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NEW FRAMEWORK FOR THE PRE-DESIGN STAGE USING STATISTICAL MANAGEMENT

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ABSTRACT

This paper attempts to enhance the quality level on projects in order to achieve their goals and objectives by applying a statistical management approach. Not many methods are available to create an appropriate road map for selecting designers based on statistical analysis. Therefore, the research attempts to rectify problems at the pre-design stage of projects by activating statistical management. The study analyses two statistical methods, Six Sigma methodology and the expected value scenario, and how they may be applied in the construction industry. The research aims to establish a new framework for the pre-design stage using statistical management in order to improve project performance. It uses a scientific path starting with theoretical and analytical studies as the materials and methods. An applied study will present and measure Egypt Air Cafes brand at Assiut International Airport as a pilot case study. It is concluded that the statistical management methodology is highly effective in conducting rational analyses. This methodology is one of the tools of proactive management.

KEYWORDS: Pre-design stage, Statistical management, Six Sigma, Expected value, performance.

1. INTRODUCTION

Quality management plays a vital role in building technology. Although quality tools are major factors in the implementation and operation phases, apparently there are no statistical analysis tools for use in the pre-design stage. At the pre-design stage, the designer’s assessment is the most important action to guarantee full quality in the early stages of the project cycle. In particular, the designer acts as the maestro leading the project towards successfully achieving all its goals. The study believes that there are no methods available, which can create an appropriate road map for selecting a designer based on statistical analysis. Therefore, many projects often suffer from poor-quality performance, which is experienced in the later stage of the project cycle as a

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rational result of not applying statistical management in the pre-design stage [1]. Therefore, the research identifies the perceptions of statistical management as a useful tool that can be used in quality assessment systems via Six Sigma methodology and the expected value (EV) approach.

The sigma quality level is the main indicator of how often defects might occur. Hence, a higher sigma quality level indicates a process that is less likely to create defects. A method with less variation can accommodate more standard deviations between the midpoint of the process and the closest specification limit than a process that is highly variable [2]. Using this information, the research proposes a Six Sigma model, which can be used in the official assessment by the relevant authority after completion of each project. The Six Sigma model presents quality assessment criteria necessary to achieve all stakeholders' requirements. The construction industry has many stakeholders such as project managers, consultants, clients, contractors, governmental authorities, employees, suppliers, third parties, financial firms (banks), trade associations, pressure groups, and communities.

The EV approach functions as a scenario analysis tool, which helps decision makers, determine whether they are taking on an appropriate level of risk, given the possible outcome of their decision.

The research will use the readings obtained via Six Sigma analysis as input data to calculate the weighted average for each designer. After that, it will apply EV theory to obtain the real weighted average. In turn, we will be able to determine which decision with a clear vision can guarantee the quality level for upcoming projects.

This research will take the Egypt Air Cafés brand at Assiut International Airport as a pilot case study. It consists of five similar projects types in many dimensions. These dimensions are the same owner, same clients, same designer, same contractor, same implementation time, and same function.

The main objective of this research is to establish a new framework for the pre-design stage using statistical management to improve the project performance. The research will model new policies based on statistical management and create a new, efficient construction environment for upcoming construction projects.

Finally, the research draws its conclusions from all theoretical, analytical, and applied aspects. Recommendations with regards to the current situation will be proposed together with further research directions related to the topic.

2. MATERIALS AND METHODS

2.1 Literature Review

There are several quality management tools currently available. The selection process for the most suitable one to use is not always an easy mission. Quality tools cannot treat every quality problem, but they are certainly means for solving problems. It should be emphasized that, while tools can be very effective, they can be highly dangerous if applied in the wrong way. It is important to know how, when, where, and which tools should be used in problem-solving [3]. The most fundamental quality tools are known as the seven basic quality control (7QC) tools, namely the flow chart, the Pareto diagram, the check sheet, the control chart, the histogram, the scatter plot, and the cause-and-effect diagram. These tools were promoted by Ishikawa, a leading quality management expert, in the 1960s. Since then, other new tools have been developed for various purposes but the basis of every one of them is related to the 7QC tools [4]. Quality management also involves the use of many tools in pursuing a statistical approach, such as quality control (QC), statistical quality control (SQC), total quality control (TQC), total quality management (TQM) and six sigma (6σ). The concept of Six Sigma methodology could help decision makers in pre-design stage evaluations as shown Fig. 1. Six Sigma has become very popular throughout the world; there are many reasons for this popularity. Firstly, Six Sigma is regarded as a new quality management strategy that could replace TQC, TQM, and other approaches. In the practical field, many companies, which have not been successful in implementing previous management strategies, such as TQC and TQM, are eager to introduce Six Sigma [5]. It is viewed as a scientific, systematic, statistical, and smarter approach, which is suitable for use in a knowledge-based information society. It is characterized by the 4S approach to management innovation. The essence of Six

Sigma is the integration of four elements (customer, process, man-power, and strategy) to support management innovation.

