Raabiya Mosque
FIRST PROGRESS REPORT
ARCHI.MEDIA TRUST
October 2021
A project implemented by:

ARCHI.MEDIA TRUST

In cooperation with:

State Board of Antiquities and Heritage
Sunni Endowment

Supported by:

International alliance for the protection of heritage in conflict areas

RESTORATION AND RECONSTRUCTION OF AL-RAABIYA MOSQUE IN THE OLD CITY OF MOSUL
A Pilot Project for Skills Development, Youth Employment and Social Cohesion

PROGRESS REPORT

October 2021
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Following the signature of the Grant Agreement on 8 March 2021, the project implementation started in April. Building the management and technical team (currently 8 people), as well as signing the agreement with the Department of Architecture of the University of Florence, preceded the implementation of the sitework, started in May through the rubble removal, including the clearance from ERW. The first mission took place in June, with the purpose of meeting the stakeholders, i.e., the Sunni Endowment and the State Board of Antiquities and Heritage (SBAH), as well as with the local community, undertaking the survey of the mosque and its surroundings (UAV, TLS and photogrammetry) along with the supervision of the geological investigations performed by the Engineering Consulting Bureau of the Mosul University, and undertaking tests for the material conservation of the surfaces and sampling of foundations and masonries. The mission fully achieved its expected results and enabled the team to start the postproduction of the raw data acquired on site and the elaboration of the diagnostics. As of 30 September, the restitution of the survey is completed, while the diagnostics is ongoing. A mission is planned for mid-December to discuss the project design with the key stakeholders.

1. Summary of Project Progress

Following the signature of the Grant Agreement on 8 March 2021, the project implementation started in April. Building the management and technical team (currently 8 people), as well as signing the agreement with the Department of Architecture of the University of Florence, preceded the implementation of the sitework, started in May through the rubble removal, including the clearance from ERW. The first mission took place in June, with the purpose of meeting the stakeholders, i.e., the Sunni Endowment and the State Board of Antiquities and Heritage (SBAH), as well as with the local community, undertaking the survey of the mosque and its surroundings (UAV, TLS and photogrammetry) along with the supervision of the geological investigations performed by the Engineering Consulting Bureau of the Mosul University, and undertaking tests for the material conservation of the surfaces and sampling of foundations and masonries. The mission fully achieved its expected results and enabled the team to start the postproduction of the raw data acquired on site and the elaboration of the diagnostics. As of 30 September, the restitution of the survey is completed, while the diagnostics is ongoing. A mission is planned for mid-December to discuss the project design with the key stakeholders.
2. Stage and Evolution of Project implementation

The project addresses the restoration and reconstruction of Al-Raabiya Mosque in the old City of Mosul, combining the physical intervention with social and economic dimensions of recovery and reconstruction. It foresees a Preliminary Phase made of the acquisition of historical information, including first-hand data on the recent rehabilitation works that were implemented at the site, the documentation of the historic building and its surroundings through a full survey performed through up-to-date techniques, such as Unmanned Aerial Vehicles (UAV), also known as drones, and Terrestrial Laser Scanner, investigation on the structural elements of the mosque, its foundations and masonries, and geological investigations, to carry out the diagnostics of the current situation in terms of structural analysis and material conservation, necessary to develop the stabilization, restoration and reconstruction design. This phase also includes the active involvement of the local community that lives around the mosque and that will be in the future the user of the renovated building and courtyard. The preliminary design will be presented to key stakeholders and to the local community for discussion during November. The Preliminary Phase, started in May, will end in December 2021, after the submission – and approval by the key stakeholders (the Sunni Endowment and the SBAH) - of the executive design. The Implementation Phase, which entails the undertaking of physical works on site, is expected to start in January 2022, with the inauguration of the building site and the recruitment of local labour, to be trained through a yard-school approach. Twelve local non-skilled and/or semi-skilled workers will be guided through the various stages of the restoration process, which includes structural consolidation of the masonries and the foundations, the material conservation of all surfaces (Mosul alabaster, lime plasters and ceramics) and the reconstruction of the madrasa that collapsed further to the bombardments of 2017. Following the signature of the Grant Agreement on 8 March 2021, the project implementation started in April 2021. The major stages of the first semester of project implementation are listed below:

