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INTERFACE DESIGN FOR LOW SCHOOLING AND LOW LITERACY USERS: THE ECHO PROJECT.

O Design de Interfaces direcionado a utilizadores com baixos níveis de escolaridade e de literacia: O Projecto Echo

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ABSTRACT

This study was developed as a part of the "ECHO: echoing the communal self" research project, which aims to document self-initiated practices in social housing neighbourhoods in Vila Nova de Gaia, Portugal, and disseminate them in similar social contexts, mainly through an online platform. A considerable percentage of low scholar and low literacy users was detected in the population of these social housing neighbourhoods, the main target audience of the online platform. Considering this problem, the need to study an Interface Design solution that ensures a pleasant and effective usage of the online platform arouse. Based on a deep literature review, a set of Design guidelines were studied, evaluated and outlined, and later tested with a prototype developed for this purpose. The usability tests administered confirmed the efficacy of the proposed guidelines, thus contributing to answer this research projects aforementioned problem, as well as other potential Interface Design instances directed towards this kind of low literacy and low scholar users.

KEYWORDS

Interface design; low literacy users; Digital accessibility; User Experience Design; Community practices.

RESUMO

O presente estudo foi desenvolvido no âmbito do projeto de investigação "ECHO: ecoar o eu comunitário", que visa documentar práticas auto-iniciadas em bairros sociais de Vila Nova de Gaia, Portugal, e disseminá-las em contextos sociais análogos, sobretudo através de uma plataforma online. Neste grupo da população dos bairros sociais, principal público-alvo da plataforma online, detetou-se uma percentagem considerável de indivíduos com baixos níveis de escolaridade e de literacia. Perante este problema, surgiu a necessidade de estudar uma solução de Design de interface que garantisse, a este tipo de indivíduos, uma utilização agradável e eficaz da plataforma online. Com base numa profunda revisão de literatura, foram estudadas, avaliadas e delineadas um conjunto de orientações de Design, e, posteriormente, testadas num protótipo criado para o efeito. Os testes de usabilidade realizados comprovaram a eficiência das orientações propostas, contribuindo, desta forma, para responder ao problema supramencionado deste projeto de investigação, como também para outros potenciais casos de Design de Interface dirigidos a este tipo de utilizadores de baixos níveis de escolaridade e de literacia.

PALAVRAS-CHAVE

Design de interfaces; Utilizadores com baixa literacia; Acessibilidade digital; User Experience Design; Práticas comunitárias;

1. INTRODUCTION

This study was developed as a part of the research project "ECHO – Echoing the communal self: designing the dissemination and replication of self-initiated practices in underprivileged urban communities in a post-pandemic world", funded by the Foundation for Science and Technology (FCT), it aims to identify and study good examples of self-initiated community practices in social housing neighbourhoods, with the goal of displaying them and stimulating their replication in analogous contexts. This exploratory study, centred itself in the city of Vila Nova de Gaia, located in the north of Portugal, where two community practices initiated in Balteiro's social housing neighbourhood were identified: "Escola Oficina" and "Associação Recreativa Clube Balteiro Jovem" [1; 2; 3].

According to data provided by Gaiurb, a company responsible for Urbanism, Social Housing and Urban Rehabilitation in the municipality of Vila Nova de Gaia, the resident population of the social housing neighbourhoods of this city is characterized by low schooling and literacy levels, namely, digital literacy.

One of the goals of this research project is to create an online platform to promote these community practices. The citizens of Vila Nova de Gaia's social housing neighbourhoods are the platform's main target-audience, whom we aim to inspire and motivate to replicate this kind of initiatives in their own communities. Thus, the present research aims to study an interface design solution for ECO's online platform, aiming to guarantee effective use by its target-audience, individuals with low education and low digital literacy levels.

Focusing on these individuals, a literature review was conducted to identify their difficulties and necessities when using digital devices, as well as a survey of methods and guidelines for interface design. Based on these [4; 5; 6], on the analysis of current interface design heuristics [7; 8], and on the conducted tests, we proposed a new set of interface design guidelines, to help designers develop solutions that include this type of users. Lastly, these guidelines were applied during the development of the ECO platform and were validated through usability testing.