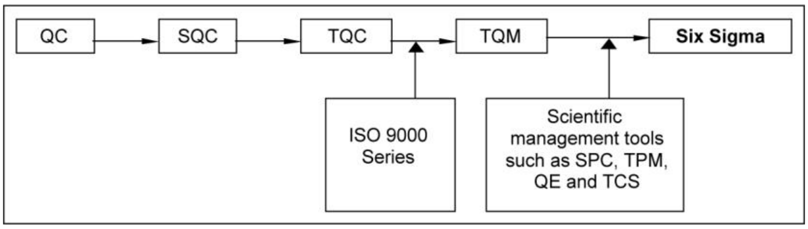

Fig. 1. Development process of six sigma in quality management.

The second reason is that Six Sigma provides efficient man-power. It uses a "belt system" the levels of which are classified as green belt, black belt, master black belt, and champion. Each person on a team obtains certain training at his/her level.

The third reason is that there are many Six Sigma application success stories, starting with Motorola in 1987 as shown Fig. 2. Since then, many global firms have launched a Six Sigma initiative [6].

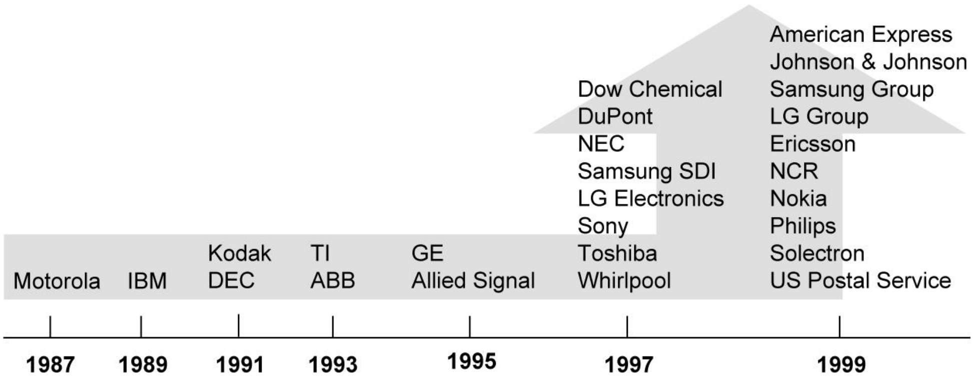

Fig. 2. Globally well-known six sigma companies.

2.1. Six Sigma Initiatives

There are several definitions of Six Sigma. For instance, Tomkins (1997) defines Six Sigma as "a program aimed at the near elimination of defects from every product, process, and transaction". On the other hand, Harry (1998) defines Six Sigma as "a strategic initiative to boost profitability, increase market share and improve customer satisfaction through statistical tools that can lead to breakthrough quantum gains in quality" [6].

From the above definitions, it can be concluded that Six Sigma is an appropriate indicator when it comes to developing a new strategy, which uses statistical measures, based on designers' evaluation of previous projects. Hence, this allows decision makers to eliminate and remove defects at the early stages of a project instead of managing defects or problems after they occur.

Six Sigma methodologies provide a statistical and scientific basis for the measurement of quality levels in all processes. With them, we can visualize and make comparisons at all stages of the design process and establish how good the process is [7].

The core aim of Six Sigma is to improve design process performance. By improving the process, a Six Sigma initiative seeks to deliver on three aspects: 1) reduce costs, 2) improve customer satisfaction and 3) increase revenue, thereby increasing profits. The sigma quality level is an indicator of how often defects probably occur. Hence, a higher quality level of sigma clearly indicates a process that is less likely to create defects. Theoretically, this refers to the bell-shaped curve known as the standard normal distribution or Gaussian curve as shown Fig. 3 [7].

