

# Free cloud storage service: An online data-sharing solution for small-to-medium size construction companies in Thailand

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**Abstract** - Information Technology (IT) plays a very important role in many businesses as a tool for ability improvement of data sharing and transferring. Construction is one among those which needs correct and updated information to simultaneously react to the performance such as materials delivery, on-site working progress or financial aspect. This study investigates the current time, cost and quality (TCQ) of construction companies in Thailand and then the feasibility of free cloud storage services as an online data-sharing for small-to-medium size (SMEs) construction companies. The results illustrated that SME construction companies are able to benefit not only from TCQ but also from the opportunities in businesses, market sharing or even enhancement of customer relationships.

## I. INTRODUCTION

An information Technology (IT) plays a very important role in many businesses to improve the ability of data sharing and transferring. One of the IT cores is a database which is used to store data and information via some management systems. There are two types of mostly used databases nowadays which are the stand-alone database and web-database. The stand-alone database is a group of data stored with its structure and certain format, which can be queried by database programs and sometimes used to make decisions. The computer programs which are used in creating, managing and querying databases are normally called Database Management Systems (DBMS). DBMS can be simple or complicated/integrated and the integrated approach has a vital role in database design and maintenance for large databases in an organization as (i) Data Sharing, (ii) Minimizing Data Redundancy, (iii) Data Consistency and Integrity, (iv) Enforcing Standard, (v) Improving Security and (vi) Data Independence (Bai, 2012). The web-database or online database is the one which data and information are located on remote servers (computer) through web-browsers and web-servers. Users are able to reach the stored data and information remotely via intranet or internet. Web database can sometimes serve as a data warehouse in a large organization for keeping and managing data from sub-databases of an entire company.

Its significant features are that the database on the server can be easily updated with new data from any other user of the team. The updated information can be accessed through digital user ID and password from any location at any time (Nitithamyong and Skibniewski, 2004).

Construction industries, especially for small-and-medium size enterprises (SMEs), have very few contractors who have a comprehensive integrated information system in their core businesses, although on-site operations have a huge number of data flow and data transferring. A study on a model of information management for construction showed that the construction and real estate industries are lagging behind many other industries in using IT for information management. IT is considered extremely useful for construction industries as a project normally involves many parties. The systems, which are able to exchange and store information among the project team members, i.e. the client, the engineers, the project managers and the main contractors, can make smooth working process on-sites at a minimal cost as little as less than one percent of total project cost (Mak, 2001). Contractors are investing in IT because they believe that IT can increase work efficiency and cut cost of manpower. Alley et al. (2012) from Microsoft reported that the construction industry is now consuming IT services and solutions at an accelerating rate. While, in last 10 years, internet technologies grew rapidly with more and more commercial oriented. Construction industries are also able to apply a database management system via Internet technologies. However, most of users overlook the value of IT in the sense of business such as increasing risk of turnover or financially competitiveness. Companies need more computing power, bigger and faster servers to run the applications. The capital cost will increase significantly. Moreover, more spending on highly skilled IT staffs to run applications and maintain existing infrastructure also topped-up. Both internet and intranet adapted in construction companies are security via a firewall device to prevent accesses from outside the corporation without a proper authorization. When the construction companies or contractors use internet to transfer data of, e.g. project based procurement, payments for work-in-progress, the multi-tier sub-contracting practice, non-standard payment system and financial reports, to sub-contractors and suppliers, it makes less accuracy due to duplicate of the latest version of file or "Sneakernet". IT has not been able to control

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cost either due to the lack of IT expertise of construction staff.

The most important factor affecting the success or failure of web-based construction project management systems is the exchange of information across the project life cycle, which not only requires a state of readiness within one organization but also within all organizations involved in the construction processes (Nitithamyong and Skibniewski, 2004). The prototype of a web-based project information management (WebPIM) system for civil engineering applications has been developed with the latest internet and web technology to help project managers handling all project-related information in their hands (Lam And Chang, 2002). As the information is fresh and documents are submitted in electronic format, the time, cost and manpower required can be reduced to the minimum. Furthermore, the advantage in project plan or scheduling can be achieved due to quicker and more efficient in the use of computer communications between construction sites and headquarter such as, in the real business, materials delivery tracking or precast component scheduling (Chan et al., 1999).