Data from the Census 2021 showed that in Portugal over two million individuals present a maximum schooling level equal or inferior to grade four, while over a million hasn't even completed the fourth grade [9]. These numbers prove the pertinence of the present study and the high number of individuals that would benefit from interfaces developed according to their difficulties.

2. LOW LITERACY USERS

Recent literature shows different definitions and methods to identify low literacy users (LLU). To better understand and define this target audience, a literature review about this category of users was conducted [4;5;6;10;11].

We identify LLU as adults that, independently of age, IQ or schooling level, present literacy, numeracy and cognitive deficits, difficulties in reading, interpreting or writing text [10; 11; 12]. This type of individuals tends to interpret information literally and present low capacity for abstraction [11]. In addition, independently of previous contact with digital media, these users also present difficulties interacting with digital interfaces [10; 13].

However, there isn't a consensus regarding this population's characterization. For example, Windisch [12], argues that low literacy individuals also tend to present low education levels. While Vágvölgyi et al. [10] defend that an individual's schooling level on its own, doesn't reflect their literacy level. The same author reveals that there's a lack of consistent methods to diagnose LLU, which difficulties the study and analysis of this audience. Even the definition for LLU used

in this study matches different literacy levels, depending on the model used.
According to UNESCO's 2007 model: Literacy Assessment and Monitoring Programme (LAMP), from a scale of minus one to five, the definition we employ corresponds to levels one and two [14; 15]. Whilst, in accordance with the Program for International Assessment of Adult Competencies (PIAAC), used by OCDE, in 2013, from a scale of minus one to five, our employed characterization of this audience corresponds to level minus one and one [16].
Thus, while understanding the implied limitations, in this study, the participants' schooling level was taken as indicative of their literacy level, in addition to indicators presented by GAIURB's social services technicians, which reinforce this argument.

2.1 Low literacy users' difficulties

LLU interact with digital platforms differently from individuals with medium or high literacy levels, this is due to their specific deficits [17].
LLU showcase a disperse search method, spending more time per page. When confronted with a task in a digital interface, they usually take eight times longer to complete it, when compared with common users. LLU also get lost more often during navigation and they get satisfied with search results earlier. These navigation issues lead to frustration and less precise search results [17].
Medhi et al. [18] advocate that this user group showcases difficulties in information processing and analyses, tending to focus on one element at a time. People with low literacy are incapable of skim reading, they read and analyse contents word by word. When presented with dense information these users tend to skip ahead [18; 19]. Due to their short-term memory deficits and their narrow field of vision, LLU tend to forget about the existence of common actions such as the scroll and back functions [10; 20]. Thus, they ignore elements outside of the texts flux or elements with lots of information, which results in slow navigation and reading experiences [18].
In terms of navigation, LLU show difficulties when confronted with hierarchical menus. Due to their spatial organization deficits, they group information based on personal, hypothetical or wrong interpretations of concepts, creating hierarchies with few levels [18; 21]. This way, these users navigate through a trial-and-error technique, experiencing difficulties when using search engines, due to their writing mistakes [18].
Interpreting visual information is also a problem to this group. Due to their trouble with abstraction and concentration, they experience difficulties reading high detailed photography or icons that are too abstract. According to Thies [5], figurative icons or drawings contribute to an easier interpretation.
To summarize, LLU present several difficulties related to navigation and researching, acquiring, interpreting and analysing information. Therefore, several interface elements may pose problems for these individuals experience.
To understand how to handle the referred problems, the next subsection presents recommendations for the development of accessible user interfaces for LLU, found in recent literature.

2.2 Methodologies to promote Low literacy users inclusion

LLU present specific difficulties when confronted with digital interfaces. Several authors, such as Nielsen [10] and Srivastava et al. [6], explore this theme to improve this user's web experience.
Authors such as Medhi et al. [20] research different input and output methods, seeking a solution that limits written language. However, as LLU also show cognitive deficits, this study focus on authors that explore solutions related to design and interaction, while keeping a conventional graphical user interface structure. These authors reject the complete removal

