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Project factsheet information

Project title	A Cloud Based Application Measuring and Controlling Electricity Used for Indonesian houses
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Country where project was implemented	Indonesia
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Total budget approved	AUD 23,182
Project summary	This project is to develop a cloud based application to capture the electricity consumption data for every area of a typical Indonesian household such as kitchen, children room, guest room, bathroom, etc, without having to modify the electricity meter from PLN (National Electricity Company). Interviews, literature research and experiments will be conducted to develop the prototype of the system. For the hardware, Arduino Board and Current Transformator will be used to capture the data about electricity consumption in every room of the house. Meanwhile, an application will be designed using PHP in cloud platform. After receiving the data, it will be sent to cloud server so that the user can see the report in the form of chart and graph for each room through Android mobile application or computer with Internet access. Switching on and switching off a lamp in the house can also be controlled through Android mobile application or computer. This feature is expected to give a smarter way for the users to monitor and control their electricity consumption at home. Finally, the device is low cost deployment, low power consumption and easy to maintain.

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Project Summary

This project is to develop a cloud based application to capture the electricity consumption data for every area of a typical Indonesian household such as kitchen, children room, guest room, bathroom, etc, without having to modify the electricity meter from PLN (National Energy Company). In Indonesia, people cannot track the electricity home use since PLN bills only display total price. Currently, people cannot control devices (turn on/off) from outside of the house, which if possible, will lead to electricity savings. Interviews, literature research and experiments will be conducted to develop the prototype of the system. For the hardware, Arduino Board and Current Transformator will be used to capture the data about electricity consumption in every room in the house. Meanwhile, an application was designed using PHP in cloud platform. After receiving the data, it sends to cloud server so that the user can see the report in the form of chart and graph for each room through Android mobile application or computer with Internet access. Switching on and switching off a lamp in the house can also be controlled through Android mobile application or computer. This feature is providing a smarter way for the users to monitor and control their electricity consumption at home. Finally, the device is low cost deployment, low power consumption and easy to maintain.

The software has been tested in a small prototype house, which consists of 1 or 2 rooms that have one lamp, TV, AC, and desktop computer.

This project is to find the alternative solution of power shortages in Indonesia. Lack in monitoring and control of electricity consumption are seemed to be a factor that contribute to the shortages in electricity distribution. The outputs of the project will be delivered in 3 forms: First, is the assembled new Arduino device to receive the electricity input and transmit the output to the server; Second, is the user application in the cloud computing platform (this handles the monitoring and control over the internet); and finally, the third form is the monitoring control over the mobile devices. The project has now been completed, but the planned timeline for these activities was extended from 12 months duration to 17 months project duration.

Background and Justification

Indonesia is one of the developing economies in South East Asia. It has more than 238 million inhabitants and claimed as the forth world most densely populated country. With this outstanding growth of population, the energy usage in Indonesia keeps increasing. Indonesia net electricity consumption increased drastically from 1980 until 2010. In 1980, less than 20 billion KWH used in Indonesia, but in 2010 the usage of electricity exceed 140 billion KWH [1]. This result concludes that the electricity usage in Indonesia is tremendously multiplied in 30 years time.

As the electricity usage keeps increasing, the price is increasing as well. When the demand of a product is beyond its supply then the price will increase. Jero Wacik, the Indonesia Minister of Energy and Mineral Resources said that Indonesia will increase its electricity tariff every 3 months by 4.3 percent which will allow the government to spend less on electricity subsidies, approximately US$1.5 billion [2]. With that tariff increment, the expected subsidies for electricity in Indonesia would be around US$ 8.27 billion [3] for 2013, which is quite onerous compared to subsidies for Indonesia health care which approximately US$ 1.8 billion [4].

In fact of the growing quantity of electricity used, the wasted electricity keep increasing as well. According to Maryam, Director of Energy Conservation from Ministry of Energy Sources, households can waste around US$ 500 per year for electricity and offices around US$ 12,000 per year [5]. Parts of the costs associated with this wasted electricity are covered with government subsidies. If the government could save the money it spends paying for wasted electricity, and invest the saving into something else, Indonesia will be better off.

