การพัฒนาเว็บเซอร์วิสแผนที่ดินเซรามิกในประเทศไทย โดยประยุกต์ใช้ระบบสารสนเทศภูมิศาสตร์

Development of Ceramic Clay Map Web Service in Thailand by Applying GIS

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บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อพัฒนาเว็บเซอร์วิสรวบรวมแหล่งดินเซรามิกในประเทศไทยโดยประยุกต์ใช้ระบบสารสนเทศภูมิศาสตร์ (GIS) ที่สามารถรองรับการแสดงตำแหน่งพื้นที่สัมปทานบนแผนที่กูเกิลแมพ และคำนวณหาขนาดพื้นที่ได้รับสัมปทาน การพัฒนาเว็บเซอร์วิสในงานวิจัยนี้แบ่งออก 3 ส่วนหลัก ได้แก่ (1) ส่วนจัดเก็บข้อมูลตำแหน่งพื้นที่สัมปทาน (2) ส่วนการนำข้อมูลตำแหน่งละติจูดและลองติดจูดมาแสดงผลขนาดเขตแหล่งดินเซรามิกบนแผนที่กูเกิลแมพ และ (3) ส่วนการเรียกเซอร์วิสจากเว็บแอปพลิเคชันด้วยกัน การออกแบบสถาปัตยกรรมเว็บเซอร์วิสจะประยุกต์สถาปัตยกรรมซอฟต์แวร์เอ็มวีซี (MVC Architecture) และการพัฒนาเว็บเซอร์วิสในงานวิจัยนี้จะพัฒนาด้วยภาษาจาวาผ่าน SOAP โปโตคอล และใช้ฐานข้อมูล MySQL ผลลัพธ์การนำเว็บเซอร์วิสลงทะเบียนผ่าน UDDI และติดตั้งใช้งานผ่านเว็บไซต์สมาคมเซรามิกส์ไทยเพื่อรองรับการร้องรอเซอร์วิสจากเว็บแอปพลิเคชันด้วยภาษา WSDL จากกลุ่มตัวอย่างผู้ประกอบการเหมืองแร่ ในภาคใต้และภาคเหนือที่มีการคัดเลือกแบบเจาะจง พบว่าระบบเว็บเซอร์วิสสามารถแสดงประเภทดินเซรามิกและแหล่งดินเซรามิกที่สำรวจได้ในระดับจังหวัด อำเภอ ตำบล สามารถแสดงตำแหน่งพื้นที่ผ่านกูเกิลแมพ และมีการคำนวณพื้นที่ขนาดในระดับ ตารางเมตร หรือจำนวนไร่ และสามารถคำนวณขนาดพื้นที่ได้ตรงกับผลการลงพื้นที่สำรวจจริงจากผู้ประกอบการเหมืองแร่ จำนวน 5 แห่งในจังหวัดระนอง และลำปาง นอกจากนี้ระบบยังสามารถแสดงผลจำนวนสำรองดินเซรามิกที่ได้จับเก็บไว้ กรณีพื้นที่มีการยกเลิกสัมปทานไปแล้ว

คำสำคัญ: ดินเซรามิก, พื้นที่สัมปทาน, ระบบสารสนเทศภูมิศาสตร์, เว็บแมพเซอร์วิส, สถาปัตยกรรมเอ็มวีซี

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ABSTRACT

The objective of this research was to develop a web service to collect ceramic clay in Thailand by applying the Geographic Information Systems (GIS) that can support concession area location on Google Map and calculate the area size that had web service development concessions. This research was divided into three main parts: (1) data storage section for concession area location, (2) latitude and longitude location data display for ceramic clay area size on Google Map, and (3) service call section from web applications. Web service architecture design was applied to MVC Architecture. Web service development in this research was developed in Java through SOAP protocol and using MySQL database for storing ceramic ground positions. Web service implementation results were registered via UDDI and installed through the Thai Ceramics Association website in order to support requests for service from web applications in WSDL languages. From the mining operators in the south and north with purposive sampling, it was found that the web service system was able to show the types and sources of ceramic clay surveyed at the provincial, district, and sub-district levels which were able to show the location of the area through Google Map and calculate the area size in square meters or *rai*. The area size calculated from the web service and the field survey at five mining sites of Ranong and Lampang was found precisely the same. It is also possible to display the number of ceramic clay reserves that have been captured in the event of a concession revocation.

