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Evaluation Criteria for Maintenance Priorities of Bridges

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ABSTRACT
It has been observed that there is no maintenance plan in most of the developing countries and maintenance is only conducted based on users' complaints or when significant structural defect is obvious to the public. Therefore, it is very important to have assessment criteriaof bridges as accurate evaluation is one of the most important and significant steps in any maintenance plan of bridges.
The main purpose of this paper is to develop a criterion which is capable of assessing and evaluating the bridges, their overall condition and the condition of each element.Moreover,to develop a method that canrank the bridges in a network according to their repairing urgency. First of all different inspection typesare reviewed, then in order to obtain reliable judgment the experience and knowledge of the bridge maintenance experts in Egypt were added to the criteria by carrying out questionnaires and interviews with these experts in order to set the importance of each parameter in the evaluation criteria and the importance of each element of bridges. Finally obtaining a Bridge Overall Priority Indicator (BOPI) that ranks bridges in a network according to their condition and maintenance urgency. As a result, advancedapproach and accurate judgment to bridges is created through evaluating and assessing each parameter that may affect bridges. Also criterion that can help decision makers to rank the bridgesaccording to theirmaintenance urgency is proposed.
KEYWORDS-Maintenance;Assessment; Evaluation criteria;Sustainable bridges; Performance; parameters

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I. INTRODUCTION

Egypt currently possess a road network of 64,000 km or more across the country, more than 3,000 bridges are located in this network. Statistics of General Authority for Roads, Bridges and Land Transport (GARBLT) show that mainly 98 % of its domestic cargo relies on this road network as a result no doubt that this road network plays an important role to Egypt's national economy and to daily activities of citizens. However, those bridges and roads haven't been adequately maintained to prevent degradation and deterioration. It is a fact that about half of Egypt's bridges are 50 years old and more as proved by GARBLT declaration that the average age of bridges which are currently managed is 40 years. Referring to types of bridges in Egypt, reinforced concrete bridges are about 90% and steel bridges are less than 10% (GARBLT, 2015). Due to all the aforementioned facts, it is extremely significant to develop assessment criteria for bridges in Egypt taking into consideration the limited financial resources in the country.

II. QUANTITATIVE AND QUALITATIVE METHODS IN RESEARCH

Quantitative methods for creating evaluation criteria are only validated through implementation. As a result the acceptance of these criteria will be delayed. Especially in the project management field as it has to be accepted from the professional and academic communities. In order to overcome this issue it is recommended to merge the qualitative and quantitative methods to provide a more reliable model (Yang et al, 2011). It was also clarified in their study that the quantitative methods involve numerical measurements to set relations between different parameters. While qualitative methods use data in the form of ideas or words instead of numbers. Qualitative methods include interviewing, content analysis and previous cases and studies. In the other hand quantitative methods content questionnaires, statistical analysis and structured evaluation. Combining qualitative (symbolic) information and quantitative (numeric) information both are the required data of the structure's damage evaluation. The qualitative data is considered to be the judgment used along with engineering calculations for providing data outside a known range and compensating insufficient data (Srinivas et al., 2016).Therefore, the proposed criteriaare developed by combining qualitative and quantitative methods as this will definitely enhance the credibility of the results.

III. INSPECTION OF BRIDGES

Inspection is the most significant activity in the cycle of bridges' management as it specifies the condition of bridges and the necessary repairs to be performed. In the beginning careful monitoring and inspection should be conducted to achieve precise evaluation for any bridge. Rashidi (2013) assured that in order to enhance efficiency and reduce the fixed costs, the system of inspection should be arranged at the network level of bridges not for a single bridge. According to the Egyptian Code of Bridges (2014) there are five types of inspection.

3.1.Inventoryinspection

It is the primal and initial inspection performed on the bridge which records the main and basic information of the bridge, its bearing capacity, pointing at any element which is critical or requires special monitoring and to record the condition of all the bridge elements before putting the bridge into service. Also any newly appearing defects which weren't present at construction time should be reported as well any changes in the surrounding environment or the site.