The typical document in construction is the Bill of Quantities (BOQ), Particular Specifications and Drawings (Nitithamyong and Skibniewski, 2004), with which there is an enormous project information flow along construction activities. For example, the Purchasing Department will be given a schedule of material requirements; the Accounting and Personnel Departments make arrangements to set up files databases. Situations are more or less the same for the Financial Department or Human Resources administration. On-site operations are involved in less of information types but normally generate enormous information amount. Appropriate software is vital for facilitating construction firms to reach their achievement (Mak, 2001). With Google, the search for "construction management software" in 2013 was found up to 78,700,000 lists related to construction/project management and management software, indicating that software in information management for construction is becoming one of the most significant tools, even the maintenance and yearly upgrade are needed. Engineering News Record (ENR) in the United States reported that the number of construction firms using management software has risen by 16% within the past 2 years. In addition, the same trend has occurred in Thailand and tends to be increased continuously (Nitithamyong and Skibniewski, 2004).

The large companies were the main group of software users in construction due to their huge budget and a good return rate of investment. In addition, the software currently in use in large firms, such as SCM, ERP, CLM, and PLM, totally covers every performance of all departments or sectors in the organizations (Atkinson, 1999). On the other hand, SMEs have less employees and departments. The information management needed mostly comes from on-site operation. The information sharing as web-database with no cost and not too complicated could be most appropriate to those SMEs by using a free cloud service/computing, with which connections everybody is able to access computing lives everywhere (Mcfedries, 2008). The cloud computing is a better and more effective way of working with IT. Collaborative portals in the cloud enable information sharing and allow information to be centralized around construction projects, including savings

operation cost of the firms. The study of a web-centric information model for managing road infrastructure data using extensible mark-up language (XML) showed that the information management practices from central unit to remote locations can improve data integration, interoperability, accessibility and reusability not only for civil infrastructure assets but also all other management processes (Capuruco et al., 2006).

In the cloud, whether Storage-as-a-service, Database-as-a-service, Process-as-a-service, Application-as-a-service, or Platform-as-a-service (Linthicum, 2010), a kind of web-database, data and software reside within the cloud (remote server) where people can access everything not only from PCs but also cloud-friendly devices, such as smart phones, tablets, PDAs and etc. Cloud computing may allow user's data always available and also power-up computer networking ability of many companies. Not far from now, construction firms which move to use the cloud services should be able to use their enhanced IT capabilities to be more flexible, agile and competitive (Alley et al., 2012). The opportunity to increase business chance may also be achieved with the powerful features of an online real-time approach by engaging consumers or investors with interactive presentation techniques (Mahdjoubi et al., 2012). However, it is in fact difficult to persuade SMEs construction companies in using IT software or IT network, due to various reasons such as limitation in IT personnel, lacking of knowledge in IT, costly investment in IT and so on. Consequently, to introduce online data-sharing with less or minimum cost might initiate positive vision to SMEs construction industry to enhance their work efficiently. By this, the objectives of this paper is to provide the efficacy of cloud application (Storage-as-a-service), and such facilitate and encourage the using of free cloud storage as a simple self-created online data-sharing for SMEs or local construction companies in Thailand.

## II. METHODOLOGY

This study was carried out on non-IT base SMEs in Thailand to determine the benefits of construction companies in terms of Time, Cost and Quality (TCQ). The results were proposed to compare the advantages of using any kind of online-data sharing, and thus encouraging SMEs to apply the technologies to efficiently enhance construction's ability.

### 2.1. A SMEs case study

In cooperation with SMEs Construction Company in Thailand, the conventional working processes with documentation formats/patterns were analyzed and categorized. Only the company's departments which are related to construction works were investigated while the Departments of Accounting, Finance, and Law are excluded.

### 2.2. A cloud storage service

Cloud service providers available at present are studied. All features and functional aspects were compared to each other. The best fits were then chosen as cloud services in this study. It must be noted that one of the most important criteria was that the selected services have to be absolutely free and be a user friendly.

### 2.3. Analyzing results

According to the nature of construction site of SMEs in Thailand, there are several groups of data, e.g. those from project progressions, material deliveries and store inventories, needed to be shared or updated between headquarter and other departments. TCQ aspects are used to identify how an improvement can be achieved due to its measurable results in terms of Time and Cost reduction and Quality assurance. Construction is one of the projects which have definitely starting and finishing points, the time and cost of a project therefore need to be carefully considered to optimize resource utilization and to compromise various aspects of projects during construction. However, the quality performance shall be added to fulfill the term time-cost to create new models and objectives of construction 'time, cost and quality'. Project management in construction runs through project planning, monitoring and control, with each having specific issues of concerns, for example, the definition of work specification, determination of quantity of work and estimation of resources required for project planning. Project manager and all team members have to insure the completion of project in time, within budget and to the project specifications (TCQ). TCQ is also a key of making decision, considering quality and generating the optimal performance (Afshar et al., 2007) and (Babu et al., 1996). Consequently, for this study, the benefits and advantages were comparatively evaluated in terms of Time, Cost and Quality (TCQ).

