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The Impact of Supervision Teams on Contractor's Performance in National Housing Projects in Egypt

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Abstract: *Construction supervision consultants share the responsibility of project success with construction contractors. The support, directions, and timely inspections of completed works helps projects progress as planned. Supervision consultants help their clients address problems and improve upon project performance; Their role is to complement the effort of contractors to ensure a successful completion of a project as planned. To clients, when projects slip over their planned schedule, the supervision consultant may be blamed for not providing expected care to the project. The aim of this research is to identify the relationship between the size of the supervision team and the project progress in large governmental housing projects in Egypt. The Ministry of Housing, Utilities and Urban Communities of Egypt is currently implementing a mega national program of social housing since 2012. This paper focuses to understand the factors affecting the performance of the overall housing program during the period from January 2016 to July 2017 in different cities. A comparison of Schedule Performance Index (SPI) variations among (94) Contractors across five cities (8 geographic sectors) for a projects value of (7.3 Billion L.E.) have been completed. Also, the supervision team performance is studied and a comparison of human resources index (HRI) for the consultant team have been completed. The correlation between the SPI and the HRI for all cities have been studied. The results indicate that the most significant factors affecting the consultant performance were the number of supervision team and their ability to coordinate and work as a team. Based on these results, recommendations to improve overall performance of the program are presented.*

Keywords: *Human Resource Index (HRI), Schedule Performance Index (SPI), Social Housing Project*

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I. Introduction

Project management is only one of the many criteria upon which project performance is contingent, it is also arguably the most significant as people formulating the processes and systems who deliver the projects. [1]. The consultant ensures that the project is completed to the right quality against technical specifications and design standards, on time and within budget, i.e. gives the Employer Value for Money. Precisely, some of the main duties of the Consultant according to FIDIC IV are: reviewing and updating design details; monitoring contractor's operations to ensure timely commencement of operation; reviewing contractor's program; carrying out quality control tests; reviewing contractor's monthly invoices and certifying for payment; evaluating all claims for additional payment and applications for extension of time; and preparing monthly, quarterly and annual progress reports.

Project failures are not solely caused by contractors. Consultants also contribute to the failure of overall project performance. Assaf [2] stated that to clients:"when projects slip over their planned schedule, the consultant has not performed". Bleout, [3] & Pinto [4] mentioned that consultants must be able to operate and coordinate effectively on a day to day basis to ensure positive impact on the overall quality of their projects.

Bandow [5] asserted that the ability to work as a team is one of the most factors affecting consultant performance. If consultants have strong leadership skills, they are able to liaise well with their team, so that project performance can be monitored, controlled and managed. Dadzie J. [6] stated that the most significant factors affecting consultants performance on development projects are: 1) urgency of the project at hand, 2) project duration in terms of time spent in getting the work done, 3) political influence from higher authority affecting project delivery, 4) timely decision making on the part of the consultancy team, and 5) the experience of the design team on the project. Other factors include the ability of the consultant to work as a team, creativity on the part of the consultant in controlling cost and developing own efficiencies so that contract sums are within budget. Furthermore, the consultant's ability to coordinate efficiently and effectively the works and poor

working relationship among team members were identified. Nadim N. [7] introduced (8)measures of project performance and evaluation include: cost, schedule, billing, profitability, quality, safety, project team satisfaction, and client satisfaction.

