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**(I) IT-ENABLED E-PROJECT MANAGEMENT PRACTICE TO ASSURE ACCURATE
TELECOM CABLE NETWORK INVENTORY WITH REMOTE SMART QUALITY CONTROL**

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This paper attempts to figure out root causes for the cost and quality control problems facing many telecom operators for managing a large telecom infrastructure project and subsequently the cable network inventory updates. It gives an account of the traditional measures to cope with the problem, and finally it presents the latest methodologies and visions to resolve the problem by using an IT platform. We trust that this IT platform not only would eventually assure the accuracy of the cable network inventory data, but also it should offer the best-balanced total quality management (TQM) platform to minimize any sub-standard work done by subcontractors and/or company direct staff, with enhanced efficiency on project management.

The underlying tricks are: a) real-time data updating in-situ using smartphones or tablets by field technicians to eliminate subsequent paper-based process, and b) remote smart QC that could be done on a 100% basis (with or without an on-site inspection check) by the work supervisors to relief the current labour-intensive QA process based on a sampling basis. Furthermore, the IT platform would ease project financials reporting and subcontractor cost payment control.

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SECTION 1: INTRODUCTION

Telecom operators have long had difficulties in keeping their cable network inventory data accurate and up-to-date. This data accuracy problem has been causing fallouts in service provisions or prolonged maintenance repairs due to the disparities in inventory records and assigned plant.

Generally, the initial cable network provision should supposedly come with accurate inventory data and acceptance test records after work completion, but as time goes by, the inventory data become inaccurate due to many operational issues. This problem could become a key challenge for telecom operators with less comprehensive quality assurance (QA) system and increasing subcontracting activities for achieving efficiency savings. Eventually, costly and tedious inventory record clean-up exercises with retrofits to tidy up the physical cable network are inevitable.

A sophisticated feature-rich project management and/or inventory management system may not fully resolve the inaccurate inventory problem due to: a) time lagging and duplicated data entry (e.g. firstly jot down the data on papers and then subsequently input the data to the corresponding system) with possible data input errors, and b) no 100% QC check for minor works (e.g. maintenance repairs) where it would be too labour-intensive without any remote smart QC tool.

Apparently, IT-enabled e-Project Management (Kulik, Samuelsen, 2001) practice would become the best-balanced solution because it would ease project supervision with less work supervisors, and would ensure that subcontractors are doing a good job to assure cable network construction quality and inventory data integrity. However, the role of subcontractors and field technicians would be changed remarkably to shoulder more responsibilities and to assure the inventory accuracy and work quality.

SECTION 2: ROOT CAUSES OF THE INACCURATE INVENTORY AND QUALITY PROBLEMS

The prime objective of field technicians (be they subcontractors or company direct staff) is to complete the assigned work as efficient as possible, whereas the quality of work may not be of their prime concern. This quality issue could be getting worse when more outside plant works are outsourced while the level of work supervisory staff becomes slimmer under the slogan of "Do more with less".

It would be of interest to review if the following root causes of data accuracy deterioration in cable network inventory have been happening in the company:

- Paper-based and time-lagging data updating process (may lead to inadvertent/fraudulent acts)
- Too many parties Involved with ambiguous ownership/responsibility (eventually it would be nobody's fault)
- Cost saving initiatives with increasing outsourcing work with relatively fewer work supervisors
- Tedious QA process based on a sampling basis (possibly unable to justify 100% QC checks, particularly for minor maintenance works)
- Lack of automated tools to assure quality of work-in-process (WIP) and completed work

Whilst many experienced field technicians were complained of "gold-plating the network" with overemphasis on quality, many telecom operators in the era of competition are becoming more cost conscious and thus work efficiency improvement is of their prime concern. While it is usual that "the mouse will play when the cat's away", how we are to best-balance the work efficiency versus quality (for both WIP and completed work) is becoming a key challenge.

