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# Agile Software Development for Housing Reconstruction: The 2017 Earthquake case in Mexico

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**Abstract.** On September 19, 2017 an earthquake occurred in Mexico with epicenter in the limits of the states of Puebla and Morelos. It had a magnitude of 7.1 on the Richter scale. 31,090 homes were affected, of which 1659 with total damage. In order to attend to the contingency, the government of Morelos formed an inter-institutional committee in the first hours to carry out an initial diagnosis of the damage and to provide emergency services. This article presents a case study and lessons learned from the software engineering support for the development of a data-driven platform in the various phases of contingency response: census of damaged homes, identification of aid beneficiaries, determination of aid packages according to a damage assessment, logistics and follow-up of aid package delivery, data-driven decision making, and a public portal for open data and budget transparency.

**Keywords:** Decision-Making Platform; Agile Methodologies; Housing Reconstruction; Earthquake

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# Гибкая разработка программного обеспечения для реконструкции жилья: землетрясение в Мексике в 2017 г.

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**Аннотация.** 19 сентября 2017 года в Мексике произошло землетрясение с эпицентром в пределах штатов Пуэбла и Морелос. Оно имело интенсивность в 7,1 баллов по шкале Рихтера. Пострадало 31 090 домов, из них 1659 были полностью разрушены. Для принятия мер в условиях чрезвычайной ситуации правительство Морелоса в первые же часы сформировало межведомственный комитет для проведения первоначальной диагностики ущерба и оказания экстренной помощи. В этой статье представлены тематическое исследование и уроки, извлеченные из поддержки разработки программного обеспечения для разработки платформы на основе данных на различных этапах реагирования на чрезвычайные ситуации: перепись поврежденных домов, выявление получателей помощи, определение пакетов помощи в соответствии с оценкой ущерба, логистика и отслеживание доставки пакетов помощи, принятие решений на основе данных, а также общедоступный портал для открытых данных и прозрачности бюджета..

**Ключевые слова:** платформа поддержки принятия решений; гибкие методы; реконструкция жилья; землетрясение

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## *1. Introduction*

On September 19, 2017 at 1:14 p.m. an earthquake occurred with an epicenter in the limits of Puebla and Morelos with a magnitude of 7.1 degrees on the Richter scale and a duration of one minute. 74 people died and 1,944 people required medical attention. Likewise, 31,090 homes were affected, of which 1,659 with total damage and the rest with varying degrees of damage.

A few hours after the seismic event, informal rescue networks and relief groups were set up in the main disaster areas, and at the institutional level, triage and emergency medical care teams and civil protection teams were dispatched to deal with the situation. There were also some spontaneous aid initiatives by the affected population itself, particularly in the most isolated rural areas.

For earthquake response there are official protocols directed to the population and also for the actions of state and municipal authorities. Unfortunately, however, when earthquakes occur in non-seismic zones, as was the case, neither the population nor the civil protection authorities were prepared.

During the first weeks there was no clearly identified entity to lead and coordinate the relief, medical assistance and reconstruction work. Each of the heads of the state government agencies, by official decree, took charge of the needs as a whole of each of the 33 municipalities, with the support of the municipal agencies of Health, Civil Protection, Education, etc.

This article addresses the support given by the state government's digital government office for housing reconstruction. The article does not describe the efforts made by other state offices and civil society organizations to attend to the contingency. Although the data obtained were widely used by

all these offices to meet the information needs detected in the areas of health, education, mobility, etc.

The objective and focus of this article are the description, from a software engineering point of view, of the process of developing a single comprehensive data platform for damaged housing, as well as the implementation of a management and logistics system to offer reconstruction assistance and to provide information to the population and federal authorities under the open data modality.

Due to the haste with which action had to be taken to address the contingency, it was not possible at that time to think of a properly planned development process. The imperative was to meet the demand and urgency of data that were being required by the various agencies, depending on the resources available to be able to obtain and deliver them.

Due to the urgency with which the contingency had to be dealt with, at the beginning there was no planned development process or system architecture. The imperative was to meet the demand for data required by the various agencies and with the resources available at the time at the various locations affected.

In relation to the subject of this article, most of the works found in the literature are related to various prevention proposals to mitigate damage in seismic zones.

In relation to the subject of this article, in [1], [2] we find several prevention proposals to a) mitigate damage in seismic zones, b) reduce risks to the population and c) reduce material damage.