## III. RESULTS AND DISCUSSION

### 3.1. Size of construction firms and IT in construction sector in Thailand

According to the National Statistics Office of Thailand (NSOT), there are three forms of legal organizations, namely, Individual Proprietor (IP), Juristic Partnership (JP) and (Public) Company Limited (PCL) (NSOT, 2011). Generally, IP and JP are grouped as small-to-medium size firms (SMEs), while PCL and CL are grouped as the large enterprises (LE). The 2010 data showed that there is a huge gap in the number of SMEs, 81.2% (IP, JP and Others), and LE, 18.8% (PCL) as shown in Fig 1.

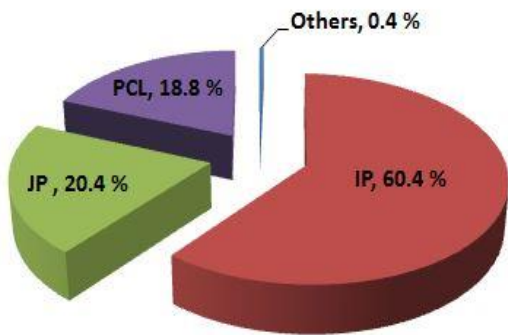


Fig 1. Percentage of size establishment firms

Fig. 2 shows the graphical summary of computer users and internet access in routine work of construction companies in Thailand. It can be seen that in total, only 37% of construction

firms use computer and the rest of 63% of them do not. In contrast, over 75% of these computer users in construction sector normally access to the internet at least once a week. It is also known that that most of internet activities are sending or/and receiving e-mail, purchasing/selling goods, and services or trading.

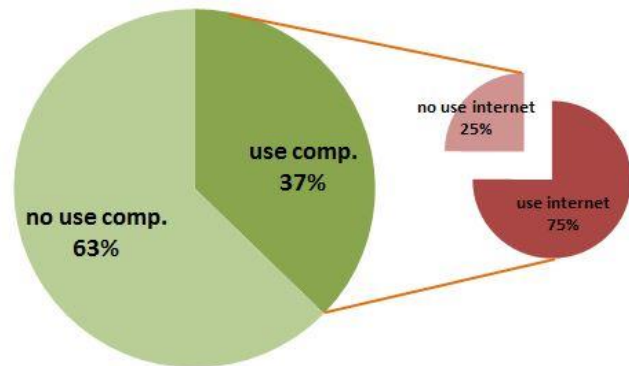


Fig 2. Percentage of internet use of all computer users

Overall, it can be concluded that the majority of construction firms in Thailand are SMEs as the case in other countries, e.g. European countries. Although there is only a small number of computer and internet user in Thailand, the numbers of companies using computers and internet in construction businesses are believed to be increasing dramatically in the next five years due to the ease of internet access.

Further investigation into six samples of small and medium size (SMEs) Construction Company in Northern Thailand, by personal interview, shows that the organizations operate between 3 and 35 construction sites with the varying numbers of 10 to 250 employees. Nevertheless, all of six SMEs have no online-database as a tool or software. Some obstacles and difficulties they thought are listed from the most to less considered aspects as follows, they

- are more familiar with conventional method (Manually use email, fax or phone);
- have no time to find out IT tools or new system;
- have no support team or no simple advisory;
- feel less worthiness on spending with online system cost;
- feel difficult and complicated to deal with new online system;
- use very few functions of packaged software features;
- have much fluctuation in duration and number of projects;
- have very low accessing ability of internet connection on remote sites

It is apparent that to step over these barriers, the simple approach with less cost and being well instructive should be introduced to encourage the uptakes of the technologies. With the nature of on-site construction, a recommended technique could include key aspects of uncomplicated procedures, fee-free and priority with security. By doing this, the construction members will be able to improve their efficiency of work in terms of data/information transferring, such, in future, they are

able to become IT based companies, and eventually not only gain the benefits in time, and cost and error reduction, but also become more competitive.

### 3.2. Current TCQ status within SMEs in Thailand

This part of study consists of six typical departments in SMEs with overall 41 working units. The majority of file type is Microsoft Excel (.xls) with the rest of Microsoft Word (.doc) and paper base documents. The details of working units and file transferring across the company departments can be summarized in Fig 3 and Table 1. It can be seen from Figure 3 that the Head-quarter (HQ), which works as an Information Centre, has to send monthly calendar file and monthly notice file to all working units (40 units) via fax, while all Construction Sites (CS) which located in the 35 different remote areas have to send on-site progress file, machine request form and machine breakdown report to the Head Quarter (HQ), Quality Control (QC), Sale Department (SD) and Machine Maintenance (MM) by using email and fax. The results showed that more than 150 files are transferred via fax, email, phone call and photocopy in each time of file transferring, and the majority of file transferring belonged to HQ and the CS (Table 1). Although, transferring by fax is costly but it is still used due to the signature identification, which in fact, in the cloud service, can be achieved by using username and password for logging in.

