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# Cloud-based Project Supervision to Support Virtual Team for Academic Collaboration

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**Abstract.** Concurrent Engineering (CE) aims at the goal of cost and time reduction as well as quality improvement. For this achievement of CE, the collaboration of various activities are considered, ranging from design disciplines, manufacturing and assembly, marketing and purchasing, all the way to the end users. In this respect, collaboration of people from various activities among different locations is crucial to the success of CE, where the collaboration does not mean the activities for industries but also for academia to pursue global research/education. TMAC (TokushimaU UTeM Academic Centre) has been established in September, 2014 in order to enhance the academic collaboration between the two institutions. TMAC is not a satellite office of Tokushima University at UTeM but a joint academic center which is designed to be operated by a virtual team composed of the existing faculties who serve for each institution. In other words, TMAC has a unique organizational structure based on the virtual team across the globe. Therefore, it is a very critical project to figure out how to enhance the global collaboration among TMAC staffs. For enhancing the collaboration, some existing communication tools and collaboration system are already under use. However, a new type of cloud-based computing system is required to satisfy the specific needs of this unique organization. This paper overviews the outline of TMAC and presents an idea of cloud-based supervision system to support virtual team organization for global academic collaboration of TMAC, which could be applied to the similar types of global collaboration.

**Keywords.** Remote supervision, virtual team organization, academic collaboration, cloud-based computing

## 1. Introduction

The number of Japanese companies expanding business manufacturing in Malaysia is getting more than 1,400 [1], which implies the strong relations between the two countries in terms of business and industry partnership. On the other hand, the academic partnership between the two nations is also getting active as can be seen from the various on-going projects, such as the project of MJIIT (Malaysia-Japan

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International Institute of Technology) [2], JMTI (Japan-Malaysia Technical Institute) [3], MSSC (Kyushu Tech. Malaysia Super Satellite Campus) [4], TUT-USM Penang (Toyohashi University of Technology - Universiti Sains Malaysia Technology Collaboration Centre in Penang) [5], etc. Under these circumstances, Tokushima University - Univerisiti Teknikal Malaysia Melaka Academic Center (TMAC) [6] has been established in September of 2014 after MOU (Memorandum of Understanding) agreement in 2013, in order to promote further collaboration between the two institutions in terms of education and research activities. One of the critical factors of this successful establishment was the long-term reliable relationship between the two institutions based on the alumni network in the past one decade, supporting various activities such as mobility program [7], or the international conference, for example, iDECON [8][9]. TMAC has opened two offices, one of which is J-TMAC at Tokushima University (TU) and the other one is M-TMAC at Univerisiti Teknikal Malaysia Melaka (UTeM). It is unclear if the operation of TMAC function works well or not. This is because of the fact that the organization of TMAC is quite unique as a virtual organization, where TMAC staffs are supposed to work collaboratively over the computer network. Incidentally, all of the TMAC staffs are concurrently appointed from the regular staffs of TU/UTeM. Therefore, in order to make it successful, the remote collaboration activities among TMAC staffs play a very critical role and are the fundamental function of TMAC [10].

Various types of collaboration tools are available these days, for example, cloud-based mail system [11], project scheduling system [12], video conference system [13], etc., some of which are already installed at TMAC offices and are under use for the activities. These tools definitely support the remote collaboration over the internet even between different countries, such as Japan-Malaysia [14]. However, the environment for remote collaboration has still many issues to be considered to satisfy the needs of TMAC and to truly support the collaboration of TMAC. Five months have been passed since the first Education-and-Research Unit (*ER Unit*) members of TMAC were appointed in October 2014 after the establishment of TMAC. Reviewing the past 5 months activities of TMAC under the collaboration of ER unit 2014, this paper presents how TMAC worked so far towards the collaboration, and discusses the basic requirement factors of remote collaboration support system of TMAC for further enhancement of collaboration. First, this paper overviews of TMAC academic center to show its unique feature. Reviewing the TMAC activities related to the remote collaboration, this paper clarifies the critical factors of remote collaboration support system. Finally, this paper proposes the cloud-based remote collaboration system, which could be the basis of project supervision over the virtual team like TMAC staff under the system.