In [3], [4], they point out the effectiveness of protocols to reduce losses and indirect costs such as interruption of productive activities and basic services and the effects of post-traumatic stress.

Other works [5], [6], [7], emphasize the complexity of disaster scenarios and the need for the different actors involved in damage repair to share unique information, in particular the use of mobile computing and social networks.

We did not find references of works to provide systematized and structured data to meet the needs throughout the various stages of the contingency, as in this case study.

## *2. Setting up of a specialized agency to support the contingency*

In the first hours, the government of Morelos created an organization called Unidos por Morelos (UxM) with advisory, technical and legal support, coordination and planning units. Its objective was to implement the necessary actions for the reconstruction of the areas affected by the earthquake, through self-construction, citizen participation and priority attention and linking the needs of the affected population with the public, private and social sectors.

In order to have complete, reliable and timely data during the entire process of assistance to the affected population, the presidency of the Technical Committee of the UxM organization decided to have a technological arm for data support.

To address this need, UxM turned to the Digital Government office of the government of Morelos. The instruction was to support the process of planning and organizing the work from practically zero. It was the first experience of its kind, since Morelos had no history as a seismic zone.

## *3. The work team*

After the formalization of the UxM organization and the integration of the digital government office, the development of the Integral Platform for Logistics and Decision Making Based on Data for the Reconstruction of Housing in the State of Morelos began. At first, no precise scopes or goals were specified, only the intention of accompanying the various UxM actors in their various information requirements and in parallel to integrate and interoperate the various systems that were built over the following months. In some cases, the systems were discarded, the data were backed up and new, and more appropriate systems were built. In other words, the platform specifications were obtained gradually over several months. In some cases, the same data, but with a different name and format,





were required by different authorities. There we had to reconcile with the various requesters in order to keep, as far as possible, a single type of name and format for a given piece of data.

It was a two-speed development, on the one hand those in charge of identifying information needs and formalizing them with the various requesting groups, and on the other hand, in a very distinct manner, the solution design and software development group.

### 3.1 Integration of the work team

The team was composed as follows:

- A project leader, interlocutor with the various UxM agencies. His responsibility was to ensure deadlines for the delivery of information or systems required, and to negotiate with the corresponding instances the requirements of personnel, equipment and facilities for the development of the project. Try to be the only visible face of the development team vis-à-vis UxM and other authorities.
- A software architect, in charge of ensuring the a) integration and interoperability of the systems created, b) the sizing and planning of the development effort, and c) the quality assurance of the data obtained. It is important to mention that as the platform grew, so did the amount of data store. It was necessary to constantly review the causes of incomplete or erroneous data. For example, there were people who had more than one CURP identity card, where it was necessary to search the database of the National Population Registry (RENAPO) and take the first CURP on the list, as well as cases in which more than one person sought to request support for the same affected house, etc. The main activity and commitment of the architect was very oriented to ensure the quality of the data.
- A senior developer, responsible for coordinating the programmers, both those assigned to the same area of digital government and those located in other units.
- Programmers, a variable group of 5 to 8 people divided into developers of the software logic, specific utilities such as web services, database design and configuration, user interfaces, etc.

Likewise, for the physical deployment of the systems in the territory of Morelos, the digital government office coordinated with various computer and telecommunications areas of the state government:

- The state agency of computing and telecommunications infrastructure, (i) to identify the areas with coverage of the state radio and internet telecommunications network, as well as the areas where commercial broadband internet and mobile data are available, (ii) to provide connectivity to a provisional office in each of the capitals of the 33 municipalities, (ii) to provide computing and network equipment for the applications that were being developed.
- The state public security agency, i) to provide personnel for the development of the first systems implemented in the affected municipalities, and ii) to install the developing versions of the systems in its data center before uploading them to the cloud for operation.

## *4. The development methodology used*

Although several members of the team were familiar with agile methodologies, in particular Scrum. From the beginning it was difficult for us to apply it because the objective was not so much the development of a system but to meet very specific information needs. There was no client to show a prototype or a graphical interface, it was not the right time. The information was needed under any support, even preferably in spreadsheets. The client was rather ourselves, as we sought to obtain a single system that could house the various systems that were generated. In any case, we did agree to support the development in some agile methodology because of the need to respond quickly and systematize all our activities. Under these considerations, we found that the closest methodology was eXtreme Programming, better known as XP [6], [7], [8], [9], [10].