3.2.Routine inspection

This inspection is performed in order to clarify any changes had occurred in the functional performance, to set the essential improvement recommendations, maintenance needs and precise monitoring on the critical spots as quick as possible. It should be repeated regularly with a maximum 12 month intervals.

3.3.Condition inspection

Condition inspection is for evaluating the integrity of the bridge and it focuses as well on suspected elements which had been reported before. It is not conclusive like routine inspection. Also it should be conducted after nature disasters and major incidents. Special inspection must be repeated depending on the degree of element deterioration but generally it can be repeated between the 12 month intervals of the routine inspection.

3.4.Detailed inspection

It is a close visual and manual inspection of elements to record any damage which can't be noticed easily in the routine inspection. It can be performed on specific elements or on the whole bridge. Also it may be included with the routine inspection or on its own. It requires skilled engineers, material tests and frequently non-destructive tests. The results should be carefully recorded as they are way important than the routine inspection data. It must be performed every six years for major bridges crossing waterways and every ten years for otherwise.

3.5.Emergencyinspection(Inspection for damage)

This inspection is immediately performed after severe nature incidents like earthquakes, floods, hurricanes ….etc. and also after destructive accidents. It is a non-scheduled inspection which should specify the degree of damage occurred because of these incidents.

IV. ASSESSMENT AND PRIORITIZING CRITERIA OF BRIDGES

Meanwhile inspections indicate the damage in the bridge elements; they don't clearly specify the overall structural soundness of bridges. Therefore, an evaluation criterion has to be developed to judge the overall structural soundness and integrity of bridges. After conducting the required inspections, the evaluation stage begins. A highly recommended technique which was adopted by various agencies is to use performance indicators to make a wide multi attribute system to be used for assets' fund allocation (Javed, 2011). This approach is very efficient and convenient but these indices should accurately represent the repair needs. It is a difficult task but this research is trying to overcome it by setting clear limits for the different parameters affecting bridges. Most of the researches that perform bridges' condition assessment were mainly based on structural aspects only. In order to achieve multi-objective criteria, the proposed evaluation criteria of bridges depend on the assessment of the different bridges' performance measures such as Structural Performance (SP) and Functional Performance (FP). In addition to other parameters which are considered under the title of External Factors (EF), as flow capacity, year of construction, degree of exposure, inspection quality, historical importance and surrounding environment. These parameters are extremely significant because they investigate other aspects that could make enormous influence on bridges. All the proposed factors are clearly listed in Figure 1 and their relations. As a consequence of specifying the aforementioned indicators (SP, FP and EF), the Bridge Overall Priority Indicator (BOPI) can be obtained. BOPI is a precise indicator to rank the priority of every single bridge in any bridges' network