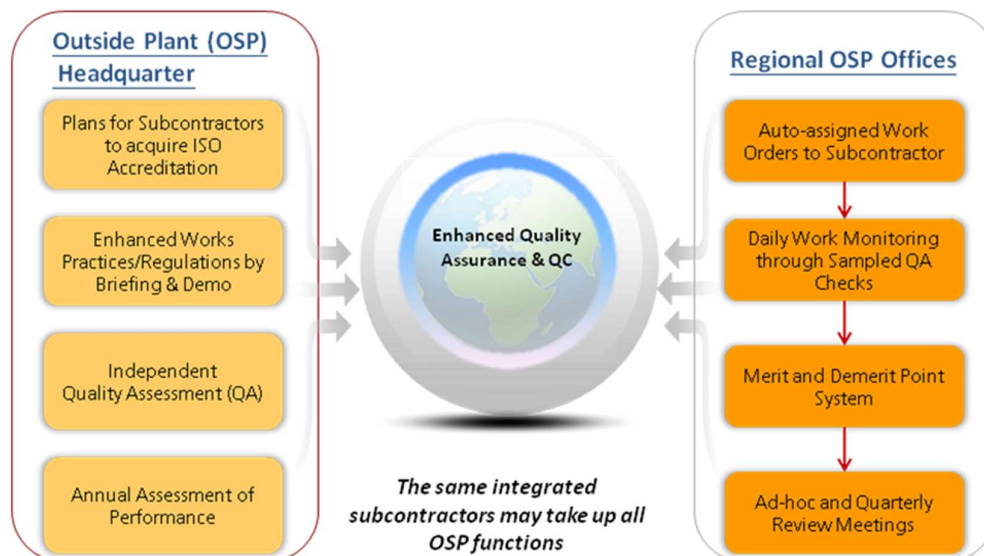
SECTION 3: TRADITIONAL MEASURES TO RELIEF THE PROBLEMS

Many telecom operators have been facing typical quality issues such as shallow depths (insufficient depth of cover) for excavations; malpractice or lack of safety measures due to insufficient training; and deterioration in data accuracy of cable network inventory, etc.

The traditional measures or quick fixes are to improve work practice and associated training; strengthen work supervision and QA inspections, and eventually enhance the corporate quality culture as follows (see Figure 1 below):

- Deploy company or trustworthy staff to perform key/critical tasks
- Improve fool-proof design on outside plant components to minimize mal-practice
- Increase QA inspection sampling frequency, or deploy an independent 3rd party for QA/QC inspections, particularly for sites with safety concerns
- Demand on-site photos taken by subcontractors (seems difficult during the past for the tedious effort in organizing the photos and validation of the exact locations/work orders)
- Uplift quality assurance system (e.g. by using quality reminder cards, tool box talks and QA debriefings)
- Assign the same party/subcontractor with total ownership to handle all tasks for the whole region/district to avoid possible complains on unclear ownership
- Tidy up or data clean-up for messy sites or inventory data as and when required

Figure 1: Traditional Measures to Uplift Quality Assurance System



However, the above-mentioned measures could only be considered as a temporary solution and could lead to overall cost increase, whereas Management normally takes it for granted that the quality of work should be of a high and acceptable standard to the required specification. In the era of improving work efficiency to meeting competitions, it would be too difficult to justify any additional cost incurred to “double” assure the quality of work.

SECTION 4: VISIONS FOR E-PROJECT MANAGEMENT PRACTICE TO ENABLE REAL-TIME RECORD UPDATING AND REMOTE SMART QC

The temporary measures described above look reasonable despite the additional resources and costs, but have not fully resolved the root causes mentioned.

With a view to completely resolving these radical root causes, it is desirable to develop an IT platform with some artificial intelligence (AI) to automate the traditional data updating and QA process with the following visions:

1. Vision No. 1

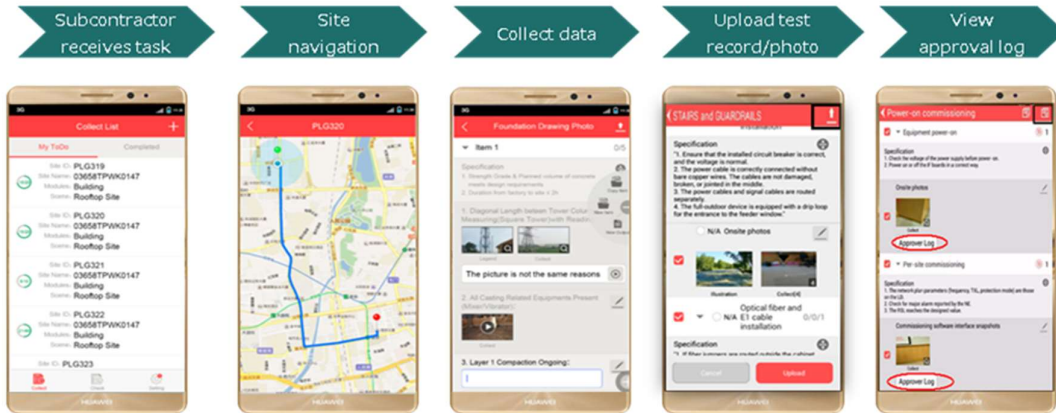
Deploy real-time record updating (*ROADS*) practice to eliminate traditional paper-based process [remarks: the terminology of *ROADS* is similar to the concept put forward by the Open *ROADS* Community (Huawei, 2019), however, *ROADS* in the context of this paper means the following: *R* for real-time, *O* for online and on-demand, *A* for automation, *D* for do-it-yourself or DIY, and *S* for synchronization among multiple databases]

As per traditional practice, the work supervisors for a construction project would have to use paper-based process (work diaries, log books or test result sheets) to keep track of field work progress, site measurements, test results and inventory data. They would need to go to the assigned work sites regularly or on a daily basis, oversee the work progress, record all field findings/instructions on the log book, and provide on-site instructions to subcontractors as and when required. After the site inspections, they need to go back to office to do the administrative or data inputting work. It is not uncommon that a work supervisor has to oversee many work sites and therefore it creates backlogs due to the delayed/duplicated data input and paper works.

This type of duplicated data inputting work would be mostly eliminated with the use of real-time data updating process enabled by an IT platform. The work supervisor or subcontractor would just need to bring with him a smartphone or tablet, input site data directly onto the electronic forms or templates in the smartphone or tablet Apps, take site photos associated with the work order (please note: the GPS coordinates and time stamp features would be activated as soon as the user logs into the IT platform to allow for traceability), and then send the data via Internet in the field to synchronize the data in the office PC environment. The entire process would be kept track of or validated by the IT platform instead of manual checking.

Conclusively, the suggested ***ROADS*** project management practice enabled by this IT platform would assure no fallout due to the traditional paper-based, time-lagging and duplicated data updating process. Examples of ***ROADS*** project management practice with smartphones enabled by the IT platform are shown on Figure 2 below.

Figure 2: Examples of **ROADS** Project Management Practice with Smartphones



2. Vision No. 2

Develop an IT platform to automate the QC process with remote smart QC for overall quality and efficiency enhancements

Quality inspection activities would become simpler with the smart QC App embedded in the IT platform, whereby the subcontractor could do the measurements in-situ, take photos (with GPS coordinates and time stamp) to show the conditions or results, and send the data back real-time to the platform with the smart QC App.

All these QA or QC activities could be done remotely with remote chatting and tele-conferencing functions to resolve any site problems when required. Therefore, the work supervisor would have the option to verify the results, either remotely or go to the site for an on-site discussion/decision.

The work efficiency would thus be improved as the subcontractor does not need to wait for the work supervisor to verify the site conditions before the next work activity, such as backfilling after trenching and duct laying. Development could be done to use image recognition by the IT platform to automatically verify if the work (such as proper installation/connection) has been done properly.

By then, QC inspections and acceptance may be extended to all installation and maintenance activities (even for small work orders), on a 100% basis, with the use of this remote smart QC App. Eventually, we should overcome the possible shortcomings on: a) no complete QC inspection or missing key quality record, and b) lack of product traceability platform/system to allow for fault investigation/prevention as per the ISO9000 requirements.