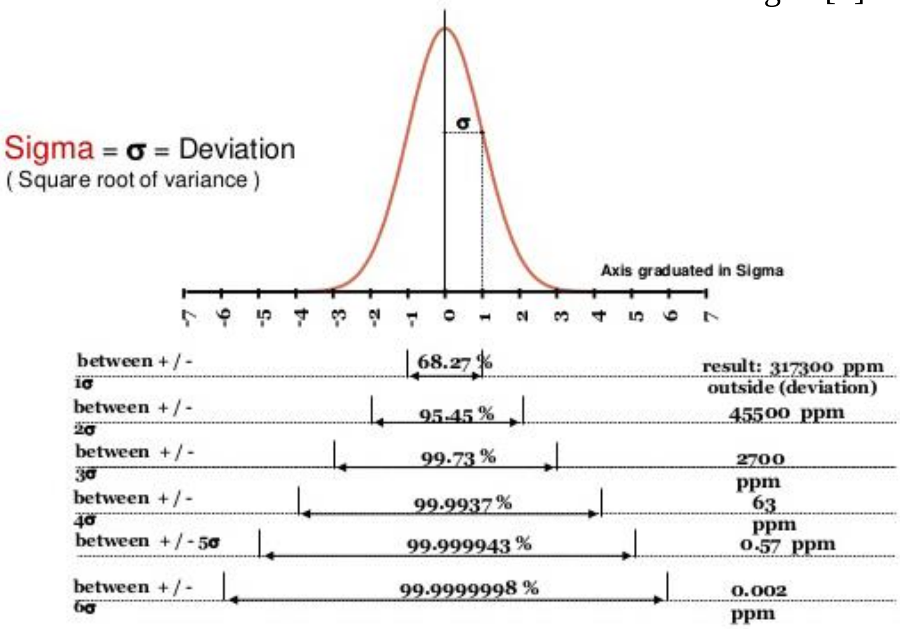

Fig. 3. Normal distribution or the Gaussian curve [7].

Inputs are transformed into outputs in a repetitive flow at the general boundary of a series of activities or processes, as shown in Fig. 4.

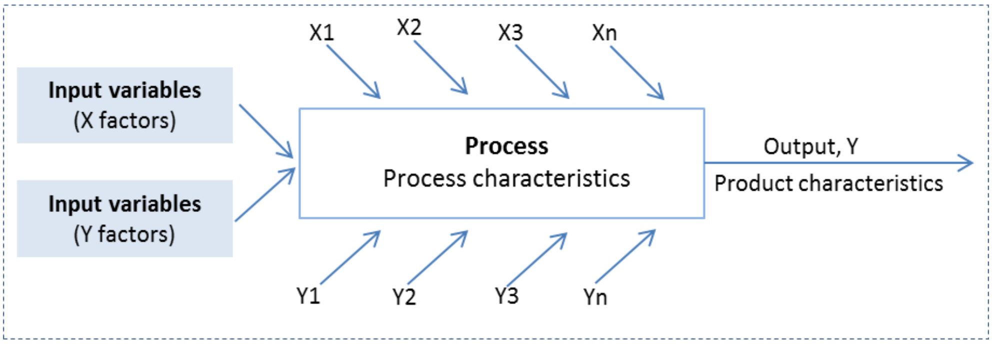

Fig. 4. The process with inputs and outputs.

Based on the project type, the inputs can be anything from labourers, machines, materials, information, and measurements to weight and temperature. Inputs are control factors which can be controlled.

In the Six Sigma model, in terms of processes and improvement, the result variable (characteristics of the process or product) is a function of x and y:

The result variable = $f(x_1, x_2 ... x_n; y_1, y_2 ... y_n)$

Here, x represents one or more control factors, and y represents one or more other factors.

The defect rate is the ratio of the total number of defective items, which are out of specification to the total number of items processed and inspected. The number of defective items out of one million inspected items is called the parts per million (PPM) defect rate. In some cases, the PPM defect rate cannot be properly used, in particular, in the case of service work. In fact, the construction industry is a very good example of this scenario, where the defects per million opportunities (DPMO) metric is often used. DPMO refer to the number of defective opportunities, which do not meet the required specification out of one million possible opportunities [8].

The research proposes a Six Sigma model, which can be used as a measurement procedure for assessment criteria. On construction projects, architects strive to achieve the best architectural design elements to meet end users' satisfaction at the end of the project [9].

