Experience in the creation of the JUMI Community: Achievement after two years

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Summary

The linkage of women to university contexts in science and technology areas is an issue of concern to different actors in the educational environment. This concern is due to the low participation of women in STEM areas despite the initiatives led by governmental and private entities. The objective of this paper is to present the experience in the creation of the JUMI community (Youth of Women in Science and Engineering), an initiative of the Faculty of Engineering of the University of Medellin to strengthen the female involvement of students in engineering programs, especially in systems engineering, the program that leads the community. This article describes the activities carried out by JUMI, the public impact, the adaptations according to the needs identified, and the partial results obtained.

Keywords

Science and Engineering, Women, STEM

1. Introduction

Currently, at regional, national, and global levels, several initiatives are being carried out to motivate the participation of women and girls in activities related to the world of science and new technologies, breaking the paradigm of activities mainly related to the male gender. Likewise, different actions aimed at highlighting the role of women in science and technology have gained importance, becoming an attractive topic, not only for review but also for research [1].

However, despite the efforts of women's communities from academia and private organizations, reports such as UNESCO's "Cracking the Code" reveal that only 28% of all researchers in the world are women and upon reaching higher education, women represent only 35% of students enrolled in Science, Technology, Engineering and Mathematics (STEM) studies, with the lowest number of women enrolled in areas related to information, communications and technology, engineering, manufacturing, construction, natural sciences, mathematics and statistics [2]. The CEPAL, the Economic Commission for Latin America, also reports that increasing the participation of women in STEM areas is required to transform the development of countries in search of equality. However, curricular, cultural, and organizational aspects still make STEM programs continue to be seen as predominantly masculine [3].

Likewise, the Inter-American Development Bank indicates that although the participation of women in education and the labor market has been gradually increasing, this increase needs to be reflected in science, technology, and innovation. Although efforts and initiatives to promote the professional development of women in STEM areas have been identified, closing the gender gap in these areas is still a challenge to be solved [4]. CEPAL Recommendations emphasize the need to design systems that promote women's digital inclusion and decrease gender gaps to empower and engage women in both STEM areas and educational systems [5].

In the Faculty of Engineering of the University of Medellin, the indicators follow the world reality parameters in the scenario mentioned, particularly accentuated in the Systems Engineering program. This scenario motivates the creation of initiatives such as the work in academic and research

communities like the Youth Community of Women in Science and Engineering (JUMI) that promote the participation of girls and young women in STEM areas based on scientific-technological activities carried out in and for primary and secondary education contexts promoted by women.

The mentioned confirms that there is still a significant gap associated with the participation of women in STEM fields of study. Thus, it constitutes a challenge that moves science around creating strategies to encourage women to participate in training programs and increase their participation in the labor field [6]. One of them is the design of strategies to achieve greater participation through motivation and learning of women in science and technology.

The JUMI community emerged in the first semester of 2021, led by a group of female professors from the Systems Engineering Program and supported by a group of female student leaders from the same program. JUMI has a network of allies and active participants from the University of Medellin who have been trained as mentors and leaders.

This paper presents aspects associated with the motivation for creating this community, including a review of previous works in Section 2. Subsequently, in Section 3, the JUMI community is described in detail through its origin, structure, achievements, and future goals. It closes in Section 4, with conclusions and final reflections.

2. Motivation, previous work

The gender gap is a widespread and widely identified problem in different social contexts, particularly in STEM training and linkages; its incidence is very marked. The low participation of women in science, engineering, and technology is due to social, political, vocational, institutional, and even family factors [7].

According to the Inter-American Development Bank, the participation of women in education and the labor market has been gradually increasing. However, science, technology, and innovation do not reflect this behavior [8]. Although there are numerous efforts and initiatives to promote the professional development of women in STEM fields, there is still a gender gap that hinders their motivation, participation, advancement, and recognition [9]. This gap manifests itself at the post-secondary levels of schooling when women move away from scientific fields progressively.