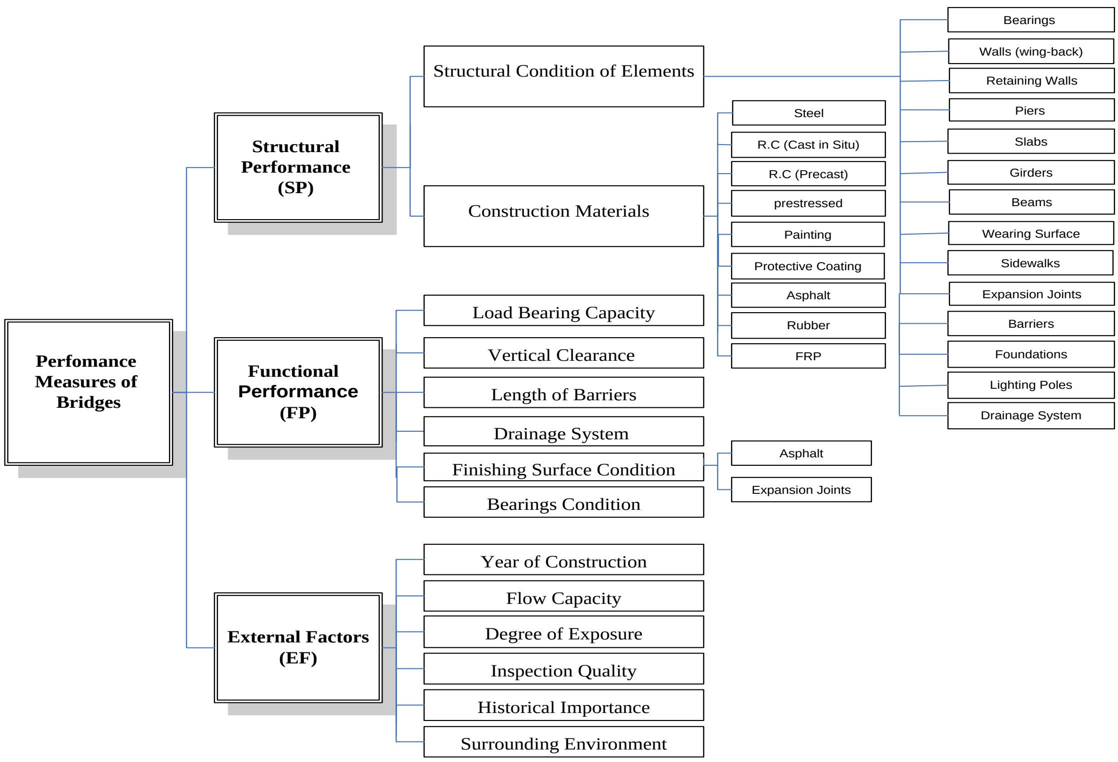

Figure 1. Proposed evaluation criteria parameters

4.1. Structural Performance assessment (SP)

This research focuses on the element-level strategy to consider the condition of each element instead of evaluating the whole bridge at once. Therefore, the proposed criteria divide the bridge into a number of elements with different properties so that higher accuracy is maintained. In order to obtain the Structural Performance Indicator (SP), three parameters must be considered. These parameters are discussed below.

4.1.1. Element Structural State Indicator (ESSI)

According to GARBLT the condition of bridges' elements can be described from Table1. It can be noticed that this table contains accurate details to eliminate results uncertainty as possible.

Table 1. List of possible defects, their rating and condition number

Condition No. (c_i)	Rate	Explanation
1	Good	• No deterioration
2	Fair	• Fine cracks of max. 0.1 mm spacing at 0.5 m or wider in one direction • Rusted rebar
3	Poor	• Moderate cracks of max. 0.2 mm spacing at about 0.5 m in one direction with fine cracks in right angle direction • Rebar exposure of max. 0.3 m
4	Bad	• Rebar exposure of longer than 0.3 m • Corroded rebar • Visible deflection at girder • Large cracks exceeding 0.2 mm forming grids • Leakage/free lime • Delamination/Spalls

Therefore the condition of each element (c_i) should be determined and the quantity (q_i) corresponds to each condition number as well. The single bridge element may contain different conditions, so the quantities can be listed for each condition and the Element Structural State Indicator (ESSI) will be calculated from Equation 1.

$$ESSI = \frac{\sum(q\ i \times c\ i)}{\sum q\ i} \text{(Equation 1)}$$

Where: c_i: the condition of element or sub-element, it ranges from 1 to 4.

q_i: the elements' quantity.

Not all the elements of bridges have the same significance, neither have the same durability. There are other factors must be considered to achieve a trusted judgment. Such as the Structural Importance Factor (SIF) and Construction Material Factor (CMF). No specific data are available for these factors. Some references are available but they were based on personal judgment. So the results listed for these two factors were conducted from direct interviews in order to maintain clarity and better understanding from the participants. These participants are working in different agencies (contractors- consultants and owners) to provide wide range of knowledge.

4.1.2. Structural Importance Factor (SIF)

In approbation with Abu Dabous and Alkass (2010), the structural significance of any component of bridges can be measured by its contribution to the whole integrity and structural safety of the bridge. Based on this concept and the judgment of bridges' experts the following results were obtained. Higher number corresponds to the most important elements.