The Ministry of Housing, Utilities and Urban Communities of Egypt is currently implementing a national program to build one million social housing apartments. The Social Housing Program has been in place since 2012 with the aim of providing residential units for low-income citizens and to curb the growth of informal settlements. The project's implementation was forestalled following the 25 January uprising, and later re-launched in July 2012, with the plan of building 200,000 units each year till 2017. The project entails the construction of 656,000 social housing units in the first two phases at a total cost of EGP 97billion in different governorates across Egypt, [8]. The first phase of the project has 256,000 housing units worth EGP37 billion. The second phase will target the completion of 400,000 units at a total cost of EGP 60 billion. As part of the third phase of social housing project, the Ministry of Housing has started the implementation of 27,876 residential units in 17 governorates. This paper focuses to understanding the factors affecting the time performance of the overall program during the period from January 2016 to July 2017. Schedule Performance Index (SPI) among (94) Contractors across five cities (eight locations)and size of supervision team expressed as an index related to contracts budget (HRI)have been investigated. Also, the correlation between the SPI and the HRI for all cities have been studied. The investigation of progress data of 94 contractors in the construction of (2,460) typical buildings (55860 units) with (7.3 Billion LE) budget were completed. The Eight (8) geographic sectors/cities included in this study are: **1) Badr City, 2) 10th of Ramadan City- Sector "1", 3) 15th of May City, 4) Obour City, 5) 10th of Ramadan- "Sector 2", 6)Six of October – "Sector B", 7) Six of October – "Sector C", 8) Six of October – "Sector D".**

II. Methodology

This research adopted a quantitative analysis methodology through three phases: where the factors affecting the time performance of the Housing Program were surveyed as first phase through evaluating time performance of (94) Contractors across (8) Sectors/Cities against supervision consultant team size and corresponding contract values in these sectors/cities. The data collection is followed by a second phase to analyze the surveyed data, where Data analysis includes correlation between Schedule Performance Index (SPI) as an indicator of contractor time performance and a newly developed index (HRI) as an indicator of the ratio of supervision team size and contract value in each sector/city.

The parameters used in this analysis include:

1) Schedule Performance Index (SPI) = EV/PV where:

EV = Earned value, Budgeted cost of work performed: the cumulative budgeted cost for work completed to date.

PV = Planned Value, Budgeted cost of work scheduled: the budgeted cost for work scheduled (as per budget) to date.

2) Supervision Team Size as relates to Contract Value (HRI):

(HRI) = Total man for Supervision team during the study period /
Contract value

III. Data Analysis

3.1. Data Collection

The Social Housing Project across eight sectors/cities is surveyed. Data collection from project records include the following categories:

1) City general data (Number of typical buildings, Number of contractors, Contracts' value and Size of supervision team in each city).

2) Different factors affecting the consultant performance.

3) Monthly construction progress data and invoices for each contractor.

Each section is discussed in details. The survey is done through interviews with different project managers and through data gathering in these cities.

3.2.Sample Profile

Social Housing construction projects data in eight (8) sectors/cities were surveyed during the period from January 2016 to July 2017 which include:

1) Badr City,
2) 10th of Ramadan City –"Sector 1",
3) 15thof May City,
4) Obour City,
5) 10th of Ramadan City –"Sector 2",

6) 6th of October City – "Sector B",
7) 6th of October City – "Sector C",
8) 6th of October City – "Sector D"

The typical design of Social Housing Buildings includes ground floor and five (5) typical floors, each floor is divided into 4 apartments of $90m^2$ each.

The construction in Badr, 10th of Ramadan - "Sector 1", 15th of May cities started at the end of 2014 and project duration was planned to be 15 months, while the other cities started consequently in 2016 and project duration was planned to be (12) months. All contractors in all cities have been granted an extension of time of additional (3) months duration as a compensation of price increase starting from 3/2017.

Table (1) reveals the number of buildings, number of contractors, contract value and size of supervision team in each city. As shown in Table (1), 6th of October City – "Sector C" followed by 10th of Ramadan City – "Sector 1", has the highest total contract value while 15th of May City has the least. Also 10th of Ramadan City – "Sector 1", has the highest number for supervision teams while 6th of October City –"Sector D" has the least in spite of that it has the highest number of contractors. It is noticeable that supervision teams include engineers more than technicians which is common in Egyptian construction industry.

Table (1): Summary Data of Each City

Geographic Sector/City	No of Buildings	No of Contractors	Contracts Values	Total Size of Supervision Teams
Badr City	244	8	742,584,838	36Engineers, 12 Technician
10th of Ramadan City – "Sector 1"	427	10	1,070,798,068	120Engineers
15th of May City	139	4	430,371,180	14Engineers, 9 Technician
Obour City	220	12	703,219,787	41Engineers
10th of Ramadan City – "Sector2"	368	11	922,905,112	48Engineers 1 Technician
6th of October City – "Sector B"	373	10	1,167,093,257	54Engineers, 10 Technician
6th of October City – "Sector C"	440	14	1,414,802,038	68Engineers, 7 Technician
6th of October City – "Sector D"	249	15	800,989,748.7	41Engineers

3.3.Factors Affecting the Consultant Performance

The second section of the survey addresses the different factors that affect the performance of consultants on the development of these projects. The results sort these factors according to their importance as shown in Table (2).