In the Americas, Brazil is one of the pioneering countries in developing and developing strategies associated with the subject. The "Meninas Digitais" program of the Brazilian Computer Society, which arose from the instinct to generate more women in higher education, is one of the most important examples [10]. Furthermore, it has been the umbrella for projects under the same name in different universities. Thus, by 2021, 880 people were reported to be linked to the cause of the 825 female participants in the roles of teachers, mentors, and monitors. In the same year, 61,711 people were impacted as participants of the projects' actions, and 320 schools were involved in the extension actions [11]. In Latin America, there are also joint initiatives, one of which is the Latin American Open Chair Matilda and Women in Engineering (CAL Matilda), which was created in 2020 and brings together the efforts of women engineers and scientists who advocate for equal opportunities and spaces for women in engineering [12].

To highlight some specific strategies, it is worth mentioning the "Heroínas Digitais" program [13], which aimed at activities to promote the representation of women in science, mainly technology. This program brings to elementary school classes the use of Web 2.0 tools and block programming to encourage dialogues, reflections, and critical thinking. Another initiative is the "Gurias digitais" program [14]; this project aimed to raise awareness of computer science as a valid training career option among girls from municipal schools by programming their games. With a similar methodology, the program "*Meninas em ação*" [15] not only carried out actions inside schools but also improved the actions as the experience was carried out. These actions aimed at encouraging girls to pursue careers in engineering and technology.

In Spain, the Girls4STEM project stands out in the community of Valencia, which since 2011 initiated pilot activities to cover spaces related to interaction with families, secondary schools, and educators promoting inclusive programs; extracurricular activities to support students who select studies in STEM-ICT disciplines and collaboration with graduates in these same areas to build

professional support networks [16]. The W-STEM project, financed by the European Union through the Erasmus+ program, is also worth mentioning. This project is responsible for developing actions to modernize the administration and operation of educational institutions to improve women's access to STEM programs [17].

Initiatives such as those described above have a high outreach component, arise from a university context, and are taken to other educational institutions. However, it is still necessary to continue joining efforts and including research processes in these initiatives [18], from a formal review and mapping of actions to generating knowledge to close the gender gap based on measurable results of the effectiveness of such actions. Initiatives and strategies for women's participation and involvement help reduce this gap from a practical perspective [19]. However, from a scientific research perspective, it is also of interest to review the relevance of different approaches and techniques of pedagogical mediation in the approach of these activities or actions.

3. Youth of Women in Science and Engineering: JUMI

The main objective of the Community of Young Women in Science and Engineering, denoted under the acronym JUMI, is to promote the vocations of girls and young women in STEM areas, including a pre-university and university audience. JUMI has been established as an inspiring initiative, which, above all, seeks to be inclusive and integrative, so it is not a community closed to any gender; on the contrary, it seeks to reach a varied audience that shares and agrees on the desire to work for the increase of female representation in these disciplines and the unique support to girls and adolescents. That is, emphasis is placed on girls and young women without restricting gender to be part of the community.

In pursuit of the above, the objectives of the community are as follows:
- To highlight the role of women in science and engineering.
- To reduce the gap associated with the participation of women in these fields of study.
- Encourage and promote women to participate in engineering training programs and their subsequent approach to the labor field.

This section describes the origin of the community, its structure, main achievements, and plans.

3.1. Origin

The JUMI community, Youth of Women in Science and Engineering, began in February 2021 at the University of Medellin, located in the city of the same name in the department of Antioquia. In this institution, the faculty of engineering concentrates on eight academic programs belonging to STEM areas. In the IT area, the undergraduate program in Systems Engineering is offered, which, since its inception, has reflected low participation of female students, being currently below 17% of the total number of students, a behavior that is not far from the reality experienced in this area at the higher education level.

The community was an initiative of a group of female professors of the Systems Engineering program who, considering the scenario presented, proposed the initiative with the instinct to strengthen the participation of female students in the programs of the School of Engineering and the IT area, and consequently increase the rate of income and permanence of female students at the University.

The initial project team comprised three coordinating professors and three volunteer students, all part of the Systems Engineering program. As the team had no previous experience of participation or management of communities aimed at the involvement of women in the IT area, questions were raised related to What justifies or is the cause of the low participation of women in engineering programs and particular systems engineering at the University. What actions exist to strengthen the participation of women in the IT field? Which of these actions would be appropriate to minimize the gap reflected in terms of access and permanence of women in the programs of the faculty?