Table 2. Elements of bridges and their Structural Importance Factor (SIF)

Structural Importance Factor (SIF)	Element
1	None
2	Sidewalks, Lighting Poles
3	(wing- back) walls, Retaining Walls, Wearing Surface, Barriers, Drainage System
4	Piers, Slabs, Beams, Expansion Joints, Foundations
5	Bearings, Girders

4.1.3. Construction Material Factor (CMF)

The elements of bridges are made of different materials. Each material has its own properties, strength and durability. In order to consider these differences among them, the materials will be categorized with respect to their durability. The results in the following table are conducted from the experts of bridges in Egypt and the Construction Material Factor (CMF) is listed below. It should be noticed that higher numbers represent the more vulnerable materials.

Table 3. Materials of bridges' elements and their Construction Material Factor (CMF)

Construction Material Factor (CMF)	Material
1	None
2	Concrete (Cast in Situ), Concrete (Precast), Prestressed Concrete
3	Steel, FRP
4	Protective Coating, Asphalt, Rubber
5	Painting

Finally after considering all affecting parameters, the Structural Performance (SP) of a bridge can be estimated as below:

$$SP = \frac{\sum(\text{ESSI } i \times \text{SIF } i \times \text{CMF } i)}{9\ n} \text{(Equation 2)}$$

ESSI i: Element Structural State Indicator.
SIF i: Structural Importance Factor of an element.
CMF i: Construction Material Factor of an element.
n: number of elements.
SP: dimensionless number represents the measure of the structural performance of a bridge. It will not exceed 4 and the necessity of maintenance and repair are directly proportional to the increase of this number. Equation 2 is developed with respect to the data gathered from interviews and listed in tables 2 and 3. So it will change if the assigned numbers of (SIF) and (CMF) were different.

4.2. Functional Performance assessment (FP)

Recently the functional performance is just as significant and critical as the structural performance; Yanev (2007) reported that the functional life of a bridge can be estimated about 25 – 50 years under high traffic conditions and about 50-100 years for structural life. This reveals the value of considering the functional performance in this research. The functional performance contains many parameters should be carefully considered as the load bearing capacity, vertical clearance, length of barriers, condition of the drainage system, finishing surface condition (asphalt, expansion joints) and bearings' condition. These parameters are extremely important as any defect or damage occurs in them directly affect the serviceability and accelerates the process of deterioration.

4.2.1. Load Bearing Capacity (LBC)

Loading tests are a basic part of any inspection process; they are used to evaluate the overall integrity of bridges (not like other tests which are specific for evaluating or testing one element) including the inaccessible zones under repeated and dynamic loads. Load Bearing Capacity factor (LBC) will be calculated as the actual load bearing capacity over the designed load bearing capacity. If LBC is greater than or equals 1, the bridge can bear more than the designed loads or exactly the designed ones respectively. If LBC is less than 1, the bridge is defective and unsound.

4.2.2. Vertical Clearance of Bridge (VC)

It is extremely important to maintain the vertical clearance which was designed according to specifications. Railways, roads or a navigation crossing each one of them requires a different vertical clearance in design. Also the height above the bridge deck should be maintained as well, because it will be a safety issue if the height below or above the bridge deck has changed. The vehicles which are crossing above or under the bridge should have clearance sufficient enough to pass significantly. All of the above highlights the weight of the Vertical Clearance (VC) factor in this study which can be obtained from the following equation.

$$\mathrm{VC} = \left|\frac{\mathrm{Hd}-\mathrm{H}}{\mathrm{Hd}}\right| * 100 \text{(Equation 3)}$$

Where H_d is the designed vertical clearance and H is the actual one.

4.2.3. Length of Barrier (LB)

The length of barriers is another indicator of the soundness and the integrity of the bridge. They are considered to be a significant safety tool for traffic which is mainly designed according to specifications. In order to evaluate this item, the length factor must be judged as no lateral deflection or deterioration is permitted in the barriers. Length of barrier (LB) is estimated in the next equation.

$$\mathrm{LB} = \left|\frac{\mathrm{Ld}-\mathrm{L}}{\mathrm{Ld}}\right| * 100 \text{(Equation 4)}$$

L_d is the designed barrier length and L is the actual length.