The following qualities of the XP methodology were taken into account, at first intuitively but later deliberately:

- Iterative and incremental development. Due to the lack of requirements specification because the UxM staff was only interested in having the data they needed as the contingency evolved. Within the work team we had to decide the type and level of granularity of the data and show it to know if it was the required data before starting any development.
- Pair programming. It was a very convenient strategy, if not the programming totally in pairs, it was very convenient to have two programmers supporting and complementing each other in the development of the code, the choice of algorithms, tests and documentation.
- Continuous unit testing. To ensure the integrity of the software and a robust development of the platform, it was established as a requirement to perform unit tests of all subsystems and modules.
- Periodic bug fixes. It was decided not to let bugs slip through for correction later. We had to be sure to have an error-free development for a correct integration of the platform's subsystems and modules.
- Integration of the programming team with the client. The project leader was in charge of interacting and establishing agreement with the authorities of the UxM organization. In some cases, he was only accompanied by the software architect to quickly agree on solution options and delivery deadlines. This decision was taken to expedite decision making.
- Simplicity, shared code ownership and code refactoring. These were some of the premises of the software development: to be lightweight and portable; to work together for the development of a platform of which we are all co-authors; and finally, to review the consistency and efficiency of the coding. Evolutionary software development projects that are prolonged over time, as in this case, involve different actors. If, in addition, we work against the clock and under pressure, we will have an accumulation of programming errors that it is important to control and correct in time [11], [12].

## *5. Technologies and standards implemented*

Some of the technologies implemented were:

- The design of the platform using the following languages as appropriate: Java, PHP, Scalable Vector Graphics (SVG), HTML5 and CSS.
- Implementation of dynamic and interactive infograms in web browsers from the data of the affected houses using the D3.js library. This solution enabled the design of dashboards for monitoring and data-driven decision making.
- Responsive and adaptive web development allowing the display of information on desktops, laptops, tablets and smartphones.
- Implementation of biometric identification mechanisms such as registration and verification of fingerprints, for the validation of beneficiaries for the UxM.
- Implementation of the use of bank-type terminals for the download of points (material for reconstruction) according to the level of support assigned to the beneficiary.
- By having a centralized database and web access with low bandwidth requirements, access in general was very agile, for these purposes a cloud platform service was contracted with 99.99 availability, with mirror in the data center of the state public security agency.

Some of the standards and norms implemented were:

- Implementation of INEGI's own Technical Standard for Geographic Addresses for the survey of addresses of affected homes [13].
- Implementation of a geographic information system (GIS) for georeferencing affected homes. This allowed the precise location of affected homes on a map and the generation of heat maps and identification of the areas most affected by the earthquake.





- Implementation of the open data guide, for the cleaning and stabilization of data, as well as for the corresponding integration of the same, in the open data sets of the Government of the State of Morelos.

The objective was to build a data platform under a flexible, robust, secure and reliable architecture for UxM, and in turn feed a transparency portal aimed at the population of Morelos, an open data portal, as well as various dashboards with indicators for other state and federal government agencies.

## *6. Platform development stages*

### 6.1 Rapid Census

Starting on the third day of the earthquake (September 22, 2017), a rapid census was initiated to obtain a diagnosis of the situation in the 33 municipalities of Morelos. A mobile application based on JotForm was developed with which 1,200 brigadistas classified homes with structural risk or located in risk zone, identified injured people as well as other basic needs of shelter, clothing and food [14]. The application was developed to store data locally when broadband internet or mobile data was not available on site. Once internet or mobile data was available, the data was synchronized with the central server. The first census teams were sent to the municipalities and communities where the main effects were known. The work was carried out by brigades deployed simultaneously in the 33 municipalities and coordinated by a command center made up of personnel from the state civil protection, the state security commission and the secretary of government, in conjunction with municipal civil protection authorities and personnel.

*Fig. 1. A coordination meeting of UxM with the municipal authority of Huizilac*

Features of the rapid census application:

- Standardized form for the census including name of the head of household, address, type of dwelling, data on injuries and other non-material damage.
- Photographic record of up to 10 images.
- Characterization of 11 types of damage and their qualification of partial or total damage.
- Georeferencing of damaged homes.