Based on questionnaires that we distributed to 90 households, 59% of the respondents said that the Jakarta electricity provision is bad. 41% strongly agreed that blackouts happen very often in Jakarta, and that is part of

the problems facing the electricity service. 43% strongly agreed that they pay more than what they are expecting, and 44% said that they strongly agreed that too much energy is consumed in Jakarta's households. The house consumption monitoring can be inferred as a major problem for the respondents. They do not know which room and appliances in the house cost more, neither their electricity usage thoroughly.

Majority of the respondents attribute the inefficient household electricity usage to users forgetting to turn off appliances or leave devices in standby mode. As people cannot control electronic devices remotely in Indonesia, it is considered as one of the factors causing inefficient consumption. From the survey, it can be concluded that inefficiencies in electricity usage are happening at all levels of the population in Jakarta. With the differences of income level, electricity spending, and electricity usage of each house, the respondents agreed that although it was true that they were using electricity inefficiently, they could not manage it better since there is no system to monitor it at the moment.

Project objectives

- Assembling Arduino components to create a monitoring tool to control electricity consumption in a house.
- To develop cloud-based electricity measurement application that helps measure, manage, monitor and report the electricity consumption per room
- Create an analysis and implementation strategy for bringing the web application to be implemented in Cloud.
- Build Android mobile application and desktop application to switch on / off the use of lamp in the house

Users and uses

We expect to change Indonesia's electricity users behaviour so that they are aware of how to save energy, especially at home. In addition, users will have better relationship with the National Electricity Company since they will receive a more detailed breakdown of the electricity bills. The application developed through this project, will capture more details information compare to what is in the existing electricity bills.

Through the project activities, the project team would like to improve its project management skills and communication skills, specially with the National Electricity Company, IT vendors and internal financial department. Also, the project team would like to contribute so our organization becomes more actively involved in social innovation to improve life in Indonesia through the use of technology.

This application will be used to monitor and control the electricity at home. In general, we see the middle and upper-income households to be the direct user. Meanwhile, government and National Electricity Company can be the indirect user.

The most relevant topics the project team wants to learn are:

1. **Communicate with the user:** a survey was distributed to several potential users with the purpose of getting a deeper understanding of their problems. After the product has being developed, we will promote it through social media and working with the National Electricity Company so that the potential users are aware about it. Then, we will invite several potential users for training on how to use the application and collect their feedback.
2. **Manage vendor:** choosing the right vendor to help us in this project and make sure the vendor follows our timeline and fulfil all our requirements. At the moment, we communicate with the vendor regularly and they have to update us with weekly report on technical progress report based on the project timeline given.
3. **Manage our budget:** we have to make sure that our expenditure will be according to the total budget given by ISIF Asia grant. We got approval from the ISIF Asia secretariat on 1st March 2013 to re-

allocate some lines in the approved budget since some sections need more budget than the other. Here, we learnt to do budget proposal better so that it will suit the reality in doing the project.

Indicators

The progress of this project is monitored through several indicators. And the indicators of the project have been categorised into input, process, output and outcomes indicators [6].