A process of recognizing works and initiatives carried out by other universities or private entities in the Colombian context and even Latin America was initiated to answer these questions. This search

took the form of a narrative review and exploration of the websites and social networks of the initiatives and projects identified. From this and through brainstorming exercises carried out in meetings of the founding teachers and students of the community, the main actions that could be carried out began to be documented.

3.2.   Structure

The community currently has a delimited structure that has allowed actions to be directed from different fronts, taking advantage of the diverse capacities and strengths of the members. This structure was conceived during the community's second year of operation after identifying that progress had been made with the actions undertaken. However, an internal order was needed to motivate and attract new volunteers to participate actively in the community.

Thus, as of the second half of 2021, the community adopts the structure shown in Figure 1 below.

3.2.1. Internal Relations Committee

To maintain the constant interaction of the community members, the internal relations committee is in charge of planning the activities carried out regularly. Now, a permanent activity is carried out once a month. This activity corresponds to the community meeting, but at the same time, it is the opportunity to act as training, tutoring, talk, interaction, or entertainment. The permanent activities are also offered to the academic community, especially to the Faculty of Engineering and, in some cases, to the public of other secondary education institutions. Additionally, a semi-annual activity of greater importance has been arranged, which is conceived and organized by this committee. This activity seeks to be a focus of dissemination of the community and to attract those interested in participating actively as members.
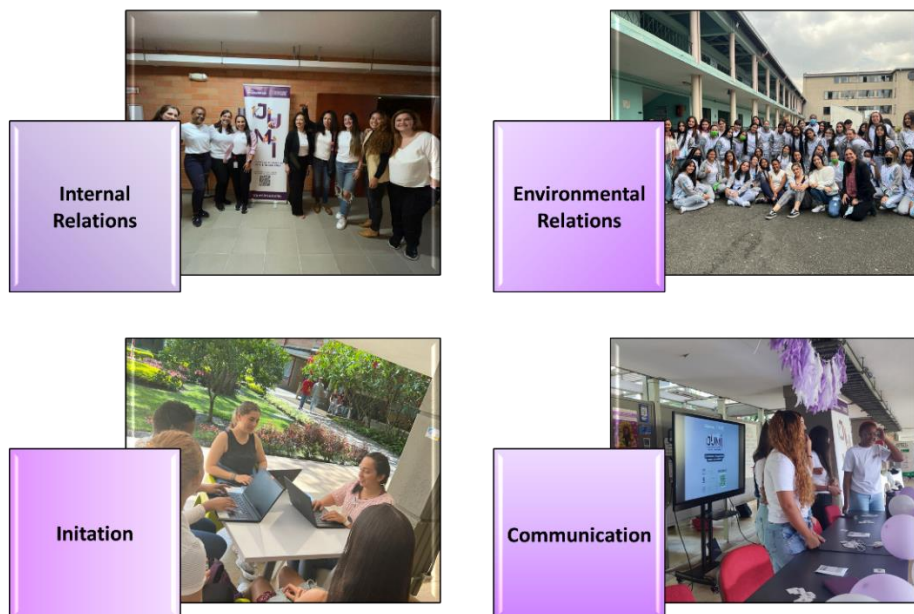

Figure 1: JUMI Community Structure

3.2.2. Initiation Committee

Once people interested in learning more about the community and becoming part of it are identified, the initiation activities committee is in charge of, in principle, being attentive to the registration form and making contact with interested people through activities that seek to make known in greater detail the intention of the community, the structure and the way of working. This presentation is made in the middle of an activity in which the participants are directly involved in one of the strategies designed or adopted by the community to make interventions in primary and secondary education institutions, thus seeking a description and an immersion in the community's mode of operation. We include different moments that go from breaking the ice to reflecting on the reason for the activity and the degree of appropriation and motivation it generates in the participants.

3.2.3. Environmental Relations Committee

The extension of the community outside the university campus is part of its raison d'être. The community was created as an outreach channel for initiatives to motivate girls and young women to consider and select programs associated with STEM areas as part of their career options. For this reason, the community relations committee organizes spaces in which practical workshops take motivation strategies to elementary and middle school institutions. It is also the committee in charge of logistics when the community is invited to participate in exhibitions or academic events, including preparing experiences, materials, and other elements deemed necessary. This committee leads the execution of these extra-mural activities; however, it does not limit the participation of other community members in the development and support of these activities.