Key words: ceramic clay, concession area, GIS, MVC architecture, web map services

INTRODUCTION

Ceramic is clay pottery made mostly of ball clay, a lump of clay formed by the precipitation of kaolin, which is made up of kaolinite. The chemical component comprising approximately 40-60% silica, 30% alumina, and about 10% of crystallized water and organic matter makes the soil extremely fine (The Department of Science Service, 2021). This clay is tough, when dry or calcined. It has high strength, and after firing, it becomes white or cream (Bazina *et al*., 2014). Therefore, ceramic entrepreneurs use ball clay to integrate the crockery production process as an indispensable material. Currently, there are 638 registered ceramic factories in Thailand: 275 plants in the north, 273 in the central, 42 in the east, 23 in the northeast, and 25 in the south (Information and Communication Technology Center, Department of Industrial Works, 2021). In Lampang province alone, there are over 200 ceramic factories (Lampang Ceramic Association, 2021) including these well-known ones: Indra Ceramic Factory, Silp Nakhon Factory, and Lampang Khoon Ceramic Factory. In Ratchaburi province, there are 58 ceramic factories with these large-scaled producers: Crown Ceramic Factory, Thao Hong Thai Factory, and Rattanakosin 2 Factory (Ratchaburi Ceramic Association, 2021). The clays for producing ceramics are in Ranong, Lampang, Ratchaburi, Nonthaburi, Nakhon Ratchasima provinces. (Department of Mineral Resources, 2018).

The problem is that several of the government-allowed ceramic clays have run out. According to the Department's survey, various mineral deposits were identified only by specifying the location and length of the concession, and the area size could not be mentioned in the concession document, so the size and location of the area could not be determined clearly, which is difficult to explore and manage in the ceramic industry mineral clusters (Department of Mineral Resources, 2018). Therefore, to make the ceramic clay mineral resources more manageable, this research uses latitude and longitude coordinates collected in the document to show the map size and determine the area size through the Geographic Information Systems (GIS) to support the management of mineral resources, ceramic industry and mine operators relevant agencies in both the

public and private sectors or the general public can know the sources of ceramic clay. Google Map is well known as the map operator that many software developers can use it via Google API without a fee. The users do not need to install map programs.

MATERIALS AND METHODS

Web Service

Web Service is a service between web applications that can work together freely without being attached to the platform with the exchange of information through the SOAP protocol or RESTful protocol (Rodriguez, 2015) to help increase service efficiency, such as a secure web service for electronic tuition payments (AlHawari and Mohammad, 2020). The behavior of the web service system serves requests from clients and client responses through the communication protocol HTTP in the XML file format, and a web service consists of 3 parts: (1) Service Consumer, (2) Service Provider, and (3) Service Registry as shown in Figure 1.

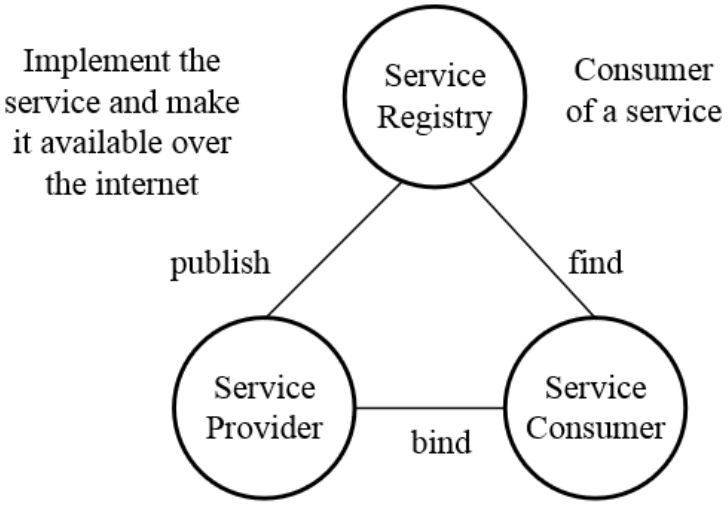


Figure 1 Web service Architecture (AI-Shargabi, 2020)

From Figure 1, The service running process starts with the service consumer requesting service that has been registered (UDDI Register). When a service is found, it will be executed by the service provider. The WSDL language is the language used to describe message communication between web services in SOAP messages (The Apache Software Foundation, 2018). When using the service, the service consumers must utilize WSDL files, indicating details of receiving -sending data, to install in the targeted software, that uses the service. Components of the SOAP document are the structure of the XML language. It consists of 3 parts: (1) part of identifying the requester (SOAP envelop), (2) the SOAP header, and (3) the part used to call the service, including the parameters passing between the services (SOAP body) such as a SOAP protocol for communication between service requesters and providers of currency exchange rates by as for SOAP request sending the value of Hong Kong 1000 HKD. When the service calculates the exchange rate, it will reply to the SOAP response reply to the Thai currency at 4,250 baht, as shown in Figure 2.