April 2021:
Communication with Iraqi key stakeholders (Sunni Endowment and the SBAH): AMT started phone conversations and official correspondence with SBAH and the SE to agree on the terms of reference of the project. The communication with the key stakeholders has started prior to the signature of the Grant Agreement (see letters to Sunni Endowment and to SBAH).

Team building: Recruitment of Project Manager / Senior Architect Conservator (see contract attached).
**Key partnership:** Agreement with the Department of Architecture of the University of Florence (DIDA) is signed on 12 April 2021 (see agreement attached). DIDA will carry out the survey and diagnostics phases, as well as provide scientific supervision of the project.

Technical meetings: Two meetings held on 8 and 27 April to prepare the mission and the fieldwork to be performed in Mosul.

**May 2021:**

**Team building:** Recruitment of Project Accountant and of Project Assistant. Letter of appointments are signed with Project Focal Point / M&E Officer, with Senior Surveyor and with Senior Restorer. Contracts with Senior Surveyor and Senior Restorer are also signed (see contracts and letters of appointment attached).

**Site preparation:** Further to a selective bidding process that saw 6 bidders from Mosul submitting their offers (see Note for the File, offers and awarded contract attached), the rubble removal was carried out on site, including the clearance from site of Explosive Remnants of War (ERW), in order to enable the survey and documentation of the historic property (see photographs).

**Mission preparation:** The first mission is carefully prepared in all its technical, contractual, logistical and security aspects. Rental agreement for a Phantom IV Pro drone and a Faro laser scanner was signed with the Erbil-based company Multipath Inspection (see contract attached). Visas, air tickets, medical insurance, COVID-19 PCR tests, BSAFE certificates, etc. are procured and accomplished. Accommodation and local transportation in Iraq are booked in advance (see Mission programme attached).

**June 2021:**

**Implementation of the Preliminary Phase on site:** 5 international experts field the first mission to Mosul from 1 to 17 June (see Mission report attached). Purpose of the mission was three-fold: a) meeting with the key stakeholders, i.e., the Sunni Endowment and the State Board of Antiquities and Heritage (SBAH); b) undertaking the full survey (UAV, TLS and photogrammetry) along with the supervision of the geological investigations performed by the Engineering Consulting Bureau of the University of Mosul; and c) carrying out tests for the material conservation of the surfaces and sampling of foundations and masonries, as requested by the Project Structural Engineer. The mission fully achieved its expected results and enabled the team to start the postproduction of the raw data acquired on site and the elaboration of the diagnostics (see “Technical outputs of the Preliminary Phase” as Annex).

**Soil investigation:** A contract with the University of Mosul/ECB was signed on 7 June (see contract attached). The main borehole was made in the street accessing the mosque on 10 June. The works were supervised by Dr Qutayba Al-Saffar.


**Community mobilization:** The mobilization of the community started during the June mission. The Community mobilization specialist laid the
foundations for a good participation of the local community, to be directly involved in the following phases.

**Cooperation:** One meeting held on 17 June (pm) to share the mission findings with the two French organizations (La Guilde Européenne du Raid and L'Œuvre d'Orient), who are managing other three sites in the Old City of Mosul under the same framework “Mosul Mosaic”, funded by ALIPH.

**July 2021:**

**Team building:** Recruitment of the Project Focal Point / M&E Officer (see contract attached).

**Elaboration of data acquired in the field:** The elaboration of the data from the survey started during the first week of the month. Data from the drone completed.

**August 2021:**

**Elaboration of data acquired in the field:** The elaboration of the data from the survey continued. Data from the laser scanner and photogrammetry completed.