SECTION 5: BENEFITS AND ADVANTAGES BRING ABOUT BY THE E-PROJECT MANAGEMENT PRACTICE

The IT platform can greatly assist work supervisors to manage the work orders and projects assigned to subcontractors and/or company staff, whereas the subcontractors and/or field technicians have to shoulder extra responsibilities to input in-site WIP test data and photos for remote checking or verification. The benefits and advantages bring about by the e-Project Management practice are as follows:

1. Work and Supervision Efficiency Enhancements

- Less on-site visits are required whilst the field technicians will be quality conscious. Any arbitrary photos not relevant to the specific work order or site would be easily rejected.
- Field technicians no longer need to wait for on-site instructions by work supervisors as approval can be given remotely with the assistance of the IT platform.
- Less extensive skill sets and experience for work supervisors are required with the remote smart QC assistance.

2. Quality and Quality Management Enhancements

- Well-defined QA/QC process and in-process acceptance levels can be clearly understood/retrieved/verified in the IT platform.
- QC can be done on every work order (100% basis) by using remote smart QC App, provided the work orders are issued and controlled by the IT platform.
- The in-process photos uploaded can serve as quality records for product traceability and allow for fault investigation/prevention as per the ISO9000 requirements.

3. Project Financials Monitoring and Reporting Enhancements

- The IT platform may interface with the in-house databases whereby the financials of projects can be easily computed (e.g. total approved project amount, percentage of work completed and work-in-progress, partial and total amount paid and etc.).
- The IT platform can be used as the payment control system for payments to subcontractors as soon as the work orders and inventory updates are complete.

After all, we are not in a position to generalize or quantify the cost savings of such an IT platform in this paper because the benefits and cost savings may vary with different projects and organizations, and they are very much dependent on the functional requirements, customizations and data take-on activities required to suit the business needs of the organization.

SECTION 6: CONCLUSIONS

The current paper-based and duplicated data updating process should be revamped with easy real-time in-situ inventory data updating using customized electronic forms/templates. Furthermore, we may automate the QA and QC process with remote smart QC applications to enable 100% QC inspections (some can be done in-situ and the rest remotely with possible AI assistance) to assure the accuracy of the on-going cable network inventory updates. This enhanced process would be a major change to the industry, nevertheless, it ensures field technicians shoulder their responsibilities to perform the work to the required quality standards, because they need to regularly upload photos of the WIP and completed work (with in-situ measurements) to the IT platform for product traceability. These uploaded data would serve as quality records to meeting the ISO 9000 standard.

We trust smartphones and tablets would be the most innovative handheld project management tool in the next decades to enable the suggested e-Project Management (e-PM) practice. Any inadvertent or fraudulent acts to cover up non-conformities during the WIP and completed work would be grossly reduced by using the suggested real-time and in-situ record updating (**ROADS**) practice suggested in this paper. Apparently, the **ROADS** project management practice should become the direction and benchmark for future e-PM development.

An e-Project Management (e-PM) platform for managing a large-scale construction project has been always on the wish list for many telecom operators. We have had some successful experience on using this type of e-PM platform for some global FTTx turnkey projects. It is beyond the scope of this paper to describe in details the functionalities offered by the e-PM platform to enhance operational efficiency. However, we are confident that telecom operators would sooner or later unveil the beauty of remote smart QC offered by the platform in assuring data accuracy and integrity of the cable network inventory, once the platform is used in subsequent outside plant maintenance activities. All in all, the visions to develop such an IT platform for project delivery and subsequent cable network maintenance are viable and proven.

The automations and reduction of duplicated paper works brought about by this end-to-end (E2E) web-based project management platform (see Figure 3 below) could completely revamp the traditional labour intensive telecom infrastructure deployment and operations. Also, the IT platform would greatly ease project financials reporting for WIP and completed works, and the associated cost payment control.

Figure 3: Automations and Reduction of Duplicated Paper Works with Smartphone Apps



With the advent of IT platform for automation and artificial intelligence (AI), our visions could come to reality for the automated real-time data updating process and remote smart QC with substantial improvements on quality and efficiency. We trust we have got the clue and are getting closer to the solution mix to completely resolve the traditional work quality and data accuracy problems.

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