## 2. Overview of TMAC Academic Centre

TokushimaU-UTeM Academic Centre, or TMAC was established at the main campus of Universiti Teknikal Malaysia Melaka (UTeM) in September 2014 as a result of long term academic collaboration between Tokushima University and UTeM in the laboratory level in its start, followed by MOU at institutional level and its upgrade to university level. The branch office of TMAC, or J-TMAC was also opened at the same time in Josanjima campus of Tokushima University.

TMAC pursues a more advanced method of collaboration by way of global educational and research approach [15], which is not identical to what is commonly performed in typical satellite offices of host universities. One of the core ideas of TMAC framework is to invite/assign an education/research unit, or *ER Unit* from UTeM to TU attachment every year and assign them as the TMAC staff in Japan. *ER Unit* is defined as a pair of student and his/her supervisor. The student is basically a double-degree program Ph.D. student who belongs to TU/UTeM. The supervisor is a Ph.D researcher who supervises his/her student towards Ph.D degree. TMAC invites one or two pairs of ER unit every year under the financial support of TU.

Figure 1 shows the organizational structure of TMAC, which is jointly operated under the collaboration of TU and UTeM. As for educational approach, the goal of TMAC is to provide a framework of global education for both institutions, which include lectures via teleconferencing, on-site lectures at UTeM by TU professors, English lectures organized by *ER Unit* for TU students, etc. As for research approach, the goal of TMAC is to offer a framework of global joint research including researchers not only from TU/UTeM but also from wide areas of Japan / Malaysian Universities. In 2014, two pairs of ER Unit were invited and working for TMAC. This paper presents the joint collaboration between TU/UTeM using two case studies. One of them is a machine oriented collaboration and the other one is a software oriented collaboration. Reviewing these case studies, this paper shows how the collaboration has been supported by the activities of TMAC and clarifies what kind of environment is required for further collaboration in TMAC.

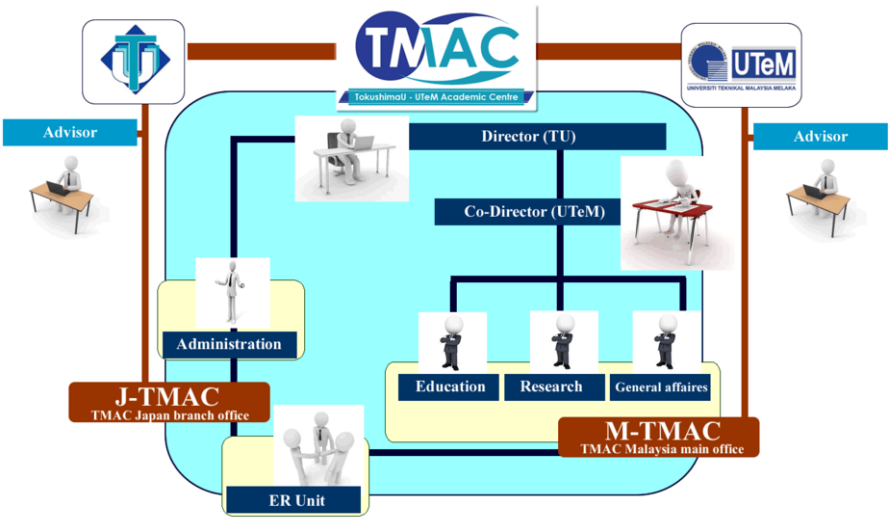


**Figure 1.** Overview of TMAC academic center as a virtual organization.

## 3. Case studies of remote supervision-based projects at TMAC

*ER Unit* members at J-TMAC work cooperatively at TU not only with TU researchers/students but also with UTeM people under the remote collaboration. This section picks up the case of *ER Unit* 2014 and reviews how their remote collaboration

has been carried out. The members of *ER Unit* were appointed as a TMAC staff for 1-year during 2014-2015.