**Exhibition at the Venice Biennale 2021:** The project preliminary phase’s results were submitted to the Exhibition “Together”, that inaugurated at the Olivetti Showroom in Piazza San Marco in Venice on 14 September. The two panels showing the project outputs are on display until the 22nd of November.

**Cooperation:** An agreement was signed with Mosul Eye on 5 September, to provide trees and shrubs for the garden of the mosque.

**September 2021:**

**Team building:** Recruitment of the Architect Conservator (see contract attached).

**Elaboration of the stabilization, conservation and reconstruction design:** The phase of designing the stabilization, conservation and reconstruction has started. It is expected to be completed by the end of November. Regular online meetings are organized with key local stakeholders to discuss the design main concept and details.

**Cooperation:** An agreement was signed with Mosul Eye on 5 September, to provide trees and shrubs for the garden of the mosque.
Status of the Project Activities and their Deliverables (as included in the project proposal)

Preliminary phase in Iraq (Activity 1.1 to 1.7)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Preliminary mission to take stock of current situation and meeting with key stakeholders</td>
<td>Fully achieved</td>
</tr>
<tr>
<td>1.2</td>
<td>Sampling of majolica tiles, mortars and plasters and different building materials</td>
<td>Partially achieved</td>
</tr>
<tr>
<td>1.3</td>
<td>Research and acquisition of geological maps of the area</td>
<td>Ongoing</td>
</tr>
<tr>
<td>1.4</td>
<td>Survey of the geo-materials available in the area and consequent sampling</td>
<td>Fully achieved</td>
</tr>
<tr>
<td>1.5</td>
<td>Collection of all the historical and photographic documentation of the monument</td>
<td>Fully achieved</td>
</tr>
<tr>
<td>1.6</td>
<td>Laser-scanner and drone surveys of the mosque and its environment</td>
<td>Fully achieved</td>
</tr>
<tr>
<td>1.7</td>
<td>Design a plan for the sampling and analysis of the constructive materials of the mosque’s structure and foundation</td>
<td>Fully achieved</td>
</tr>
</tbody>
</table>

Preliminary phase in Italy (Activity 2.1 to 2.5)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Chemical/mineralogical and technological analysis</td>
<td>Ongoing</td>
</tr>
<tr>
<td>2.2</td>
<td>Purchase of equipment and materials not available in Iraq</td>
<td>Equipment needed for the project</td>
</tr>
<tr>
<td>2.3</td>
<td>Review of the historic documents and data collected on the ground and of the results of the diagnostic study of the structure and foundation</td>
<td>Data collected and diagnostic study</td>
</tr>
<tr>
<td>2.4</td>
<td>Acquisition and treatment of data gathered in the field (postproduction) and development of diagnostic charts</td>
<td>Detailed graphic documentation</td>
</tr>
<tr>
<td>2.5</td>
<td>Design of the executive project of restoration and structural consolidation</td>
<td>Executive project</td>
</tr>
</tbody>
</table>

Implementation phase in Iraq (Activity 3.1 to 3.8)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Secure storage area for heritage-sensitive rubble</td>
<td>Fully achieved</td>
</tr>
<tr>
<td>3.2</td>
<td>Site preparation</td>
<td>The building site is ready for onsite activities</td>
</tr>
<tr>
<td>Other</td>
<td>Other activities</td>
<td>To be implemented in 2022</td>
</tr>
</tbody>
</table>
3. Risk Management

The project site is located in the heart of the historic town of Mosul. In recent years, the city witnessed civil unrest, the ISIS occupation for more than three years, and a massive destruction of its urban fabric, including its major infrastructures, as the result of the warfare to liberate the city from ISIS. The forced migration of large parts of Mosul communities led to the fragmentation and dissipation of its social and economic fabric, resulting in a situation of social fragility and insecurity.