4.2.4. Drainage System (DS)

One of the factors which directly affect the deterioration process rate of a bridge is the efficiency of the drainage system of bridge to drain wastewater. It can cause different defects to many items like corrosion of reinforcement bars, deterioration of wearing surface, deterioration of expansion joints and influence the safety, durability and serviceability of the bridge. The Drainage System parameter (DS) can be evaluated in the inspection process and report its condition as (Good, Fair, Poor or Bad).

4.2.5. Finishing Surface Condition (FSC)

In this section two parameters should be investigated asphalt and expansion joints to evaluate the Finishing Surface Condition (FSC) as they deeply affect the flow passing on the bridge.

4.2.5.1. Asphalt

The element which is exposed directly to external and severe irritations is asphalt pavement. These irritations are environmental effects, loads of traffic, etc. Therefore, it has short service life and requires a frequent maintenance more than other elements. The different defects which can be reported in the pavement condition according to GARBLT are pavement cracks and pavement upheaval or ratting.

4.2.5.2. Expansion Joints

Expansion joints are like asphalt, both are used in harsh operational conditions. There are several types of expansion joints which are used, such rubber surface type joint, buried type joint, steel finger type, steel tooth type joint, etc. However, unfortunately, most of the expansion joints had been damaged without performing appropriate maintenance.The type of deterioration can be reported as break or cracking of steel fingers, clogging of expansion gap, cracks on post cast concrete portion, a missing faceplate, (bump, abnormal sound) etc. Reasons of these damages should be investigated to prepare an adequate repair plan and to prevent reoccurring of the damage after the repair process.In addition, it should be stated that settlement of substructure, inclination of substructure, lateral displacements or dysfunction of bearing will lead to damage in expansion joints. In this situation, repair of bearing and reinforcement of substructure must be performed in parallel with the repair of expansion joints.As a result of the inspection processes, the Finishing Surface Condition (FSC) can be rated as

(Good, Fair, Poor or Bad) considering the aforementioned damages and defects.

4.2.6. Bearings Condition (BC)

Bearings are considered as the most unique and significant member in bridges. Deterioration and damage of bridge bearings result in further unfavorable defects to other bridge members. Due the dusty or sandy circumstance in Egypt, huge number of bridge bearings are buried or surrounded in accumulated sand that produced from expansion joints. This directly increases the probability of damages as rust, unmoving, deterioration of paint, etc. Accordingly, the accumulated dust or sand keep the loosening of lock nut, cracks of leveling mortar, cracks on body and other defects are hidden. Also damage of bearings might be due aging or bridge structural problems.It should be highlighted that lateral displacements, settlement of substructure, leaking water from expansion joint or inclination of substructure will cause damages to bridge bearings and results in an excessive displacement. Therefore repairing the substructure is essential along with repairing of the bridge bearing.According to the several types of damage or deterioration in bearings like (corrosion, loosening or missing lock nuts, cracks, break of anchor bolts or side blocks, paint/coating deterioration, sand accumulation, abnormal sound/vibration, abnormal movement, failure, deformation, abnormality of transition), Bearings Condition factor (BC) will be recorded as (Good, Fair, Poor or Bad).

In Conclusion, after considering the aforementioned parameters, the Functional Performance (FP) can be obtained from this equation

$$FP = .32\,LBC + .09\,VC + .08\,LB + .09\,DS + .18\,FSC + .24\,BC$$

(Equation 5)

LBC: Load Bearing Capacity factor of bridge.
VC: Vertical Clearance factor of bridge.
LB: Length of barrier factor of bridge.
DS: Drainage System condition of bridge.
FSC: Finishing Surface Condition of bridge.
BC: Bearings Condition of bridge.

