

Incorporation of QR codes to provide information about academic conferences, register attendance, and generate certificates

Incorporación de códigos QR para brindar información sobre congresos académicos, registrar asistencia y generar certificados

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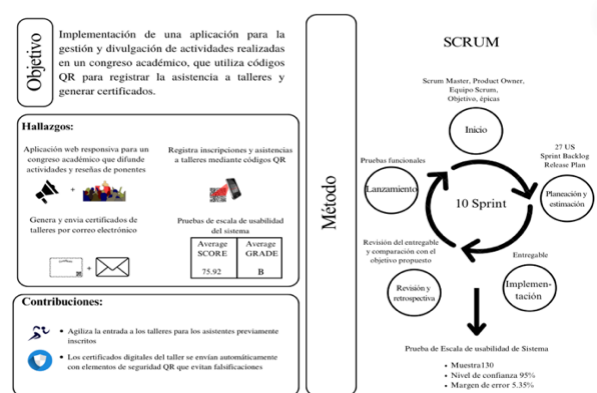
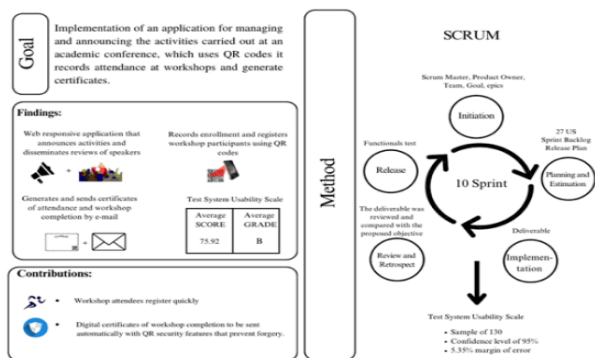


Abstract

Goal: Implementation of an application for managing and announcing the activities carried out at an academic conference, which uses QR codes it records attendance at workshops and generate certificates. **Method:** The Scrum methodology was used; the requirements of the application were captured in user stories; ten Sprints were used. Functionality tests were applied and the System Usability Scale was employed to test usability. **Findings:** Responsive web application for an academic conference that allows announces activities and disseminates reviews of speakers, records enrollment and registers workshop participants using QR codes, generates and sends certificates of attendance and workshop completion by e-mail. The usability tests placed the application in the B percentile, which is considered acceptable. **Contributions:** Workshop attendees register by scanning a QR code with a smartphone; this streamlines entry for previously registered attendees, and enables digital certificates of workshop completion to be sent automatically with QR security features that prevent forgery.

Resumen

Objetivo: Implementación de una aplicación para la gestión y divulgación de actividades realizadas en un congreso académico, que utiliza códigos QR para registrar la asistencia a talleres y generar certificados. **Método:** Scrum; los requisitos se plasmaron en historias de usuarios; resultaron diez Sprints. Se aplicaron pruebas de funcionalidad y se empleó la Escala de Usabilidad del Sistema para probar la usabilidad. **Hallazgos:** Aplicación web responsiva para un congreso académico que difunde actividades y reseñas de ponentes; registra inscripciones y asistencias a talleres mediante códigos QR; genera y envía certificados de talleres por correo electrónico. Las pruebas de usabilidad ubicaron la aplicación en el percentil B, que se considera aceptable. **Contribuciones:** Los asistentes al taller se registran escaneando un código QR con un teléfono inteligente; esto agiliza la entrada para los asistentes previamente inscritos y los certificados digitales del taller se envían automáticamente con elementos de seguridad QR que evitan falsificaciones.



QR Code, Responsive web application, Academic Conference

Código QR, Aplicación web responsiva, Congreso académico

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Peer review under the responsibility of the Scientific Committee MARVID®- in the contribution to the scientific, technological and innovation Peer Review Process through the training of Human Resources for continuity in the Critical Analysis of International Research.



Introduction

Public universities in the state of Hidalgo, Mexico, hold academic conferences where researchers, teachers, students, and professionals can exchange knowledge and experiences in a given area of knowledge to position them at the forefront of the field. At these events, academics disseminate the results of their research, which increases their visibility and recognition as academics; it also facilitates networking and fosters collaboration among academics, businesspersons, and organizations.

