÷5
Total Criterion		66		68.8		70		67		71

Result															
No.	6	%			7	%			8	%			9	%		
Sub	6a	75	*0.75	56.25	7a	70	*0.75	52.5	8a	65	*0.5	32.5	9a	70	*0.5	35
Sub	6b	70	*0.25	17.5	7b	70	*0.25	17.5	8b	70	*0.5	32	9b	70	*0.5	35
Total				73.75				70				67.5				70

Table 3.(b) evaluation for (IOTC) by using a fuzzy approach

Enablers										
Criterion No.	1	%	2	%	3	%	4	%	5	%
Sub Criterion	1a	68	2a	70	3a	64	4a	76	5a	75
Sub Criterion	1b	61	2b	76	3b	73	4b	79	5b	80
Sub Criterion	1c	72	2c	75	3c	66	4c	75	5c	76
Sub Criterion	1d	69	2d	74	3d	65	4d	77	5d	78
Sub Criterion	1e	66			3e	60	4e	78	5e	74
sum		336		295		328		385		383
		÷5		÷4		÷5		÷5		÷5
Total Criterion		67.2		73.8		65.6		77		76.6

Result																
No.	6	%			7	%			8	%			9	%		
Sub	6a	72	*0.75	54	7a	73	*0.75	54.75	8a	70	*0.5	35	9a	80	*0.5	40
Sub	6b	73	*0.25	18.25	7b	74	*0.25	18.5	8b	68	*0.5	34	9b	85	*0.5	42.5
Total				72.25				73.25				69				82.5

EFQM and other quality management standards place a premium on what is known as "enabling factors" and "outcomes." The individual criteria are considered as well as the aggregate score. Analyze the full results of both systems and compare them. There seems to be little variation. Scoring on each criterion yields two values, but the relative difference between them is so small that it's nearly difficult to tell which approach was used.

CONCLUSION

An integrated approach to enhance the overall performance of the Iraqi Oil Tanker Company is enhanced through decision-making based on fuzzy logic. The EFQM publication now includes RADAR and Fuzzy Logic for assessing subcriteria. The organization's strengths and weaknesses are identified, and then corrective actions are taken. To follow up on the existing and implemented improvement initiatives, action plans have been formulated for each area (intensification of educational activities and courses, in addition to encouraging employees to achieve and innovate by honouring them, giving them material and moral incentives, praising good leadership. And others). The Iraqi Oil Tanker Company has assessed based on the EFQM and Fuzzy Logic model. A status document has determined that it applies to other Iraqi oil companies.

You can, for example, focus on problem points and make appropriate adjustments from there. Among the many potential applications of the proposed technology is the integration of several Fuzzy Logic standards,

such as (AHP), OR, DEMATEL, and ELECTRO. To achieve the goal of integration, the proposed method is strengthened by sorting out problem areas and necessary operations according to the established criteria.

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Improving the model of the European Foundation for Quality Management by applying the radar and fuzzy logic approaches (143- 160)

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Abstract:

In the present day's fast-paced and competitive business world, managers attempt to distinguish their firms from the competition. The most common strategy for accomplishing this objective is consistently increasing performance standards. The European Foundation for Quality Management (EFQM) Excellence Model is the most reliable and relevant tool for monitoring a company's progress towards organizational excellence. The European Foundation for Quality Management established this notion. This study employs the EFQM model to provide a novel, unified strategy for boosting the firm's overall performance. The Iraqi Oil Tanker Company conducted a case study to demonstrate the applicability of the proposed technique. This significance was proved by identifying strengths and development opportunities using a European Foundation for Quality Management technique. In the case study, the RADAR method and the proposed fuzzy logic technique were applied (EFQM). Matlab software was utilized to execute the proposed design.

Keywords: EFQM, Fuzzy Logic, RADAR.

INTRODUCTION

Many businesses in today's interconnected global economy benefit from the rapid pace of technological progress and the persistent nature of economic and social problems [1]. They are innovative, ethical, and customer-centric, making the most of existing and emerging technologies to create first-rate products and services. To pinpoint the company's strengths and weaknesses, it's important to have a consistent framework for assessing individual functions. They can organize priorities and find areas that can be recovered. An organization's potential for greatness can be unlocked through employee involvement [2].