SOAP Request

```
<?xml version = "1.0" encoding = "UTF-8">
<S: Envelope xmlns: S= "http:// schemas.">
  <SOAP-ENV: Header />
    <S: Body>
      <ns2: exchange xmlns: ns2= http://ws/>
        <hkd> 100.00 </hkd>
      </ns2: exchangeRequest>
    <S: Body>
</S: Envelope>
```

SOAP Response

```
<?xml version = "1.0" encoding = "UTF-8">
<S: Envelope xmlns: S= "http:// schemas.">
  <SOAP-ENV: Header />
    <S: Body>
      <ns2: exchange xmlns: ns2= http://ws/>
        <return> 4250.00 </return>
      </ns2: exchangeResponse>
    <S: Body>
</S: Envelope>
```

Figure 2 Structure of SOAP protocol

Web Service Architecture Design

Web service architecture design integrated ceramic clay sources in this research with applications of web services and GIS can be divided into two software components: (1) This web service section supported the location of the land concession area, and (2) the ceramic land area size display section. They consisted of a part of the area display through Google Maps and a portion of the area size calculation at each concession point. The development of a Ceramic Clay Map WS in this research in Java to support service consumption between web applications together via SOAP protocol, with WSDL language as the language used to describe the form of communication between web applications, as shown in Figure 3.

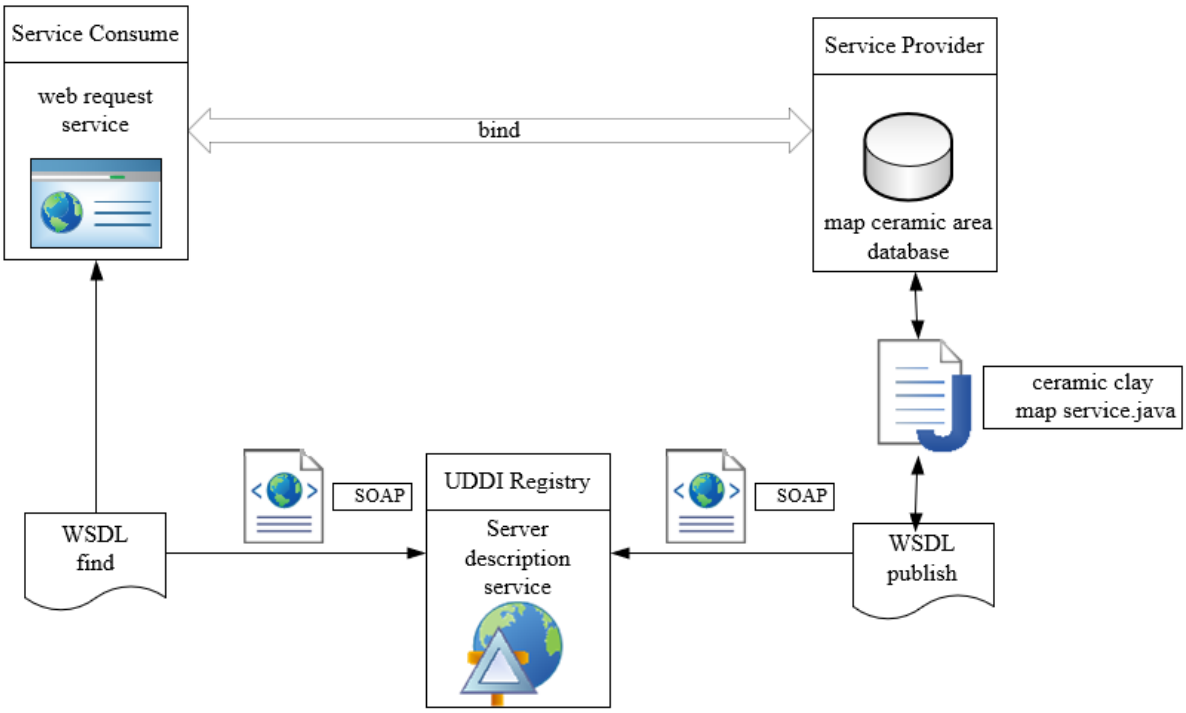


Figure 3 Web service developing

Software architecture design of a Ceramic Clay Map Web Service in Thailand in this research applied MVC Architecture. It consisted of a MapService package that stored the geographic coordinate system of the ceramic land concession number, and the MapServiceWS package that displayed the results of the ceramic territories on the Google Map by extracting data from the MySQL database system, as shown in Figure 4.