FP: dimensionless number represents the evaluation of the functional performance of a bridge. It will not exceed 4 and the requirement of maintenance and repair are directly proportional to the increase of this number. The weights in Equation 5 are driven from the responses of the bridges' experts in their interviews. The results are listed in the Table 4.

Table 4. Weights assigned to each parameter according to bridges' experts

Parameter	LBC	VC	LB	DS	FSC	BC
Weight %	32	9	8	9	18	24

Rashidi (2013) reported that according to bridges' experts in Australia, if the load bearing capacity factor is less than 0.7, vertical clearance and length of barrier factors are more than 20 %, the bridge is critically substandard. Therefore in approbation with this information the different limits for this study are summarized in Table 5so that each condition of each factor is determined and then these conditions are used in Equation 5 in order to calculate the Functional Performance (FP) of bridge.

Table 5. Limits of functional performance parameters and their ratings

	1	2	3	4
LBC	LBC ≥1	0.9 ≤ LBC< 1.0	0.7≤ LBC < 0.9	LBC < 0.7
VC	VC ≤ 5%	5% < VC ≤ 12%	12%< VC ≤20%	VC > 20%
LB	LB ≤ 5%	5%< LB ≤ 12%	12%< LB ≤20%	LB > 20%
DS	Good	Fair	Poor	Bad
FSC	Good	Fair	Poor	Bad
BC	Good	Fair	Poor	Bad

4.3. External Factors (EF)

Bridges deteriorate because of other significant factors besides those were mentioned before. The deterioration rate is a function of different parameters like the age of the bridge, flow capacity, degree of exposure to harmful materials and the surrounding environment. These different parameters are discussed in the next section.

4.3.1. Year of Construction (YC)

According to reports clarified by GARBLT, only 40 bridges were constructed before the Egyptian revolution at 1952, this was in the period of the British occupation of Egypt about 1940. From 1952 till the 1960s, construction of bridges had been actively performed. Half of the usable bridges currently were built in this period. In other words, approximately half of bridges in Egypt are more than 50 years old.From the 1970s, on average around 15 bridges were constructed each year. However, this is widely varied from year to year—for example, more than 100 bridges had been built in one year, but in other years no bridges were built at all. Many culverts were constructed in the 1980s, which is due the road development history. The average age of the currently managed bridges by GARBLT is around 40 years. As a fact concrete bridges could remain serviceable for a long time of preferably 100 years or more. Based on this, 100 years is assumed to be the service life of a bridge in many cases. However, this theory applies only to the recently built bridges. Judging from the existing bridges' general conditions in Egypt and based on the previous two validations life span of a bridge of 80 years has been determined. So the year of construction factor (YF) in this study will be categorized into 4 intervals: Recently Built (0-20 years), New (20-40 years), Old (40-60 years) and Very Old (60-80 years).

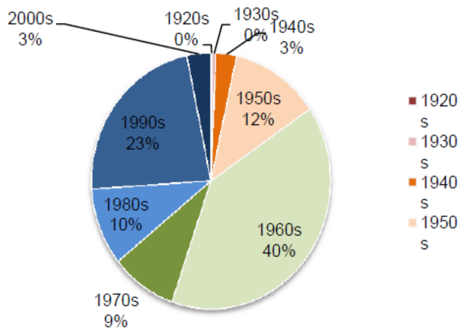

Figure 2. Breakdown based on the Year of Construction of bridges in Egypt

4.3.2. Flow Capacity (FC)

Bridges can be classified by using road number classification and road type classification. Number classification means that all the bridges located on a specific road which have a specific number, these bridges will be given the same road number. Meanwhile type classification means that the importance and the usage of the bridge must be determined. Also the flow capacity is an extremely important factor and must be well considered. Therefore four intervals will be listed in order to determine the road type and the flow capacity factor (FC) with respect to the annual average daily traffic (AADT). The four intervals are: Minor (AADT≤150), Local Access (150<AADT≤1000), Collectors (1000<AADT≤3000) and Arterials (AADT>3000).

