A suggested framework for evaluating the status of design by using the concepts of (Prioritization Matrix) and (SWOT)

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Abstract:

This paper seeks to devise a systematic framework to be used in defining the status of the industrial design (ID), in terms of (1) Select the best design amongst a set of designs, (2) Determining the status of a certain design, (3) Defining the alternatives of evolution for a certain design. This systematic framework can help the productive institutions in defining the status of the current and/ or the new design/ designs, with the purpose of determining the alternatives of development.

The suggested framework is based on the use of the concept of the (Prioritization Matrix) in calculating the relative decimal value (RDV) for the most important factors that affect the quality of the design, namely, (Appearance; Function; Price; and Time of supply), in addition to exploit the concept of (SWOT) as a tool that helps in determining the status of design by sorting the factors affect the design quality into two main groups, where the first group includes the internal factors, and the other group includes the external ones. It is worth to mention that the research doesn't seek to use any of the design analysis tools of SWOT nor the prioritization matrix strictly, however the paper is limited to make a combination between the concepts of both of the aforementioned analysis tools to devise a simplified framework. Eventually, the paper provides a case study which dedicated for applying the suggested framework in analyzing the design of some glass products. **As for the most important results**; it was possible to demonstrate the importance of design as an innovative activity in the enterprises which seek to Excellency and leadership by establishing a relation between the status of the design and competitiveness, in the frame of sustainability and social responsibility concepts, which rule the market nowadays. Furthermore, its was possible to use the concept of (SWOT) in specifying the internal and external factors that affect the design status. Eventually it was possible to devise a suggested framework, to be used in analyzing the status of design by using the concept of the relative decimal value (RDV) and (G.RDV), that derived from the methodology of the (Prioritization Matrix), in addition to harnessing the concept of (SWOT) in classifying the factors that affect the quality of the design, thus determining the development alternatives for a certain design, the research ended by applying the suggested framework –in question - to a case of analyzing the designs of some glass products, where it was possible to stand on the best design, and define the potential alternatives for the evolution of the designs under study.

Keywords:

- SWOT Concept
- Prioritization Matrix
- Design
- Evalution Alternatives
- Glass Design Evaluation
- Industrial Glass Design

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Introduction:

It is well known that the development of the industrial design (ID) [8] is considered one of the most important issues that preoccupy any instructor works in the domain of teaching (Art & Design), where the need for providing the rational instructions that help student/ students in handling the aesthetical and functional factors that affect the quality of the design outputs,

The difficulty of teaching the industrial design, lies in the need for providing the student/ students with the rational instructions, that help in revising and improving the design/ designs through the different stages of the designing process, with the purpose of enriching the design, and make the proper compromise between the most common, outstanding factors, which affect the quality of the design, namely: the appearance; the function; price and time of supply.

It is worth to mention that those factors are applicable to any product design in general and the design of the glass product in particular.

Accordingly, it was possible to specify the problem of this paper in the need for a systematic framework that can help in defining the status of design and the potential alternatives for the design evolution.

Hence, the aim of this paper is specified in devising a systematic framework to be used in defining the status of the new design/ designs and/

or the current designs under processing, in addition to provide a practical example for applying the suggested framework in a case study with the purpose of demonstrating the use of the suggested framework. According to the above, **the paper assumes that,** it's possible to derive the suggested framework – in question- by harnessing the concepts of (Prioritization Matrix) [5] calculation and (SWOT) [14] analysis.

The significance of this paper lies in the possibility of applying the derived framework in both of academic and productive institutions, which concerned with the industrial glass design; **the scope of this paper is** to provide a practical example by applying the suggested framework in defining the design status and the potential evolution of some glass products.

Ø Terminology and concepts:

1. Ergonomic [3] factors that affect on the status of the design:

The research goes to pick the most outstanding and common factors, which affect the quality of the industrial design (ID) [8]:

- Appearance [11]; as an aesthetical factor which affects the attraction of the product.
- Function; as an ergonomic factor, which affects the utility of the product.
- Cost; as an Economical factor, which affects the Price of the product.
- Time of Production; as an Engineering factor, which affects the productivity, thus the time of Supply.

2. SWOT analysis [15]:

SWOT analysis is a technique used in strategic planning and decision making. A (SWOT) technique is based on finding a correlation between a combination of factors, namely, Strength; Weakness; Opportunities and Threats, which represent the internal and external influences on any activity. The following figure (1) is derived to interpret the acronym (SWOT).

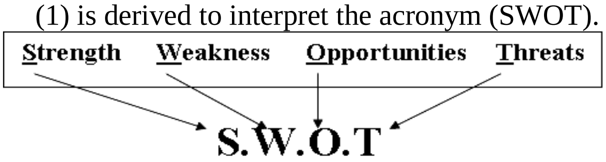


Figure (1): Interpretation of the acronym SWOT

a. Internal factors (Strength & Weakness) [10]:

Strength & Weakness are internal factors, which can be controlled by the designer, such as:

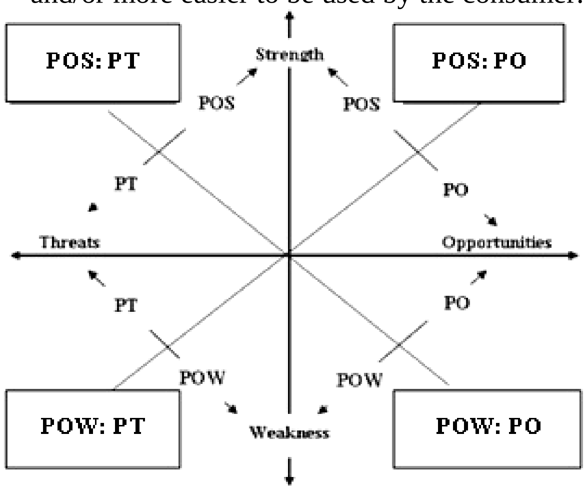
- The (Cost) factor, which affects on the (Price) of the end product, thus indicates the availability of the product for a larger number of consumers.
- The (Time) factor, which affects the productivity, and indicates the availability of the product in the nick of time.