### *3.1. Remote supervision from J-TMAC over final year project at UTeM*

*Final year project* at UTeM, which is commonly called *graduation research* at TU, is one the ultimate manifestation what the undergraduate student learns at the end of the 4 year engineering degree program. The research topic in the project is basically relevant to what the student has obtained by the time. *Final year project* encourages students to explore the areas of interest in depth, and to collaboratively work in a project team as well as an independently pursuing the scholarly area. Basically, the *final year project* is a series of main projects initiated by the supervisor. However, the project scope is exclusively dedicated to the students. Therefore, it is very important to design an appropriate research plan, structure, and supervision model in the *final year project* so that the project could be fulfilled by the project team as well as by individual students in the team.

Common practices of UTeM student experiments were conducted as the *final year project* of UTeM for five months in 2014-2015 [16]. The experiment was mostly completed under the supervision of one of the authors from the remote site, or TU, of which collaboration framework is shown in Figure 2. Table 1 below shows examples of basic experiments conducted under this framework.

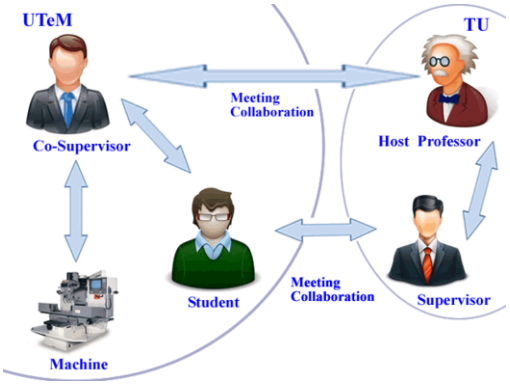


**Figure 2.** Remote supervision framework for final year projects.

**Table 1.** Examples of final year project experiments.

| Study # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| **Equipment** | Electrical discharge machine | Grinding machine | Simulation in milling process | CNC Milling machine | Wire electrical discharge machine | Water hammer test rig |
| **Area study** | Surface roughness and Electrode | Surface roughness of Nickel based | Cutting force of hard material | Tool performance and surface | Cutting performance of Nickel based | Accumulator performance |
| **No. of student** | 2 | 1 | 1 | 2 | 1 | 1 |
| **No. of Research Assistant** | NA | NA | NA | NA | 1 | NA |

These basic experiments have been completed in the framework of remote supervision. This is mainly because co-supervisor at UTeM well took care of the students to perform the experiments guided by the supervisor at TU. However, several problems below were recognized during the projects due to the fact that the supervision to the UTeM students in Malaysia was offered from a far distant place, or TU in Japan.

*Research guidance problem:* It was sometimes not easy to give an appropriate guidance from a distance. Just a brief meeting in the same room could make it easier.

*Low planning of the research project:* It was a tendency for students to plan/design the research experiments in an easier way not in an appropriate way. Supervising the appropriate way of experimental design was an issue.

*Poor language proficiency:* Pure language communication was not enough for research discussion. More direct interaction using human gestures, body languages, physical movement, could enhance the communication.

### *3.2. Remote supervision from J-TMAC over FEM simulation projects at UTeM*

Finite Element Method (FEM) analysis is another area covered by the researcher at J-TMAC [17]. FEM is one of the very popular approaches to validate structures/fabrications of mechanical parts design. Based on the various kinds of input data to model the target process, accurate results can be obtained as shown in Figure 3. Several FEM simulation projects are on-going under the remote supervision of the researcher as shown in Figure 4, with the help of the local technician at UTeM.