The research takes the main elements in the architectural design as vertical inputs in the Six Sigma model. The architectural design elements are functional elements, circulation elements, structural elements, lighting elements, ventilation elements, aesthetic elements, protection elements, and service elements as shown in Table 1 [10, 11]. These elements must achieve the traditional architecture aspects, social aspect, cultural aspects, and natural context [12].

These elements will present input variables or x factors in the vertical columns. Each element will be divided into sub-subjects based on the project type and its requirements [13].

Table 1. Architectural design elements.

1- Functional Elements	Relations	2- Circulation Elements	Mobility standard
	Different paths		Network movement
	Meet building requirements		Merge footpaths
	Dimension		Meet standard for frequency of use
	Meet standard		Meet standard for time of use
3- Structural Elements	Strength	4- Lighting Elements	Illumination density
	Stability		Distributed regularly
	Economic value		Prevent glare
	Iconic design		Meet standard the natural illumination
	Meet standard		Meet standard the artificial illumination
5- Ventilation Elements	Control temperature	6- Aesthetic Elements	Meet building requirements
	Replenish oxygen		Meet standard
	Remove moisture		Iconic design
	Odors and smoke		Achieve all functions
	Heat		Harmony
	Dust and carbon dioxide		
	Airborne bacteria		
7- Protection Elements	Weather	8- Services Elements	Meet wet areas standards
	Fire protection		Meet courtyard standards
	Natural disasters		Meet guard rooms standards
	Theft and robbery		Meet laundry spaces standards
	Doors		Meet electrical rooms standards
	Windows		
	Roof		

To this end, this research calls on decision makers and consultants to consider the same project type when evaluating previous projects in order to make new decisions leading to more accurate results [14]. Meanwhile, the different project sectors will present input variables or y factors on the horizontal rows. These sectors may be presented as building departments, building floors, building phases etc. In other words, the building is divided into different sectors in order to collate an inventory of opportunities and defects in a more accurate form. Each sector will be divided into sub-subjects based on its zones or spaces [15]. The cells between the vertical columns and horizontal rows will be filled with opportunities, commonly denoted by (√) if it is achieved with the standard requirements, and with defects, commonly denoted by (×) if it is not achieved with the standard requirements as shown in Table 2 [16].

After completing all relations among all architectural design elements as a vertical column and all building departments as a horizontal row, the decision maker can account for the total number of opportunities and the total number of defects. This information is then recorded in the row below.

Table 2. Six Sigma proposed model

			1					2					3					4					5							6					7							8				
			functional elements					Circulation elements					Structural elements					Lighting elements					ventilation elements							Aesthetic elements					Protection elements							services elements				
			Relations	different paths	requirements	dimension	standard	mobility	network	footpaths	frequency	time of use	strength	stability	economic	design	function	illumination	distributed	prevent glare	illumination	illumination	temperature	oxygen	moisture	smoke	heat	carbon dioxide	bacteria	requirements	standard	design	functions	harmony	weather	fire protection	disasters	robbery	doors	windows	roof	standards	courtyard	guard rooms	laundry spaces	electrical R.
building Sectors	Department 01	space (1)																																												
		space (2)																																												
		space (3)																																												
		space (4)																																												
	Department 02	space (1)																																												
		space (2)																																												
		space (3)																																												
		space (4)																																												
	or Phase 01	space (1)																																												
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		space (3)																																												
		space (4)																																												
	Phase 02	space (1)																																												
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		space (4)																																												
	or floor 01	space (1)																																												
		space (2)																																												
		space (3)																																												
		space (4)																																												
No. of Defects																																												
No. of opportunities																																												

Analysing data via statistical management tools or production or service processes related with the vexing problem can help to identify the main causes and determinants of performance. Doing so will calculate the sigma for the process or the DPMO using the equitation below [8]:

$$DPMO = [No.\ of\ Defects \div (No.\ of\ Opportunities \times No.\ of\ Units)] \times 1{,}000{,}000$$

This equation can be summarized as follow:

$$DPMO = [No.\ of\ Defects\ \text{“}X\text{”}\ on\ the\ Data\ Collection\ Sheet \div (No.\ of\ Opportunities\ or\ Defects \times No.\ of\ Units)] \times 1{,}000{,}000$$

Decision makers can repeat the above statistical method for several previous designs by the same designer (consultant, company, architect, etc.). After each process, they will obtain a sigma indicator for the quality level of the project. At this point, decision makers have different sigma indicator readings for the same designer. These different readings are called the distribution parameters for the designer. In statistical management situations, it is necessary to determine whether the distribution parameters have particular values or relationships. Thus, this research seeks to test the hypothesis that the mean or standard deviation of a distribution has a certain value. This value represents the designer’s design quality level. Based on this value, decision makers have access to the best analysis afforded by statistical management methodologies and the full capacity to decide which upcoming project should be assigned to which designer.