The internal factor could be a point of strength (POS) - as termed in this paper- which has a positive influence on the design status, or a point of Weakness (POW) which has the negative influence, and they might be affected by the following changes:

- The emergence of new rival products with more suitable prices for the consumer.
- The emergence of new products, that easy to be reached by the consumer within a shorter time.

b. External factors (Opportunities & Threats) [10]:

- Opportunities & Threats are external factors which are hard to be controlled by the designer, such as:
- The (Appearance) factor, which affects on the choice of the consumer in the market, and indicates the (Attraction) of the product.
- The (Function) factor, affects on the consumer choice in the market, and indicates the (Utility) of the product.
- The external factor could be a potential opportunity (PO) – as termed in this paper - which has a positive impact on the status of the design, or a potential threat (PT) which has the negative influence, and they might be affected by the following changes:
- The sentiment and/or the culture of the individuals in the market.
- The emergence of new competitive products more attractive for the consumer.
- The emergence of new multi-function products and/or more easier to be used by the consumer.



Where:

- POS = Points of Strength.
- POW = Points of Weakness
- PO = Potential Opportunities
- PT = Potential Threats

Figure (2): The distribution of factors according to SWOT concept

Figure (2) is derived [10] to illustrate the distribution of factors according to its negative or positive influence on the design status, as per to (SWOT) concept.

3. Prioritization matrix:

a. definition [9]: A prioritization matrix is a simple tool that provides a way to sort a diverse set of items into an order of importance. It also identifies their relative importance by deriving a numerical value for the priority of each item.

b. Deriving the key steps for establishing a (Prioritization Matrix) [17]**:**

- Define criteria.
- Calculate the relative decimal value (RDV).
- calculate the General Relative Decimal Value (G.RDV)
- Specify Weights (W.).
- Compare priorities.

4. The use of SWOT [13] concept in determining the status of design:

As shown in figure (3), the decision making zone differs due to the total weight (W.) of each quadrant.

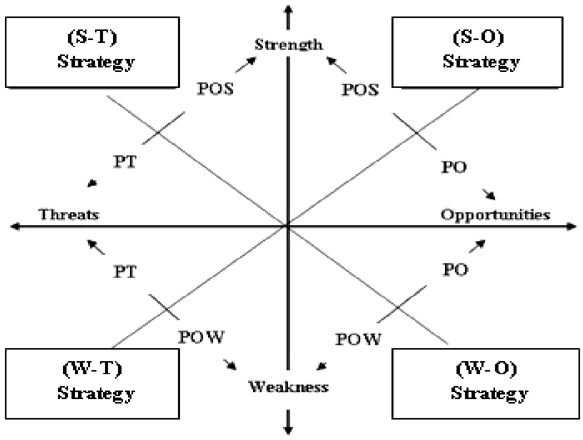


Figure (3): Alternatives of decision making according to SWOT chart

- As per to figure (3), the alternatives of design evolution could be one of the following:

Option (1):

(S-O) strategy: take advantage of the opportunities to boost the points of strength (POS), and moving straightforward to the growth and expansion phase.

Option (2):

(W-O) strategy: overcome weakness to **maximize** the role of opportunities, and assure the stability.

Option (3):

(S-T) strategy: make the proper development and **improvement** by taking the advantage of the (POS) to avoid the negative effect of the **potential** threats (PT).

Option (4):

(W-T) strategy: find a defensive way to avoid the **negative** effect of the external threats by improving the points of weakness (POW).

5. The relation between design evaluation and competitiveness position:

It's well known that the continuous improving is one of the inevitable objectives for any institution adopts the concepts of sustainability and competitiveness [1] as a part of its social responsibility [7]. The following figure (4) is derived by the researcher through monitoring and tracking the evolution of some benchmark products in the market, the figure illustrates the sequential phases for design evaluation in compliance with the concepts of sustainability and competitiveness that motivate the institutions to the continuous development and improvement.

Ø A suggested framework for determining the design development alternatives:

1. Evaluation [2]:

a. The first step of the suggested framework starts with the evaluation process of the designs under study, by using the evaluation form [2] that shown in the following table (1).