The following risks were identified during the preparation of the proposal. Please find here below how the project team has managed those risks during the first semester of project implementation, and in particular during the first mission of 5 experts in June 2021:

UXO (Mines, IEDs, VBIEDs): After the demining of the site by the Iraqi Army in January 2021 and the rubble clearance by a local contractor in May 2021, both operations carried out in consultation with SBAH, no particular risks related to UXO were reported, with the exception of two bombs found on site on 5 June, and removed by the Army (not dangerous at the time of removal).

Episodes of violence / civil unrest (car accidents / bad road conditions / check-points crossing): No incidents reported, but check-points crossing require a good coordination with the local authorities, both KRI and Iraqi.

The Iraqi institutions (SBAH) and the local religious authorities (Sunni Waqf) are supporting the project. This is a key asset to minimize the above risks.

The project site is relatively secure as it is guarded by the local community, which was already informed and sensitized during the mission undertaken in June 2021. The site is secured on all sides by the walls that encloses the mosque. In principle, Archi.Media Trust welcomes an open-door policy to protect the site.

The project team faced issues connected to corruption. Due to the sensitivity of the issue, this will be discussed separately with ALIPH.

The impact of COVID-19 pandemic affected primarily budget (circa $1000 USD during the first mission of 5 experts) and logistics, due to the requirements requested by the Iraqi and KRI authorities.
4. Modification of the Project

It is early at this stage to envisage any modification of the project. AMT is planning a mission to Mosul in November-December 2021 to get approval of the final design for the restoration and reconstruction of the mosque complex from SBAH and the Sunni Endowment, as well as discuss the detailed methodology for the implementation of the site works.

As of October 31, 2021, the diagnostic study of the structure and the foundations, as well as the stone deterioration mapping, as a key component of the material conservation, are completed.

An agreement concerning the rubble removal, including ERW, was reached with ALIPH and the other two implementing partnering organizations (La Guilde Européenne du Raid and L’Oeuvre d’Orient). The removal of the remaining rubble from the roofs and from the drum of the dome of the Al-Raabiya Mosque will be carried out by a local contractor.

The project site signage has been designed and approved by the Iraqi project partners. It will be manufactured and installed at the earliest. The project vehicle requested by SBAH-Ninewah during the initial stage of the project is not going to be purchased. Archi.Media Trust will receive $6,000 (USD) previously anticipated to ISMEO for this purpose.

The project is on display at the Olivetti Store in St. Mark Square as a side event to the Venice Biennale (Sep-Nov 2021).

A short video presentation is being prepared, showing the progress made in the first semester of project implementation. It will be shared with ALIPH at the earliest convenience.

Addendum

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Technical outputs of the Preliminary Phase

As of 30 September 2021, the restitution of the survey is completed, while the diagnostics is ongoing:

- On-site drone survey and data elaboration - Fully achieved.
- Terrestrial photogrammetric survey and data elaboration - Fully achieved.
- On-site laser scanner survey and data elaboration - Fully achieved.
- On-site cleaning testing - Fully achieved.
- On-site masonry and foundation sampling - Partially achieved.
- On-site soil investigation and data elaboration - Fully achieved.
- Diagnostics (deformation charts, and mapping of weathering of the materials) - Fully achieved.
- Stabilization, conservation and reconstruction design - Ongoing.

Drone survey / Terrestrial photogrammetric survey and data elaboration

During AMT team carried out the surveys of the external walls of the monument and the survey of the surrounding area by drone (ca. 3000 images). In addition, the team has acquired terrestrial images of internal and external walls (ca. 5000 images). The data processing has been carried out using Terrestrial Laser Scanner point cloud to extract reference points for the photogrammetric process: this task allowed to produce all data in the same reference system, and to perfectly integrate the dataset from different sources.