The current time, cost and quality (TCQ) of data-sharing in the organization are defined and shown in Table 2. The time

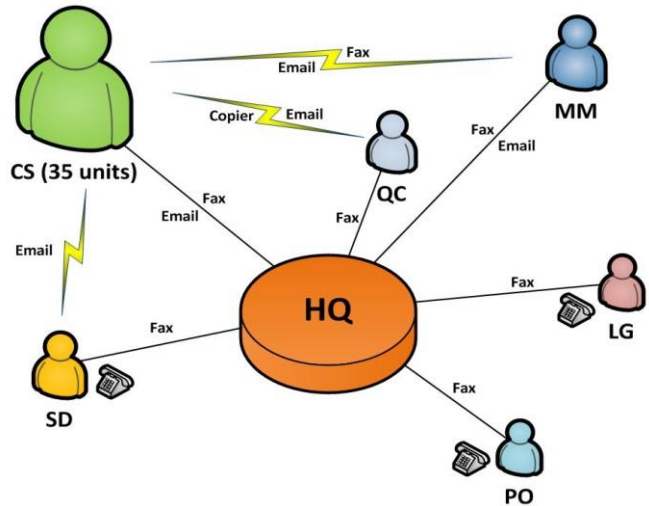


Fig 3. File transferring across the company.

and cost were counted in minutes and Thai currency (THB) respectively, which mostly occurred from faxing and phone calls. The quality is dependent on personal communication and method of communication. Taking the transferring by fax in HQ as an example, the monthly calendar file was sent to 40 working units twice a month and needed at least 3 minutes to finish each faxing. By this, the time consuming was  $40 \times 2 \times 3$

**Table 1**  
Breakdown of working units and file transferring across the company

Department	Unit	Job Description	File transferring	Original file type	Share to (units)	Transfer methods
Head Quarter, HQ	1	Information Centre	Monthly calendar files	MS Excel	All (40)	Fax.
			Monthly notice files	MS Excel	All (40)	Fax.
Construction Sites, CS	35	Working on site	On-site progress files	MS Excel	HQ/QC/SD	Email
			Machine request form	MS Word	MM (1)	Fax.
			Machine breakdown reports	MS Word	MM (1)	Fax.
Quality Control, QC	1	Quality Control	Inspected data sheets	MS Excel /Paper	QC/CS (36)	Photo copy
Machine Maintenance, MM	1	Machine maintenance & management	Machine schedule & status files	MS Excel	HQ/CS (35)	Email
Local Gov. Coordinator, LG	1	Any if needed	Progress updating files	-	Any if needed	Phone call
Payment Office, PO	1	Any if needed	Payment status	-	Any if needed	Phone call
Sale Department, SD	1	Any if needed	Sale & Reservation reports	-	Any if needed	Phone call



which equals to 240 minutes. In addition, for cost of using fax with 5 THB per sending, the fax cost will be  $40 \times 2 \times 5$  which equal to 400 THB. However, the quality of using email was found to be poor as a sneakernet problem when the same file name was re-duplicated, although poor connection frequently occurred in communication with phone call or fax.

From Table 2, it can be seen that the longest duration of transferring data or information is the using of telephone call by LG, PO and SD at the average duration of 1,050 minutes per department per month and followed by the using of fax in HQ and the using copier in QC of overall 600 minutes and 30 minutes respectively. The most costly activity is a photo copying (Inspected data sheet) in QC department at approximately 21,600 THB. This is followed by the average cost of post-paid phone call in LG, PO, SD of 2,100 THB and the using of fax (Machine request form) in CS of 1,400 THB.

### 3.3. Identification of cloud service for the construction studied

There are many providers in the current business environment serving both free and paid services. The significant features or conditions of access vary depending on provider's regulations. The cloud service shall be able to help daily or routine data-transfer among headquarter and remote sites. The main criteria to be considered in identifying the service for the construction business should include its:

- flexibility, including easy use for in-house or limited resources, and work remotely on site, office or even on the move;
- agility, including less time training for IT staff by all delivered via cloud providers, and upgrade or use new services quickly without internal resources deployment;
- cost-efficient, including less investment and risk and no server maintenance or management;
- scalability, including scaling up or down with less or no- adjustment.