4.3.3. Degree of Exposure (DE)

The degree of exposure factor (DE) is one of the most important factors. The rate of deterioration is directly proportional to the degree of exposure, which is really making sense. The presence of harmful elements can greatly affect the durability of the bridge. Bridges exposed to chlorides, sulphates, wide climate changes, chemically aggressive salts, freeze- thaw cycles or carbonation of concrete are in great risk to have a very high rate of degradation (Raina, 2005).

4.3.4. Inspection Quality (IQ)

Most of the data which is gathered to evaluate the condition of bridges and to list the different defects are collected by inspectors. As a result there is a probability of having errors. These errors can happen due to many reasons like lack of accessibility or visibility, time constraints, heavy traffic, inappropriate checklists, climate constraints, lack of equipment and insufficient inspection training. Therefore the inspection staff should be carefully monitored by the asset managers and the bridges' experts in the organization. This will guarantee achieving high confidence level and obtaining reliable inspection data. The quality of the inspection process will be judged and the inspection quality factor (IQ) should be specified using the following scale (Good, Fair, Poor or Bad).

4.3.5. Historical Importance (HI)

Egypt is globally known for having a lot of historical sites. Some bridges may be related to these sites or they may represent the civilization of a significant era in the Egyptian history. Logically this will affect the priority considerations in the scheduled maintenance plan. This highlights the fact that the historical importance factor (HI) must be considered in the very first planning steps.

4.3.6. Surrounding Environment (SE)

The environment of the bridge can widely vary from case to another. Bridges can be constructed in urban or rural area. Also the nature of the crossing is different from a bridge to another. It can cross roadway, railway or waterway. The aforementioned parameters should be clearly identified as they directly affect the surrounding environment factor (SE). Environment with severe and risky influence on bridges will be rated as Very High surrounding environment factor and vice versa.

Each external factor was previously discussed is listed in Table6 and it will be given a number that represents the severity rate of each factor with respect to the four intervals stated before.

Table 6. Limits of external factors parameters and their ratings

	1	2	3	4
YC	Recently Built	New	Old	Very Old
FC	Minor	Local Access	Collectors	Arterials
DE	Low	Medium	High	Very

IQ	Good	Fair	Poor	High Bad
HI	Low	Medium	High	Very High
SE	Low	Medium	High	Very High

The experts of bridges were asked to assign weight which represents the significance of each factor and the next formula was generated:

EF=.15 YC + .17 FC + .17 DE + .17 IQ + .17 HI + .17 SE(Equation 6)

YC: Year of Construction factor
FC: Flow Capacity factor
DE: Degree of Exposure factor
IQ: Inspection Quality factor
HI: Historical Importance factor
SE: Surrounding Environment factor
EF: dimensionless number which contains all the previously listed factors. It represents the effect of the different external factors of this study and its maximum value is 4.

4.4. Bridges' Ranking and Prioritization

After gathering all the aforementioned parameters, the Bridge Overall Priority Indicator (BOPI) is obtained. This index contains all the important and affecting factors in bridges and can be used as a judging tool to set bridges' ranking in any network.Eventually in order to calculate the Bridge Overall Priority Indicator (BOPI), the experts of bridges were asked to assign weight for each primal factor. The following results were recorded and visually explained in Figure 3.

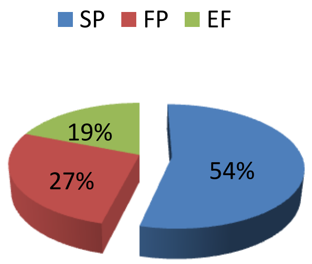

Figure 3. Pie chart explains the assigned percentages for the main factors (SP, FP and EF)

The Bridge Overall Priority Indicator can be maintained from the next equation:

$$BOPI = .54\ SP + .27\ FP + .19\ EF$$

(Equation 7)

SP: structural performance measure of a bridge.
FP: functional performance measure of a bridge.
EF: external factors.

BOPI: Bridge Overall Priority Indicator which is a dimensionless number will not exceed 4. The bridges will be ranked according to this index which bridges in critical condition and require maintenance the most will have the higher BOPI. The proposed evaluation criterion provides an evaluation system for the decision makers and warns the decision makers toward any expected risks and it can be summarized as in Figure 4.