*Fig. 2. Rapid census of damage to affected homes*

This first development made it possible to quickly obtain coarse data; however, it had the disadvantage of making an open description of the addresses, without catalogs of roads, human settlements, or specifications of the types of damage. In rural areas, georeferencing can have an error of up to 100 meters. It should be noted that 80% of the homes in Morelos are located in rural areas, and most of this population does not even have an official address according to INEGI's Technical Standard on Geographic Addresses. In rural areas the specification of the address is very different than in urban areas. A lot of desk work was required to clean the information and export it to tables in a standardized database. However, these data configured a first map, which was very useful to start the next phases of this project.

## 6.2 The PVC ID Card System

To ensure the completeness and correctness of the affected housing census in a timely manner, from October 15 through November 2017, one month after the earthquake, the data previously captured through the JotForm application were migrated to a more robust database. Some specific utilities were developed for data cleaning, particularly for the elimination of duplicate records and removal of invalid records, among other errors.

Subsequently, it was decided to carry out a process of elaboration of PVC ID Cards for the beneficiaries and at the same time to carry out a new validation and completing of the data already obtained through the quick census. Three hundred volunteers were trained to prepare and deliver a PVC ID Card to each of the heads of household of the 31,090 affected households. This activity was carried out in public spaces set up in the 33 municipalities. As a result, an electronic file was created for each of the beneficiaries with their complete identity data, official identification code CURP validated by the National Population Registry (RENAPO), address with georeferencing according to INEGI's technical standard, scan of an official identity document, address reference, as well as photographs and an official damage report. It is worth mentioning that of the total of 31,090 homes affected, the National Disaster Fund assisted 15,586 homes and the remaining 15,504 were assisted by UxM. Both datasets were integrated into our platform to avoid duplication and to follow up on both types of support.

The kit for the elaboration of the Plastic PVC Card was composed of a lap top to capture the personal data of the beneficiary and the affected home, a scanner printer to digitalize the official identification





of the head of household and proof of address, a camera to take a photograph and a scanner of the fingerprint of the owner of the affected home. All integrated to make and deliver the plastic PVC Card with barcode and ID associated to the affected person in only 3 minutes. Likewise, two sheets of paper are printed in duplicate: the official request for assistance of the affected person and the delivery of the aid package, documents that must have a handwritten signature for legal reasons. The beneficiary receives a copy of these two documents. It is important to mention that in order to offer greater certainty to the beneficiaries and to give greater legality to the procedure, it was decided to recur to the printing of documents and to request autographic signatures, although originally it was considered a totally digital development.

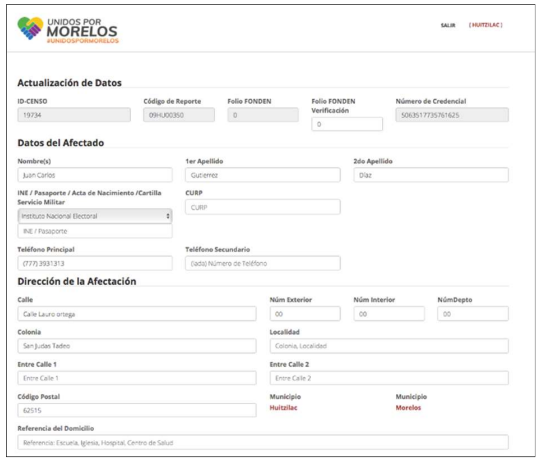


*Fig. 3. Web capture sheet for the elaboration of the Plastic PVC Card, 1 of 2*

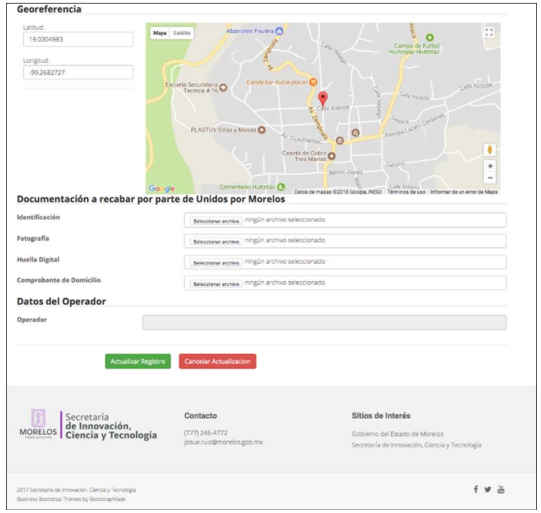


*Fig. 4. Web capture sheet for the elaboration of the Plastic PVC Card, 2 of 2*

Information obtained:

a) identification and biometric data of the beneficiary and at least two landline or cell phone numbers,

b) data on the dwelling: address according to INEGI's Technical Standard on Geographic Addresses, including its georeference by means of a map; 3 photographs of the damage; characterization of the damage according to 11 types of damage defined by civil engineering experts and the qualification of the damage according to the following criteria: minor damage, partial damage, severe damage and total damage.