of the written word but instead defend its simplification [22].
Barboza & Nunes [23] and Wrench [13] defined several guidelines for text simplification, aiming to improve the accessibility of both LLU and common individuals. These authors recommend applying a simple everyday language, avoiding jargon, technical words, double negative and ambiguity. They also propose a clear and direct writing style, accompanied by short summaries, headers or small introductions, according to the text's length. They also suggest applying descriptions to graphics and illustrations, without breaking the user's reading patterns.
Zaphiris et al. [24] and Strivastava et al. [6] recommend highlighting the relevant information in bullet points and avoiding repeating content. Wrench [13] underlines the need for repeating the most relevant information at the beginning and end of the medium, employing a direct writing style, in the active voice, resourcing to words familiar to the reader, considering their cultural references. On the other hand, Nielsen [20] suggests that the most relevant information should be presented at the top of each page and on the main page of the platform.
Regarding interface design, a simple and minimalist design is recommended [6], along with abundant white breathing space to create a less intimidating experience [4; 5; 30]. In recent literature, a convergence of ideas was identified regarding the need to simplify and optimise search elements to deal with LLU writing errors [5; 20].
However, distinct guidelines were detected concerning the user experience. Nielsen [20] stressed the relevance of applying a single column design and using the scroll function, while Srivastava et al. [6], advise for the explicit accent of the scroll element. On the other hand, Zarcadoolas et al. [19] defend a design that doesn't require the use of this element.
Regarding the platform's navigation, several authors agreed on the need to simplify these users experience, due to their deficits in information processing and analyses, as well as spatial organization deficits [18; 20]. Nielsen [17] suggests applying linear menus, while Medhi et al. [18] advises for list menus, and Zaphiris et al. [24] propose using hierarchical menus with few levels. Even though several authors agree on the need to simplify navigation for this audience, there isn't a clear explanation on how to achieve that. Authors suggest to incorporate redundancies in all pages, through indexes and navigation history [19]. They recommend prioritizing relevant elements at the top of pages [20], but also defend avoiding duplication of content [6; 24].
The best method to highlight elements is also debated. Wrench [13] suggests that full word capitalization should be avoided, the author defends underlining or bolding certain concepts, instead. Nielsen [20] proposes changing the texts colour, while Zaphiris et al. [24] defend transforming the shape of the element, considering that the color change should be very slight.
On the other hand, several of the analysed suggestions align with guidelines from Nielsen's heuristics [8] and Norman's design principles [7], such as: supporting recognition rather than recall; providing simple and easy to use error messages; limit choices to reduce user errors; providing help and documentation; and developing a connection between the system and the real world.
In recent literature, a significative consensus on methodologies to improve LLU' accessibility can be identified. These include the optimization of search elements, employing a clear and simple language, and applying a simple navigation system. Clear guidelines on how to simplify and improve these users' navigation weren't found, while distinct opinions regarding topics such as scroll, information presentation and content highlight were identified [13; 20].
Aiming to group and synthesize existing information found in this literature review, as well as to bring clarification and propose enhancements, a new set of guidelines to help designing accessible user interfaces for LLU was defined.

2.3 Guidelines to promote accessibility for low literacy users

The proposed guidelines were developed based on the presented literature review, taking into account the existing suggestions and the LLU' difficulties. We also considered current design

references such as Norman's principles [7] and Nielsen's heuristics [8]. We recommend that, in each project, profound research is carried out on the target users, analysing their specific problems and difficulties, to interpret guidelines in line with these specificities.
These suggestions result from the adaptation of current reference heuristics and recommendations [6; 17], while simultaneously defending specific viewpoints [25]. 12 guidelines where developed, being characterized in four groups: Design; Language and Information; Navigation; and Error Prevention (table 1).

Tema	**Recomendação**
Design	R1: Manter um desenho minimalista e simples
	R2: Limitar a informação no ecrã ao seu essencial
	R3: Utilizar as indicações visuais de um modo prudente
	R4: Visar o reconhecimento e não a recordação
Linguagem e informação	R5: Utilizar uma linguagem clara, concisa, direta e óbvia
	R6: Limitar a informação ao seu essencial
Navegação	R7: Utilizar navegação simples
	R8: Oferecer visibilidade do estado do sistema
Prevenção de Erros	R9: Otimizar a tarefa de pesquisa
	R10: Considerar a falta de memória e de escrita do utilizador
	R11: Fornecer mensagens de erro simples e claras
	R12: Oferecer ajuda e documentação

Table 1
Guidelines for interfaces design for low literacy users.
Source: [25].