All Images has been processed to produce:
- Photogrammetric point cloud to integrate laser-scanner point cloud with the elements that were not possible to acquire with terrestrial equipment (Dome, high portions of the walls).
- High resolution 3D mesh of the monument (exteriors and interiors).
- Ortho-images: the 3D mesh has been used to rectify images in order to produce the orthoimages of all walls and horizontal surfaces.
On-site laser scanner survey and data elaboration

The survey campaign carried out at the Al-Raabyia Mosque in Mosul stemmed from the preliminary analysis of the urban context, aiming at the understanding of the Moslawi architecture and its key elements. AMT and DIDA teams started by analyzing the available materials referring to the historic building and its surrounding areas; thus, choosing the most appropriate equipment to be used on site. This phase included a preliminary field study of the architectural heritage through sketches (architectural eidotypes), to be compared with the existing documentation previously acquired, and eventually adapted to lead to the design of the survey plan. The survey plan defines all the phases of the data acquisition campaign in order to proceed consistently and ensure coordination between the personnel involved in the survey.

The digital survey equipment guarantees the topo-morphological reliability of the entire survey process, and included a last generation Terrestrial Laser Scanner, namely a Faro Focus S350, registering a very high accuracy in the measurements, considering that every single point captured by the scanner at a distance of 25 meters has a margin of error of less than 1 mm. The registration and rotation phase of the 130 scans carried out inside the mosque followed adequate methodological protocols developed within DIDA, which enabled to obtain an overall error of less than 1 cm, distributed on the external polygon of the investigation area; from the analysis of the section of the surfaces of the buildings, no misalignments of more than 1 cm were found.

Each single scan reached a highly detailed point cloud in such a way as to obtain at least one point measured every 0.5 cm over the entire building. The performance of each scan took 3 minutes, to measure the points (with a 0.7 cm grid at the distance of 10 meters from the instrument). Each scan recorded three times to reduce the margin of error and digital noise, 3 additional minutes were invested to make an overview of frames, useful to provide the RGB data to the points. As far as the laser scanner survey is concerned, the laser scanner stations were organized previously and then positioned accordingly. The positioning of the instrument was adapted to exterior and interior conditions. In the exterior zones, including the roofs, the stations were positioned equidistant from each other, so as to facilitate the merging of the clouds of each point during the post-processing phase; in the interiors, the instrument was positioned so as to enable the scanning to detect each part of every space, paying particular attention to the positioning of the intermediate scans that connect two adjacent areas. During the laser scanner survey, the team proceeded with the photogrammetric survey (see paragraph above). The photogrammetry was carried out for all the project concerned areas, both internal and external ones, and consisted of a collection of photographs taken sequentially to describe each surface of the historic building. The data elaboration started immediately after the fieldwork in Mosul. The processing was implemented through the use of different software, which was eventually integrated to elaborate the final graphics. Cyclone is the software that allows to import, merge and extrapolate the data from the laser scanner survey.
Once the point clouds of all the single scans are merged, Cyclone provided with a detailed 3D model of the object. The operation was divided into two phases, to export two different graphic works for each section: the first, called slice, represents the section; the second, called half space, represents the projection of the objects positioned behind the section line. However, the graphics provided by Cyclone are not suitable for final use; therefore, it was necessary importing them into another software that enables interaction with the extrapolated data. After the import of the images, the work focused on polishing the data, to describe the various sections in their entirety, identifying the section line, the projections on the various levels of depth and the critical parts of degradation. Since this operation follows the rules of the architectural representation, a scale factor of 1 to 50 was applied.

These drawings, which so far consisted of a wire profile of the notable sections only, were integrated with the graphic renderings resulting from the photogrammetric survey. These photo-plans were processed using a software called Reality Capture: more than 5000 images, taken in every area inside and outside the mosque, were imported. Once the images are assimilated by the software, they produced a detailed 3D model, from which the sections previously defined were completed with ortho-photos. The final phase of the data processing for the survey's graphic restitution consists of the integration of all the drawings extrapolated from the various software, to produce various types of analysis, e.g., the diagnostics, the deformation charts, as well as the stone degradation and weathering of other materials for conservation and restoration purposes. Thus, the wire drawings were exported using AutoCAD, integrating the photogrammetry exported from Reality Capture, although the Cyclone's point cloud had also an instrumental graphic appearance in this phase.
On-site cleaning testing

During the mission preliminary cleaning tests were carried out on the “Mosul marble or alabaster” (faresh). The description of the preliminary results is described below.