Some details of well-known cloud service providers are summarized in Table 3 and Fig 4, including storage spaces, service prices, features and platform (Alley et al.,2012), (Augie,2012), (Butler,2012), (JustCloud.com,2013),(Neal,2013).

A comparison of the functions of free cloud available shows that all of the systems could be used as a prototype system. The free storage space ranges from 2 GB (DropBox) to 7 GB (SkyDrive). In terms of the Folder Sharing and the Support of all file types, which are two of the most important features to be fitted with systems, all of the listed cloud service providers are able to achieve these capacities. All cloud services mentioned in table 3 are also able to operate in both platforms, Windows and MAC OS, excluding icloud

**Table 2**  
Current status of data-sharing in term of TCQ per month

<i>Department</i>	<i>Unit</i>	<i>File transferring</i>	<i>Transfer methods</i>	<i>Time (mins.)</i>	<i>Cost (THB)*</i>	<i>Quality</i>
Head Quarter, HQ	1	Monthly calendar files	Fax.	240	400	-
		Monthly notice files	Fax.	360	600	-
Construction Sites, CS	35	On-site progress files	Email	3	-	Poor (Sneakernet)
		Machine request form	Fax.	18	1,400	-
		Machine breakdown reports	Fax.	12	700	-
Quality Control, QC	1	Inspected data sheets	Photo copy	30	21,600	-
Machine Maintenance, MM	1	Machine schedule & status files	Email	10	-	Poor (Sneakernet)
Local Government Coordinator, LG	1	Progress updating files	Phone call	1,050	2,100	Bad (Slow service)
Payment Office, PO	1	Payment status	Phone call	1,050	2,100	Bad (Slow service)
Sale Department, SD	1	Sale & Reservation reports	Phone call	1,050	2,100	Bad (Slow service)

\*50 THB is approximately equal to 1 GBP

which can be run on MAC OS only. However, the SKYDRIVE from Microsoft has its particular features of user interface. In addition to its core services, drive spaces, web stabilization and system security (Alley et al., 2012), the SKYDRIVE;

- 1) is ready to be used with Hotmail address. In fact, most of the investigated organization's official email addresses are Hotmail.
- 2) is the best fit with Microsoft Office (Word, Excel, Power point and etc.) document without initial Download to user PC. For example, using Microsoft Excel, some specific Mathematics function are able run

on SkyDrive and also editable on sky, but disable for Google Drive (Doc). The 'Dropbox' or 'Box.com' that even have terrific user interface still need users to make a download before opening files.

- 3) provides an acceptable security system and also a priority of access permission to files. From those protections, it is enough for data transferring in the nature of construction.
- 4) offers an enough space for individual working, in fact, it is too much drive spaces of 7 GB if using only Microsoft Office file (Word, Excel, Power point and etc.) and it can be run on Windows, OS or even Android and Windows phone apps.



Fig 4. Current cloud service providers

**Table 3**  
Current well-known cloud service providers

Functions & Features	Service Providers								
	Sky Drive	Google Drive	Drop Box	iCloud	JustCloud .com	Sugar Sync	Open Drive	Box .com	Amazon Cloud Drive
<b>Storage Space</b>									
Free	7 GB	5 GB	2 GB	5 GB	-	5 GB	5 GB	5 GB	5 GB
50 GB monthly	\$25*	-	-	\$100	-	-	-	\$20	\$25
100 GB monthly	\$50*	\$5	\$10	-	-	\$15	\$5	-	\$50
Unlimited	-	-	-	-	\$9.95	-	\$9.95	-	-
<b>Features</b>									
Folder Sharing	√	√	√	√	√	√	√	√	√
Restore deleted file	NG	NG	√	√	√	√	√	√	NG
Support all file types	√	-	√	-	√	√	√	√	NG
Mobile access	√	√	√	√	√	√	√	√	√
<b>Platforms</b>									
Windows	√	√	√	-	√	√	√	√	√
MAC OS	√	√	√	√	√	√	√	√	√