2.2 Expected Value Initiatives

The EV is defined as an anticipated value for a given investment at many points along the project timeline. In probability and statistical analysis, the EV is calculated by multiplying each of the possible outcomes by the probability that each outcome will occur and adding all those values. By calculating the EV, investors can choose the scenario that is most likely to give them their required outcome. Scenario analysis is one technique for calculating the EV of an investment and decision-making opportunity. It uses estimated probabilities with multivariate models to examine possible outcomes for a proposed investment. Scenario analysis also helps investors and decision makers to determine whether they are taking on an appropriate level of risk, given the probable outcome of the investment [17]. The EV of a random variable gives a measure for the distribution focus of the variable. The EV is the long-term average value of the variable. Given the law of large numbers, the average value of the variable converges towards the EV as the number of repetitions approaches infinity. The EV is also known as the expectation, the mean or the first moment. The EV can also be calculated for single discrete variables, multiple discrete variables, single continuous variables, and multiple continuous variables. For continuous variable situations, integrals must be used. The EV is designed mainly to give a measure for the distribution focus of the variable. To calculate the EV for a single discrete random variable, the value of the variable is multiplied by the probability of that value occurring. Take, for instance, a normal six-sided dice: once you roll the dice, it has an equal one-sixth chance of landing on one, two, three, four, five or six. Given this information, the calculation is straightforward [19]

$$(6\times1/6) + (5\times1/6) + (4\times1/6) + (3\times1/6) + (2\times1/6) + (1\times1/6) = 3.5$$

In attempt to achieve the research aims, the research takes the reading outputs from Six Sigma analysis as the input data where the value of the variable is represented by the probability of that value occurring in the EV process.

3 RESULTS AND DISCUSSIONS

3.1 Egypt Air Cafes Brand at Assiut International Airport as a Pilot Case Study

In this part, the research presents a real pilot case study for validation purposes. When selecting pilot case studies, based on the research strategy, it is vital to consider previous projects of the same project type in order to obtain more accurate results.

- Project name: Egypt Air Cafés brand at Assiut International Airport.
- The owner: Egypt Air In-flight Services Company (the Egypt Air company)
- Project type: entertainment project
- Clients: passengers
- The quality requirements: the research will assume that the minimum quality threshold will have been met when Level 4 of the Six Sigma model is reached.

- Project description: the project consists of five cafés, Travel lounge outside customs office café, International hall café, Arrival hall café, Domestic hall café and VIP travel lounge café.

Each café consists of:

- Seating area – enclosed space (SA-ES). This will be termed Sector 01 in the model.
- Seating area – semi-enclosed space (SA-SES). This will termed Sector 02 in the model.
- Kitchen (Kit). This will termed Sector 03 in the model.
- Counter area (CA) –displaying various snacks. This termed Sector 04 in the model.
- A refrigerator (for ice creams and cold drinks). This will be part of Sector 04 (CA) in the Six Sigma model.
- A store room (SR). This will termed Sector 05 in the model..
- A decorated entrance foyer. This will be included in Sector 02 (SA-SES) in the Six Sigma model.
- Some natural and artificial plants to make the interior space look greener and livelier. This will be included in Sector 02 (SA-SES) in the Six Sigma model**.**

The main reasons for selecting this case study are:

1- Egypt Air Cafés project has the same sectors in each one, thereby helping to obtain more accurate values in the verification process.

2- The number of the project sector is appropriate for comparing sectors with each other in order to detect any defects in the allocation process.

3- The Egypt Air Cafés project is classified as a government project and should give good results. Government projects are fair when it comes to evaluation without favouring any party.

3.2 Six Sigma Results

Table 3 presents the Six Sigma model proposed for the travel lounge outside the customs office café.

Table 3. Six sigma analysis for travel Lounge outside customs office café.