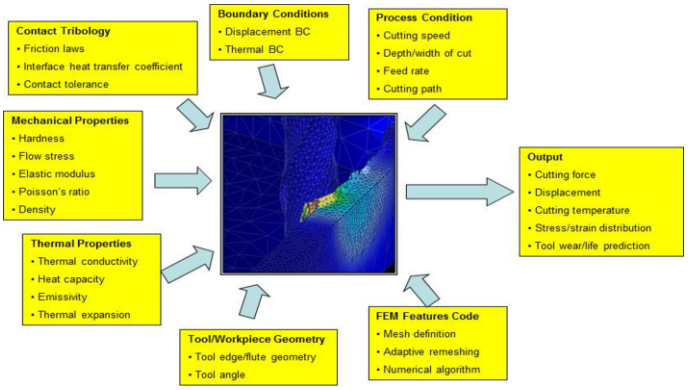


**Figure 3.** Input and output data overview in FEM analysis.

Reviewing the collaboration activities during the last few months, remote communication with the students is well supported thanks to the information and communication technology (ICT) environment at TMAC. As for the good points of remote communication, shorter meeting time, better meeting preparation by students, better engagement of students, suitable for simple problem solving, easier data exchange, etc. were recognized. However, as for some drawbacks, it is not available to have three way call, online machine monitoring, etc.

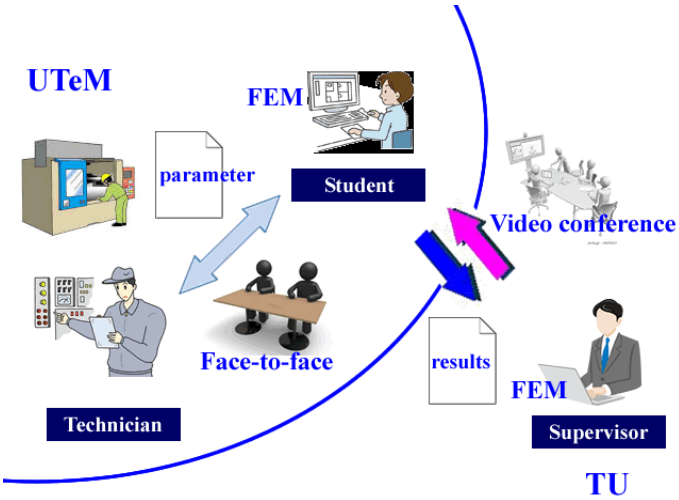


**Figure 4.** Remote supervision framework for FEM analysis projects.

### *3.3. Remote supervision from M-TMAC over a Ph.D project from a view point of Double Degree student*

This section presents an example of remote supervision to a Duble-Degree student of TMAC, where the supervisor is located at UTeM and his student is located at TU. The student is pursuing a Double-Degree of Ph.D from TU and UTeM during the three years of 2014-2017 regarding the research topic of cloud-based manufacturing [18][19]. In addition to that, she has been appointed as a student staff of TMAC in the first year of her Ph.D program.

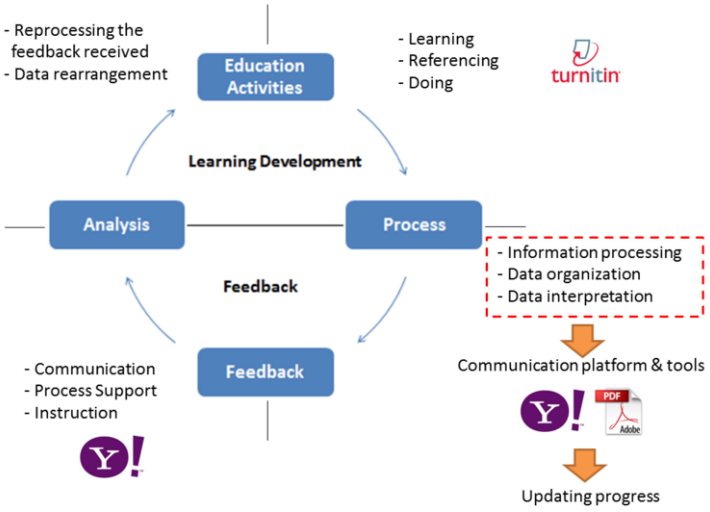


**Figure 5.** PDCA cycle of Double-Degree student under remote supervision.

Reviewing the activity of the student, a PDCA (Plan-Do-Check-Action) cycle of the activity was dipitced as shown in Figure 5, which shows how the student worked under the remote supervision from UTeM. *Education actitities* is the first phase to obtain knowledge about the resarch project, with the help of Turnitin database to learn how to write good papers under the support of the supervisor. *Process* is the second phase to learn the systematic thinking in data/information management. *Feedback* is the third phase to review the research activities by the advise/instruction through the interaction with the supervisor using ICT tools. *Analysis* is the last phase of the cycle to make adjustment on the research activities to upgrade towards the next step. In addition to the ICT tools such as turnitin, yahoo messsages, Twitter, as shown in Figure 5, the student often used phone calls, which is one of the traditional communication tools but is proved to be the effective communication tool over the globe.