3. METHODOLOGY

This study applied a Design Thinking, user centred methodology. This iterative and explorative method is considered a creative problem-solving strategy [26]. In this study, we employed the Design Thinking model proposed by the Nielsen Norman Group, which is composed of three main phases [27]: Inspiration, Ideation and Implementation.
In the first stage, in order to create empathy with the target-audience and characterize it, data was collected and analysed. Through a literature review, the low literacy and low schooling users were identified and characterized. In this stage the user personas were also defined, highlighting their objectives and difficulties with interfaces. In the following phase, Ideation, multiple hypotheses were generated to answer the previously identified problems. For that, wireframe iterations were developed. Lastly, in the Implementation phase, the final solution was designed, so that in a subsequent analysis its main problems and qualities could be identified. In the last stage, a high-fidelity prototype was created, and usability tests were conducted.
Afterwards, during the usability testing, the System Usability Scale (SUS) was adopted, as to collect valid and quantifiable data, regarding the online platforms usability. The SUS allows to generate results in a scale from 0 to 100, which enables its interpretation in relation to other similar products [28; 29; 30]. According to Sauro's analysis [31], results between 0 and 50 mean that the usability is not acceptable, results between 50 and 70 point to a marginal usability and when they are above 70 they tell that the platform has an acceptable usability.

4. ONLINE PLATFORM'S DEVELOPMENT

The development of the ECO's online platform, available at https://eco.ipca.pt, went through a user focused, iterative design process, based on the Design Thinking methodology. We started by identifying user personas, analysing their difficulties and necessities through the elaboration of user scenarios. User personas correspond to fictitious descriptions of a typical user of the product being studied, while user scenarios are descriptions of the everyday interaction between the user and the platform [32; 33]. These methods allowed to stay focused on the target-user during the whole development process. Based on this information, the interface's contents were organized, and the information architecture structured.

Then, simple low-fidelity sketches were developed, allowing for the exploration of different concepts. Initially, we tried to apply a single column design. The goal was to avoid positioning elements side by side, to minimize LLU's difficulties with skimming text. However, we realized that this approach would require extra-long pages, a low effective solution considering LLU's memory deficits. Thus, in the final structure a two-column design was applied.

In the high-fidelity wireframes, we aimed to apply a minimalist design, using a simple colour palette with two colours and respective tone scales: blue and black. We tried to separate each section with a different background colour, and used lots of spacing between elements, applying guidelines 1,2,4 and 10 (Figure 1).

Fig. 1
Homepage Interface.
Source: Self-source, 2023.

On the homepage, short, concise paragraphs were used and images were highlighted so that the main information could be read easily and briefly. To this end, recommendations five and six were taken into account: "use clear, concise, direct and obvious language" and "limit information to its essentials" (Figure 1). On the "About" and "Team" pages, some information was collapsed and could be expanded, in order not to overload the user and to apply recommendation number six (Figure 2). In the same way, the technical content was placed on secondary pages of the platform.

Regarding navigation we decided for a single, top-fixed menu, as to simplify users' interactions and implement guidelines 7 and 8 (Figure 2). The menu is one of the few elements that has visual cues since it is interactive, as are the buttons. The goal was to limit the visual cues used to highlight elements, as referred by guideline 3.

Some guidelines, like number 9: "optimize search tasks" weren't applied in this platform, as they don't fit its needs. The same happened with guidelines 11 and 12.