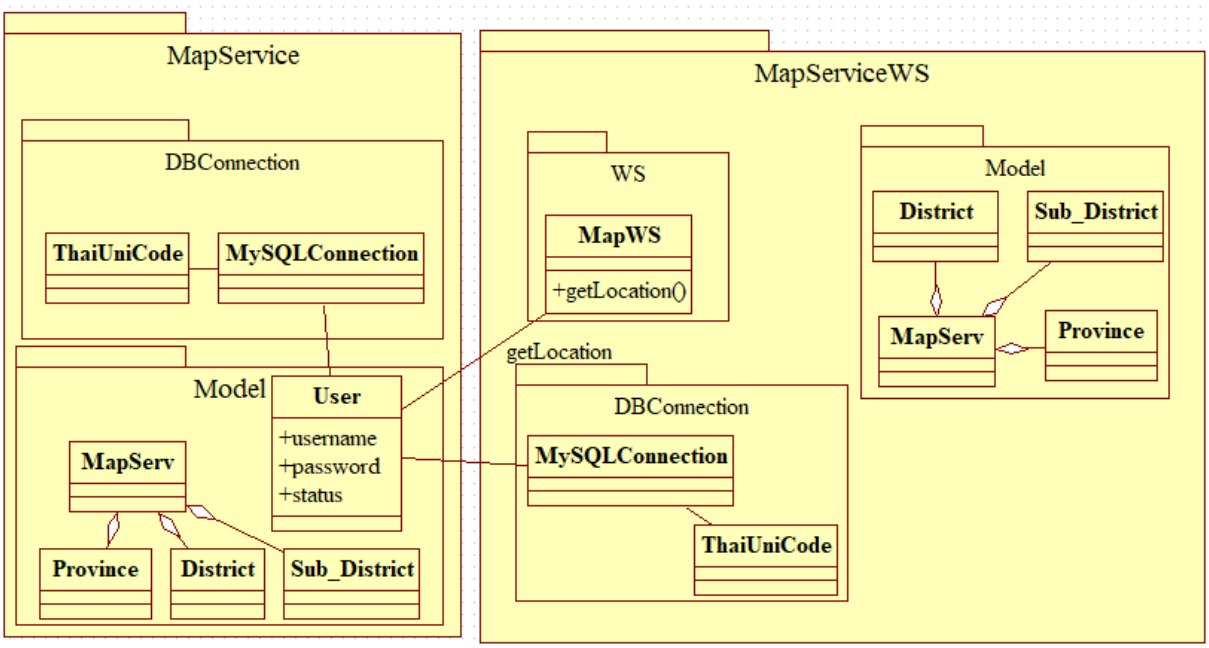


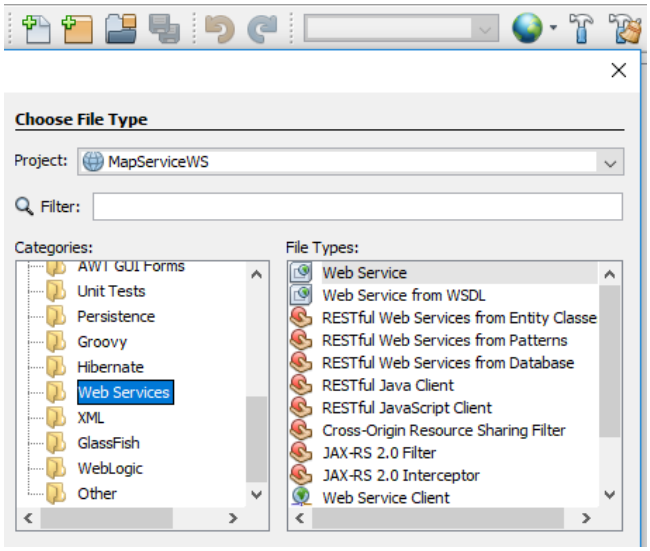
Figure 4 Web service architecture collecting the sources of clay and ceramics in Thailand

The web service architecture components are shown in Figure 4. The two packages were designed according to the MVC pattern, which consisted of models that stored ceramic resources: province, district, sub-district, ceramic clay type, latitude, and longitude.