3.2.4. Communication Management Committee

One of the most important factors for the community is to disseminate the actions carried out and generate content that ratifies the importance and appreciation for the role played by women in science and engineering; therefore, the communication management committee is constituted as the one in charge of the administration of social networks (@jumimedellin), the construction of advertising pieces for the dissemination of meetings, workshops and events, the construction of pieces to commemorate dates of particular interest such as women's day, day of the girl in science, among others. Similarly, this committee is responsible for the logistics of community outreach processes through different virtual or face-to-face channels. In the face-to-face case, it has been in charge of activities to visit the classrooms within the faculty, making known and inviting to be part of the community and announcements in spaces such as hallways and corridors of the institution. In the virtual aspect, she manages a communication channel in WhatsApp, in which she shares, in addition to what is related to the community, calls of interest, and talks of different institutions and scholarships, among others, constantly filtering that they are aligned with the objectives and raison d'être of the community.

By way of summary, Figure 2 shows the path that a JUMI girl follows when she becomes part of the community, from participation in the initiation activity and monthly activities, joining one of the committees described above, and even her role as a mentor for new girls joining JUMI.

3.3. Achievements

JUMI aims to foster the vocations of girls and young women in STEM areas, and under the defined structure, it has managed to institutionalize activities that constitute several exciting achievements. Although the evaluation of the experiences is a subject that is still being worked on, as an indicator of achievement in this first stage of the project, the history of students enrolled and discriminated by gender has been studied. Table 1 presents a history of students enrolled between 2017 and 2023. The behavior of the data suggests a slight change that could mean the beginning of an increase in the

participation of women in the Systems Engineering program at the University of Medellin. This change is evident from 2021-2, going from 13.9% to 15.8% of women enrolled in the program in 2022-1. A sustained increase is evident until 2023-1, with 16.9% of women enrolled.
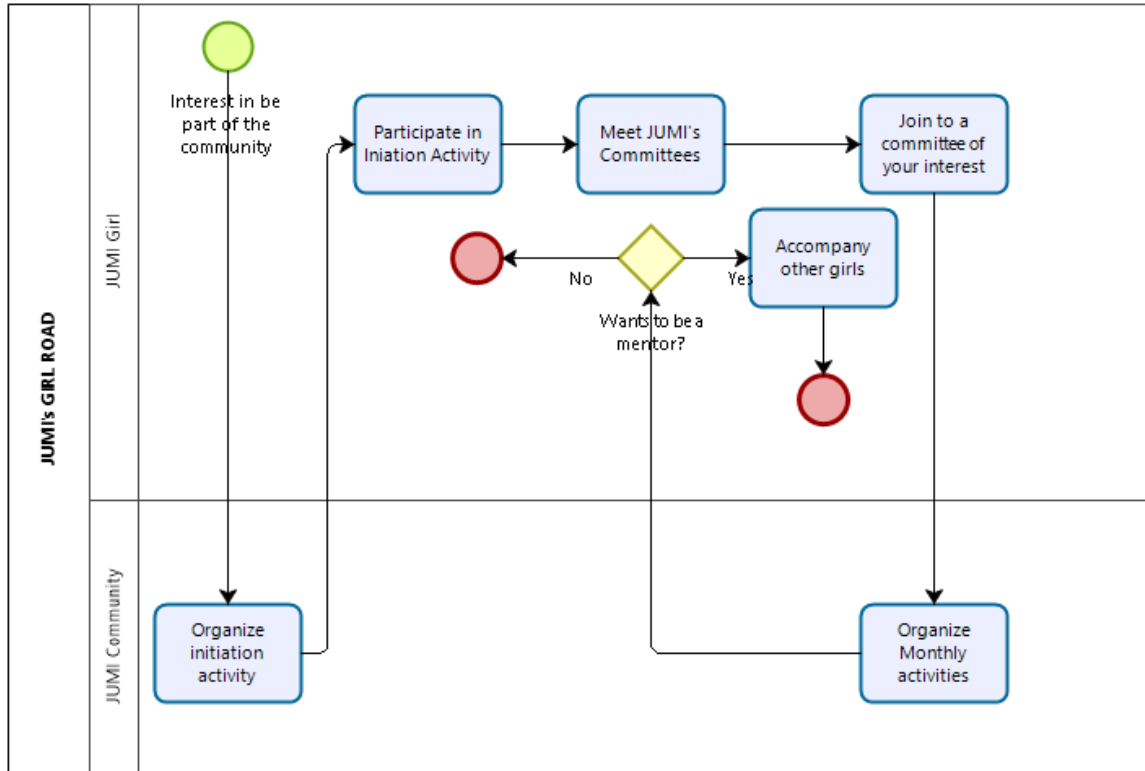