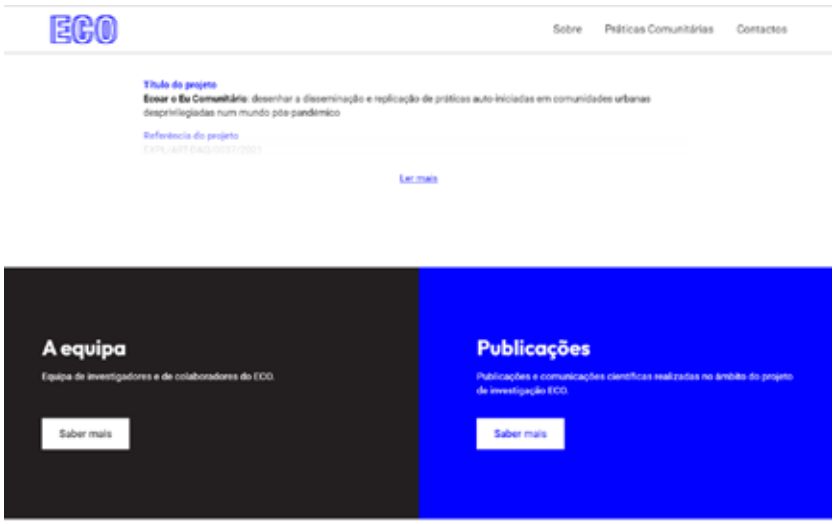

Fig. 2
About page Interface.
Source: Self-source, 2023.

After the wireframe's approval, the high-fidelity prototype was developed using Figma software. Lastly, usability tests were conducted as described in the next section.

5. TESTING AND RESULTS

The goal of usability testing is to determine if an online platform presents an intuitive and pleasant navigation experience, and to identify possible usability deficiencies as well as suggestions for improvements.

Based on Nielsen's [34] studies, two testing sessions were conducted, each involving five users. According to Nielsen [34], after five users, the comments and reactions of the participants begin to repeat themselves, adding no new information for analysis. Each session had a different target-group: the first session was conducted with LLU, the second session had medium to high literacy users. The goal of this second session was to confirm that medium to high literacy users wouldn't be penalized for using an online platform adapted towards LLU.

At the start of the usability tests, we presented a small introduction of the project, explaining the purpose of the evaluation. We then asked the participants to share their process by speaking out-loud, adopting the concurrent-think-aloud method. Afterwards, pre-test questionnaires were distributed as to identify biographical data and register the participants literacy levels and digital habits.

After the questionnaire was filled, each participant had access to a computer with the prototype. The facilitator presented the tasks one at a time, registering the users' behaviours or comments for the online sessions. In total, five tasks were proposed (Appendix 1), which were defined based on the user personas created. The tasks provided were realistic and achievable, without describing the step-by-step solution, as to not provide the answer to the users [35; 36].

Lastly, the post-test questionnaires were delivered (Appendix 2) with some generic questions about the project and the platform, along with a SUS questionnaire.

The first testing session took place in-person, with five users, aged between 51 and 60 years old, and low literacy skills, namely digital. In this session each test took around 45 minutes to be completed, including the questionnaires.

In these qualitative tests, we confirmed these users' difficulties using digital devices. Two individuals showed trouble using the mouse, which complicated their experience and led to user frustration. These users showed a tendency to get distracted and frustrated during the usability tests. In several moments the facilitator had to intervene to help users complete the tasks. However, these difficulties didn't reflect themselves in the answers to the questionnaires. Chadwick-Dias et al. [37] and Sonderegger et al. [38] found similar situations, where users reported good usability, even tough test facilitators saw difficulty and excessive time spent per task.

Brownan [39] pointed out that these users' low confidence with technology was an impacting factor in usability testing. We identified two users who reported feeling insecure when using the internet; one of the users showed indifference and two others reported slight confidence. It was also noted that four of the five users highlighted the relevance of the platform.

After the tests, the collected data from the SUS questionnaires was analysed and interpreted, being later translated into a scale from 0 to 100. This session averaged at 73.5, which represents the way users perceived the usability of the platform [29; 30; 40]. Sauro [31], through the analysis of a vast number of platforms and respective results, created a qualitative evaluation scale of usability tests, classified between A (highest grade) and F (lowest grade). According to this scale, the result of 73.5 would correspond to a B grade, or an acceptable usability.

The second session was conducted asynchronously online, with five users, aged between 20 and 59 years old, with schooling levels equivalent to or higher than high-school level. Each session took about 20 minutes. The average of the SUS questionnaire evaluation was 95.5. This average corresponds to an A grade, which means that the platform was perceived by users as excellent and its usability was acceptable.

We confirmed that LLU take longer to complete tasks, present more difficulties and a greater tendency to give up on tasks, as referred by authors such as Kodagoda et al. [17].

We understand the advantages and limitations of the design guidelines created. These supported the design process, serving as a base for an accessible platform for LLU, and users with medium to high literacy.