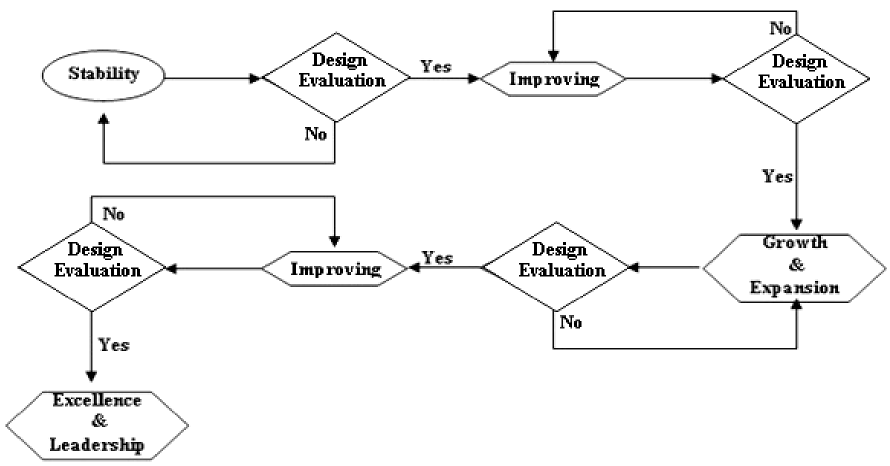


Figure (4): The relation between design evaluation and competitiveness position

Table (1): the suggested form for collecting responses of the arbitrators

S. No	characteristics	Good	Appropriate	Weak
Type (1)				
1-	Appearance & Attraction			
2-	Function & Utility			
3-	Price			
4-	Supply Time			
Type (2)				
S. No	characteristics	Good	Appropriate	Weak
1-	Appearance & Attraction			
2-	Function & Utility			
3-	Price			
4-	Supply Time			
Type (3)				
S. No	characteristics	Good	Appropriate	Weak
1-	Appearance & Attraction			
2-	Function & Utility			
3-	Price			
4-	Supply Time			
Type (4)				
S. No	characteristics	Good	Appropriate	Weak
1-	Appearance & Attraction			
2-	Function & Utility			
3-	Price			
4-	Supply Time			

b. Converting the qualitative assessment to a quantitative one, by giving numerical values to every response, according to table (2).

c. Table (3) represents the suggested form to be used in recording the numerical values, in addition to calculating the (RDV) value for each criterion.

Table (2): Numerical values of each response

Response	Weak	Appropriate	Good
Value	1	2	3

Table (3): assessment and calculation form

	Value (1)	Value (2)	Value (3)	Value (4)	Value (5)	Σ	RDV.
Appearance							
Function							
Price							
Time							
Σ						Σ_{TC}	

Where:

- **Value (1): (5)** = the numerical value given by each arbitrator.
- Appearance, Function, Price, and Time are the factors under assessment.
- **Σ** = the grand total of (Σ) column.
- **RDV**. = the Relative Decimal Value.

2. Calculating of the (RDV.) [16]:

a. This step is to establish a relation between the whole factors in each design of the designs under assessment, by finding the Relative Decimal Value (**RDV**), according to the following formula:

Relative Decimal Value (RDV.) for Appearance factor =

$RDV_{(A)} = \Sigma_{A.} / \Sigma_{TC}$ ---------------------- (1)

Where:

- **$RDV_{(A)}$** = Relative decimal value of the (Appearance) factor.
- **Σ_A** = the grand total of the values (1), (2) … (5), which given to the (Appearance) factor.
- **Σ_{TC}** = the grand total of the (Σ) column, which represent the grand total of the whole factors.

And so: for calculating the ($RDV_{(F)}$), ($RDV_{(P)}$) and ($RDV_{(T)}$); which refer to the other factors (Function, Price and Time) respectively.

b. The following table (4) shows the use of the previous form in table (3), in recording values and calculating the (RDV.).

Table (4): A suggested form to be used in recording and calculating the (RDV)

	Value (1)	Value (2)	Value (3)	Value (4)	Value (5)	Σ.	RDV.
Appearance	$V_{A1.}$	$V_{A2.}$	$V_{A3.}$	V_{A4}	$V_{A5.}$	$Σ._A$	$Σ._A / Σ._{TC}$
Function	$V_{F1.}$	$V_{F2.}$	$V_{F3.}$	V_{F4}	$V_{F5.}$	$Σ._F$	$Σ._F / Σ._{TC}$
Price	$V_{P1.}$	$V_{P2.}$	$V_{P3.}$	V_{P4}	$V_{P5.}$	$Σ._P$	$Σ._P / Σ._{TC}$
Time	$V_{T1.}$	$V_{T2.}$	$V_{T3.}$	$V_{T4.}$	$V_{T5.}$	$Σ._T$	$Σ._T / Σ._{TC}$
Σ.	$Σ._{V1.}$	$Σ._{V2.}$	$Σ._{V3.}$	$Σ._{V4.}$	$Σ._{V5.}$	$Σ._{TC}$	

Where:

- **$V_{A1.}$: $V_{A5.}$** = the (Appearance) factor Values given by each arbitrator.
- **$V_{F1.}$: V_{F5}** = the (Function) factor Values given by each arbitrator.
- **$V_{P1.}$: V_{P5}** = the (Price) factor Values given by each arbitrator.
- **$V_{T1.}$: V_{T5}** = the (Time) factor Values given by each arbitrator.
- **$Σ_A$** = the grand total of the values **$V_{A1.}$: $V_{A5.}$** , that represents the **(Appearance)** factor.
- **$Σ_F$** = the grand total of the values **$V_{F1.}$: $V_{F5.}$** , that represents the **(Function)** factor.
- **$Σ_P$** = the grand total of the values **$V_{P1.}$: $V_{P5.}$** , that represents the **(Price)** factor.
- **$Σ_T$** = the grand total of the values **$V_{T1.}$: $V_{T5.}$** , that represents the **(Time)** factor.
- - **$Σ_{TC}$** = the grand total of the whole factors in the (**Σ.)** row and column.

3. Calculate the (G.RDV) for the factors that affect the status of designs:

This step is dedicated to calculate the General Relative Decimal Value (G.RDV), by finding a relation between the (RDV) of each factor and the whole factors in all designs under assessment, the table (5) below shows the suggested form to be used in recording values, and the method of calculation.