Baseline	Indicators	Progress	Assessment	Course of action
Users lacking mobile & online application to control and monitor their electricity consumption and cost There is a need to have solution to save electricity consumption and cost in Indonesian households (users).	Input indicators (resources provided for project activities) are: a. Initial research grant of IDR 216.457.280,90 b. Procurement of 1 Arduino board and 2 Android devices. c. A total of 2 programmers (1 for hardware, 1 for software). Process Indicators (project activities): d. 9 months to develop the project (include contract signing, planning, design, implementation, testing& rollout) e. 3 months to write the paper for conference and journal. Output Indicators (goods & services produced): f. PIPA Electricity Monitoring & Control Solution g. User Training h. 1 International conference paper & journal of the solution Outcomes Indicators (impacts): i. Reduce cost for electricity consumption. j. Promote a greener lifestyle	The progress of each indicators: Input indicators: **a. A spent of IDR about in project expenditure.** b. 1 Arduino board and 2 Android devices have been acquired. c. 2 programmers have been hired. Process Indicators: d. 12months of development has reached 100% completion. Output Indicators: a. A PIPA Application; a cloud and mobile based application to control and monitor the electric consumption in a house. b. A technical report paper that was presented at the 23rd IBIMA International Conference in Valencia, Spain. c. A survey result that was conducted as part of the user testing process. Outcomes Indicators (impacts) : a. Networking opportunities with IBIMA participants b. Constructive meetings with IDEA, USM, UPC on energy savings project and for having a joint potential research in the future. c. A training on ITIL management for the research team is among the outcome received by the team members.	Indicators assessments have been performed on input and process indicators. Input indicators are assessed by the research team and with the help of the research team`s institutional assistance in providing detail financial reporting. Process indicators are assessed though weekly reports on technical progress. Output indicators were assessed in a mutual participation of the International conference participants of the 23rd IBIMA Conference in Valencia Spain. Also, positively assessed by several institutions during the meeting series before and after the conference. Outcome indicators were assessed by group of students that were doing the testing for user acceptance and interface.	Even though there are no major changes to the original project development plan, the two additional revamps from the whole plan have been performed. 1. The ITIL training for better project management knowledge: Teuku Aulia Geumpana as one of the research team has sit for the ITIL Foundation training last 29 – 30 April 2014. 2. The extension of paper publication and conference Have been done on 13 – 14 May by attending IBIMA International Conference in Valencia, Spain. A paper technical report on the project has been published with a Scopus index on the conference proceeding.

Project implementation: understanding the chain that leads to results

Narrative - project implementation

The project activities officially started in February. Several planning and administrative works like internal coordination, tools procurement and preliminary data gathering took three months to complete and in June 2013, the technical development was begun. This project is named as PIPA project. PIPA itself is a sort of abbreviation in Indonesian language of *Pemantau Pengendali Arus* or in English called Electricity Control and Monitoring. Literally, PIPA is an Indonesian word that means "tube". This can be a branding name for the output product of this project as a tube that control and monitor the electricity consumption.

The output of the project is to answer several problems that are related to the electricity consumption in Indonesia. Those problems are like:

   a. Lacking of electricity distribution that causes some locations not to be reached or a regular black out at certain locations.
   b. Inability to monitor the electricity consumption that leads to high cost.
   c. Inability to control the electricity consumption from the outside houses.

From the initiation of this project, several collaborative meetings and interviews to gather base requirements and information related to the project have been performed; this involved the National Energy Company of Indonesia (Perusahaan Listrik Negara – PLN), private electricity consultant and also professionals in cloud area.

A formal partnership has just been established with a Small Medium Enterprise type of company in software & hardware development called PendekarTeladan (PT). The responsibility of PendekarTeladan is as the implementing technical partner while all other areas of the project such as project initiation, data requirements, business process requirements, problem and solution analysis, testing and recommendation are being done by the research team.

We have identified several beneficiaries that will be involved in this project. In general, we see the middle and upper income households to be the direct beneficiaries. Meanwhile, government and cloud providers are the indirect beneficiaries to the project. Direct beneficiaries identified have helped the project team to reach a deeper understanding of the initial problem and will be providing feedback on the proposed solution. Both of these activities are being conducted through surveys. At the time this report was prepared, the early survey to understand the initial problem that has been completed. The feedback survey on the proposed solution will be conducted once the project has reached around 80-90% completion, when the prototype is completed.

On the other hand, the involvement of the indirect beneficiaries like government and cloud providers is being conducted through interviews and meetings to plan and design the solution.

The implementation of this project will benefit both gender; men or women and accommodate all ethnics in Indonesia who are consuming electricity at their homes. However, looking deeper into more specific group, the project outcome should benefit more to those head of families who bear major cost of the household, in which based on the 2012 demographic data from the National Indonesia Statistic Agency there are about 17.26 % educated head of families who live in Jakarta whom we aim to reach as our target beneficiaries. This is out of more than 64 million total households in Indonesia. In general, the positive impact should be acquired by everybody who is using PIPA to monitor and control their electricity usage at home.