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Many businesses have adopted quality management to better their operations and maintain a market advantage. In most cases, these methods adhere to predetermined criteria for assessment [3]. Excellence in the workplace, when properly executed, produces fruitful results and ensures continuity. Organizations use comparative data from the outside to boost their competitiveness and allocation of resources [4]. [5][6]. Analyzing a company's performance helps it achieve its strategic objectives. Effective performance assessment systems have been the focus of a number of research [7]. Institutional success is facilitated by performance analysis. Exemplary practices in the institution are promoted.

Three models determine quality, financial success, and institutionalization. Deming's Model, the Baldrige Performance Excellence Criteria, and the European Foundation for Quality Management can all be used to assess the effectiveness of an institution. When it comes to improving a business' quality, EFQM is unrivalled. Human resource management, skill development, and staff autonomy are all components of the European Foundation for Quality Management [8]. Employees, customers, processes, strategies, value creation, and long-term viability are all part of EFQM.

Organizations can implement Total Quality Management Principles with the aid of EFQM and eventually reach the pinnacle of success [9]. The European Foundation for Quality Management (EFQM) hastens development in both production and service. Product and service quality are enhanced. The TQM methodology and management excellence paradigm promoted by EFQM is widely adopted [10]. The European Foundation for Quality Management (EU). European Foundation for Quality Management (EFQM) Excellence Model [11] was developed in 1992 for the European Quality Award. Its fame extends beyond the borders of Europe. The societal and economic impacts of a company and its customers' satisfaction are all part of EFQM's excellence model. This idea promotes quality management in organizations across Europe. [12]. TQM and EFQM are used by businesses to strive for excellence. Improved levels of customer satisfaction, employee dedication, international trade, new product development, and knowledge management result from using

EFQM. [13] These outstanding features boost the business's ability to compete. The EFQM Management Toolkit creates a system-oriented model of a company's performance by combining financial and non-financial data.

With EFQM's help, your company may achieve higher levels of performance. Organizational processes are also reviewed and tweaked in this process. [14]. the cause-and-effect relationships inside an organization can be better understood with the aid of data collected using the Excellence Framework for Quality Management. Finds and eliminates redundant data and faulty structure. [15]. [Bibliography] By providing a competitive edge to model firms, the EFQM excellence model benefits all stakeholder groups. [16]. The European Foundation for Quality Management (EFQM) is a selfassessment framework [17]. The subjectivity of the model is altered by expert judgments, reducing its usefulness. The model's score prevents us from collecting accurate data from experiments and expert opinions (language variables) [18]. The EFQM model's credibility is undermined by its ambiguous language parameters. When dealing with ambiguity and complexity, fuzzy logic can be useful. We used a fuzzy logic model to simulate this. The same linguistic form can have many meanings with fuzzy logic thanks to the 0-1 membership functions. As a result of its fuzzy nature, fuzzy logic allows for grey areas. [19] The use of fuzzy logic improves the EFQM model. The Fuzzy EFQM was developed in MATLAB's fuzzy inference editor to combine the RADAR scoring system from the traditional EFQM model with the maximum aggregate technique, allowing for a more streamlined implementation process [20]. Because of this, FEFQM was born. The "if-then" framework is central to the FEFQM paradigm. The FEFQM score of the Iraqi Oil Tanker Company was evaluated against that of the more conventional EFQM survey (IOTC).

I*:* Literature review

Literature indicates two EFQM usage. EFQM uses linguistic factors and fuzzy logic to measure quality. EFQM criteria use fuzzy multicriteria decision-making, as seen below. Fuzzy logic simplifies EFQM. This study