Table (2): Ranking of Factors that Affect the Performance of Consultants

Factor		Rank
Factors related to management of the team	Size of supervision Team	1
	Ability to coordinate	
	Ability to work as a team	
Quality related factors	Team Experience	5
	Test records	
Time related factors	Timely decision making	3
	Timely submission of reports, payment and claims	
	Completing major specified work sections	
	Proper planning and scheduling of works	
Cost related factors	Reliable budget estimate	4
	Excessive variation orders	
	Controlling Cost	
Other Factors	Political influence	2
	Urgency	

IV. Results and Discussion

4.1 Human Resource Index for Each City

According to Table (2), the most significant factors affecting the consultant performance were the factors affecting team management(Number of supervision team, their ability to coordinate and work as a team) followed by political influence and urgency of projects which is not surprising as it is a national housing project.

This paper will focus on the most significant factor which is supervision team size. Human resource index (HRI) as an indicator of the ratio of supervision team size and contract value in each city is developed. Human resource index (HRI) for each city is calculated as shown in Table (3) according to equation (4.1) as follows:
HRI = Size of Supervision / contract value (4.1)

Table (3): HRI of Each City

City	**HRI *(1000000) (Engineers)**
Badr City	0.05
10th of Ramadan City –"Sector 1"	0.11
15th of May City	0.03
Obour City	0.06
10th of Ramadan City –"Sector2"	0.05
6th of October City – "Sector B"	0.05
6th of October City – "Sector C"	0.05
6th of October City – "Sector D"	0.05
Average	**0.056**

As shown in Table (3), 10th of Ramadan City –"Sector 1"has the highest HRI, while 15th of May city has the least. The average value of HRI is 0.056.It is expected that the variation in supervision team size to have an impact on project progress.

4.2 Schedule Performance Index for Each Contractor in Each City

Schedule Performance Index (SPI) is a parameter of Earned Value Analysis (EV) that reflects the ratio of actual performance to planned performance. SPI is calculated as the sum of the budgets of completed activities (or milestones) by the data date; also known as (Budgeted Cost for Work Performed (BCWS) or Earned Value {EV})divided by the sum of the budgets of all activities scheduled to have been completed by that date (Budgeted Cost for Work Scheduled {BCWS} or Planned Value {PV}).Schedule Performance Index (SPI) for each contractor in each city for each month is then calculated according to equation (4.2) as follows:

SPI = EV/PV (4.2)

If the SPI is less than one, it indicates that the project is potentially behind schedule to-date whereas an SPI greater than one, indicates the project is running ahead of schedule. The analysis of Social Housing project performance covers the period from January 2016 to July 2017, so data were gathered about the planned progress percentage and actual progress percentage of work for each contractor in each city for each month during this period.

The SPI for Badr City and Obour City are shown in Table (4) and Table (5) as an examples for the work done for all cities.

Also Fig. (1) shows comparison of the SPI for contractors in each month during the period of January to June 2016 for Badr City as an example.