## 4. Review of the remote supervision examples at TMAC

### *4.1. Communication tools in UTeM/TMAC collaboration*

The communication between the supervisor and his students was very frequent, cooperative, and close for all cases in order to collaborate between the two difference locations, or UTeM and TU. The typical communication tools were Email, VoIP applications, video conference system, etc. This section shows what we have found in using these tools.

*Email:* Email is the basic and widely used communication media. The well-known advantage is that the message can be sent in different time zones, which is very suitable to make overseas communication in TMAC. The function of Email is not only to exchange messages, but also to share files, such as weekly report, experimental data, statistical data and journal of current research. Therefore, Email offers the opportunity to students to write reports in a nice way and send them in a timely manner.

*Wikis:* Wikis, such as SharePoint, PmWiki, XWiki, etc., is a viable alternative to e-mail, because wikis has many advantages when working in a team. Even though TMAC has not used Wikis so far, a defining characteristic of wiki technology is known as the ease with which pages can be created and updated. Considering the security issues, Wikis is under consideration as the collaboration tool of TMAC.

*IM and VoIP applications:* instant messaging (IM) and voice over internet protocol (VoIP) are recently quite popular. Typical applications used in the projects were Skype, Viber, Line, and WhatsApp, all of which are free software and can easily be accessible by mobile devices. As a result, behavior/movement of experimental machines could be captured/monitored very clearly in high resolution, and be shared among the members of the experiment. The captured video could also be sent as a vido clip file after the meeting to be shared among the team.

*High-quality video conference system:* J-TMAC at TU and M-TMAC at UTeM are connected with a high-quality video conference system (Polycom), which is installed on both sites and is ready to use anytime for TMAC collaboration activities. Thanks to its high quality audio/video communication, TMAC members often use it for regular meetings, or ad-hoc discussion over the computer network, which is very useful for remote collaboration.

### *4.2. Limitations in project supervision under long distance communication*

Even though the typical communication tools have advantages as mentioned in the previous section, some drawbacks were observed in the projects, some of which are shown in this section.

*File sharing:* Due to capacity limitations, some large size files could not be sent via email and IM applications. Email file attachment requires proper file management, otherwise, important information may be lost. Some integrated files linked to the specific applications, such as CAD/CAM and CAE simulation software, could not be opened with a single data file in a different application. Some students captured the desktop images or made video clips to share the results of experiments with the supervisor. However, these files cannot be edited to make corrections by the supervisor unless both student and supervisor operate the same software concurrently to edit the original data during the video communication.

*Physical data sharing:* The experiment in the *final year project* research involves various activities including machine operation. Therefore, machine setup and machine handling have to be completed correctly in order to avoid any accidents or undesirable results. However, it is not possible to share the physical data regarding the machine operation over the computer network.

*Data transmission speed:* Typical communication tools, such as Skype, worked very effectively in all of the projects. However, the network speed and video quality was an issue. Poor internet speed also restricted to perform group video calling in some cases.

*High-quality video conference:* Polycom provides high quality video streaming, and does not suffer from the data transmission problem just like the Skype case. However, it could not be used in the experimental facilities because neither the machine tools nor the Polycom system was portable.

*Time zone:* The different time zone was another issue, even though it was only one hour difference in Japan and Malaysia, for example, difficulties in meeting scheduling, time misunderstanding, etc.

*Data handling:* The communication data requires large memory space, especially video recorded data. Due to scarcity of memory space of PC or mobile device, it often happened that some communication data was completely lost, which made it impossible to recall back later.