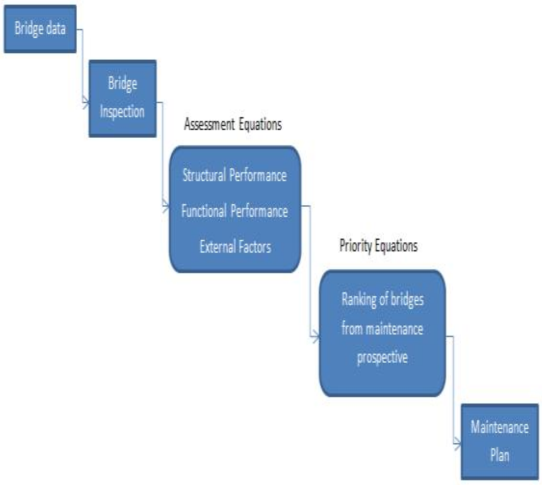

Figure 4. Summary of the developed criteria

V. CASE STUDY

In order to verify the proposed criteria, the following case study is introduced using all the previously mentioned parameters and equations. The results are displayed in the following table.

						Quantity for each condition					
No.	Bridge Elements	SIFi	CMFi	Total Quantity	Unit	1	2	3	4	ESSIi	SIFi*CMFi*ESSIi
1	Bearings	5	3	14	each		10		4	2.57	38.57
2	Girders	5	2	5412	m^2	152		5230	30	2.95	29.49
3	Piers	4	2	1465	m^2	22		65	1378	3.91	31.28
4	Slabs	4	2	6020	m^2	60	40	800	5120	3.82	30.59
5	Beams	4	2	3858	m^2	58		3200	600	3.13	25.00
6	Expansion Joints	4	4	17	each	2	2	3	10	3.24	51.76
7	Foundations	4	2	832	m^2	52	360	420		2.44	19.54
8	(wing-back)Walls	3	2	65	m^2	40	25			1.38	8.31
9	Retaining Walls	3	2	30	m^2			30		3.00	18.00
10	Wearing Surface	3	4	4830	m^2			1230	3600	3.75	44.94
11	Barriers	3	2	1630	m^2	840	790			1.48	8.91
12	Drainage System	3	3	2	each		1	1		2.50	22.50
13	Sidewalks	2	4	1870	m^2		620		1250	3.34	26.70
14	Lighting Poles	2	3	68	each	30		38		2.12	12.71
										∑	368.31

$$SP = \frac{\sum (ESSI\,i \times SIF\,i \times CMF\,i)}{9n}$$

SP	2.92

LBC	1
VC	2
LB	2
DS	3
FSC	4
BC	2

$$FP = .32LBC + .09VC + .08LB + .09DS + .18FSC + .24BC$$

FP	2.13

YC	1
FC	2
DE	4
IQ	2
HI	3
SE	3

$$EF = .15YC + .17FC + .17DE + .17IQ + .17HI + .17SE$$

EF	2.53

$$BOPI = .54\,SP + .27\,FP + .19\,EF$$

BOPI	2.63

VI. CONCLUSION

Bridges are considered to be high asset value projects with limited available financial resources to keep them in an adequate working and serviceability standardsto extend their lifecycle. Therefore it is important to make considerable effort into the assessment process in order to ensure that bridges are carefully analyzed and any defects were recorded early, before it has a significant impact in reducing bridge useful life.In this paper, a methodology for bridges' priority ranking is introduced. Following a Bridge Overall Priority Indicator (BOPI) is generated for each bridge. BOPI is a number which makes it possible for the decision makers to compare the condition of bridges in a network. Due the multi-objective nature of the methodology, various parameters are included to obtain accurate and precise assessment. The research explains how to achieve accurate assessment of a bridge from the very first procedures as inspection till very last ones as obtaining factors and parameters which indicate the condition and the priority of the bridge in road network.

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