During this first few months of implementation the team works very hard to transform the business process solution into a real system. Several meetings with local vendors and national electric agency were conducted to get a comprehensive understanding on how to approach the problem for electricity monitoring and control.

For self-development, the team has included additional training on ITIL (Information Technology Infrastructure Library) to help gain more knowledge on managing IT infrastructure project. This training is useful to give better IT Management knowledge to the team members in implementing and deploying the PIPA project to the community.

Input	Project activities	Outputs	Outcomes	Timeline	Status	Assessment
Programmer hired for 4 months. 1 Arduino device to run the electricity module has been purchased. 2 Android devices have been purchased with different specifications and running latest version of Android Jelly Beans.	Interfaces for software modules (cloud and mobile application) have been developed. Hardware module has also been developed but still need attention in fixing the data consistency.	Three outputs from different modules have been integrated at the end of the implementation: 1. PIPA Reader v1.0 This is an Arduino Module that functions to read the electricity spent from electronic devices 2. PIPA Mobile v1.0 This is a mobile application to monitor and control the electricity consumption at home. 3. PIPA Online v1.0 This is a cloud application to monitor and control the electricity consumption at home.	PIPA application has enabled the users to monitor and control the household electricity consumption, though a PIPA's mobile and/or computer application.	Computer and Mobile applications development: 01/07 –23/08 - Design UI/UX - Backend Dev. - Mobile Dev. - Web Dev. - API Dev. - Bug Fixing Hardware Development Activities: 01/07 – 23/08 - Purchasing Arduino and WiFi components - Purchasing electronic materials for Demo model - Building of Demo model - Research and development - Electrical wiring - Coding - Bug fixing - Hardware Development Activities: 01/09 – 30/04 - App installed on device - App testing by user	Completed	The project team has evaluated the implementation progress of PIPA Project. Hardware module (reader) and software modules (cloud and mobile) have been prototyped. Preliminary testings found some accuracy problems in reading the data consistency while tracking the electricity usage. Troubleshoot action has been taken and we are in the process of finding the solution for data inconsistency. Regardless of the data inconsistency issue, the hardware module and software modules have successfully tested to communicate in both ways. The hardware modules have all been tested and smoothly running The data testing of the application on cloud and mobile were done over the prototype house created with 2 lamps and 1 other source of

					electricity.

Project outputs, communication and dissemination activities

Project outputs	Status	Assessment	Dissemination efforts
PIPA Reader v1.0: This is an Arduino Module that functions to read the electricity spent from electronic devices PIPA Mobile v1.0: This is a mobile application to monitor and control the electricity consumption at home. PIPA Online v1.0: This is a cloud application to monitor and control the electricity consumption at home.	PIPA Reader v1.0: testing & bug fixing has been completed PIPA Mobile v1.0: testing & bug fixing has been completed PIPA Online v1.0: testing & bug fixing has been completed	Several forms of assessment are conducted to ensure the dimension quality of the project outputs/outcomes. 1. Unit Testing is used to assess the smallest part (sets of codes) of PIPA reader, PIPA Mobile and PIPA Online modules. The aim is to determine if each unit is working properly or not. The test result from PIPA Reader indicated the module has successfully read the electric usage on a toaster. The data has also been captured and sent to the backend server for every 5 seconds. The unit testing on PIPA Mobile and PIPA Online were performed on the success access/ retrieval of backend server. No significant issues found yet on the assessment result. 2. Integration testing is to assess the proper group working modules from PIPA Reader, PIPA Mobile and PIPA Online. Even though PIPA Reader has successfully sent the data to the backend server, yet the data consistency is still an issue. Data captured sometime shows the missing information on certain seconds during the capturing process. Therefore, integration between 3 PIPA modules is still under revision. 3. System testing is to assess the working system as a complete unit. At this point, it has not been done yet considering some bugs and errors are still need to be resolved. 4. Usability Testing and Feedback survey: We have invited 13 users to test the software and most of them can do the given tasks in about 18 – 20 seconds. With this testing, some bugs and errors are found and need to be fixed. The feedback survey was distributed to assess the outcome of the solution offered through user feedback. The result shows that most of them are satisfied with the software and willing to use it in the future.	The dissemination efforts made to socialize the solution are through education and promotion. Education will include the user training workshops, presenting solution to forums, conferences and publishing the solution findings through media communication like journals, newspapers or e-newspapers. Meanwhile, promotions are being done through utilizing available existing media by creating community on Facebook and twitter.