## 5. A proposal of cloud-based project supervision framework

Virtual organization of TMAC has been established in a unique manner and is in operation under the global collaboration between TU and UTeM. For enhancing the collaboration, some existing communication tools and collaboration system are already under use. However, the computer network-based framework to support this global collaboration is merely based on the typical ICT tools so far as mentioned in the previous sections. It is very critical to figure out how to enhance the global collaboration among TMAC staffs who are globally separated in two different countries. Therefore, a new design of cloud-based project supervision system, which is based on the idea of cloud-based manufacturing framework, is under study to satisfy the needs of this unique organization.

The framework is composed of two types of cloud servers, or cloud-based information server and cloud-based remote machine control server as shown in Figure 6. The cloud-based information server is composed of an internet-based public cloud and an intranet-based private cloud in a seamless integration. The data files can be stored in these servers, and be shared among the members in a seamless manner with high security. As a result, the use of email file attachment for data sharing would be avoided. The cloud-based remote machine control server is also an integration of public and private cloud server, but it is directly connected to the machine tools to be controlled/monitored. As opposed to the video monitoring via ICT tools, the user could directly operate/monitor the machine tools at UTeM facilities from J-TMAC office. The implementation of this framework is under study as a TMAC project.

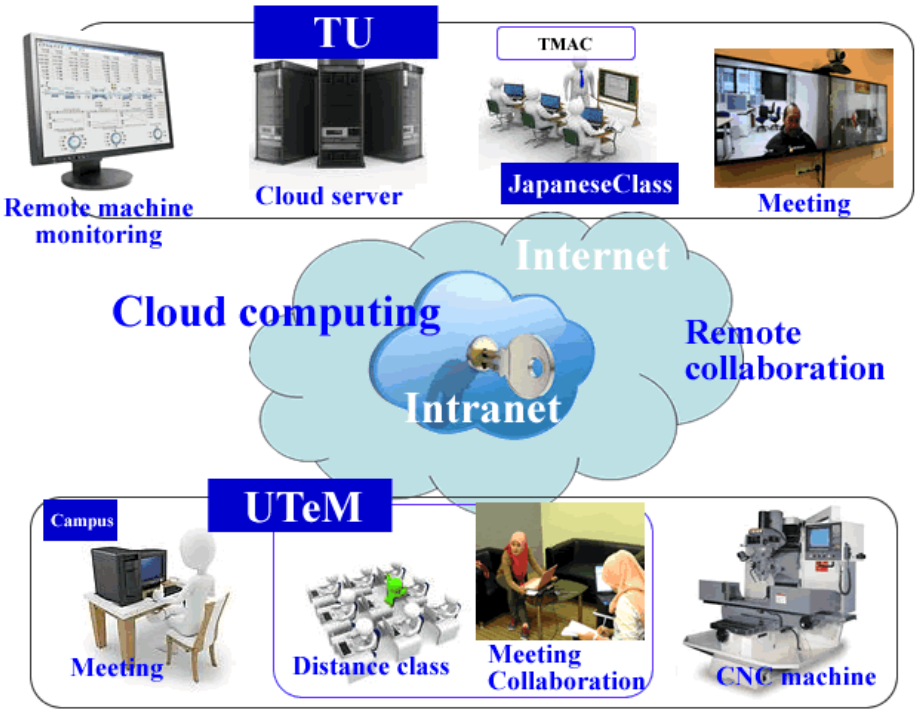


**Figure 6.** Framework of cloud-based project supervision system.

## 6. Concluding remarks

This paper overviewed the outline of TMAC and presented the case studies of academic collaboration at TMAC under remote supervision. Then, the paper proposed the idea of cloud-based supervision system framework to support the virtual team organization of TMAC towards the global academic collaboration. Future work includes the development of the system based on this framework and its feasibility study at TMAC.

TMAC has a unique organizational structure based on the virtual team across the

globe. Therefore, it is very critical to figure out how to enhance the global collaboration among TMAC staffs, who work as the critical linkages between the two institutions. For enhancing the collaboration, some existing communication tools and collaboration systems are already under use as reported in the paper. However, a new type of cloud-based computing system is required to satisfy the specific needs of this unique organization.

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