Table (5): suggested form and method to calculate the (G.RDV)

Designs / Criteria	Design (1)	Design (2)	Design (3)	Design (4)	Σ.RDV.	G. RDV.
Appearance	**RDV_{D1A}**	**$RDV_{D2A.}$**	**RDV_{D3A}**	**$RDV_{D4A.}$**	**Σ. $RDV_{A.}$**	**G. $RDV_{A.}$ = Σ. RDV_A / Σ. RDV.**
Function	**RDV_{D1F}**	**$RDV_{D2F.}$**	**$RDV_{D3F.}$**	**$RDV_{D4F.}$**	**Σ. $RDV_{F.}$**	**G. $RDV_{F.}$ = Σ. $RDV_{F.}$ / Σ. RDV.**
Price	**$RDV_{D1P.}$**	**$RDV_{D2P.}$**	**$RDV_{D3P.}$**	**$RDV_{D4P.}$**	**Σ. $RDV_{P.}$**	**G. $RDV_{P.}$ = Σ. $RDV_{P.}$ / Σ. RDV.**
Time	**$RDV_{D1T.}$**	**$RDV_{D2T.}$**	**$RDV_{D3T.}$**	**$RDV_{D4T.}$**	**Σ. $RDV_{T.}$**	**G. $RDV_{T.}$ = Σ. $RDV_{T.}$ / Σ. RDV.**
Σ.RDV.	**Σ.RDV. D(1)**	**Σ.RDV. D(2)**	**Σ.RDV. D(3)**	**Σ.RDV. D(4)**	**Σ. RDV.**	

Where:

- **$RDV_{D1A.}$: RDV_{D4A}** = the **(Appearance)** relative decimal values of designs; (1), (2), (3) and (4) respectively.
- **$RDV_{D1F:}$ $RDV_{D4F.}$** = the **(Function)** relative decimal values of designs; (1), (2), (3) and (4) respectively.
- **$RDV_{D1P:}$ $RDV_{D4P.}$** = the **(Price)** relative decimal values of designs; (1), (2), (3) and (4) respectively.
- **$RDV_{D1T:}$ $RDV_{D4T.}$** = the **(Time)** relative decimal values of designs; (1), (2), (3) and (4) respectively.
- **Σ. RDV_A** = the grand total of the values; (**RDV $_{D1A}$: RDV_{D4A}**), for the (Appearance) factor.
- **Σ. RDV_F** = the grand total of the values; (**RDV $_{D1F}$: RDV_{D4F}),** for the (Function) factor.
- **Σ. RDV_P** = the grand total of the values; (**RDV $_{D1P}$: RDV_{D4P}),** for the (Price) factor.
- **Σ.RDV_T** = the grand total of the values; (**RDV $_{D1T.}$: RDV_{D4T}),** for the (Time) factor.
- **Σ.RDV.D(1)** = the grand total of **(RDV_{D1A}, RDV_{D1F}, RDV_{D1P}, and RDV_{D1T}) for design (1)**, and the same is applied to **Σ.RDV.D(2), Σ.RDV.D(3) and Σ.RDV.D(4)**
- **G. RDV. =** The General Relative Decimal Value.
- **Σ. RDV =** The total sum of **(Σ. RDV_A; Σ. RDV_F; Σ. RDV_P and Σ. RDV_T**

4. Finalize and the summarize calculation process:

This step is to calculate the (**Σ. D**), which represent the total Weight (W.) that given to each design by finding the grand total of the factors' Weights for each design, namely: ($W._A$) for Appearance factor; ($W._F$) for Function factor; ($W._P$) for the price factor and eventually the ($W._T$) for the time factor, the following table (6) shows the suggested form for this process, in addition to the method of calculation.

Table (6): Summarize and finalize the calculation process

Designs / Factor	Design (1)	Design (2)	Design (3)	Design (4)	G.RDV.
Appearance W. (A)	$\Sigma.A_{D1} \times G.RDV_A$	$\Sigma.A_{D2} \times G.RDV_A$	$\Sigma.A_{D3} \times G.RDV_A$	$\Sigma.A_{D4} \times G.RDV_A$	$G.RDV_A$
Function W. (F)	$\Sigma.F_{D1} \times G.RDV_F$	$\Sigma.F_{D2} \times G.RDV_F$	$\Sigma.F_{D3} \times G.RDV_F$	$\Sigma.F_{D4} \times G.RDV_F$	$G.RDV_F$
Price W. (P)	$\Sigma.P_{D1} \times G.RDV_P$	$\Sigma.P_{D2} \times G.RDV_P$	$\Sigma.P_{D3} \times G.RDV_P$	$\Sigma.P_{D4} \times G.RDV_P$	$G.RDV_P$
Time W. (T)	$\Sigma.T_{D1} \times G.RDV_T$	$\Sigma.T_{D2} \times G.RDV_T$	$\Sigma.T_{D3} \times G.RDV_T$	$\Sigma.T_{D4} \times G.RDV_T$	$G.RDV_T$
Σ. D.	Σ. D (1)	Σ. D (2)	Σ. D (3)	Σ. D (4)	

Where:

- **$\Sigma.A_{D1}$ =** grand total of the Appearance factor's values for Design (1), and the same for ($\Sigma.A_{D2}$); ($\Sigma.A_{D3}$) and ($\Sigma.A_{D4}$)
- **$\Sigma.F_{D1}$ =** grand total of the Function factor's values for Design (1), and the same for ($\Sigma.F_{D2}$); ($\Sigma.F_{D3}$) and ($\Sigma.F_{D4}$)
- **$\Sigma.P_{D1}$ =** grand total of the Price factor's values for Design (1), and the same for ($\Sigma.P_{D2}$); ($\Sigma.P_{D3}$) and ($\Sigma.P_{D4}$)
- **$\Sigma.T_{D1}$ =** Grand total of the Time factor's values for Design (1), and the same for ($\Sigma.T_{D2}$); ($\Sigma.T_{D3}$) and ($\Sigma.T_{D4}$)
- **G. RDV. =** The General Relative Decimal Value.
- **$G.RDV_A$ =** General Relative Decimal Values for the Appearance factor.
- **$G.RDV_F$ =** General Relative Decimal Values for the Function factor.
- **$G.RDV_P$ =** General Relative Decimal Values for the Price factor**.**
- **$G.RDV_T$ =** General Relative Decimal Values for the Time factor.
- **Σ. D (1), Σ. D (2), Σ. D (3) and Σ. D (4)** are the total (W.) values of each design by finding the grand total of the values in the same column.