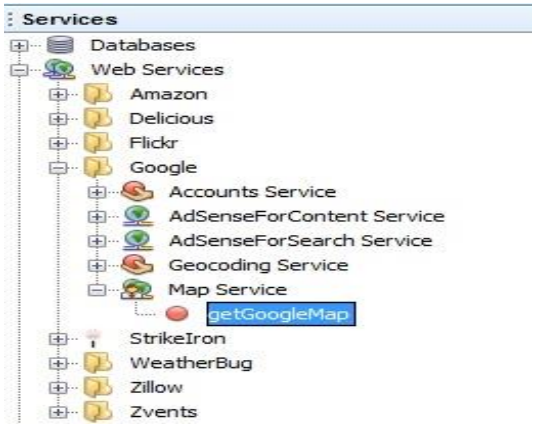
The view served to display the results through the web page window: results, area size, a land source on Google map, detailed information, number of rai or square meters, including reserve ceramic clay. The control was responsible for calculating the size of each concession area, receiving data from the web application, and storing it in a database such as location data, latitude, and longitude, etc.

Web Service Architecture Implementation

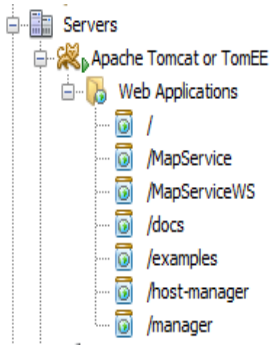
Developing and testing web services with NetBeans (The Apache Software Foundation, 2018). The service was developed to support the subordinate, including getLocation, getSize, and getImage service, as shown in Figure 5.



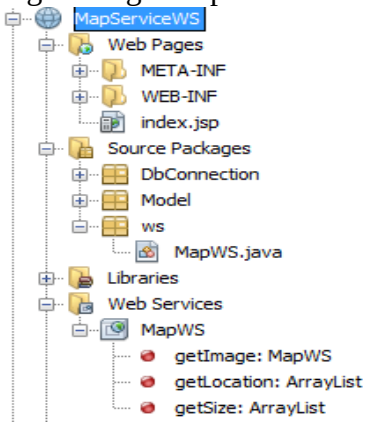
(a) Netbean IDE 8.2



(b) Using a Google map in the web service



(c) Connecting the database via Tomcat sever



(d) Sevice distribution part

Figure 5 Processing the Web service development on GIS

From Figure 5 (a) Components of the NetBeans IDE 8.2. used to develop web services in this research in Java Figure 5 (b) is a Google Map plug-in that can be run through NetBeans. Figure 5 (c) is testing web services through Apache Tomcat, and Figure 5 (d) is a component of the MapWS that has been developed.

It will consist of packages to store the class files for installing the web service and call the web service. In the instruction set in Table 1. Line 1 indicates the location of the web service with a @WebServicePath prefix mark to provide specific access to the MapWS class and call the getLocation method in line 5 with a @WebMethod prefix mark. This method will retrieve the geographic coordinate system in the MySQL database system to send back to the requester, as shown in Table 1.

Table 1 Web service instruction set, MapWS class

```
1.  @WebService(serviceName = "MapWS")
2.  public class MapWS {
3.  private String lat = "";
4.  private String lng = "";
5.  @WebMethod(operationName = "getLocation")
6.  public ArrayList<Model.MapServ> getLocation(@WebParam(name = "province") ) {
7.  MysqlConn mysqlConn = new MysqlConn();
8.  ThaiUnicode thaiUnicode = new ThaiUnicode();
9.  String cond = "";
10. ArrayList<Model.MapServ> maps = new ArrayList<Model.MapServ>();
11. ResultSet rs;
12. }
```

The part of sending a message to each other will be sent in the form of a SOAP message consisting of Envelop, Header, and Body (Bolz, 2020) as shown in Table 2 of the instruction set.