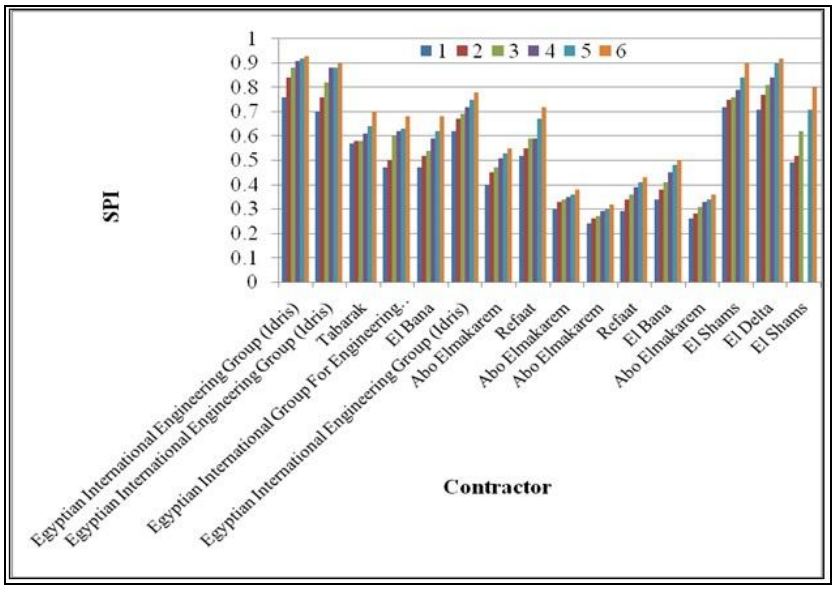

Fig. (1): Comparison of SPI for Each Contractor During Period of January to June 2016 for Badr City

Table (4): SPI for Badr City

Badr				SPI/Month																	
Contractor	Beginning date	No of Blds	Contract value	2016												2017					
				1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	7
Egyptian International Engineering Group (Idris)	30/9/2014	5	14849802	0.76	0.84	0.88	0.91	0.92	0.93	0.96	0.97	0.98	0.98	0.99	1	1	1	1	1	1	1
Egyptian International Engineering Group (Idris)	30/9/2014	6	17819423.82	0.70	0.76	0.82	0.88	0.88	0.90	0.94	0.95	0.96	0.96	0.97	0.99	1	1	1	1	1	1
Tabarak	26/1/2015	14	42007883.7	0.57	0.58	0.58	0.61	0.64	0.70	0.75	0.80	0.82	0.85	0.92	0.95	0.97	0.98	0.98	0.98	1	1
Egyptian International Group For Engineering & Contracting (Azmy)	15/10/2014	16	47922562.65	0.47	0.50	0.60	0.62	0.63	0.68	0.70	0.70	0.72	0.74	0.75	0.79	0.83	0.85	0.81	0.81	0.81	0.81
El Bana	15/9/2014	14	43137643.23	0.47	0.52	0.54	0.59	0.62	0.68	0.77	0.82	0.83	0.87	0.96	0.98	0.98	0.99	1	1	1	1
Egyptian International Engineering Group (Idris)	30/9/2014	12	35531129.7	0.62	0.67	0.69	0.72	0.75	0.78	0.79	0.82	0.84	0.85	0.88	0.93	0.95	0.97	0.99	0.99	0.98	0.98
Abo Elmakarem	15/9/2014	20	61637113.75	0.40	0.45	0.47	0.51	0.53	0.55	0.60	0.60	0.62	0.63	0.65	0.67	0.69	0.71	0.74	0.76	0.77	0.79
Refaat	24/9/2014	12	37434480.45	0.52	0.55	0.59	0.59	0.67	0.72	0.90	0.92	0.94	0.95	0.96	1	1	1	1	1	1	1
Abo Elmakarem	15/9/2014	19	58843891.75	0.30	0.33	0.34	0.35	0.36	0.38	0.40	0.50	0.51	0.51	0.52	0.55	0.57	0.59	0.55	0.58	0.60	0.61
Abo Elmakarem	15/9/2014	26	78825596.97	0.24	0.26	0.27	0.29	0.30	0.32	0.40	0.45	0.46	0.47	0.48	0.49	0.52	0.53	0.55	0.55	0.55	0.57
Refaat	24/9/2014	6	18714973.16	0.29	0.34	0.36	0.39	0.41	0.43	0.55	0.60	0.61	0.62	0.74	0.75	0.78	0.79	0.79	0.79	0.79	0.79
El Bana	15/9/2014	16	49226332.32	0.34	0.38	0.41	0.45	0.48	0.50	0.65	0.60	0.62	0.65	0.70	0.72	0.75	0.77	0.77	0.77	0.79	0.83
Abo Elmakarem	15/12/2014	25	81263707	0.26	0.28	0.31	0.33	0.34	0.36	0.40	0.50	0.51	0.52	0.53	0.58	0.60	0.62	0.58	0.58	0.58	0.58
El Shams	8/9/2014	11	33696299	0.72	0.75	0.76	0.79	0.84	0.90	0.98	0.98	0.99	0.99	0.99	1	1	1	1	1	1	1
El Delta	1/9/2014	13	35187676.87	0.71	0.77	0.81	0.84	0.90	0.92	0.95	0.97	0.98	0.98	0.98	1	1	1	1	1	1	1
El Shams	8/9/2014	29	86489321.8	0.49	0.52	0.62	0.70	0.71	0.80	0.82	0.83	0.87	0.90	0.91	0.92	0.94	0.95	0.92	0.94	0.95	0.95