examines EFQM's use of RADAR. Business outcomes. Researchers are determining which fuzzy models accurately explain EFQM. Fuzzy logic should generate the most accurate EFQM results. This paper used fuzzy logic and EFQM to analyze self-performance. Abreu et al. [21] Quality Fuzzy Logic R&D This research integrate Fuzzy Logic and EFQM to improve company performance. The case study shows RADAR's Logic's application by analyzing an R&D unit's performance. EFQM uses Fuzzy Logic to identify strengths and shortcomings. Then come high-priority modifications. Alireza Khosravi et al. [22] EFQM-Fuzzy Network Data Envelopment Analysis Model for Organizational Efficiency Assessment evaluates organizational units under fuzzy settings. The proposed method for evaluating an organization's efficiency uses Fuzzy Network Data Envelopment Analysis and EFQM. O. Uygun et al. [23] Fuzzy multicriteria decision-making for EFQM-driven institutionalization. Fuzzy multicriteria decision-making is used to examine EFQM criteria. Fuzzy DEMATEL determines EFQM criteria interactions. A fuzzy analytic network procedure is used to produce sub-criteria weights based on Fuzzy DEMATEL's relationship diagram. Mimi Fotini [24] Fuzzy-set-based self-evaluation. Using fuzzy control systems technology, a self-evaluation mechanism translates language approximation into an automated control plane. The Quality mentioned above Model features are linguistic variables. They use fuzzy LR intervals. Jamal Ezzabadi Hosseini et al. [25] A novel integrated approach based on the EFQM paradigm that integrates fuzzy logic, an AHP, and OR can increase organizational excellence by evaluating business performance and identifying high-priority improvement activities. Yousef Same et al. [26] A quality function deployment (QFD) approach for selecting effective management tools in establishing EFQM. Researchers intend to create a new way to select management tools based on QFD, which has been utilized to create new commodities. Adopting the house of quality (HOQ) to improve management tool selection procedures and corporate satisfaction with excellence achievement is the focus of this research. Fuzzy logic is used because the suggested HOQ requires ambiguous qualitative language evaluations.

A. EFQM Excellence Model

EFQM is available to any business. Operations, strategy, and management are all overseen by EFQM. Europeans developed it in 1988. They educate European businesses on the realities of international rivalry [27]. Good investors have high standards.

In 1991, EFQM introduced EQA to the business world. Companies that have earned the European Quality Assessment label always deliver consistent results. Prospective employees need to excel in making others happy. The use of high-quality software boosts productivity in groups. The European Commission and the European Organization for Quality both stress the importance of using the EQA logo. Cost centres (250 employees), government agencies, and SMEs. A total of twenty thousand persons use EFQM [28].

1992's EFQM. Honour effectiveness, lifespan, and durability [29]. Executives require weight indications. EFQM pinpoints blind spots and overlooked possibilities. Methods for assessing the efficacy of a program's leadership, management, and other components [30]. The EFQM can analyze correlations and find correlations between causes and effects. Business greatness is fueled by learning, relocating resources, expanding knowledge, and creating new services. EFQM takes into account both immediate and plans, and it also draws attention to potential weak spots [31]. Nonstandard procedure. Enabling connections, means, procedures, products, and services. Customers, communities, and results all come together. Contributors to productive outcomes. 500 total for facilitators and outcomes [32]. True. Eight fundamental sections. The EFQM standards include five enablers and four outcomes. The EFQM diagram for RADAR.

B. Why is the EFQM model a useful self-evaluation tool

Recently, connections grew. In this context, a business must improve and innovate to compete. EFQM helps managers focus on stakeholders and improve performance. Regular, detailed selfassessment identifies an organization's potential, restrictions, issue areas, and resource reallocations [33]. Self-evaluation improves performance [34]. Selfassessment drives company greatness.

Self-many evaluation's truth moments make measuring and assessing it challenging. EFQM helps managers identify problems and improvement opportunities [35]. EFQM has four levels. Five hundred points each for