Table 2 The SOAP message instruction set, the request part

SOAP Request

```
<?xml<S:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/">
  <SOAP-ENV:Header/>
  <S:Body>
    <ns2: getLocation xmlns:ns2="http://thaiceramicsociety.or.th/ MapServiceWS/MapWS
?xsd=1">
        <itemProvinceID>province_id </itemProvinceID >
        <itemPrivinceTitle>province_title </itemPrivinceTitle >
        <itemDistrictID> district_id </itemDistrictID >
        <itemDistrictTitle> district_title </itemDistrictTitle >
        <itemSubDistrictID> sub_district_id </itemSubDistrictID >
        <itemSubDistrictTitle> sub_district_title </itemSubDistrictTitle >
        <itemLocation> location </itemLocation >
    </ns2: getLocation >
  </S:Body>
</S:Envelope>
```

The statements in Table 2 is the SOAP Request portion of the Service Request Side, which consisted of the SOAP Header and the SOAP Message Body segment, comprising of province code, province name, district code, district name, district code, the name of the district, and the coordinates of the said area. The response to a request was a set of SOAP response instructions, as shown in Table 3.

Table 3 The SOAP statement, the response part

SOAP Response

```
<?xml<S:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/">
   <SOAP-ENV:Header/>
   <S:Body>
       <ns2: getLocation xmlns:ns2="http://thaiceramicsociety.or.th/
MapServiceWS/MapWS?xsd=1">
         <return> province_id </return>
         <return> provice_title </return>
         <return> district_id </return>
         <return> district_title </return>
         <return> sub_district_id </return>
         <return> sub_district_title </return>
         <return> location </return>
      </ns2:addResponse>
    </S:Body>
</S:Envelope>
```

RESULTS AND DISCUSSION

Results of ceramic clay mab web service in Thailand through GIS are the same as the study by Fauzi (2020). Displaying details of ceramic clay sources stored in the database shows the collected ceramics sites in Thailand that consists of provinces, districts, sub-districts, clay types, and the number of reserved clay in the area that has expired the concession, as shown in Figure 6.

Area

Total area size 338,785 square meters or 212 rai, total reserve of clay 9,500,000 tons.

#	Province	District	Sub-district	Raw Material Types	Reserve of Clay (ton)
🗺	Tak	Ban Tak	Tak Tok	Ball Clay	0
🗺	Phayao	Chiang Muan	Ban Mang	Ball Clay	0
🗺	Ranong	Mueang Ranong	Hat Som Paen	Kaolin	0
🗺	Ranong	Mueang Ranong	Hat Som Paen	Kaolin	0
🗺	Ratchaburi	Chom Bueng	Chom Bueng	Kaolin	0
🗺	Lopburi	Chai Badan	Kut Ta Phet	Kaolin	0
🗺	Lampang	Ngao	Nagae	Kaolin	0
🗺	Lampang	Muang Pang	Thung Kwang	Ball Clay	0
🗺	Lampang	Sopprab	Sopprab	Kaolin and Ball clay	9,500,000

Figure 6 Detail of clay source.

The support part of entering the ceramic clay concession area position through the Add/Edit icon on the left column can specify the ceramic clay type, province, district, sub-district, and the specified geographic coordination system in the concession or survey number, including the amount of ceramic clay in the case of the reserved area as shown in Figure 7.

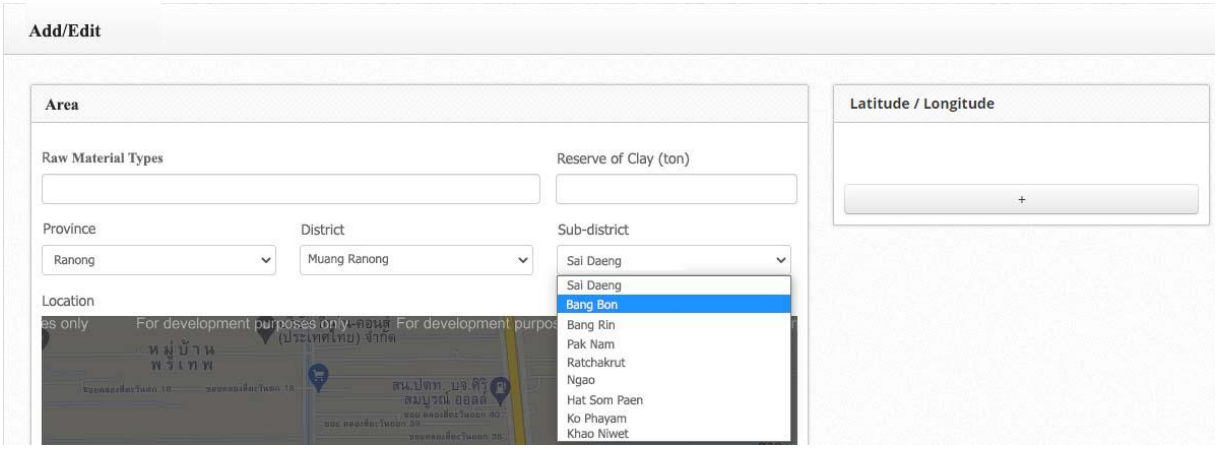


Figure 7 Web browser window to add/edit coordinates ceramic clay area size.