\*Yearly price

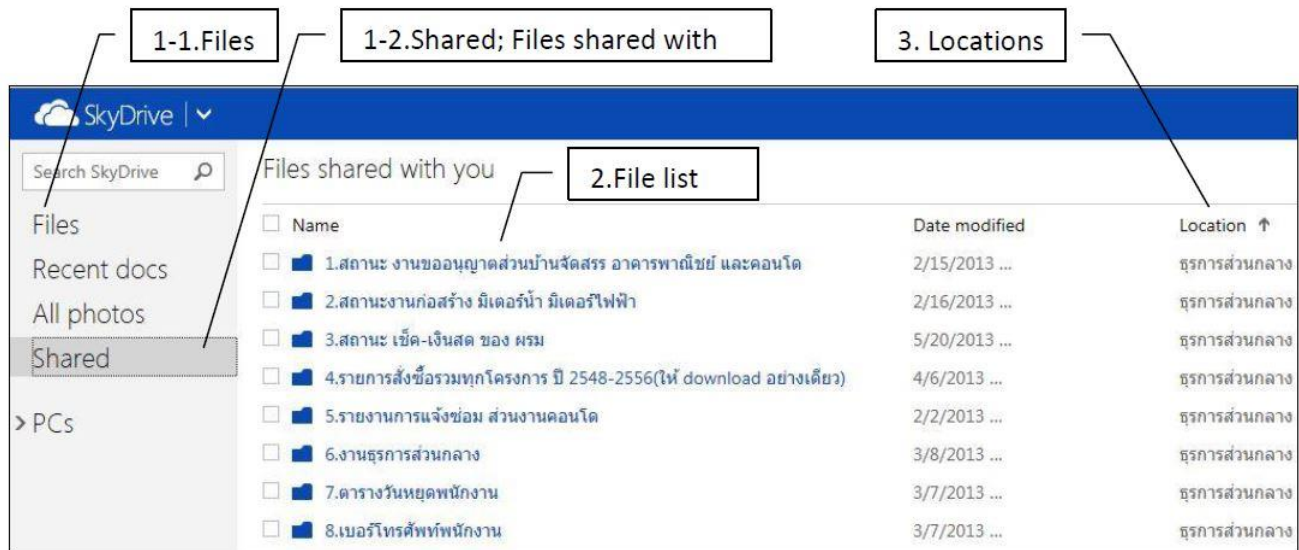


Fig 5. Window of Files, Shared files and folders on SkyDrive

แปลง ที่ Lot no.	เจ้าภาพ Foreman	กำหนด โอน Schedule	แล้วเสร็จ แล้วเสร็จ	PROGRESS		ความคืบหน้า				QC progress		Permission ใบอนุญาตก่อสร้าง		Water supply มิเตอร์น้ำ		Electricity มิเตอร์ไฟฟ้า		
				%	งาน	เริ่มงาน ครั้งที่ 1	ตรวจบ้าน ครั้งที่ 1	ตรวจบ้าน ครั้งที่ 2	ผ่าน วอไอออน	โอนแล้ว	พนักงาน ยื่นแบบ	ได้รับใบ อนุญาต	พนักงาน ร้องขอ	ยื่นขอ อนุญาต	ติดตั้ง แล้วเสร็จ	พนักงาน ร้องขอ	ยื่นขอ อนุญาต	ติดตั้ง แล้วเสร็จ
243	นิพล	25/7/55	30/6/55	98%	ติดตั้งสุขภัณฑ์		15/7/55		19/7/55	14/8/55	14/5/55	30/5/55	30/8/55			7/8/55	13/8/55	
เดือน สิงหาคม 55 August 2012																		
221	นิพล	1/8/55	15/7/55	100%	ทำความสะอาด		28/7/55		1/8/55	15/8/55	14/5/55	30/5/55	30/8/55			4/10/55	7/8/55	13/8/55
266	เอกชัย	8/8/55	15/7/55	100%	ทำความสะอาด		30/7/55		8/8/55	7/9/55	14/5/55	30/5/55	30/8/55			4/10/55	19/11/55	
276	นรินทร์	9/8/55	15/8/55	100%	ทำความสะอาด		20/8/55		19/9/55	29/7/55	27/8/55	30/8/55	30/8/55			25/10/55	19/11/55	
240	นิพล	15/8/55	20/6/55	100%	ทำความสะอาด		16/8/55		12/9/55	14/5/55	30/5/55	30/8/55	30/8/55			4/10/55	16/8/55	22/8/55
224	นิพล	30/8/55	15/8/55	100%	ทำความสะอาด		25/8/55	22/9/55		5/10/55	14/5/55	30/5/55	30/8/55			25/10/55	7/8/55	13/8/55
244	นิพล	31/8/55	23/8/55	100%	ทำความสะอาด		25/8/55	8/9/55	25/9/55	28/9/55	14/5/55	30/5/55	30/8/55			30/8/55		
เดือน กันยายน 55 September 2012																		
246	นรวิชัย	6/9/55	30/7/55	100%	ทำความสะอาด		6/8/55	30/8/55		6/9/55	14/5/55	30/5/55	30/8/55			4/10/55	7/8/55	13/8/55
320	นรินทร์	10/9/55	25/8/55	100%	ทำความสะอาด					17/9/55	16/8/55	27/8/55	30/8/55			4/10/55	27/9/55	
241	เอกชัย	24/9/55	20/6/55	100%	ทำความสะอาด					27/9/55	16/8/55	27/8/55	27/9/55			27/9/55		
222	นรวิชัย	25/9/55	25/7/55	100%	ทำความสะอาด		26/8/55			24/9/12	14/5/55	30/5/55	30/8/55			25/10/55	7/8/55	13/8/55
249	นิพล	25/9/55	5/10/55	100%	ทำความสะอาด		27/9/55			22/10/55	16/8/55	27/8/55	27/9/55			7/11/55	16/8/55	22/8/55