   The responsive web application was developed in PHP and Java with MySQL database. It is basically a formulary to integrate data, digital documents and images. To ensure the quality of the data, specific validation mechanisms were incorporated for each type of data and, where possible, catalogs were incorporated to facilitate data entry, see fig. 3 and 4.

A training program was carried out for all personnel in charge of credentialing. The work team consisted of capturers, a supervisor in charge of resolving doubts of the people who came to the module and a technician to resolve connectivity problems, equipment configuration and to supply consumables, fig. 5.

*Fig. 5. Training for the personnel in charge of Plastic PVC Card elaboration*

This application allowed data capture and delivery of Plastic PVC Cards simultaneously in the 33 municipal stations. A calculation was made to determine the number of Plastic PVC Card production stations per municipality, taking into account the number of homes affected. All digital files were integrated into a central database. Only in some of the municipal modules with deficient internet access was a server installed to concentrate the information obtained, to later integrate it into the central database.

*Fig. 6. Elaboration and delivery process of the Plastic PVC Card in all 33 municipalities*





The development of this system took 2 and a half months, started on October 15 and concluded in December 2017. Although it began to be used to deliver Plastic PVC Cards on November 8, 2017 (fig. 6-8).

*Fig. 7. Data capture and delivery of the Plastic PVC Card*

*Fig. 8. A Plastic PVC Card delivered to a beneficiary*

## 6.3 Technical Assessment System

Its purpose was to program on-site attention by volunteer civil engineers from the National Polytechnic Institute, to review and complement the first damage survey of the rapid census, diagnose the level of damage to housing and propose repair solutions for self-construction to those affected. It was developed in 3 stages, corresponding to three modules of this system. It had as

input the information captured from the Plastic PVC Cards system, in particular the data related to the characterization of housing damage:

Stage 1: Module for scheduling and assigning emergency personnel. Based on the information generated by the Plastic PVC Cards system, the scheduling of visits by paramedics, civil protection personnel and civil engineers for the care of injured people and people at risk was generated.

Stage 2: On-site technical evaluations module. Scheduling of visits by civil engineering experts to assess damage to each of the affected homes using a mobile application to determine the types of damage and prioritize their attention. In cases of total damage to schedule routes and workloads of demolition and debris removal teams.