Academic conferences held at a technological university located in the state of Hidalgo, Mexico, are announced on the university's website by means of downloadable PDF files containing a list of activities. Paper sheets or Google Forms are used to register conference attendees, as well as to register attendees for the workshops held at these conferences. After a conference has concluded, certificates of recognition are generated through mail merge and then sent by e-mail in a process that can take up to a further month. In addition, forgery has been identified in some of the names on these certificates.

Therefore, an area of opportunity was identified: it would be convenient to have an application to manage these activities for academic conferences, including publicizing, managing attendance, and generating attendance certificates and certificates of workshop completion.

This article is divided into five sections: introduction, literature review, methodology, results, and conclusions and future work.

Literature review

According to the 2023 National Survey on Availability and Use of Information Technologies in Households (ENDUTIH) applied in Mexico to the population aged 6 years or older, 81.2% of the population made use of the Internet; 81.4% had a cell phone; 37.8% connected to the Internet through a smart TV, 44% through a computer, laptop, or tablet, and 97.1% through a smartphone (INEGI and *ift*, 2023).

These data show that more and more users are accessing websites from various different devices such as smart TVs, tablets, and computers, but especially from smartphones. These devices have different screen sizes, hence the importance of designing web applications with responsive design.

Responsive web design enables users to access website content from any device regardless of its size, screen resolution, platform, or orientation without the need to reduce, enlarge or scroll the page (Parlakkiliç, 2022). To achieve this, among other features it is necessary to adapt the design to different screen sizes, adapt images, optimize page elements such as buttons and links for mobile use, and hide non-essential elements from small screens (Bhanarkar, Paul and Mehta, 2023).

QR codes (quick response code) were created in 1994 by Masahiro Hara for the Japanese company Denso Wave to label and track vehicle parts. They have become widely used, since smartphones containing a decoder can readily scan QR codes through their cameras (Escorza, et al., 2023).

QR codes store information through a square two-dimensional dot matrix with three squares located in the two upper and lower left corners (Gallardo-Camacho, and Melendo-Rodríguez-Carmona, 2023). They have a higher storage capacity compared to other technologies (Reddy, et al., 2023). QR codes have become popular in a variety of contexts, including attendance registration.

Several recent research papers discuss the use of QR codes for managing attendance records. We cite three examples here

Liew and Tan proposed an attendance system based on QR codes, with functions to avoid attendance cheating, recording the scheduled time for a class, a registered mobile device, and geolocation (Liew and Tan, 2022).

Sujot proposed an attendance system for educational and corporate institutions based on QR codes. Their system effectively streamlines attendance management by generating a unique QR code for each student or employee, which can be printed on an ID card or distributed via email or messaging applications (Sujot et al., 2023).

Article

Research by Mustafa and Khamis produced a digital attendance management system that uses QR code technology and geolocation tracking to automate taking attendance in educational institutions (Mustafa and Khamis, 2023).

In the present paper, we propose a responsive web application for dissemination at academic conferences, which uses QR codes to track attendance at workshops offered at the conference and to generate certificates of completion.

Methodology

The Agile Scrum methodology was used to develop the application. Scrum has five iterative phases.

In the first phase, called Start, the Scrum Master, Product Owner, and Scrum Team were identified in their respective roles of designer, developer, and tester. Two types of users of the application were identified; conference attendees and administrators. Once the users and application requirements were identified, they were captured in user epics and ordered by priority in the Backlog.

This methodology enabled a responsive web application to be developed for managing the activities of the State Information Technology and Software Development Conference using QR codes to record workshop attendance and as a security element for producing workshop completion certificates.

Specifically, the responsive web application would enable the following to be carried out:

- Manage the activities of an academic conference to effectively publicize and disseminate the conference.
- Manage registration for workshops at an academic conference where the number of workshop participants is limited.
- Record attendance at the academic conference through a responsive web application.
- Use a QR code to record attendance at the workshops held at the conference.
- Automatically e-mail certificates of participation in the conference to registered attendees by e-mail.

- Send certificates of workshop completion to attendees, employing QR security to prevent forgery.
- Carry out functionality and usability tests to identify errors, and prevent or correct them, thus ensuring a quality product.