Project outcomes

A. Usability Testing and Survey Result reflects the outcome on the community

We have invited 13 users and asked them to get familiar with the software and use it. All of them can complete the given tasks successfully in a short time. 77% of them are satisfied with PIPA's features because it is easy to use and can increase efficiency in controlling electricity. They are also willing to use PIPA in the future and will recommend PIPA to their friends.

B. Networking with national and international organizations on energy savings

Networking opportunities with national and international organizations are among the best outcomes acquired from this project. The attendance of research team in presenting the technical report at IBIMA 23rd International Conference has linked the researcher to many other researchers across the globe.

C. Skill upgrade on IT project management

This project has upgraded the skill and knowledge of the research team in handling IT projects. In addition, the participation of one of the research team member in the ITIL training last April has been very valuable to the

completion of the project. Also, this will bring positive impact as well to Binus International as the company where the research team member is currently working.

D. Information Sharing and Potential collaborative project in the future with International organization

Meetings series that were carried out during the attendance of IBIMA Conference last April in Spain has brought many potential collaborative researches in the future. The team from BarcelonaTech has shown a very strong interest in doing a joint research to expand the current project into a wider scope to reach the community. The IDEA people and UCM research groups have also shared valuable information on similar project that can be used as inspiration to improve the project in the next research activities.

Project management and sustainability

A. **Management**
1. Administration: we appointed one researcher to be responsible to deal with our internal staff and the other researcher to be responsible to deal with external vendor. By doing this, each of us can focus to our part and make sure that everything is according to project plan.
2. Staffing: for research, our organisation has allocated one research assistant to help us in doing this project and one dedicated person from finance department to take care of the budget. We have recruited a programmer from the external vendor to help developing the application.
3. Procurement: at the moment all procurement has been done by researchers and PT Pendekar Teladan
4. Training: we did not allocate budget for researcher's training. If any savings on the approved budget are done, the team will request to re-allocate the budget for training to strengthen our skills and knowledge.

B. **Sustainability**
1. The project team has learned a lot from doing this project such as administrative skills in term of budget management, time management, communication and negotiation, and procurement process.
2. As mentioned before, the ISIF Asia grant has supported the improvement of the team's administrative skills by directing it to follow the existing procedures and rules. As the host institution, Binus International has also provided great support toward the improvement of the team's research skills by guiding it to understand the qualitative and quantitative research methods. Binus International has also helped the team for data gathering in this project. The project is aimed to reach wider social groups in Indonesia, so no special consideration has been made on including women or marginalized social groups because t.
3. To retain sustainability of project implementation toward the community, the team will run a feedback survey on the solution offered. The result of the survey will be used to enhance the product appropriateness in the community.
As mentioned earlier in the objective of the project, the aim of the proposed solution is to help the community reduce the electricity consumption at home. Which later will leads to energy and cost saving.
4. To sustain the research activities, partnership with other research organization will be conducted and other source of research funding will be sought. Some potential research partners are Sushito Research group from ESSI-UPC (Barcelona Tech) and Software Engineering Research Group at UCM, Madrid.

C. **Inspire Change**
The work conducted by the project team has inspired our organization in supporting its employees whom received International grants by formulating a dedicated team to handle related needs toward the project.

D. **Opportunities**
Potential opportunities on future development of this project can be done through government intervention or private investment.

E. **Consolidation**

Our organization is considering to invest in further development of this project with a goal to protect the Intellectual Property Rights of the solution, according to the ISIF Asia agreed licensing scheme, and socialize the product to a wider community. In terms of product development, our organization will support further related research activities by providing suitable resources.