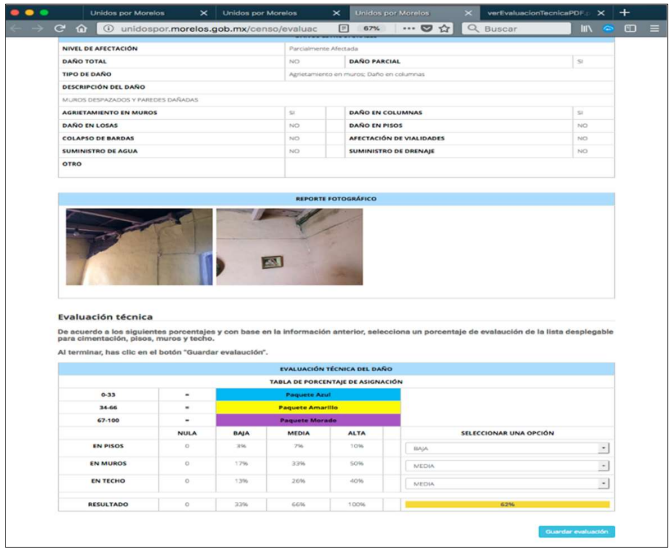


*Fig. 9. Web capture sheet of the technical evaluation system*

Stage 3: Module that allows remotely determining material assistance packages for reconstruction based on housing damage. The aid packages are established on the basis of a damage assessment based on data captured in the census relating to 11 types of structural damage, a free description of the damage, as well as 3 to 7 photographs of the damage. It was designed with the support of civil engineers specialized in structures. It uses heuristics based on artificial intelligence to assign 4 types of aid packages in construction materials, which are yellow package for minor damage, blue package for moderate damage, purple package for severe damage and green package for major reconstruction, and whose materials are economically equivalent to $15,000, $30,000, $45,000 and a variable amount of up to $60,000 Mexican pesos. For homes with total damage, i.e., not recoverable, 5 different foundations were used to build new homes with amounts ranging from $145,000 to $160,000. For damage to buildings in 11 housing units, structural evaluation techniques were used and aid was assigned depending on the type of building and other technical considerations that automatically result in the corresponding aid package. It is important to mention that for each of the houses with total damage, a complete electronic file was created, with information and scans of official documents such as demolition permits, structural report, documents of legal ownership of the property, etc. Finally, 253 damaged houses located in risk areas were identified, where the experts' recommendation was to relocate them to safer areas. See fig. 9.





It is important to mention that in order to carry out the damage assessments it was necessary to have complete information. In the event of not having enough elements for the assessment, for example, if the photographs were not clear or the description of the damage did not correspond to the photographs, an on-site visit was scheduled to verify data or to take the photographs again. These activities were carried out in coordination between UxM agency staff and personnel from the municipality

## 6.4 Operational Coordination System

This system was developed to plan, organize and coordinate the supply and delivery of materials to the beneficiary population, as well as to follow up on the reconstruction of each of the houses affected by total or partial damage based on the damage diagnosis. The platform has a module that allows budgeting, scheduling for purchase and managing the reception of construction materials from suppliers in the state of Morelos and neighboring states. It also generates distribution logistics in the 33 distribution centers, one for each municipality in Morelos.

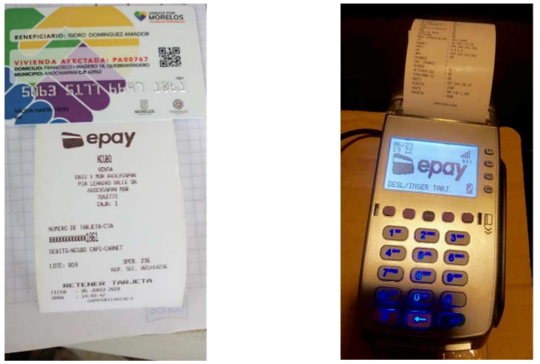


*Fig. 10. Point-of-sale terminal for delivery control of construction materials*

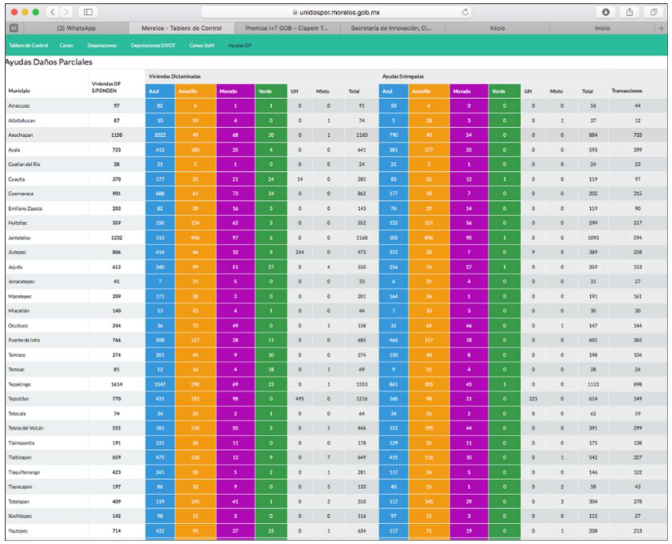


*Fig. 11. Material delivery progress control sheet by municipality*

Through the platform, a person responsible for logistics in each municipality schedules appointments with the beneficiaries to go to the distribution center to receive their materials. The aid packages consist of cement, sand, blocks, rebar, paint, among other materials. Using point-of-sale terminals, the material delivered is downloaded from the balance of the Plastic PVC Card and an inventory control is kept at each distribution center, see fig. 10.

At the central level, there is access to the platform for monitoring the delivery of materials. We delivered 15,501 material aid packages for the reconstruction of affected homes in Morelos. Likewise, those affected were provided with advice and support from civil engineers for the reconstruction of their homes at all times, see fig. 11.