5. Defining the design status and decision making:

a. Referring to table (6), the best design is the highest **(Σ. D).**

b. Classifying the factors according to SWOT concept:

- If the total number of the internal and / or the external factors is an even number such as: 2; 4; 6…etc., the calculation is conducted as follows:
- Arrange the values of the factors' weights in ascending or descending order, for instance:
- In case of 2 values: divide the highest value by the lowest one.
- In case of (4) factors' values (X_1; X_2; X_3; X_4), and ($X_1 > X_2 > X_3 > X_4$) respectively:

Sort the values into two groups, where the first group (A) includes the highest two values (X_1; X_2), while the other group (B) includes the lowest two values (X_3; X_4).

It's worth to mention that:

Group (A) which includes the highest values could be the (POW) for the internal factors, and/ or the (PO) for the external factors; while the lowest values' group (B) represents the (POW) for internal factors, and/ or (PT) external values.

Then:

Obtain the total weight of the (POS) or (PO) by using the following formula:

$$\Sigma (A) = X_1 + X_2 \text{ ------------------------------------ (2)}$$

While the total weight of the (POW) or (PT) can be obtained by the following formula:

$$\Sigma (B) = X_1 + X_2 \text{ ------------------------------------ (3)}$$

- If the internal and / or the external factors are odd number such as: 3; 5; 7…etc., the calculation is conducted as follows:
- Arrange the values of the factors' weights in ascending or descending order, for instance:
- In case of (5) values (X_1; X_2; X_3; X_4; X_5), and ($X_1 > X_2 > X_3 > X_4 > X_5$) respectively:

Exclude the middle value (X_3), to obtain two equal groups (A); (B)

Where:

The first group (A) includes the highest two values, namely, (X_1; X_2), while the other group (B) includes the lowest two values (X_3; X_4).

Then:

Add the values of each group as shown in the formulas (2), (3) above, and then add the excluded value (X_3) to each group to obtain the total weights as follows:

$[\Sigma (A) + (X_3)]$ for (POS) and/ or (PO) ------- (4)

$[\Sigma (B) + (X_3)]$ for (POW) and/ or (PT) ------ (5)

Table (7) demonstrates the probabilities of classifying the factors that affect the design's status, in accordance with SWOT concept.

Table (7): Classifying of factors according to SWOT concept

		Internal		External	
		POS	POW	PO.	PT.
Design (X)	Internal	Highest Values Of group (A)	Lowest Values Of group (B)		
	External			Highest Values Of group (A)	Lowest Values Of group (B)

c. Defining the status of design and the development alternatives according to SWOT:

- To define a certain design's status and determine the alternatives of development, the suggested framework goes to locate the weights (W.) of the factors in the proper quadrant in the SWOT chart as shown in the following figure (5).
- find the total weight (W.) for each of (POS); (POW); (PO) and (PT) by referring to clause (5-b) and table (7), where the total weight of each quadrant can be obtained as shown in the following figure(5).

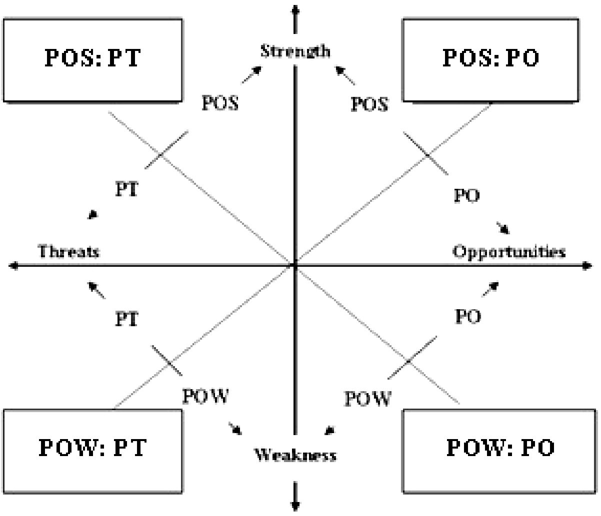


Figure (5): Placing the factors and calculating the total weight of each quadrant

Ø Applying the suggested framework in analyzing some glass products:

The following examples in figures (6), (7), (8) and (9) respectively, are samples of some glass products to be used in the application of the suggested framework in a case study.

The Application aims to:

- Define the design status, and electing the best design of the glass products in question.

- Provide some examples for determining the alternatives of the design evolution.