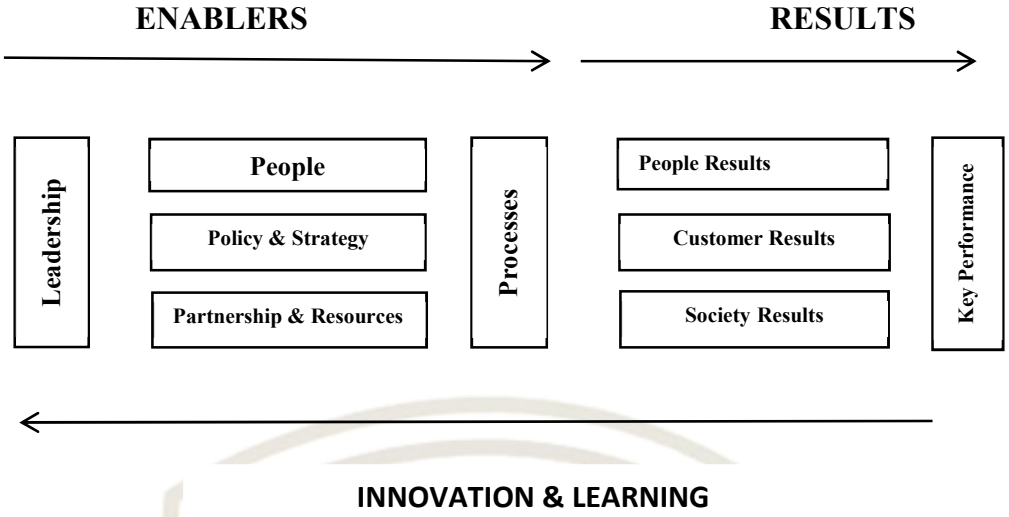
enablers and results. Each sub-attribute and sub-criterion is scored [36]. This research builds an EFQM model for IOTC. Each criterion is scored against EFQM. Data help conclude. The evaluation feeds EFQM's performance standards.

C. The criteria

The first and second sections of EFQM are depicted in this diagram. Leadership, strategy, people, partnerships, resources, procedures, products, and services contribute to a company's bottom line. The satisfaction of the clientele, employees, and the general public are essential outcomes. The application of enabling criteria can be seen in the criteria for results. Facilitators and outcomes analysis provides insight into the organization [37]. Surveys, matrices, workshops, pro formas, and prize simulations are all examples of EFQM assessment methodologies. Half of the EFQM points [38] are allocated to Enablers and the other half to Results. Consumers, employees, and the community benefit from policies, strategies, resources, and processes [39]. There are a variety of methods available for maintaining high standards of performance. When leaders make their policies and strategies a reality through their teams, networks, assets, and processes, they generate outstanding outcomes for their organizations' customers, workers, and society as a whole.

Efficient and Effective Quality Management Diagram (Figure 3). Dynamic model arrows are displayed. Changes in mindset and capability lead to better outcomes. Each organization is evaluated on how well it ticks each of the 9 boxes. None of the 9 criteria is hazy at all. Sub-criteria relevant to the current setting accompany each of the overarching criteria. Evaluations are sought in the criterion sections. Advice for each section of the criteria. These suggestions and enumerations aren't mandatory, but they illustrate the point of the criteria [40].

Fig.1. EFQM Model



D. Fuzzy Logic System

Lotfi Zadeh developed the FL decision-making method in 1965 [41]. The communication between humans and computers is boosted through fuzzy logic. Zadeh refined Aristotle's zero-one logic and established the concept of membership functions [42]. Membership in fuzzy sets can be between 0 and 1 [43]. Fuzzy systems cover many topics, from fuzzy sets to logic to algorithms to control. It is used in all "fuzzy domains," or areas where accuracy is uncertain. It offers a smooth, continuous, and steady change from 0 to 1, rather than a sudden jump [44].

Discrete values can be dealt with in classical set theory and logic. Members of regular sets (crisp sets) can be classified in just two ways. Standard logical assertions can either be true (represented by 1) or untrue (represented by 0). (expressed by 0). Fuzzy systems introduce a new dimension to research by allowing for a greater degree of nuanced accuracy. Particularly in isolated areas, fog constantly persists [45].

FL can be used to collect data from embedded microcontrollers to massive multichannel networked PCs or workstations [46]. One of its strongest points is the deft way it deals with incomplete, erroneous or unclear input. Rules such as IF X AND Y THEN Z are used instead of mathematical modelling [47]. This mapping takes in multiple input data sets and returns a single value. Components of an FL system include a fuzzifier, a rule base, an inference engine, and a defuzzifier [48].

II: Proposed approach

This study utilized fuzzy logic to EFQM's RADAR rating system. RADAR separates inputs and outputs. RADAR's input criteria (Sound, Integrated, Applied, Systematic, Measure, Learn, Create, Improve, and Innovate) Using input models, each entrance criterion is compared. The proportion of results is determined by (trends, goals, comparison, reasons, and scope). Standardization is necessary. In the EFQM Excellence Model, a score of 5 (0 to 100) is critical. A points system. Fuzzy logic is ML's AI. MATLAB used fuzzy logic to implement EFQM. Matlab's Fuzzy Logic Toolbox implements fuzzy logic (FLT). FLT structures the fuzzy inference system. We programmed the radar's components using fuzzy logic; you can do the same in Matlab or by coding directly into the system.