• Removal of the patina and black deposits (test area m 1x2): the deposits are very weak and could be removed with water. The brown spots, sometimes existing under the deposits, can be removed with ammonium citrate tablets.

• Removal of re-concreted gypsum (test area 50x50 cm): the deposits are very hard and closely adhered to the original surface; the removal of the same was done mechanically with the use of scalpels. It will be necessary to evaluate in a second phase the removal of encrustations with ammonium carbonate tablets and laser ablators (test to be carried out preliminarily in Italy with the technical assistance of the project partner EL-EN Spa).

• Removal of white cement residues and white cementitious glues (test area 50x50 cm): extremely difficult removal due to the hardness and adhesion of the residues to the faresh stone surface. The material was sampled to proceed with diagnostic investigations for its characterization and to establish the method of removal without damaging the original stone surface.

On-site masonry and foundation sampling

During the mission the following investigation activities were carried out.

The preliminary results are described below:

• 8 investigative sampling of circa 1x1 m of surface to assess the construction methods of the foundations of the mosque (pillars and main walls) and of the madrasa, and their depth. All the excavations were performed by hand using pickaxe shovels, with the assistance of local workers. The problems encountered are listed here below:
  ➢ The level of the foundations is generally not deep enough;
  ➢ There is a lack of connecting elements between the different masonries of the mosque under the ground level;
  ➢ On the northern side of the mosque, a leakage from a water pipe created an underground cavity of ca. 1X2 m. The cavity undergoes the portico of the mosque.
• Investigative sampling inside the westmost pillar of the mosque. This pillar appears to be made of stones joined by a poor-quality mortar and with no reinforcements inside. Processing carried out with the assistance of local workers.
• Implementation of 5 perforations with a drill (drill bit 24x1000 mm) and subsequent video inspection by endoscope. Processing carried out with the assistance of local workers. The perforations showed that:
  ➢ The main walls of the mosque are at least 60 cm thick and made of a homogeneous and compact structure inside them;
  ➢ The dome of the mosque, as it is visible from the outside, is made of 2 different layers (inside the structure). At the base of the dome (where it was possible to undertake the inspection using the drill), there is a gap of 40 cm between the two layers of masonry that sustain the dome.
• Investigative sampling above the vaults of the easter wing. The excavations were performed by hand using jackhammer shovels, with the assistance of local workers: the vaults are well preserved.
• Sampling (20 samples) of all identified construction materials (various types of faresh stone, mortar blocks, ceramic tiles, stones inside the walls) for archaeometry and mechanical characterization.

Samples of stones, ceramic, masonry, and mortars are currently in Erbil. AMTO is corresponding with SBAH and with Erbil Airport Security authorities to organize the shipment of the samples.

On-site soil investigation and data elaboration

The soil investigation was performed by the Engineering Consulting Bureau (ECB) of the University of Mosul, under the scientific supervision of Dr. Qutayba Al-Saffar. A 20 meter depth borehole was perforated at the north-eastern corner of the project site, in the proximity of the minaret. The summary of the data resulting from the laboratory tests performed at the Engineering College are listed below:
- The sub-soil profiles are composed of 30 cm of concrete, asphalt and crushed rocks; 3 m of dark clay silt with presence of organic materials; 3 m of clay silt with significant presence of organic materials, with increasing moisture content;
- The water table is at approximately 7 m below the street level;
- Presence of soluble salts and gypsum content.

The full ECB report is available.