Impact

The direct impact of this project at this point can only be seen at the research team benefits:

a. Better skill in IT Management Project, Android development, Embedded System

b. Many conference participants are curious about ISIF funding

c. Open networking opportunities for researcher

d. Open Joint research opportunities to widen the scope

e. Open business opportunities to make the solution as the commercial product

The intangible impacts of this project are those impacts that influence the change of behaviour or understanding of the users on the project output or the technology used in this project.
a. Change of behaviour in electric usage at home
b. Better awareness on saving electricity for more distribution to the unreached area
c. Promote greener living style
d. Educate the community on the benefit of cloud application for life

Overall Assessment

This project is expected to meet its objectives by enabling users to monitor and control the electricity usage. The survey findings confirm the hypothesis that Indonesia is still lacking in equal electricity. To address this problem, there is the need to conduct effective collaborative efforts among the community, the government and the technical experts to create awareness on avoiding unnecessary electricity consumption so electricity saved maybe redistributed to unreached areas. This project is offering a control and monitoring approach towards the electricity consumption. This project contributes with tools and awareness to the development of a positive behaviour towards electricity consumption.

Deep understanding of the problem and business process has being crucial to the efficient project and proposed solution design to be effective.
Proper time scheduling has being important to monitor the progress of each activity during the system development, to ensure the completion of the project within the timeframe. Whereas in implementation, user testing and bug fixing have been considered important to ensure the solution proposed is error-free and adopted by the users' community.

The grant has facilitated the research team to find the space to be more active and creative in finding solutions. As a result, the research team is now more exposed to engage in related discussions with government officials as well as professionals working on the electricity sector, as well as to be proactive to identify existing solutions to monitor and control electricity consumption and how those solutions can be enhanced or articulated to the one this project team is working on. The grant opportunity has also motivated other researchers from our institution to do more research to help answer development problems for the benefit of the community.

To achieve real impact beyond the design, the project team is aware of the pressing need to get government support in setting up the rule on "award and punishment on electricity standard consumption".

Recommendations

Below is a list of recommendations that the project team would like to share with other practitioners or researchers intending to solve similar problems or implement similar solutions:

1. Every country may have different rules and regulations about distributing the electricity to their users. Different government representatives may address the problem from a different perspective; therefore, it is important to get an understanding of the government perspective in the first place.

2. Understanding the problem does not stop at government level, meeting with communities is also important to acquire real understanding of the electricity consumption in the household.

3. When a proposed solution has been developed it needs to be shared to get feedback from other professionals and communities as potential users to find its advantages and disadvantages, strengths and weaknesses to be able to improve the solution before it is delivered to the communities as the users.

Bibliography

[1] U.S. Department of Energy. "Indonesia". (12 February 2013). Retrieved from: http://www.eia.gov/countries/country-data.cfm?fips=id#elec

[2] Siahaan, T. S. (28 December 2012)."New Electricity Tariff Scheduled to Begin on Jan. 1". December 28, 2012. Retrieved from: http://www.thejakartaglobe.com/business/new-electricity-tariff-scheduled-to-begin-on-jan-1/563814

[3] Azwar, A. S. (29 December 2012)."Businesses ready to raise prices as electricity costs rocket". Retrieved from: http://www.thejakartapost.com/news/2012/12/29/businesses-ready-raise-prices-electricity-costs-rocket.html

[4] International Institute for Sustainable Development. (2012).Panduan Masyarakat Tentang Subsidi Energi di Indonesia Perkembangan Terakhir. Switzerland: IISD

[5] Dhany, R. R. (3 March 2012)."Waduh! Miliaran Rupiah Terbuang Gara-gara Colokan Listrik Terus Nempel". Retrieved from: http://finance.detik.com/read/2012/03/03/121226/1857029/1034/waduh-miliaran-rupiah-terbuang-gara-gara-colokan-listrik-terus-nempel

[6] Horsch, K. (1997). "Indicators: Definition and Use in a Results-Based Accountability System". Retrieved from: http://www.hfrp.org/publications-resources/browse-our-publications/indicators-definition-and-use-in-a-results-based-accountability-system