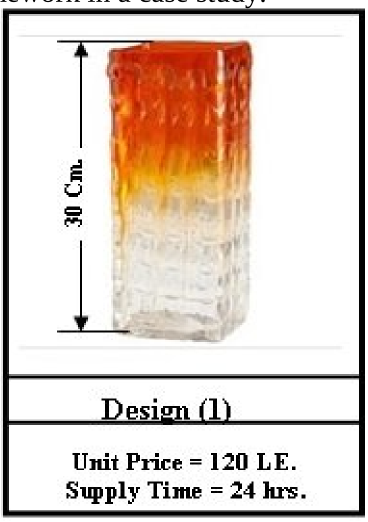


Figure (6): Product No. (1)

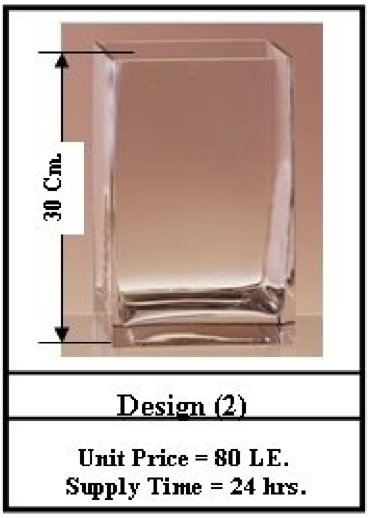


Figure (7): Product No. (2)

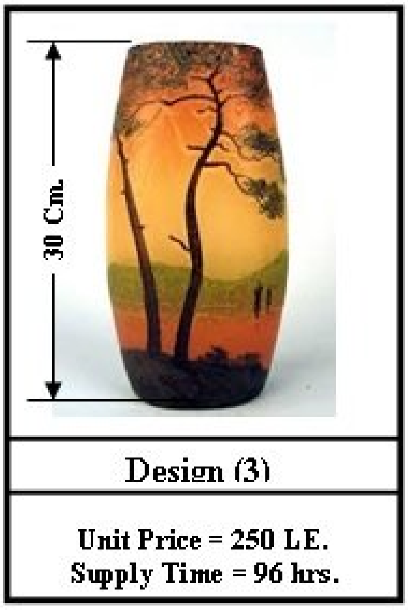


Figure (9): Product No. (4)

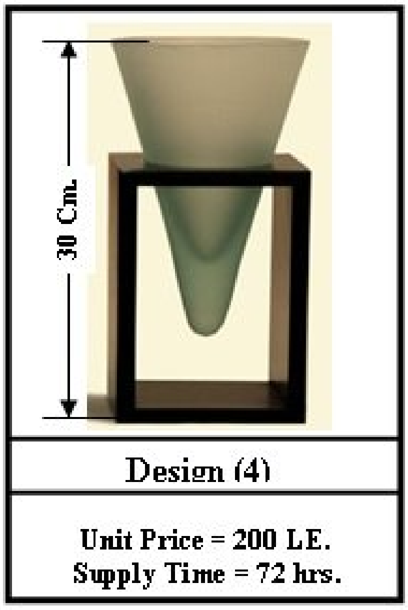


Figure (8): Product No. (3)

1. **Converting the responses and calculating the (RDV):**
   As per to the arbitrators' responses, the numerical values and the (RDV) of the factors of each design are demonstrated in the following tables (8); (9); (10) and (11) respectively.

Table (8): The numerical values for design (1)

	Value (1)	Value (2)	Value (3)	Value (4)	Value (5)	Σ	RDV.
Appearance	3	3	3	3	3	15	**0.28**
Function	3	3	2	3	2	13	**0.25**
Price	3	2	2	2	2	11	**0.21**
Time	3	3	2	3	3	14	**0.26**
Σ	2	3	1	3	4	**53**	

Table (9): The numerical values for design (2)

	Value (1)	Value (2)	Value (3)	Value (4)	Value (5)	Σ	RDV.
Appearance	3	2	2	2	1	10	**0.2**
Function	3	1	2	3	2	11	**0.24**
Price	3	2	1	2	2	10	**0.2**
Time	3	3	2	2	2	12	**0.27**
Σ	4	2	1	0	-2	**45**	

Table (10): The numerical values for design (3)

	Value (1)	Value (2)	Value (3)	Value (4)	Value (5)	Σ	RDV.
Appearance	3	3	3	3	2	14	**0.27**
Function	3	3	3	3	3	15	**0.29**
Price	2	3	3	3	1	12	**0.23**
Time	1	3	3	2	2	11	**0.21**
Σ	9	12	12	11	8	**52**	

Table (11): The numerical values for design (4)

	Value (1)	Value (2)	Value (3)	Value (4)	Value (5)	Σ	RDV.
Appearance	2	3	2	3	3	13	**0.28**
Function	2	3	1	3	3	12	**0.26**
Price	1	3	2	2	2	10	**0.22**
Time	2	3	2	2	2	11	**0.24**
Σ	7	12	7	10	10	**46**	

2. **Calculation of the (G.RDV):**
   The following table (12) shows the calculation of the general relative decimal value (G.RDV) for the factors that affect on the design assessment.
   As per to the calculations in the following table: the ($G.RDV_A$) of the (Appearance) factor is (0.26), while the ($F.RDV_F$) of the (Function) factor is (0.27), and the ($F.RDV_P$) for the (Time) factor is (0.23), and eventually the ($F.RDV_T$) of the (Price) factor is (0.25)

Table (12): calculation of (G.RDV)

Designs / Criteria	Design (1)	Design (2)	Design (3)	Design (4)	Σ.RDV.	G. RDV.
Appearance	0.28	0.2	0.27	0.28	1.03	0.26
Function	0.25	0.24	0.29	0.26	1.04	0.27
Price	0.21	0.2	0.23	0.22	0.86	0.22
Time	0.26	0.27	0.21	0.24	0.98	0.25
Σ.RDV.	1.00	0.91	1.00	1.00	**3.91**	

3. **finalize the calculation process:**
   The following table (13) shows the (**Σ. D.) –** as termed in this paper - , which represents the total weight of each design, in addition to demonstrating the final relative decimal values (F.RDV) for each of the factors that affect the design assessment, the (FRDV) is refers to the Weight (W.) of each factor.