Project Sectors		1				2							3			4							5					6							7						8				
		functional				circulation							structural			lighting							ventilation					aesthetic							protection						services				
		Relations	different paths	requirements	dimension	standard	mobility	network	footpaths	frequency	time of use	strength	stability	economic	design	function	illumination	distributed	prevent glare	illumination	illumination	temperature	oxygen	moisture	smoke	heat	carbon dioxide	bacteria	requirements	standard	design	functions	harmony	weather	fire protection	disasters	robbery	doors	windows	roof	standards	courtyard	guard rooms	laundry spaces	electrical R.
SA-ES	space (1)	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
SA-ES	space (2)	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
SA-SES	space (1)	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
SA-SES	space (2)	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
SA-SES	A entrance	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	√	√
SA-SES	artificial P.	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Kit	preparation	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Kit	operation	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Kit	Handling	√	√	√	√	√	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CA	Counter area	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CA	A refrigerator	√	√	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
SR	space (1)	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
SR	space (2)	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
No. of Defects		0				1							1			2							1					1							0						1				
No. of opt.		58				59							58			60							84					61							86						62				
Total No. of Defects																																									7				
Tal No. of opportunities																																									528				

The following formula was used to calculate the sigma indicator for the quality assessment of the contractor responsible for the travel lounge outside the customs office café.

$$\text{DPMO (Proj. 01)} = 7/(528\times1)\times1{,}000{,}000 = 13{,}257.6$$

Based on the sigma conversion shown in Fig. 5, the equivalent sigma for the calculated DPMO for Project 01 of (13,257.6) is (3.7 σ), which means that percentage of items executed properly by the designer is only 98.6%.

Yield	DPMO	sigma	Yield	DPMO	sigma	Yield	DPMO	sigma
6.6%	**934,000**	**0**	**69.2%**	**308,000**	**2**	**99.4%**	**6,210**	**4**
8.0%	920,000	0.1	72.6%	274,000	2.1	99.5%	4,660	4.1
10.0%	900,000	0.2	75.8%	242,000	2.2	99.7%	3,460	4.2
12.0%	880,000	0.3	78.8%	212,000	2.3	99.75%	2,550	4.3
14.0%	860,000	0.4	81.6%	184,000	2.4	99.81%	1,860	4.4
16.0%	840,000	0.5	84.2%	158,000	2.5	99.87%	1,350	4.5
19.0%	810,000	0.6	86.5%	135,000	2.6	99.90%	960	4.6
22.0%	780,000	0.7	88.5%	115,000	2.7	99.93%	680	4.7
25.0%	750,000	0.8	90.3%	96,800	2.8	99.95%	480	4.8
28.0%	720,000	0.9	91.9%	80,800	2.9	99.97%	330	4.9
31.0%	**690,000**	**1**	**93.3%**	**66,800**	**3**	**99.977%**	**230**	**5**
35.0%	650,000	1.1	94.5%	54,800	3.1	99.985%	150	5.1
39.0%	610,000	1.2	95.5%	44,600	3.2	99.990%	100	5.2
43.0%	570,000	1.3	96.4%	35,900	3.3	99.993%	70	5.3
46.0%	540,000	1.4	97.1%	28,700	3.4	99.996%	40	5.4
50.0%	500,000	1.5	97.7%	22,700	3.5	99.997%	30	5.5
54.0%	460,000	1.6	98.2%	17,800	3.6	99.9980%	20	5.6
58.0%	420,000	1.7	98.6%	13,900	3.7	99.9990%	10	5.7
61.8%	382,000	1.8	98.9%	10,700	3.8	99.9992%	8	5.8
65.6%	344,000	1.9	99.2%	8,190	3.9	99.9995%	5	5.9
						99.99966%	**3.4**	**6**

Fig. 5. Six sigma conversion.

After repeating this analysis of the Six Sigma model on the other projects, the final results are presented in Table 4.

Table 4. Six sigma analysis results.

Project Name	DPMO	Sigma Level	Yield, %
Travel Lounge outside customs office café	13,257.6	3.7	98.6
Arrival hall café	4,750	4.1	99.5
International hall café	7,980.5	3.9	99.2
Domestic hall café	9,989.3	3.8	98.9
VIP travel lounge café	2.540.3	4.3	99.75

3.2 Expected Value Results

The output results from the Six Sigma analysis were used as input data to calculate the EV.

$$EV = (1/4 \times 3.7) + (1/4 \times 4.1) + (1/4 \times 3.9) + (1/4 \times 3.8) + (1/6 \times 4.3) = 3.975$$

This means that, if decision makers assign the designer who has been evaluated, the project will achieve (3.975) out of (4.0).