The results showed that the area size of ceramic clay was divided into 2 parts, namely No.1. area size display through Google Map (Gong *et al*., 2015) and No.2. area size calculation in square meters or number of rai (Sayar *et al*., 2005). In addition, it can display the result of the reserve of ceramic clay that has been collected in the event that the concession has been canceled, as shown in Figure 8.

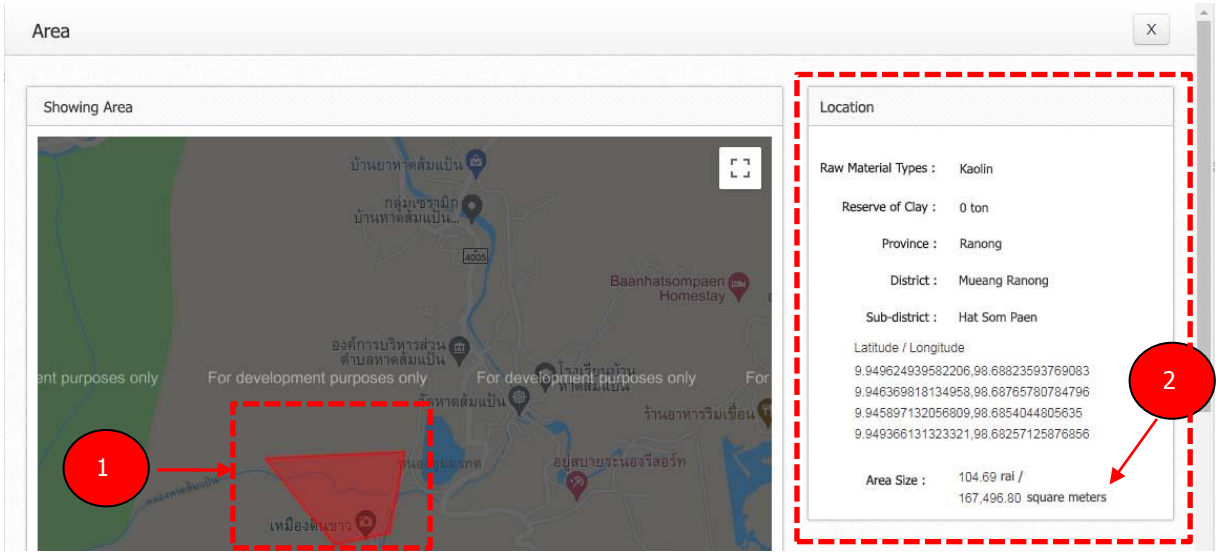


Figure 8 Web browser window with the land size of the ceramic clay area

For supporting service requested from the web application, the WSDL file displayed on the URL can be imported through http://thaiceramicsociety.or.th/MapService Document that can be installed on the web application that needed service request, as shown in Figure 9.

Web Services

Endpoint	Information
Service Name: {http://ws/}MapWS Port Name: {http://ws/}MapWSPort	Address: http://thaiceramicsociety.or.th:80/MapServiceWS/MapWS WSDL: http://thaiceramicsociety.or.th:80/MapServiceWS/MapWS?wsdl Implementation class: ws.MapWS
Service Name: {http://ws/}TestWs Port Name: {http://ws/}TestWsPort	Address: http://thaiceramicsociety.or.th:80/MapServiceWS/TestWs WSDL: http://thaiceramicsociety.or.th:80/MapServiceWS/TestWs?wsdl Implementation class: ws.TestWs

Figure 9 A web browser window showing WSDL language file sharing.

The results of the collection of ceramic clay were obtained from the researcher's survey and the concession documents of the Department of Mineral Resources and the documents of the Mineral Town Association, Lampang Province. The area size calculated by the web service and the actual field survey by the researcher was the same. The survey was conducted in five mining areas in Ranong and Lampang provinces, as purposive sampling. Those are (1) MRD Co., Ltd., Tambon Hat Som Paen, Mueang district, Ranong Province (2) Mrd-Ecc Co., Ltd., Tambon Sopprab, Sopprab district, Lampang Province (3) SCG Co., Ltd., Tambon Sopprab, Sopprab district, Lampang Province (4) Phatara Ratana Clays & Minerals and Serirat Mining Co., Ltd., Chae Hom district, Lampang (5) Mueang Chiang Muan Co., Ltd., Tambon Banpu, Mueang Chiang Muan district, Lampang Province. Some selected pictures of the field survey are shown in Figure 10.