Fig 6. Sample study of shared information in MS Excel format on SkyDrive

It is therefore chosen in this study. By using the chosen SkyDrive, the samples of using cloud data-sharing on for this study can be showed in Fig 5 and Fig 6. It can be seen from Fig 5 that the main window of SkyDrive consists of 3 major parts which are (i) 1-1.File: your own files which are able to share to other people with or without access permission and 1-2.Shared: the files which are shared from other people with you. (ii) File list: the name list of shared files from other people with you. In the Shared part, the users (you) will be allowed to view and download only or able to edit the file depending on the sharer's allowance. (iii) Location: the origin

of shared files or file owner. Fig 6 shows a sample study of shared file from Construction Site (CS) in MS Excel format. '1' is a file name of this sharing (On-site working progress). '2' is a group of data which are filled by CS about on-site progresses while '3' are filled by Local Government Coordinator (LG) about the updated permission from local government. In this sample, the file's owner is CS and this file is shared to Headquarter (HQ), Quality Control (QC) and Sale Department (SD) with view and downloads only, while the exclusively sharing is shared to LG with editable permission.



By doing this, HQ and QC are able to monitor the progress of this remote site regularly by the real-time, while CS is able to react with any permission from local government immediately and allow work to go faster. Furthermore, SD also keeps tracking the work progress of any housing and advice to the customers by the real-time.

### 3.4. TCQ improvement by using the chosen cloud

A comparison of the conventional and cloud TCQ is given in Table 4. It is apparent that using cloud data-sharing can reduce overall average time up to 97.5% (Table 4). As also discussed in the previous sections, sending fax and telephone calls took significant amount of time in construction companies each month. It can be seen that the greatest time reduction is cloud replacement to phone call in LG, PO and SD by 1,030 minutes (from 1,050 minutes to 20 minutes) or 98.1%. The change of fax machine to the cloud in HQ department achieved an overall reduction of 590 minutes (from 600 minutes to 10 minutes) or 98.3%. Furthermore, the satisfy results are also obtained in replacing of using paper base and faxing in others departments with a reduction of 86.7%. The lowest reduction rate in this study is for the replacement of MS Word fax with cloud service in Construction Sites (66.7%). In total, the cloud data-sharing is able to dump overall time usage from 3,823 minutes monthly to 97 minutes.

In terms of cost reduction, changing electronic filing to the cloud transferring results in a reduction of the operation costs up to 90.6% from 31,000 THB (£620) to 2,797 THB (£56) in one month. The major expenses came from paper photocopy and some of those came from post-paid telephone.

By replacing paper documentation with electronic file via cloud data-sharing, the greatest amount of the cost reduction is achieved in QC department with an approximately 20,600 THB (95.4%) reduction. In fact, some of documentation such as Monthly calendar files in HQ or Machine request form in CS can be completely substituted by cloud with no cost to the companies, i.e. the reduction of the cost by replacing MS Excel or Word fax by the cloud service is 100%. The reduction of the costs of HQ monthly notice file reaches to 83%, CS machine breakdown report 71%, and LG, PO and SD telephone costs 76% (Table 5).

For the quality improvement, although there was no numerical comparison of the results, the qualitative observation and interviewing concluded that the most advantage aspects of cloud data-sharing in term of quality improvement are (i) the information release from origin with real time and (ii) there is no confusion in file's version which normally happens in using email. The improvement in quality of using cloud data-sharing of each department is summarized in Table 6.