Figure 2: JUMI's Girl Road

The most significant periods of change (2021-2 to 2023-1) coincide with the origin of the JUMI community and the institutionalization of activities with interventions at the secondary basic education level and internally. Within the strategies carried out in this program, the participation of the JUMI community has been imperative, so it is considered a possible motivating factor to be analyzed.

As a starting point, this indicator can be considered the baseline for subsequent measurements.

Table 1
Students enrolled between 2017 and 2023.

Period	Men	% Men	Women	% Women	Totals
2017-1	258	85.7%	43	14.3%	301
2017-2	233	85.7%	39	14.3%	272
2018-1	249	84.7%	45	15.3%	294
2018-2	239	84.8%	43	15.2%	282
2019-1	263	86.5%	41	13.5%	304
2019-2	253	85.8%	42	14.2%	295
2020-1	248	86.1%	40	13.9%	288
2020-2	245	84.2%	46	15.8%	291
2021-1	268	83.8%	52	16.3%	320
2021-2	265	83.6%	52	16.4%	317
2022-1	315	84.2%	59	15.8%	374
2022-2	309	85.1%	54	14.9%	363
2023-1	365	83.1%	74	16.9%	439

The following are the most representative achievements that have been attained through the activities carried out and considering the distribution of the objectives of each committee.

3.3.1. Internal Relations Committee

The most important achievement of this committee is to institutionalize internal activities that allow us to maintain a permanent work dynamic with the community members. These activities aim to achieve high levels of motivation and commitment from the members. Therefore, the first responsibility of the community participants is to support the organization of permanent events organized by JUMI. Among the events that have been institutionalized with the support of this committee are:

- Semiannual JUMI event. This event is oriented to the university community, and its purpose is to develop skills and consolidate knowledge in areas of interest to women in science and technology. The last event, held in September 2022, shows relevant results concerning the impact it had on the university community of the University of Medellin, with a participation of 83 attendees, two national guests, and 1 University executive.
- Monthly follow-up meeting. This activity is aimed at the members of each committee described in the community structure. The objective is to maintain general management of the activities and follow up on the action plan proposed annually to be developed in the community.
- Monthly activation activity. This activity is oriented to the university community. Its objective is to strengthen and motivate the permanence of the members of the community through the programming of diverse activities such as panels with national or international experts, academic conferences on topics of interest for the members of the community, cinema forums with films where the role of women in science and technology is shown, such as Hidden Talents.

3.3.2. Environmental Relations Committee

The most relevant achievement of this committee is the impact that the JUMI community has achieved through its recognition in different scenarios at the regional level, with governmental entities and other institutions of primary and higher education. Among the activities that have been carried out with the support of this committee, the following stand out:

- Annual celebration of Girls in Science and Technology Day with government entities such as the Secretary of Education of Medellin and the Governor's Office of Antioquia in 2022 and 2023.
- STEM promotion workshops. Design and execution of several workshops with primary education institutions such as private and public schools in Medellín. The most relevant achievement of this activity is the capacity generated by the members of the JUMI community to facilitate the execution of this type of workshop, designed by the leading teachers of the community.
- ExpoTech 2022. Participation of the members of the community through the invitation received to present the JUMI community in this space of convergence and cooperation between the academic, research, economic, and productive sectors, which promotes meetings of ideas, dissertations, research, prospects, and proposals between the University, the productive sector, and the state.
- Hosts for the University of Feevale. The JUMI community receives a researcher from this University to develop the monthly activation activity for December 2022. A working session was developed to exchange good practices in the consolidation of communities of women in engineering.
- International visits. One of the community leaders participated in a meeting to exchange experiences with the Universidade Federal de Minas Gerais. This meeting provided an opportunity to learn about the BitGirls project of the *Meninas Digitais* Program in Brazil and to consolidate a relationship for the benefit of JUMI. In addition, this visit was an opportunity to establish a relationship with the Associação Efigênia Vidigal de Educação e Cultura - AVEC and *its Garotas Aplicadas* project.