Table 5: SPI for Obour City

Obour				SPI/Month											
Contractor	Beginning date	No of Blds	Contract value	2016						2017					
				7	8	9	10	11	12	1	2	3	4	5	7
Met Ghamr Association	27/5/2016	29	92903124	0.36	0.71	0.69	0.60	0.44	0.55	0.60	0.65	1.25	1.03	0.88	0.77
Oweda	16/5/2016	16	51134826.4	0.31	0.89	0.94	0.90	0.86	0.90	1.19	0.85	1.30	1.20	1.02	0.79
Hany Bakir	12/6/2016	17	54445765	0.66	1.25	0.66	0.58	0.60	0.60	0.52	0.46	1.07	0.75	0.67	0.56
Teba	31/5/2016	8	25609480	0.36	0.93	0.87	1.18	1	0.77	0.70	0.68	1.05	0.97	0.90	0.80
Ahmed Saad	12/6/2016	41	131187376.3	1.17	1.20	1.53	0.83	0.71	0.62	0.69	0.74	1.04	0.94	0.94	0.85
Tabarak	12/6/2016	32	102485827.3	0.63	0.73	0.70	0.59	0.66	0.50	0.57	0.45	0.78	0.73	0.66	0.58
El Mostakbal	20/9/2016	22	70377076				0.97	0.89	0.77	0.71	0.66	0.92	0.80	0.82	0.70
El Wahat El Bahareya	24/9/2016	14	44748446						0.82	0.70	0.56	0.96	0.90	0.76	0.86
Elkosia	5/10/2016	11	35068000					1.67	0.93	1.43	1.20	3.09	2.23	1.76	1.35
Marha	5/10/2016	12	37895383.8					0.80	1.88	0.97		2.28	1.33	1.68	1.26
Emaar	5/10/2016	6	19118010						0.83	1.14	1.11	1.67	1.39	1.29	1.10
Ahmed Saad	5/10/2016	12	38246472						1.34	1.09	1.10	3.07	2.17	1.69	1.21

As shown in Table (5), the SPI for all contractors increased in March 2017 and this is due to that all contractors were given additional 3 months duration as a compensation of price increase and then the performance decreased again. This is not clear in Badr city as shown in Table 4 because all contractors are almost finishing their works.

4.3 Schedule Performance Index for Each City

After calculating the SPI for each contractor in each city / month, The SPI for each City / month is then calculated according to equation (4.3) as follows and is shown in Table (6):

SPI/ Month = ∑Actual progress / ∑Planned Progress (4.3)