**Table 4**  
Time reduction of using cloud data-sharing

Department	Unit(s)	File transferring	File type / Transfer methods	Time (minutes)		
				Original	Cloud	Reduction
Head Quarter, HQ	1	Monthly calendar files	MS Excel/Fax	240	4	98.3%
		Monthly notice files	MS Excel/Fax	360	6	98.3%
Construction Sites, CS	35	On-site progress files	MS Excel/Email	3	3	-
		Machine request form	MS Word/Fax	18	6	66.7%
		Machine breakdown reports	MS Word/Fax	12	4	66.7%
Quality Control, QC	1	Inspected data sheets	MS Excel/ Photo copy	30	4	86.7%
Machine Maintenance , MM	1	Machine schedule & status files	MS Excel/Email	10	10	-
Local Government Coordinator, LG	1	Progress updating files	Any if needed /Phone call	1,050	20	98.1%
Payment Office, PO	1	Payment status	Any if needed /Phone call	1,050	20	98.1%
Sale Department, SD	1	Sale & Reservation reports	Any if needed /Phone call	1,050	20	98.1%
<b>Overall</b>				<b>3,823</b>	<b>97</b>	<b>97.5%</b>



**Table 5**  
Cost reduction of using cloud data-sharing

Department	Unit	File transferring	File type / Transfer methods	Cost (THB)		
				Original	Cloud	Reduction
Head Quarter, HQ	1	Monthly calendar files	MS Excel/Fax	400	-	100.0%
		Monthly notice files	MS Excel/Fax	600	100	83.3%
Construction Sites, CS	35	On-site progress files	MS Excel/Email	-	-	-
		Machine request form	MS Word/Fax	1,400	-	100.0%
		Machine breakdown reports	MS Word/Fax	700	200	71.4%
Quality Control, QC	1	Inspected data sheets	MS Excel/Photo copy	21,600	1,000	95.4%
Machine Maintenance, MM	1	Machine schedule & status files	MS Excel/Email	-	-	-
Local Government Coordinator, LG	1	Progress updating files	Any if needed /Phone call	2,100	499	76.2%
Payment Office, PO	1	Payment status	Any if needed /Phone call	2,100	499	76.2%
Sale Department, SD	1	Sale & Reservation reports	Any if needed /Phone call	2,100	499	76.2%
<b>Overall</b>				<b>31,000</b>	<b>2,797</b>	<b>90.6%</b>

\*50 THB is approximately equal to 1 GBP

**Table 6**  
Quality improvement of using cloud data-sharing

Department	Unit	File transferring	File type / Transfer methods	Quality	
				Conventional	Cloud
Head Quarter, HQ	1	Monthly calendar files	MS Excel/Fax	-	-
		Monthly notice files	MS Excel/Fax	-	-
Construction Sites, CS	35	On-site progress files	MS Excel/Email	Poor (Sneakernet)	Real Time
		Machine request form	MS Word/Fax	-	-
		Machine breakdown reports	MS Word/Fax	-	-
Quality Control, QC	1	Inspected data sheets	MS Excel/Photo copy	-	-
Machine Maintenance, MM	1	Machine schedule & status files	MS Excel/Email	Poor (Sneakernet)	Real Time
Local Government Coordinator, LG	1	Progress updating files	Any if needed /Phone call	Poor (Sneakernet)	Real Time
Payment Office, PO	1	Payment status	Any if needed /Phone call	Poor (Sneakernet)	Real Time
Sale Department, SD	1	Sale & Reservation reports	Any if needed /Phone call	Poor (Sneakernet)	Real Time

#### IV. CONCLUSION

The type of construction companies in Thailand was analyzed and a free cloud storage service was proposed as an online data-sharing to determine its benefits for SME construction companies. It can be concluded that:

1) Over 80% construction companies are SMEs, which normally operate in multiple sites, ranging from 3 to 35 different operation sites from those in Northern Thailand.

2) About 40% construction companies in Thailand used computer, only three quarters of which used internet. Using online database showed advantages but meantime difficulties which obstructed most SMEs users, e.g. the limitation in IT supporters, cost of software and cost of web database development or even a feeling complicated to use.

3) Current data transferring occurred between HQ, CS, QC, SD, MM, PO and LG. The longest duration of transferring data or information was the using of telephone calls by LG, PO and SD at the average duration of 1,050 minutes per department per month. The most costly activity was a photo copying (Inspected data sheet) in QC department at approximately 21,600 THB.

4) SkyDrive was considered most appropriate as free cloud service due to its particular features of user interface, and the in-situ application proved successful.

5) Using cloud data-sharing technique resulted in a reduction of data transferring time around 97% and the operation cost up to 90% with the improved quality of construction management activities.

6) Further study may include (i) specific functionalities of online system for SMEs construction firms which are lack of IT or internet access and (ii) the rapid changes in functions or user interface of cloud service providers and their impact on SMEs. However, as the Database-as-a-service (DaaS) could be developed more user friendly, the online construction management may be created to fit the individual's needs. The system could support and provide more functions and information sharing not only for PCs but also mobile devices where high speed internet network is available.

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