The activity diagram in Figure 1 shows the interaction and relationships between the two types of users of the application; administrators and attendees. The requirements of the application were captured in user epics.

In the Planning and Estimation phase, the user epics were then divided into 27 smaller user stories (US) that were assigned a delivery priority through the Sprint Backlog, enabling 10 sprints, and the products that should be obtained for each US were specified. This was then reflected in the Release Plan. The nomenclature used for the products (PRD) was SCR for views, PRO for processes, and PRT for on-screen or printed reports. Table 1 shows an excerpt from the 10 sprints or blocks, ordered by delivery priority. Six work blocks were defined for the administrator user and four for the conference attendee user. Table 2 shows the View Speakers US related to the Attendee user.

In the third phase, Implementation, the first deliverable, related to administrator access to the conference application, was codified.

In the next phase, Review and Retrospect, the deliverable was reviewed and compared with the proposed objective. Functionalities not specified in the first round were added if deemed necessary.

In the last phase, Launching or Closing, the deliverable underwent functional testing. Once the first sprint was concluded (administrator access), the next sprint related to the activities carried out at the conference was continued and iterated again through the five phases. The iterations were repeated until all ten sprints were completed.

At the end of the ten sprints, usability tests were carried out. The usability evaluation method was the Inquiry, which uses tests to gather information about users' perceptions of various aspects of the application, resulting in a broader picture and enabling statistical reports to be generated more conveniently (García, et al., 2019).

A sample of 130 was selected from the population of 210 people, mainly students, teachers and administrative staff of the Information Technology Educational Program. The sample size provided a confidence level of 95% with a 5.35% margin of error.

The System Usability Scale (SUS) test was applied, which is a test commonly used to measure the usability of digital products and systems (Hyzy, et al., 2022). It has a high psychometric validity and measures ease of use through a questionnaire with 10 items (Macías, Miranda and Tapia, 2021) related to the effectiveness, efficiency, and user satisfaction of the application, measuring product usability according to the ISO 9241-11:2018 standard (Pailiacho, Garcés and Balseca, 2022). The questionnaire items were adapted to the context of the present study and are as follows:

- Item 1. I think I would like using the web application for the State Information Technologies and Software Development Conference often.
- Item 2. I found registration for the State Information Technologies and Software Development Conference via the application unnecessarily complicated.
- Item 3. How easy was it for you to use your smartphone obtain your certificate of attendance at the State Information Technologies and Software Development Conference or certificate of completion for a workshop you attended at the conference?
- Item 4. When generating my attendance certificate or workshop completion certificate, I realized that I would need help from a technical person to complete the task.
- Item 5. I found that the various functions of the web application page of the State Information Technology and Software Development Conference were well integrated and adjusted to the dimensions of my smartphone.
- Item 6. The content of the web application did not follow a consistent style. Furthermore, I had to zoom in to see the content of the web application for the State Information Technologies and Software Development Conference.

- Item 7. I imagine that most of the attendees of the State Information Technology and Software Development Conference could easily learn how to register their attendance at the workshop using the web application and their smartphone camera to read the QR code.
- Item 8. I found it very cumbersome to use the application to record my attendance at the workshops I selected at the State Information Technology and Software Development Conference.
- Item 9. I think that the workshop completion certificates generated by the web application are trustworthy, since they include QR codes which prevent forgery.
- Item 10. I found that selecting my workshop at the State Information Technology and Software Development Conference involved a considerable learning curve.

The programs used to create the application were HTML5 combined with PHP, the database was created in MySQL, and the code editor was Visual Code Studio.

