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List of Abbreviations

ANSI	American National Standard Institute
ARC	Australian Research Council
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
AWWA	American Water Works Association
BAM	Business Activity Monitoring
BAM	Business Activity Monitoring
BOT	Built-Operate-Transfer
BEP	Best Efficiency Point
CADM	Contractor's Affairs Department Model
CPI	Certified Pump Installer
CPM	Critical Path Method
CWD	Certified Well Driller
EM	Electromagnetic
FF	Finish/Finish
FDA	Food and Drugs Administration
FS	Finish/Start
GIS	Geographical Information System
GWI	Groundwater Industry
KPI	Key Performance Indicators
MD	Managing Director
MGWC	Master Groundwater Contractor
MOCM	Moderate Organizational Contractor's model
MoP	Ministry of Planning
MWRI	Ministry of Water Resources and Irrigation

NGO	Non-governmental Organization
NGWA	National Groundwater Association
NPSH	Net Positive Suction Head
nS	Specific Speed
NSF	National Sanitation Foundation
NWC	National Water Corporation
OS	Organization Structure
PAD	Pitless Adapter Division
PIM	Project Information Management
PPC	Project performance Corporation
PPM	Project Performance Management
PVC	Poly Vinyl Chloride
PVWC	Passaic Valley Water Commission
ROI	Return on Investment
RTDC	Rules of Tennessee Department of Environment Conservation
SDR	Standard Dimension Ratio
SPSS	Statistical Package of Social Science
WBS	Work Breakdown Structure
WRDO	Water Resources Department of Oregon

ABSTRACT

This research aimed at identifying and assessing the current situation of the groundwater industry (GWI) in Sudan in order to highlight the performance deterioration noticed in this important sector after mostly being privatized.

The assessment stressed on important organizational aspects and influential technical GWI aspects such as exploration, adequacy of well design, technique, well completion, pump's selection, installation, water tanks, towers and supply stations.

The methodology of the research (action research) consisted of a survey questionnaire to obtain information relevant to the GWI performance. Data collected from the questionnaire's feedback was statistically analyzed using SPSS programme. Several visits were made to many of the relevant departments for survey and collection of the required data. Data also have been collected from references, researches, reports and verbal statements from some well-known GWI local experts.

A comparison study process was conducted between the local and international companies to identify variations and differences in the different GWI aspects to obtain the required results.

The results showed a serious deterioration in the performance of the GWI in Sudan. This deterioration affected the project's design and the groundwater quantity, quality and protection.

This research proposed **enhancement steps** for the most influential GWI components and an additional department to be linked to the existing authority structure named **Contractors' Affairs Department(CAD)** which provides the required follow up, observation and supervision of the private companies activities. The research also suggested a moderate

organizational model for use by the private companies named the **Moderate Organizational Model (MOM)** to fill the organizational gaps and enhance performance of groundwater companies. Furthermore, **amendments and additions of some conditions** to the existing contracting agreement used by most of the local companies as an important step of enhancement precaution to reap the required level of technical performance and to prevent claims and disputes between the two parties were also suggested. Hence, **Key Performance Indicators (KPI)** to act as a helpful tool of evaluation for the GWI situation and to enable stakeholders to perform early remedial steps for any deteriorated aspects were formulated.

It is therefore recommended to disseminate the results of this research among all concerned stakeholders in the GWI sector.

المستخلص

استهدف هذا البحث تعريف وتقويم الوضع السائد لصناعة المياه الجوفية بالسودان بغرض اظهار الأداء المتدهور في هذا المرفق المهم بعد ان اتجه معظمه إلى القطاع الخاص.

تركز التقييم على الامور الادارية للفعاليات الفنية المؤثرة الخاصة بصناعة المياه الجوفية كالأبحاث الخاصه بالمياه الجوفية، ومدى تناسب تصميم وتقنية الآبار، وإكمال الآبار، واختيار المضخات وتركيبها، وصهاريج وأبراج المياه ومحطات المياه. انتهج البحث عدة محاور تضمنت مسح استبيني للحصول على المعلومات ذات العلاقة بأداء صناعة المياه الجوفية. المعلومات المجمعَة من الاستبيان تم تحليلها إحصائياً باستخدام البرنامج الاحصائي SPSS.

القيام بزيارات ميدانية للإدارات ذات العلاقة بهدف المسح وتجميع المعلومات المطلوبة. تجميع معلومات ذات علاقة بأهداف البحث من المراجع، والأبحاث، والتقارير والإفادات الشفاهية من بعض خبراء صناعة المياه الجوفية المعروفين محلياً.

إجراء دراسة مقارنة بين الشركات المحلية والعالمية للتعرف على المتغيرات والفوارق في مختلف فعاليات صناعة المياه الجوفية بغرض الحصول على النتائج المطلوبة. أوضحت النتائج تدهورا خطيرا في صناعة المياه الجوفية بالسودان امتد تأثيرها سلباً على تصميم مشاريع المياه الجوفية وكميات ونوعيات وحماية المياه الجوفية.

اقترح البحث خطوات تحسين لمعظم مكونات صناعة المياه الجوفية المؤثرة على مستوى الاداء. كما اقترح البحث نمودجا تنظيميا لادارة تضاف للهيكل الإداري الحالي للهيئة المركزية المسئولة عن المياه الجوفية تسمى إدارة شئون المقاولين يقع عليها عبء المتابعة والمراقبة والإشراف على أنشطة الشركات الخاصة العاملة في هذا المجال. كما اقترح البحث ايضا نمودج اداري وسطي مقبول لاستعمال الشركات الخاصة يسمى النمودج الاداري الوسطي يتوقع منه تغطية الفراغات الادارية في التركيب الاداري الحالي غير المقنع لكثير من الشركات الخاصة وتحسين أدائها.

من مقترحات البحث ايضا تعديلات واطافات لفقرات وشروط الاتفاقيات المستعملة للتعاقد من قبل معظم الشركات مع العملاء كخطوة مهمة لتحسين وتقوية هذه العقود للوصول لمستوى الأداء الفني المطلوب ولمنع الشكاوى والنزاعات بين الطرفين.

ثم قام البحث بصياغة مؤشرات أداء مفتاحية لاستعمالها في صناعة المياه الجوفية كأداء مساعدة لتقويم أداء هذه الصناعة بغرض تمكين القائمين على أمرها لتنفيذ الخطوات العلاجية المبكرة لأي تدهور يرصد في أي من مكوناتها.

وعليه ترى هذه الدراسة ضرورة تعميم نتائجها على جميع الجهات ذات العلاقة بقطاع صناعة المياه الجوفية.