Table (13): Finalizing the calculation and finding the total weights

Designs / Factor	Design (1)	Design (2)	Design (3)	Design (4)
Appearance ($W._A$)	3.9	2.6	3.6	3.4
Function ($W._F$)	3.5	3.0	4.1	3.2
Price ($W._P$)	2.4	2.2	2.6	2.2
Time ($W._T$)	3.5	3.0	2.8	2.8
Σ. D.	**13.3**	**10.8**	**13.1**	**11.6**

The graph in figure (10) shows the values of (Σ. D.) for the designs under study. The figure shows that the design (1) is the best design, since it has the highest (Σ. D. = 13.3).

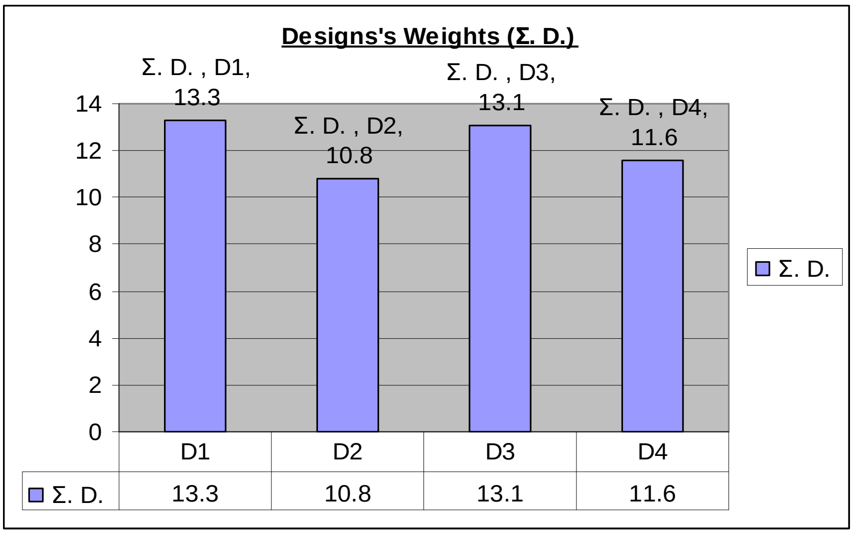


Figure (10): The schematic representation of (Σ. D.)

4. Classifying the factors according to SWOT concept:

According to the research concept which goes to classify the highest internal values as points of strength (POS), and the lowest internal ones are the points of weakness (POW), and the same for the external factors, where the highest values are potential opportunities (PO), while the lowest ones are the potential threats. The tables (14), (15), (16) and (17) below demonstrate the application of the research concept to the case of studying the factors of designs (1), (2),(3) and (4) in question.

Table (14): Classifying the factors of Design (1)

		Influences / Criteria	Internal		External	
			S.	W.	O.	T.
Design (1)	Internal	Cost & Price	------	2.4		
		Time of Production & Supply	3.5	---		
	External	Appearance & Attraction			3.9	---
		Function & Utility			---	3.5

Table (15): Classifying the factors of Design (2)

		Influences / Criteria	Internal		External	
			S.	W.	O.	T.
Design (2)	Internal	Cost & Price	---	2.2		
		Time of Production & Supply	3.0	---		
	External	Appearance & Attraction			---	2.6
		Function & Utility			3.0	

Table (16): Classifying the factors of Design (3)

		Influences / Criteria	Internal		External	
			S.	W.	O.	T.
Design (3)	Internal	Cost & Price	---	2.6		
		Time of Production & Supply	2.8	---		
	External	Appearance & Attraction			---	3.6
		Function & Utility			4.1	------

Table (17): Classifying the factors of Design (4)

		Influences / Criteria	Internal		External	
			S.	W.	O.	T.
Design (4)	Internal	Cost & Price	---	2.2		
		Time of Production & Supply	2.8	---		
	External	Appearance & Attraction			3.4	-------
		Function & Utility			---	3.2

5. Defining the design status and alternatives for evolution:-

The following figures (12) and (13) are examples to illustrate the use of SWOT concept in analyzing the status of the designs (1) and (3), according to the suggested framework in this paper.

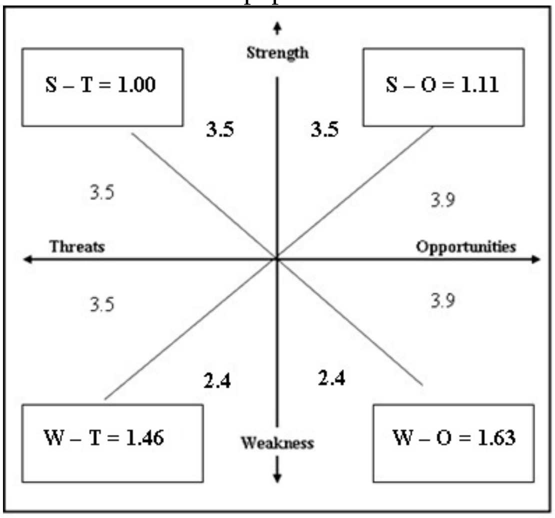


Figure (11): Status of Design (1)