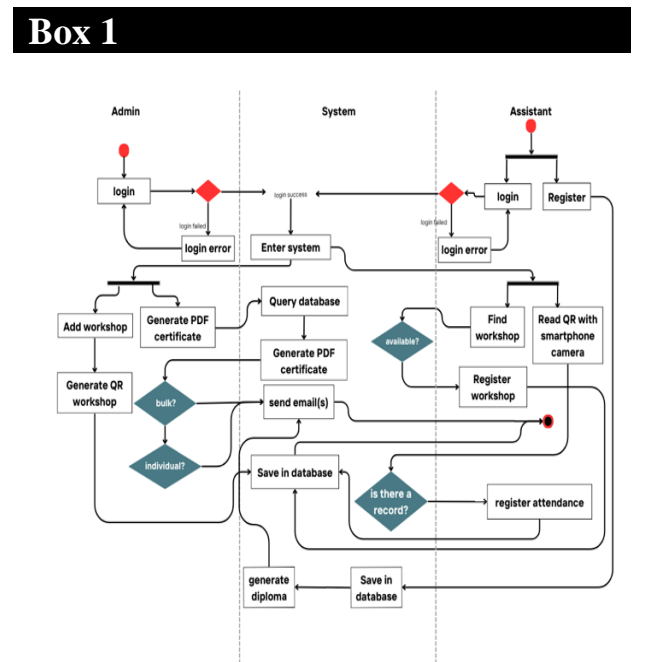


Figure 1
Conference activities diagram

Box 2

Table 1

Release Plan (excerpt)

Priority	User	US	Time estimate (days)	Required Product ID	From	Until
Sprint 6 14	Administrator	List attendees of	2	PRD-SCR-014 PRD-PRO-014 PRD-RPT-001	30/11/23	01/12/23
15	Administrator	Generate certificate	6	PRD-SCR-015 PRD-PRO-015 PRD-RPT-002	05/12/23	12/12/23
16	Administrator	Send certificate	5	PRD-SCR-016 PRD-PRO-016	14/12/23	20/12/23
Sprint 8 21	Attendee	Schedule activities of	3	PRD-SCR-017 PRD-PRO-017 PRD-RPT-003	24/01/24	26/01/24
22	Attendee	Download schedule activities of	2	PRD-SCR-018 PRD-PRO-018 PRD-RPT-004	30/01/24	31/01/24
Sprint 7 17	Attendee	View announcements	2	PRD-SCR-019 PRD-PRO-019	08/01/24	09/01/24
18	Attendee	View speakers	2	PRD-SCR-020 PRD-PRO-20	11/01/24	12/01/24
19	Attendee	View workshops	2	PRD-SCR-021 PRD-PRO-021	16/01/24	17/01/24
20	Attendee	View alumni	2	PRD-SCR-022 PRD-PRO-022	19/01/24	22/01/24

Results

The results include the following: a fully responsive web application for a conference on Information Technology and Software Development, which was held at the Technological University of the Mezquital Valley in Hidalgo, Mexico, as shown in Figure 2. By means of this application, aligned with the user stories of the attendees, the conference activities can be viewed, as well as the curriculums of the speakers, workshop participants, and alumni present at the conference (see Figure 3).

The application also allows the announcements for sport and cultural activities at the conference to be viewed, and enables attendees to register for the conference and obtain a certificate of attendance.

Box 3

Table 2

View speakers US

US	How...	I want to...	In order to ...	Acceptance criteria
View speakers	Attendee	See the list of speakers	Be informed about the speakers giving talks at the conference	Show the following information about the speakers: -Academic degree -Name -Photograph -Button to see further details -Pop-up window to view speaker CV

Box 4



Figure 2

Conference home page

Continuing with attendee user stories, the application first gives the attendee access to the workshop section, then they can select their workshop according to the topic and the attendance limit for the workshop. Once the workshop is concluded, the attendee can register their presence at the workshop by means of a QR code, and finally, the application generates a PDF workshop completion certificate for workshop attendees whose attendance at the respective workshop was recorded. The QR code for the certificate contains information on the attendee and the workshop, as well as a unique identifier or registration number, as a way to avoid forged certificates. Figure 4 shows some of the application interfaces corresponding to these attendee-related user stories.

Box 5

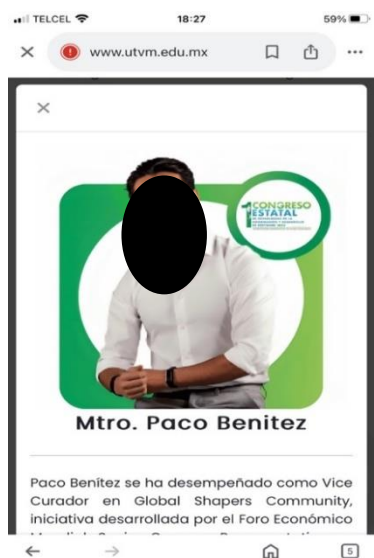


Figure 3
Speaker CV

Source: Authors

In response to administrator user stories, the application enables administrators to Create, Read, Update, and Delete (CRUD) speakers, workshop participants, alumni, activities, announcements, and workshops. Each time a new workshop is added, the application generates the QR code that will be used to register attendance at the respective workshop, as shown in Figure 5. Workshop administration is shown in Figure 6. This includes the name, attendance limit, target audience, workshop leader, and a representative image for each workshop. A part of workshop administration is the generation of workshop completion certificates. Figure 7 shows the sending of these certificates individually or in bulk.