Fuzzy system development requires Fuzzy Logic Toolbox. Matlab basics "Evaluating Enabling Factors" and "Assessing Outcomes" RADAR tables are used to score the EFQM model. The model score is 1000. Input and results each get 50% of the points. The organization's performance affects its results. The company's performance hopes to keep rising. EFQM uses weighted criteria to evaluate organizations. Standard weights exist. Table1 (a& b) shows the current standard weights. Nine major standards are weighed.

To compute sub-criteria weights, divide 100 main-criteria points by the number of sub-criteria. Example: 100 pips, 10% weight on the above, and 25% weight on each sub-criteria. Only two criteria have as much weight.

Table 1. (a) Criterion Weights

	Criterion Weight	Criteria	Lower Criterion	Sub Criterion weight
enablers Criteria 50%	10%	(1) Leadership	1. a	20
			1. b	20
			1. c	20
			1.d	20
			1. e	20
	10%	(2) People	2. a	20
			2. b	20
			2. c	20
			2. d	20
			2. e	20
	10%	(3) Policy & Strategy	3. a	25
			3. b	25
			3. c	25
			3.d	25
	10%	(4) Partnership and resources	4. a	20
			4. b	20
			4. c	20
			4. d	20
			4. e	20
	10%	(5) Processes	5. a	20
			5. b	20
			5. c	20
			5. d	20
			5. e	20

Table 1. (b) Criterion Weights

	Criterion Weight	Criteria	Lower Criterion	Sub Criterion weight
Results Criterion 50%	15%	(6) People's results	6. a	112.5
			6. b	37.5
	10%	(7) Customer results	7. a	75
			7. b	25
	10%	(8) Society results	8. a	50
			8. b	50
	15%	(9) Key performance results	9. a	75
			9. b	75

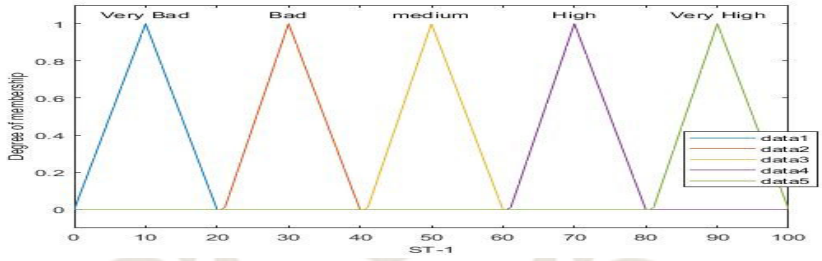
Seven sets of input members, including "sound," "integration," "implementation," "systematic," "measurement," "learning," "innovation," "improvement," and "Directing," were used to create the fuzzy system of enabling criteria.

There are five categories of inputs that contribute to the output criteria.

Examples of input and output membership pools include tendencies, objectives, comparisons, justifications, and scope. Using conventional EFQM and expert scales, you will need to evaluate the model's outputs. Thirty-two different criteria are utilized to strike a balance between competing considerations.

The membership functions' input and output parameters must be defined. The EFQM model's point values are used to input these parameters into the system. The membership function editor depicted in Figure 2

Fig.1. Membership function EFQM



After creating the membership functions, proceed to Table 2 to see the fuzzy system's membership functions and the individual parameter values for each class. To gauge quality, pick an option from "poor," "not enough," "enough," "excellent," or "very good." Possibilities and outcomes that allow this to happen follow their guidelines. A five-person EFQM evaluation team uncovered them. It Helps set the stage for success. There are certain fundamental guidelines contained in the criteria.