3.3.3. Initiation Committee

The most representative achievement of this committee is the consolidation of the JUMI community as a group of interest for the University of Medellin, particularly for the School of Engineering and the Systems Engineering Program. At a regional level, it has achieved a recognition that facilitates the development of the activities described in the previous section. Among the activities that have facilitated the achievements above are:

- Design and development of activities associated with the mentoring program. The objective of this program is that the new community members have an initial accompaniment from an active member to facilitate their integration in the first months of joining JUMI.
- Motivational meeting to recruit new members to the community designed by the leaders of each committee.

3.3.4. Communication Management Committee

The most representative achievement of this committee is the institutionalization of the digital and physical image of the JUMI community, which has allowed the management of digital content in social networks and internally at the University of Medellin. Among the activities that have facilitated these achievements are:

- Design and institutionalization of the community image with the support of the Communications Division of the School of Engineering.
- Digital content management to promote the incorporation of new members into the community through social networks.
- Support the dissemination of relevant events and festivities by designing a calendar to identify events and highlight important dates and festivities for women in science and technology.

3.4. Future

As mentioned in the previous section, the community is a recent initiative with two years of operation. However, concrete activities have been proposed for the short, medium, and long term, with openness to the ideas that arise from the group of members and the connection and exchange of experiences with other communities or similar initiatives.

One of the main achievements of the community is the satisfaction felt by the students who have been mentors in the development of workshops in schools and colleges. Therefore, in the short term, one of the activities to be strengthened is the implementation of these workshops in elementary, high school, and middle school institutions. To achieve these activities, intervention strategies are being structured for the different levels of study and ages. An internally funded research project, awarded to the founding teachers of the community, is focused on designing a gamification-based strategy to promote the participation of women in science and technology. The design of the strategies will include the definition of an instrument to measure competencies such as collaboration, teamwork, and level of satisfaction from the proposed interventions. As a starting point, a satisfaction instrument is available due to a previous research project associated with gamification. The instrument has been validated, and some pilot tests have been carried out, which serve as a reference to measure participants' satisfaction after implementing gamification strategies[20].

Diversifying alternative and permanent activities is another aspect to address in the future—the programming and consolidation of seed and mentoring groups. The objective of these groups is to establish and consolidate relationships and alliances between the JUMI community and software industry representatives, as well as with other academic communities. The aim is to expand the project to the city of Medellin and the Metropolitan Area, becoming, in the long term, a reference for other universities in the country and the world.

4. Conclusions

The JUMI community was created in 2021 due to the enthusiasm of the three founding professors and their permanent interest in promoting female participation in science and engineering areas. One of the significant challenges addressed in this process was to constitute this interest group during the COVID-19 pandemic, where all training activities were conducted virtually, which made it more challenging to motivate students in engineering programs to participate in this initiative. However, technological support and social networks were the main support for the beginnings of JUMI, where its first activities, meetings, conferences, and work sessions were held virtually, using icebreaker motivational activities and the recognition of each member as a fundamental element for the consolidation and success of the community.

The internal structuring of the JUMI community through committees made it possible to focus the efforts of the members and define an annual action plan to consolidate JUMI internally and regionally. This structure allowed each of the members to have a precise task and objective and led to achievements such as the last semi-annual event where we had the participation of 83 attendees and resulted in the interest of new members of the university community (men and women - 7) to belong to JUMI.

Among the future challenges facing the JUMI community are: (1) the consolidation of a program of primary and secondary education workshops led by the members of JUMI mentors, (2) the design of a strategy based on gamification to promote the participation of women in science and engineering within the framework of a research project, and (3) the consolidation and diversification of alternative activities to motivate students from other engineering careers as well as women in tenth and eleventh grade.

Another fundamental challenge for the JUMI community is the consolidation of interaction with other national and international women's communities, such as Matilda and Meninas Digitais, among others, which will materialize not only in the exchange of good practices but also in the formulation of joint projects and initiatives for the benefit of women in science and engineering.

Finally, as future work, it is intended, through the research project, to analyze and identify different instruments for measuring competencies and participant satisfaction for gamification strategies, including using new technologies for measuring learning, such as image recognition.

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