Box 6



Figure 4
Application interfaces related to the workshops

After the functionality test had been applied, some adjustments were made when errors were detected and corrected. The test was then repeated. An excerpt from the test log is shown in Table 3.

Box 7

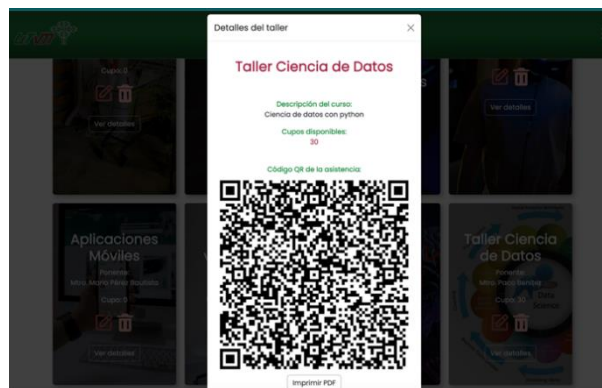


Figure 5
QR generated for a workshop

In Table 4, an excerpt from the usability tests is shown. The SUS test applied by means of Google Forms yielded a score of 75.92, which places it in the B percentile, meaning that it is acceptable.

Box 8

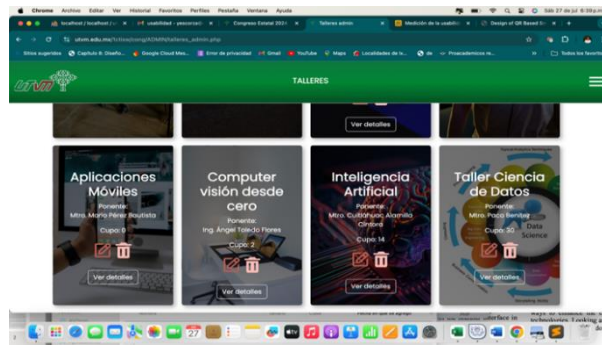


Figure 6
Administration of workshops

Box 9

Table 3
Test Log (excerpt)

Id	US	Date	Entry data/actions	Expected result	Environmental requirements for test	Special procedures required	Result obtained	Status	Severity
TCT1_014	List of attendees	04/12/2023	Administrator credentials	The administrator can see the complete list of workshop attendees	Internet connection or	No	The administrator can see the list of workshop attendees ordered and classified by workshop	Approved	High
TCT1_015	Generate certificate	13/12/2023	Administrator credentials	The administrator can generate workshop completion certificates individually or in bulk	Internet connection or PDF reader	List of participants whose attendance is recorded	The administrator has generated PDF workshop completion certificates individually or in bulk for participants whose attendance at the workshop is recorded	Approved	High
TCT1_016	Send certificate	21/12/2023	Administrator credentials E-mail credentials of registered attendees	The administrator can send workshop completion certificates by email	Internet connection or Institutional email	No	The administrator has sent the workshop completion certificate(s) by email and confirmed that the attendee(s) has/have received the email(s) with the PDF certificate as an attachment	Approved	High

Conclusions

In this article, we have presented the implementation of a responsive web application to manage and publicize the activities of an academic conference. In this case, the application was implemented for the Information Technology and Software Development Conference held at a technological university located in the state of Hidalgo, Mexico. Our objective was achieved since, as shown in the Results section, we provide evidence of a responsive web application that that gives practical access via a smartphone to the conference schedule, the curriculums of the speakers, workshop participants, and alumni, announcements of cultural and sports activities, contact information, and sponsors. This availability facilitates the dissemination of information about the conference.