This system started to be developed since October 15, 2017, a first version was released on November 19, 2017, and continued its development and improvement for several months, its final version was completed on May 15, 2018.

## 6.5 Follow-up system for UxM representants

Each of the 33 UxM representatives in each of the municipalities had web access to a control panel to verify the progress of the delivery of material packages to the affected people. The dashboard provides information on the types of packages delivered and to be delivered, damaged houses classified by total and partial damage. Whether FONDEN support is available or not. They can consult the information corresponding to their municipality: access the registry of each of the damaged houses and review their location, damage data, the affected person, as well as review the integration of the file that includes identification of the affected person with fingerprint and photograph, as well as photographs of the damage. The data can also be viewed or exported to a file as a report. See fig. 12.

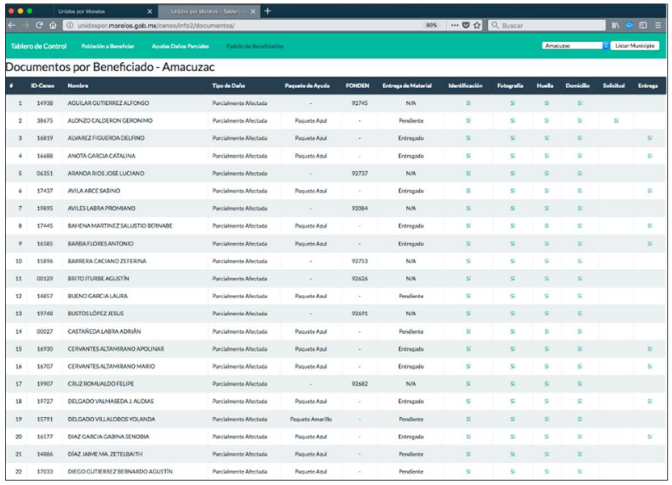


*Fig. 12. Progress in the delivery of construction material in the municipality of Amacuzac*

This system began its development in January 2018, in its first version was completed on February 15, 2018 and continued its improvement and update until its final version on May 15, 2018.

## 6.6 A Data-driven decision-making system

It was developed with the purpose of offering in real time an updated and reliable source of information for the operational and technical directorates of UxM, for the internal control body and for the various agencies of the government of Morelos involved such as the State Evaluation Commission, the Comptroller's Office, the Office of Social Development and the Office of Public





Works and Services. In addition, this system feeds data to the state open data portal and the citizen transparency portal.

This system started its development in January 2018, in its first version was completed on February 15, 2018 and continued its improvement and upgrade until its final version on May 15, 2018.

## 6.7 Transparency and Accountability Portal and Open Data Portal

The platform built made it possible to feed the Transparency and Accountability Portal of the Morelos government's Treasury Office as well as the Morelos State Open Data Portal. These portals were built by instruction of the federal government to offer the general population data of public interest generated by the various government agencies. In particular, the Transparency and Accountability Portal offering detailed information on the application and expenditure of budgetary resources and the Open Data Portal with detailed information on the georeferencing of the damages by type of damage and the progress of reconstruction. See figures 13 and 14.