Figure 10 The field survey at a mining site of MRD Co., Ltd.

The results of the survey from entrepreneurs who receive the experience are details of the location data as displayed in Table 4.

Table 4 Samples of ceramic clay sources collected

Province	District	Sub-district	Clay type	Coordinates		Area size	Reserve (tonnes)
				Latitude	Longitude	Square meters/Rai	
Ranong	Mueang Ranong	Hat Som Paen	Kaolin	9.9496 9.9463 9.9458 9.9493	98.6882 98.6876 98.6854 98.6825	110,519.75 /69.07	0
Ranong	Mueang Ranong	Hat Som Paen	Kaolin	9.9394 9.9358 9.9360 9.9399	98.6872 98.6878 98.6853 98.6847	167,496.80 /104.69	0
Lam Pang	Sopprab	Na Yang	Kaolin and Ball clay	18.5492	99.5891	Run out of concessions	9,500,000
Lam Pang	Chae Hom	Chae Hom	Kaolin	18.5276 18.5240 18.5222	99.5523 99.5523 99.5495	60,768.41 / 37.98	

From the sample data in Table 4, the results of the survey of ceramic sources to be provided into the web service system revealed that they could store location, province, district, sub-district, clay type, latitude, and longitude, and area size. In addition, the total ceramic clay reserves were included, for example, Ranong Province. The researcher surveyed 2 areas, namely Mueang Ranong District, and Hat Som Paen Subdistrict which was still operating concessions, and Lampang Province 2 areas, namely Chae Hom District, and Sop Prap District that were exhausted the concession, which was in the process of restoring the clay, so they had a reserve of 9,500,000 tons of ceramic clay.

To use a web map service, the users must insert data via a web ceramic map system by indicating the location of the ceramic clay, either in one latitude and longitude location or more than one location, in the database and transfer it into the Google Map. The obtained data will automatically calculate the size of the area in square meters or *rai (1 rai is equivalent to 1,600 square meters)* via the functions of Google Map. The latitude and longitude position derived from the concession numbers the mining concessioners received from the Department of Mineral Resources, reflecting the reliability of the information. The data can also show reserved ceramic clay in the exhausted concession areas where the concessioners declared to the researcher.

CONCLUSION

The design and development of ceramic clay map web service in this research aimed to collect ceramic clay by applying the MVC architecture to develop, modify, maintain, and design a software architecture that met international standards. The functionality was divided into two parts: the MapService package, the MapServiceWS package, and the secondary web service development emphasizing communication between layers of web applications through SOAP protocol in Java with NetBeans 8.2.

Web service registration and implementation results revealed that WSDL file-sharing was supported by implementing the web application for those who wished to request services from a ceramic clay map web service from this study. The web service collected ceramic clay by applying GIS in research by using latitude and longitude locations stored in a database displaying the area size of ceramic clay via Google Map and calculating the size of the ceramic land area. However, to use the ceramic clay map on Google Map during the development, the developers can register to use the Google Map without any fee. For long-term use, the fee will be

collected by the Google platform rules (Google Maps Platform, 2021).

Using MVC architecture to design web service in this research has advantages which include the separation of operation from service parts, service requests, and the management of a database of ceramic clay locations. Nevertheless, there are complicated issues in dealing with documents on model views and the viewpoints working under the functions at the control component. So, this architecture still cannot completely separate the view from the control parts (Dathan and Ramnath, 2014).

The dissemination of web services in the development of web services and geographic information systems to help assess the raw materials used for the ceramic industry in Thailand can support calls between web applications, web development, and a web service that was registered in the UDDI Registry. The operators using the web services can bring WSDL file from this URL: http://thaiceramicsociety.or.th:80/MapServiceWS/MapWS?wsdl and install it on their application. Those potential users are Ceramic Operator Government Agencies, the Thai Ceramics Association Lampang Ceramic Association, the Ratchaburi Ceramic Association Mining Association, the Lampang Industry Office of Space, and Geographic Information Technology (Public Organization), and the Department of Geological Resources for the implementation, and others.

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