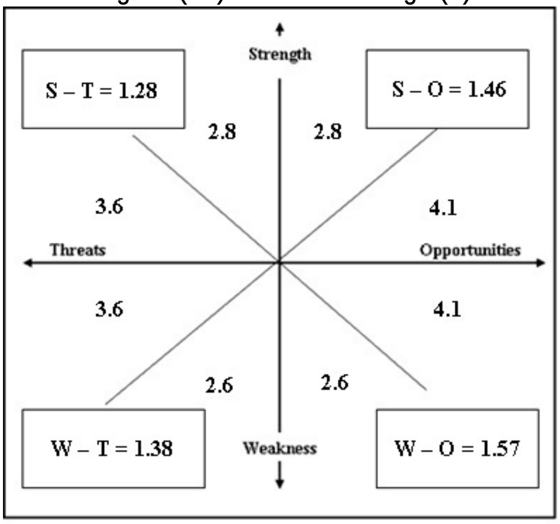


Figure (12): Status of Design (3)

- **As for design (1):** the highest weight is (1.63), and lies in the quadrant (W-O), then comes the value (1.46) which lies in the quadrant (W-T), which is mean:
  It's a must to improve the point of weakness which represented in the (Price) factor - as shown in table (14) - to take benefit from the factor of (Appearance) which represents the available opportunity, thus avoiding the recession to the (W-T) probability where the design can be affected by the negative effect of the threats.
- **As for design (3):** the highest weight is (1.57), and lies in the quadrant (W-O), then comes the value (1.46) which lies in the quadrant (S-O), and that means:
  Improving the weakness of (Price) – as in table (16) - can maximize the opportunity of (Function), and move to the next stage of (S-O).

Ø Findings and Discussion:

1. The significance of this framework lies in being based on a previous study , which shows the need for design evaluation as a creative human activity, where a survey was made by a representative sample of the key personnel in the relevant institutions that concerned with the industrial design of glass, the study shows that (99.9 %) of the respondents are supporting the need for design in enhancing the competitiveness of the industrial glass institutions, thus the need for a logical framework in evaluating the glass design, in addition to the case study of this paper, which conducted by a group of academic staff in the educational domain of industrial glass designing, where the highly responding to the survey demonstrates the importance and the need for a logical framework to be used in design evaluation.

2. It was possible to devise the illustration in figure (1), which interprets the acronym (SWOT),
in addition to specifying the internal and external factors that affect the quality of design, moreover; providing the schematic in figure (2), which illustrates; the classifying and distribution of factors according to SWOT concept, furthermore; it was possible to devise the figure (3), which demonstrates the use of SWOT chart in determining the alternatives of decision making for design evolution.

3. Establish a relation between design evaluation and the competitiveness position in the market, in the frame of sustainability and social responsibility concepts, in addition to deriving a flow chart which shows the role of design evaluation in determining the competitiveness position, as shown in figure (4).

4. It was possible to derive a systematic framework by exploiting the concepts of the Prioritization Matrix and SWOT, according to the following main steps:

a. calculate the (G.RDV) - as termed in this paper - by finding the (RDV) for each of the factors that affect the design status, by the use of equation (1), furthermore, it was possible to set the tables (4), (5) and (6) to facilitate the process in terms of calculating and recording the (RDV), (G.RDV) and the total weight (Σ. D) for each design.

b. Exploit the SWOT concept in classifying the factors in terms of being internal or external, according to the total weights, by referencing to the equations (2); (3); (4) and (5), in addition to providing the table (7), which is used in recording the values obtained.

c. the use of (SWOT) chart in defining the design status, and stand on the alternatives of the design evolution by conducting the distribution of the factors into the different quadrants of (SWOT) chart, as shown in figure (4).

5. It was possible to apply the suggested framework in evaluating and analyzing the design status of some glass products, in addition to defining the potential alternatives for the evolution of two chosen designs as examples to demonstrate concept of the suggested framework, where it was possible to stand on the following conclusions:

a. Best design is the design (1), which has the highest (Σ. D. = 13.3), then comes design (3) with the (Σ. D. = 13.1) and design (4) with the (Σ. D. = 11.6) and eventually comes the design (2) with the (Σ. D. = 10.8) as shown in table (13), and the graph in figure (10).

b. As for the alternatives of evolution:
The tables (14), (15), (16) and (17) show the classifying of the factors for the designs (1), (2), (3) and (4) respectively; accordingly it was possible to find the internal and external factors for each design by following the instructions in clause (5-b) of the suggested framework topic, thus determining the decision alternatives according to the obtained values of the total weights by referring to the clause (5-c), and figure (5) of the suggested framework topic, the following examples are to demonstrate the use of SWOT concept in determining the alternatives of design evolution as the final part of the suggested framework, as follows:

- design (1):
According to figure (11), the highest weight is (1.63), which lies in the quadrant (W-O), then comes the value (1.46) which lies in the quadrant (W-T), and that means:
It's a must to improve the point of weakness which represented in the (Price) factor - as shown in table (14) - to take benefit from the opportunity of the (Appearance) factor, and assure stability, thus avoiding the recession to the (W-T) probability where the design can be affected by the negative effect of the threat.

- design (3):
According to figure (12), the highest weight is (1.57), which lies in the quadrant (W-O), then comes the value (1.46) which lies in the quadrant (S-O), and that means:
Improving the weakness (Price) – as in table (16) - can maximize the opportunity of (Function), and move to the next stage of (S-O).

6. As this paper is considered the first of its kind in devising a framework to be used in evaluating design by combining the concepts of different tools, namely, SWOT and Prioritization matrix tools that focuses on Strategic decision making in business planning field. Accordingly, it's recommended to conduct further researches with the purpose of examining the reliability of this framework in evaluating the industrial design, in terms of the uncertainty and the correlation coefficient to validate the use of the suggested framework in question.

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