Table 2. Fuzzy sets and membership functions

Ne.	Fuzzy Set	Membership Function [α, β, γ]
1	(“Bad”) a small segment of regions/ No evidence	(0,10,20)
2	(“Insufficient”) limited evidence/≈ ¼ of regions	(21,30,40)
3	(“Sufficient”) remarkable evidence/ ≈ ½ of regions	(41,50,60)
4	(“Good”) strong evidence/≈ 3/4 of regions	(61,75,80)
5	(“Very Good”) complete evidence/≈ entire region	(81,90,100)

Internal assessments of the company's performance were made. The overall score and the scores for the individual subcriteria are displayed in a scoring table.

Using a simulation-based evaluation method, the Iraqi Oil Tanker Company was ranked for the EFQM Award. SelfassessmentSelfassessment reports, or the status document, were the initial step. Table3 (a& b) display the criteria used to assign the institution's overall and component grades. Afterwards, the values were recorded by radar logic and the fuzzy logic of the Iraqi Oil Tankers Company.

Table 3. (a) evaluation for (IOTC) by considering the RADAR approach

Enablers										
Criterion No.	1	%	2	%	3	%	4	%	5	%
Sub Criterion	1a	65	2a	70	3a	70	4a	70	5a	70
Sub Criterion	1b	60	2b	65	3b	75	4b	65	5b	75
Sub Criterion	1c	70	2c	70	3c	65	4c	65	5c	70
Sub Criterion	1d	70	2d	70	3d	70	4d	65	5d	70
Sub Criterion	1e	65			3e	70	4e	70	5e	70
sum		330		275		350		335		355
		÷5		÷4		÷5		÷5		÷5
Total Criterion		66		68.8		70		67		71

Result															
No.	6	%			7	%			8	%			9	%		
Sub	6a	75	*0.75	56.25	7a	70	*0.75	52.5	8a	65	*0.5	32.5	9a	70	*0.5	35
Sub	6b	70	*0.25	17.5	7b	70	*0.25	17.5	8b	70	*0.5	32	9b	70	*0.5	35
Total				73.75				70				67.5				70

Table 3.(b) evaluation for (IOTC) by using a fuzzy approach

Enablers										
Criterion No.	1	%	2	%	3	%	4	%	5	%
Sub Criterion	1a	68	2a	70	3a	64	4a	76	5a	75
Sub Criterion	1b	61	2b	76	3b	73	4b	79	5b	80
Sub Criterion	1c	72	2c	75	3c	66	4c	75	5c	76
Sub Criterion	1d	69	2d	74	3d	65	4d	77	5d	78
Sub Criterion	1e	66			3e	60	4e	78	5e	74
sum		336		295		328		385		383
		÷5		÷4		÷5		÷5		÷5
Total Criterion		67.2		73.8		65.6		77		76.6

Result																
No.	6	%			7	%			8	%			9	%		
Sub	6a	72	*0.75	54	7a	73	*0.75	54.75	8a	70	*0.5	35	9a	80	*0.5	40
Sub	6b	73	*0.25	18.25	7b	74	*0.25	18.5	8b	68	*0.5	34	9b	85	*0.5	42.5
Total				72.25				73.25				69				82.5

EFQM and other quality management standards place a premium on what is known as "enabling factors" and "outcomes." The individual criteria are considered as well as the aggregate score. Analyze the full results of both systems and compare them. There seems to be little variation. Scoring on each criterion yields two values, but the relative difference between them is so small that it's nearly difficult to tell which approach was used.

CONCLUSION

An integrated approach to enhance the overall performance of the Iraqi Oil Tanker Company is enhanced through decision-making based on fuzzy logic. The EFQM publication now includes RADAR and Fuzzy Logic for assessing subcriteria. The organization's strengths and weaknesses are identified, and then corrective actions are taken. To follow up on the existing and implemented improvement initiatives, action plans have been formulated for each area (intensification of educational activities and courses, in addition to encouraging employees to achieve and innovate by honouring them, giving them material and moral incentives, praising good leadership. And others). The Iraqi Oil Tanker Company has assessed based on the EFQM and Fuzzy Logic model. A status document has determined that it applies to other Iraqi oil companies.

You can, for example, focus on problem points and make appropriate adjustments from there. Among the many potential applications of the proposed technology is the integration of several Fuzzy Logic standards,

such as (AHP), OR, DEMATEL, and ELECTRO. To achieve the goal of integration, the proposed method is strengthened by sorting out problem areas and necessary operations according to the established criteria.

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