First session		
Utilizador	**Schooling**	**SUS Result**
1	6th grade	77.5
2	9th grade	80
3	6th grade	65
4	9th grade	75
5	4th grade	70
Second session		
1	University degree	97.5
2	University degree	95
3	High School	97.5
4	University degree	97.5
5	University degree	90

Table 2
Results from System Usability Scale Questionnaires.
Source: Self-source, 2023.

6. DISCUSSION AND CONCLUSION

This study focused on researching, analysing and testing methodologies and guidelines for developing user interfaces accessible to low schooling and LLU. Through the solution developed for ECO's online platform it was possible to test and validate the feasibility of the created guidelines.

The present study allowed to confirm and corroborate several ideas identified in current literature, such as the existence of differences between the web experience of LLU and medium to high literacy users [6; 20]. We confirmed that LLU need more time to complete a task [17] and that there's deviations from the precepted difficulties and real difficulties these users experience [37; 38].
This article also compiles several information about LLU, namely those present in table 1, to which we added the main inclusive design guidelines for this type of audience, highlighting the need to "consider the users low memory and writing capabilities", which corresponds to guideline 10, from table 1.
The results from the usability tests and SUS questionnaires revealed the good performance and usability of the online platform, as well and the viability of the Design guidelines created in this research. It should be clear that, despite the relevance of these guidelines, they are a support tool, which must be personalized according to the research and empathy processes taken with the target-audience. Furthermore, usability testing is an integral part of the process, fundamental to the validation of the solutions.
In this research, we confirmed several differences between low literacy and medium to high literacy users, namely, time spent per test, attention showed during task execution and confidence level with digital devices. LLU present inconsistencies between their answers to the questionnaires and the observations of the facilitator, specifically in their perceived difficulties. We understand that these users present a very different relationship to usability tests, when compared to common users.
In this study, it wasn't possible to apply all created guidelines to ECO's platform due to its nature. It would be interesting to apply and test these guidelines in future studies, namely guidelines: 9, 11 and 12: "optimizing research tasks"; "providing simple and clear error messages" and "providing help and documentation".

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9. APPENDICES

Appendix 1

Tasks administered during usability testing.

Task 1	Imagine you've been told about creating self-initiated projects and you've been shown the ECHO website to see examples. Enter the website and find a project that catches your attention.
Task 2	Let's say you're interested. Find out more about the project.
Task 3	Let's say you wanted to talk to the project manager. Find out more about him.
Task 4	Consider that you found the ECHO research project interesting. Find out more about it.
Task 5	Identify the results of the ECHO project.

Appendix 2

Post-usability testing questionnaire.

Name: _____
Date:___/___/_____ User nº:_____

Consider the ECO platform presented to you and indicate, from 1 to 5, the degree to which you agree with the following statements.

		1 (Strongly disagree)	2 (Disagree)	3 (Neither agree nor disagree)	4 (Agree)	5 (Strongly agree)
1	I think I would like to use this system frequently.					
2	I think the system is unnecessarily complex.					
3	I think the system was easy to use.					
4	I think I would need support from a technician to be able to use this system.					
5	I think the functions of this system were well integrated.					
6	I think there were too many inconsistencies in this system.					
7	I imagine that most people would learn to use this system quickly.					
8	I found the system very complicated to use.					
9	I felt confident using the system					
10	I needed to learn a lot of new things before using the system.					

1. Have you used a similar website before?

_____

2. Do you find the content of the website relevant?

_____

3. Did you find the information accessible and easy to understand?

_____

4. Do you think it is possible for a project created in a socially disadvantaged context to be successful?

_____

5. Did you understand the objectives of the ECO project?

_____

6. Do you have any other suggestions or comments?

_____

_____

_____

Please indicate from 1 to 5 how much you agree with the following statements.

		1 (Strongly disagree)	2 (Disa-gree)	3 (Neither agree nor disagree)	4 (Agree)	5 (Strongly agree)
1	I felt that I completed the tasks quickly.					
2	I felt it was difficult to complete the tasks.					
3	I understood the information presented.					
4	I feel more informed about self-initiated practices in socially disadvantaged contexts.					
5	I don't believe in the future of the projects presented.					
6	After these examples, I'm thinking of starting a similar project.					
7	I didn't understand the objectives and purpose of the ECO project.					

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