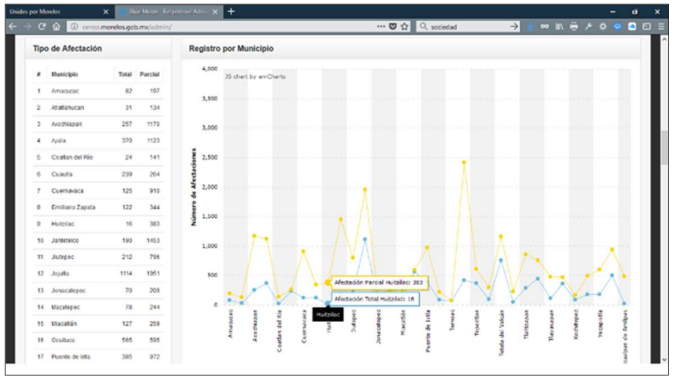


*Fig. 13. Graphical description of types of housing damage by municipality*

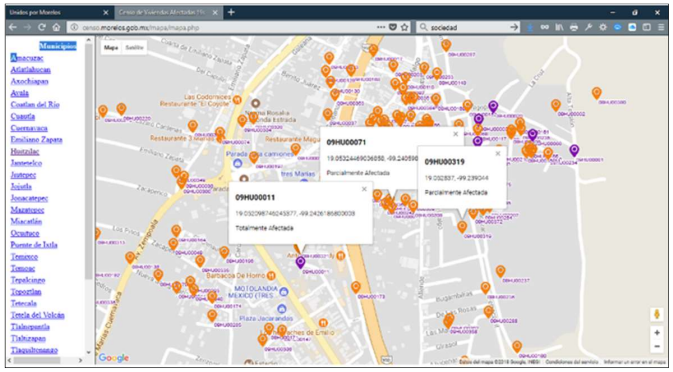


*Fig. 14. Deployment of housing damage in the municipality of Huitzilac*

## 7. *Conclusions*

The development of this platform was fundamental to support all activities related to the seismic contingency. From the first days of this unfortunate event until the closing of the UxM agency's activities in mid-2018, work on updating and improving it never stopped. There were always new needs to be addressed throughout this time, in particular special reports to the office of the governor of Morelos or to federal government authorities.

In this article we show the most relevant methodological aspects of the development of the platform. That is to say, the aspects that concern the support given to the UxM organization to have at all times the data for its planning, management and decision-making activities. In this sense, for us it was not so important the development of this platform, but to be in a position to provide data in the format and at the time they were required as the attention to the reconstruction of the affected houses evolved.

The development team had to solve many problems on the fly, not only technical, but also of communication, coordination and in general of organization to establish agreements between all the parties involved. For example, when for the same project we need to serve different types of users with different types of requirements, it happens that the concepts to name the same object or the same event may have different meanings, may have different levels of urgency and may vary the level of granularity of the information they need about that object or event.

Some of the main lessons learned were the following:

- It is essential that in the meetings for requirements gathering or project follow-up, all users and key stakeholders must be present, we have to ensure that this is the case.
- It is very important to establish and define exactly each of the terms and ensure that everyone understands them well.
- It is necessary not to compromise, due to urgency, the delivery of new versions of the developed systems.
- The systems area must be recognized as a strategic and allied area to provide useful information and not as a group of programmers subordinated to do only what they are asked to do.

Some examples of problems that appeared on the fly and that were addressed were the following:

- When there was never full agreement of the civil engineering experts to generate the catalog for damage characterization, it was necessary to conciliate with them by showing them proposals until an authority declared that the last proposal presented remained.
- When there was no standard for the survey of addresses, nor data for the georeferencing of the affected houses. After an analysis of the INEGI Technical Standard for geographic addresses, we had to develop a web application that implements it.
- When there was no way to obtain the information directly from the developed systems at the time, it was often necessary to export the data to a spreadsheet, adapt it and deliver it to the requesting entity. Users do not care about getting the information directly from the platform, they care about having the information at the time and in the format, they need it.

The development was in charge of the internal staff of the Digital Government Office of Morelos. There was no external contracting. It was entirely based on free software. Only 100 kits were purchased for the Plastic PVC Card process, which were reused internally at the conclusion of this project.

We conservatively consider that a contract to carry out all the support for the development of a platform of this type would have cost around 20 million pesos. But the most important thing is that it was an entirely customized development that will become part of the assets of the government of Morelos. This platform received 3 national awards:

- First Place National PREMIOS I+T GOB EDITION 2018, State Category, Technological Innovation Award, granted by the Committee of Informatics of the State and Municipal Public Administration A.C. [15].
- National Digital Government Award u-GOB 2018, State Category, granted by the specialized magazine U-GOB Technology in Government [16].
- 4th place National Award "The Most Innovative" in its 2018 edition awarded by Innovation Week Magazine [17].





Finally, to say that out of a total of 31,090 homes damaged as a result of the earthquake, 15,586 had support from the National Disaster Fund FONDEN and 15,504 had support from the UxM agency. A total of 13,592 construction materials were provided to repair partially damaged homes. 1,659 homes with total damage were rebuilt through 5 foundations with 50% state participation and 253 homes in high-risk areas were relocated to safer areas.

We believe that the support of this digital platform was fundamental to ensure coordination between all federal, state and municipal agencies involved, as well as some civil society organizations, in particular to share a single database, with views and privileges for all actors involved for an opportune attention to the reconstruction of homes damaged by the earthquake.

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