Since the application is responsive, conference attendance can be registered from a smartphone. Attendees can scan a QR code to record their attendance at the workshops for which they have previously registered, fulfilling the second and third specific objective.

Certificates of conference participation are generated by the application and sent automatically by email to registered attendees, as specified in the fourth objective.

Box 10

Table 4

Test System Usability Scale (excerpt)

Average SCORE: 75.92 Average GRADE: B

Gender	Type	Item										SUS Score	SUS Grade
		1	2	3	4	5	6	7	8	9	10		
1	1	3	1	5	3	3	2	4	3	3	3	65	C
1	1	3	1	4	2	4	2	4	2	4	3	72.5	C
2	1	3	2	5	1	4	2	5	1	5	3	82.5	A
2	1	4	1	3	1	3	1	4	1	2	1	77.5	B
2	1	3	2	5	2	5	2	5	1	4	3	80	A
2	1	2	2	4	3	4	2	3	3	4	3	60	D
2	2	5	2	5	2	4	2	3	3	5	3	75	B
2	1	3	2	2	2	4	1	5	2	4	1	75	B
2	1	5	1	4	2	4	2	4	2	4	3	77.5	B
2	2	3	2	3	2	4	2	4	2	4	3	67.5	C
1	1	3	3	4	2	4	2	3	2	2	1	65	C
2	1	5	1	5	1	4	2	3	2	4	1	85	A
1	1	3	2	4	2	4	2	3	2	3	3	65	C
2	1	3	1	5	1	5	2	3	1	3	1	82.5	A
2	1	3	1	4	2	5	2	1	2	5	1	75	B
1	1	5	1	5	1	5	1	4	2	5	1	95	A

Source: Authors

With this application, registration for the workshops is controlled by means of an attendance limit. According to availability, the application facilitates the editing and, if required, deletion of workshop information, fulfilling the first specific objective.

Box 11

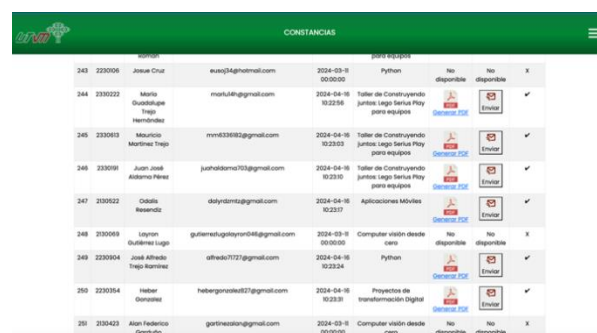


Figure 7

Administration of workshops

The results section shows how an administrator can send the workshop completion certificates by e-mail individually or in bulk. These certificates include a QR code to avoid forgery, fulfilling the fifth objective.

The application was subjected to functionality and usability tests in order to ensure a quality product. The functionality tests enabled errors in the user stories to be identified so they could be corrected, as shown in the excerpt from the test log. The SUS (usability) test placed the application in the B percentile, with a score of 75.92, which can be interpreted as indicating that the perceived usability is acceptable. This is consistent with the table of percentiles, grades, adjectives and metrics to identify SUS scores (Sauro, cited by Gamarra, Chávez, and Segundo, 2021).

In the case described in the present study, the application was developed for the Information Technology and Software Development Conference, but it can be adapted to any other academic conference held at this university. In the future, the intention is to develop a scientific papers section for the application, where authors and reviewers can be registered and papers evaluated.

Article

Declarations**Conflict of interest**

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Author contribution

Escorza-Sánchez, Yolanda Marysol: Contributed to the project idea, research, programming and writing.

Mendoza-Espinoza, Héctor Eduardo: Contributed to the project idea, research method and technique and testing.

Availability of data and materials

The datasets used or analyzed during the current study are available from the corresponding author upon reasonable request.

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Abbreviations

CRUD	Create, Read, Update, and Delete
ENDUTIH	National Survey on Availability and Use of Information Technologies in Households
HTML	HyperText Markup Language
ISO	International Organization for Standardization
PDF	Portable Document Format
PHP	Hypertext Preprocessor
PRD	Products
PRO	Processes
PRT	On-screen or printed reports
QR	Quick response code
SCR	Views
SUS	System Usability Scale
TV	Television
US	User Story

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