Table 6: SPI/ Month for Each City

	City							
Month	**Badr City**	**10th of Ramadan City–"Sector 1"**	**15th of May City**	**Obour City**	**10th of Ramadan City–"Sector 2"**	**6th of October–"Sector B"**	**6th of October – "Sector C"**	**6th of October – "Sector D"**
1-2016	0.44	0.75	0.56					
2-2016	0.47	0.85	0.59					
3-2016	0.51	0.95	0.59					
4-2016	0.55	0.86	0.61					
5-2016	0.57	0.94	0.65					
6-2016	0.61	0.89	0.67					
7-2016	0.67	0.86	0.68	0.53				
8-2016	0.7	0.86	0.68	1.2				
9-2016	0.72	0.86	0.75	0.9			0.86	
10-2016	0.73	0.92	0.76	0.74		0.83	0.76	0.9
11-2016	0.76	0.86	0.81	0.69	1.09	0.58	0.69	0.88
12-2016	0.78	0.86	0.83	0.67	1.14	0.59	0.66	0.75
1-2017	0.80	0.87	0.85	0.72	0.85	0.59	0.57	0.71
2-2017	0.81	0.86	0.85	0.68	0.89	0.59	0.55	0.65
3-2017	0.81	0.91	0.87	1.16	0.8	0.57	0.66	0.57
4-2017	0.81	0.90	0.88	1	0.81	0.76	0.79	0.79
5-2017	0.82	0.90	0.89	0.92	0.69	0.72	0.74	0.67
7-2017	0.82	0.93	0.90	0.79	0.62	0.66	0.72	0.60
Average SPI	**0.69**	**0.88**	**0.75**	**0.83**	**0.86**	**0.65**	**0.70**	**0.72**

As mentioned before, Badr City, 10th of Ramadan City–"Sector 1", 15th of May City started at the end of 2014 , while the other cities started consequently in 2016 as shown in Table (6). As noticed, all cities that started early have an increasing or steady SPI values as these cities are approaching completion stage. On the other hand, the cities that started later have a decreasing SPI values which indicates slow down of construction progress. This could be attributed to the impact of the Egyptian Currency devaluation mandated by Egypt. Many contractors were not able to abide by the contract prices and schedules upon this devaluation. The government has offered a (3) months additional duration to the (12) months contract for those affected. After studying the SPI for each month in each city, the average SPI for each city is calculated according to the number of months. As noticed all cities are behind the schedule as their average SPI is less than 1. It is also noticed that 10th of Ramadan City–"Sector 1" has the highest average SPI while 6th of October City – "Sector B" has the least.

Fig. (2) and Fig. (3) shows the SPI for Badr and Obour cities as an example. As shown the SPI for Badr City is increasing as all contractors are in the finishing stage, While in Obour City the SPI is decreasing till March 2017, then it increases due to the additional 3 months duration given as a compensation of price increase and then the performance decrease again.