Based on the quality level, which is either assumed or required, that is, if the decision makers assume the quality threshold to be at Level 5 of the Six Sigma Model, the project will achieve (3.975) out of (5.00), meaning that the respective designer is not qualified enough for this type of project.

4. CONCLUSIONS

The research is built upon the materials and methods section of the study and the final results by employing a real pilot case study. Quality aspects not only play a vital role in the construction industry but also inform the development of a clear strategy for the future use of building technology. New strategies need more effective tools in order to achieve end users’ goals and meet their needs. Upcoming projects are more complex in all architecture dimensions. The research finds that, if we cannot draw a new road map for all stakeholders, we will not be able to face the vexing problems related to architectural designs. Further, it has been concluded that statistical management methodology is highly effective when conducting rational analyses. This methodology is one of the tools of proactive management.

Pursuing statistical management via the Six Sigma approach and the EV concept will help decision makers to derive more benefits at many levels, especially in the early stages of the project life cycle.

The main stakeholders, who, at the pre-design stages, are the owners (governmental authorities and/or investors) and the decision makers (consultants, technical evaluation committee and/or project managers), are as follows:

1- The owners' level

- Government polices: The official responsible authority should introduce new legislation to obligate all partners in the pre-design stage to use and consider statistical management, based on statistical analysis, to improve the performance quality for all types of projects. All designers and architects must present a performance quality report for the executed works, to be submitted by experts from the statistical management field.
- The investors: The research advises investors to be confident about the performance quality of the designer who has just been awarded a project. Further, they should be certain that the designer will satisfy the quality assurance threshold and reduce unnecessary costs in the early phase of the project as a proactive step. Hence, this will be of a great benefit to them.

2- The decision makers' level:

- The consultants: The research urges decision makers and consultants to consider the application of statistical management and its indicators in the evaluation process of the awarding phase in order to ensure proactive management and quality assurance. The research also advises decision makers and consultants to consider the same project type when evaluating previous projects in order to make new decisions, which will lead to more accurate results.
- Technical evaluation committee: The Six Sigma and EV results are the outcomes of a fair assessment system. The research encourages the technical evaluation committee to use these tools as part of their assessment methodologies. The statistical analysis results guarantee that the assessment

procedures will be based on scientific/rational analysis and avoid favouring one party over another. The technical evaluation committee must include team members with green, black, master black belt and champion belts, as found in the Six Sigma field. This will help to achieve the desired statistical research results.

3- At the researchers' level:

Other disciplines, such as structural, mechanical and electrical works, should find alternative indicators to be able to measure design performance quality throughout each phase of the project life cycle. These alternative indicators should be used for statistical management purposes as part of the research plan.

Finally, it may be concluded that the use of statistical management initiatives for measuring the quality of projects will strengthen competition in the Egyptian construction market. This is because every designer will look forward to receiving more quality indices, which will eventually improve the overall quality of their projects.

DECLARATION OF CONFLICT OF INTERESTS

The author has declared no conflict of interests.

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إطار عمل جديد لمرحلة ما قبل التصميم باستخدام منهج الإدارة الإحصائية

يهدف البحث الى تحسين مستوى الجودة في المشاريع من أجل تحقيق أهدافها من خلال تطبيق منهج الإدارة الإحصائية للعدم وجود طرق متاحة لإنشاء خريطة طريق مناسبة لاختيار المصممين استنادًا إلى التحليل الإحصائي ولذلك يحاول البحث تصحيح المشكلات في مرحلة ما قبل تصميم مشاريع البناء والتشييد من خلال تفعيل الإدارة الإحصائية بدراسة طريقتين إحصائيتين: منهجية Six Sigma وسيناريو القيمة المتوقعة، وكيفية تطبيقهما لإنشاء إطار جديد لمرحلة ما قبل التصميم من أجل تحسين أداء المشروع باستخدام مسارًا علميًا يبدأ بالدراسات النظرية والتحليلية مع تقديم دراسة تطبيقية تقدم قياس للعلامة التجارية لمصر للطيران بالمقاهي في مطار أسيوط الدولي كدراسات حالة تجريبية مع تقديم ما تم التوصل اليه من الاستنتاجات.