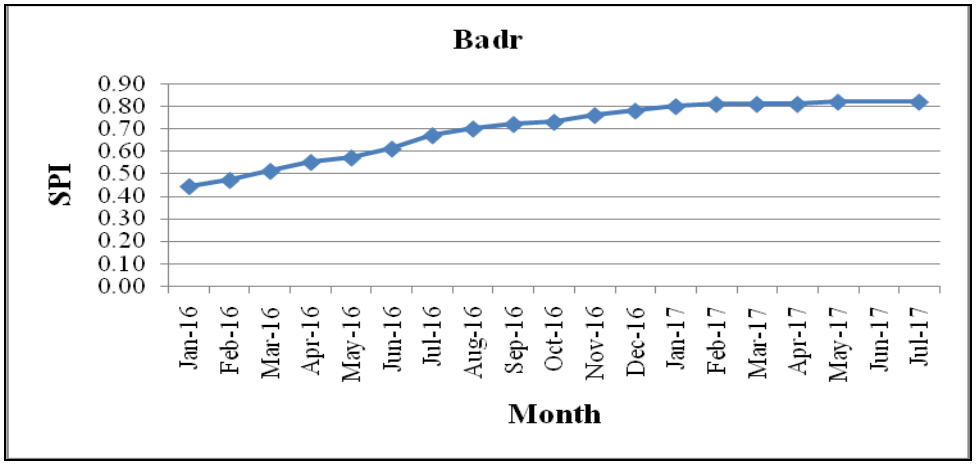

Fig.(2): SPI for Badr City

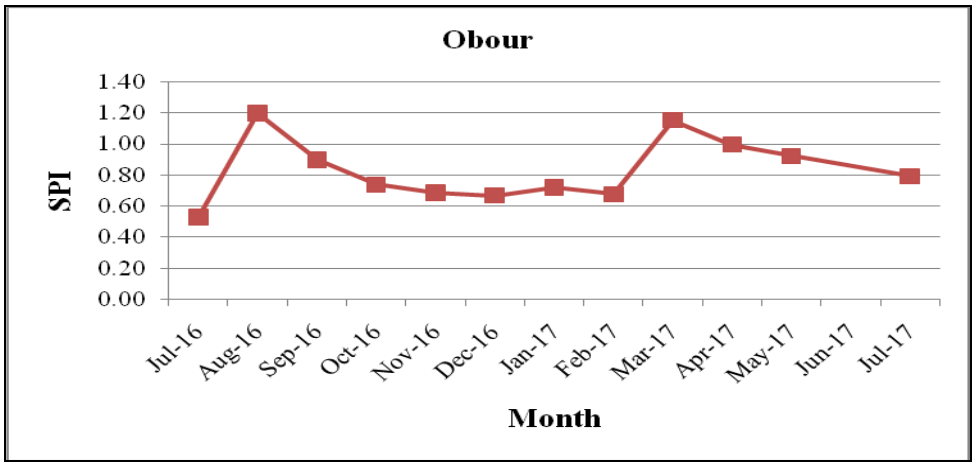

Fig.(3): SPI for Obour City

V. Correlation Between SPI and HRI

Correlation Between Schedule Performance Index (SPI) as an indicator of contractor time performance and Human Resource Indicator (HRI) as an indicator of the ratio of supervision team size and contract value in each city is studied using Microsoft excel according to equation (5.1) as follows:

(5.1) $$Correl(X,Y) = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sqrt{\sum (x-\bar{x})^2 \sum (y-\bar{y})^2}}$$

where x and y are the sample means average(array1) and average(array2).

For the three cities that started early (Badr City, 10th of Ramadan City – "Sector 1" and 15th of May City) the correlation coefficient between their SPI and HRIwas0.8which indicates strong correlation between them ,while for the other cities it was 0.5which indicates there is a correlation. Then the correlation between SPI and HRI for all cities was studied and was 0.6 which shows that there is a relation between the size of supervision team and the schedule performance indicator as shown in Fig.(4).

Fig.(4): The Correlation Between SPI and HRI for All Cities

VI. Conclusion

This paper focuses on measuring contractors' time performance in five major cities (8 geographic sectors) for the construction of (2,460) typical buildings with (7.3 Billion LE) budget during the period from January 2016 to July 2017. The parameters of Schedule Performance Index (SPI), size of supervision team (HRI) were used to compare progress data among(94) contractors. The analysis revealed the following:

1- The most significant factors affecting the consultant performance were the size of supervision team and their ability to coordinate and work as a team followed by political influence and project urgency.
2- Quality related factors were the least factors affecting the consultant performance.
3- 10th of Ramadan City – "Sector 1" has the highest total contract value while 1[5th] of May City has the least. Also 10th of Ramadan City – "Sector 1"has the highest supervision team size while 6th of October City – " Sector D" has the least in spite of that it has the highest number of contractors.

4- 10^{th} of Ramadan City – "Sector 1"has the highest Human Resource Index (HRI) for engineers, while 15^{th} of May city has the least.
5- The Schedule Performance Index (SPI) for all cities that started in 2014 are almost increasing or steady as these cities are in the finishing stage, while that of the cities that started in 2016 are decreasing which indicates that the change in prices and the sudden incremental affects the performance. When they were given extension of time of (3) months which led to increase of the performance improved.
6- 10^{th} of Ramadan City – "Sector 1" has the highest SPI while 6^{th} of October City – "Sector B" has the least.
7- The correlation between SPI and HRI for all cities shows that there is a Strong correlation between supervision team size and the time performance of contractors.

The main recommendations to improve the overall performance of the Social Housing program are to make sure that factors related to management should be improved; appoint sufficient number of supervision team relative to contract values, the consulting team should recruit competent and qualified staff with good coordination skills to solve technical issues on site and have the teamwork skills.
In addition, consultants are recommended to respond to requests of inspections raised by contractors on time to enable construction activities to progress according to the schedule.

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