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Evaluation of the Rami 4.0 architecture course offered by the campus Manaus District Industrial of IFAM

Avaliação do curso de arquitetura rami 4.0 ofertado pelo campus Manaus Distrito Industrial do IFAM

Evaluación del curso de arquitectura Rami 4.0 ofrecido por el campus Manaus Distrito Industrial de IFAM

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Abstract
This study aimed to evaluate some fundamental aspects of the course on Rami 4.0 architecture offered by the Campus Manaus Industrial District of IFAM. These aspects include a) the sociodemographic characteristics of the participants to compose their profile (to know the subjects discussed that were most interesting to them and those that are likely to be part of their portfolios of products and services to be offered to their applicants), b) to know the degree of satisfaction with the course, and c) what needs to be done to make the course even better. The data were collected through a mixed questionnaire, prepared and tested specifically for this purpose. The course participants conducted the survey on the right day and time. The sociodemographic results were a) the predominance of young, b) people and adults in the same proportion, c) a predominance of men, d) almost all exercising professional activity, e) the majority graduating for less than ten years, and f) less than five years of professional practice. The explanatory results were that only one had prior knowledge of Rami 4.0, the main reason for taking the course was to gain a new understanding, and the most exciting and most important subject was digital connectivity. The evaluative results satisfied the course and the need to work practically on the contents. The conclusion shows that the course achieved its intended objective: to make the Rami 4.0 architecture known to the participants.
Keywords: Course evaluation; Rami 4.0; Satisfaction assessment; Capacitation course; Extension course.

Resumo
Este estudo teve como objetivo avaliar alguns aspectos fundamentais do curso sobre a arquitetura Rami 4.0 ofertado pelo Campus Manaus Distrito Industrial do IFAM. Esses aspectos incluem as características sociodemográficas dos

participantes, para compor o seu perfil, conhecer os assuntos tratados que lhes foram mais interessantes e os que provavelmente vão fazer parte dos seus portfólios de produtos e serviços a serem oferecidos aos seus demandantes, saber o grau de satisfação com o curso e o que precisa ser feito para que o curso melhore ainda mais. O método utilizado foi o de levantamento, feito com os participantes do curso presentes em dia e hora acertados, cujos dados foram coletados através de questionário misto, elaborado e testado especificamente para este fim. Os resultados sociodemográficos foram a predominância de jovens e adultos na mesma proporção, predominância de homens, quase todos exercendo atividade profissional, com a maioria formada há menos de 10 anos e com menos de cinco anos de exercício profissional. Os resultados explicativos foram que apenas um tinha conhecimento prévio da Rami 4.0, o principal motivo para fazer o curso foi obter novos conhecimentos, o assunto mais interessante e mais importante foi conectividade digital. Os resultados avaliativos foram satisfação com o curso e a necessidade de se trabalhar de forma prática os conteúdos. A conclusão mostra que o curso alcançou seu objetivo pretendido, que era o de tornar a arquitetura Rami 4.0 conhecida pelos participantes.
Palavras-chave: Avaliação de curso; Rami 4.0; Avaliação da satisfação; Curso de capacitação; Curso de extensão.

Resumen
Este estudio tuvo como objetivo evaluar algunos aspectos fundamentales del curso de arquitectura Rami 4.0 ofrecido por el Distrito Industrial Campus Manaus de IFAM. Estos aspectos incluyen las características sociodemográficas de los participantes, para componer su perfil, conocer los temas tratados que les resultaron más interesantes y los que probablemente formen parte de sus portafolios de productos y servicios a ofrecer a sus postulantes, conocer el grado de satisfacción con el curso y lo que hay que hacer para que el curso sea aún mejor. El método utilizado fue la encuesta, realizada con los participantes del curso presentes en el día y hora indicados, cuyos datos fueron recogidos a través de un cuestionario mixto, elaborado y testado específicamente para este fin. Los resultados sociodemográficos fueron el predominio de jóvenes y adultos en igual proporción, predominio de hombres, casi todos ejerciendo actividad profesional, siendo la mayoría graduados con menos de 10 años y con menos de cinco años de ejercicio profesional. Los resultados explicativos fueron que solo uno tenía conocimientos previos de Rami 4.0, el principal motivo de tomar el curso fue adquirir nuevos conocimientos, el tema más interesante e importante fue la conectividad digital. Los resultados evaluativos fueron la satisfacción con el curso y la necesidad de trabajar los contenidos de manera práctica. La conclusión muestra que el curso logró el objetivo previsto, que era dar a conocer la arquitectura Rami 4.0 a los participantes.
Palabras clave: Evaluación del curso; Rama 4.0; Evaluación de la satisfacción; Curso de capacitación; Curso de extensión.

1. Introduction

The contemporary world is full of information and technologies. These two phenomena are consequences of human daring to build new knowledge and transform it into physical or extraphysical artifacts capable of solving problems. For this reason, it can be said that the inhabitants of the present, and even more those of the future, who want to be successful need to develop their cognitive and achievement potential so that they can be able to meet the growing human needs of the entire planet. It is this willingness to supply needs that the Rami 4.0 architecture and the extension actions of science and technology institutions have in common. They are explicit demonstrations they want and can contribute to constructing an increasingly better world for the present and future generations.

It is necessary to prepare people to live at least satisfactorily in the present and enable themselves to live better shortly. And this preparation can often come through obtaining theoretical and practical knowledge about the main aspects and tools that structure the growing novelties that modify the present all the time, hastening the arrival of the future. In this sense, the Rami 4.0 architecture is an effort to make organizations, especially industries, more intelligent, more human, and more substantive. And through university extension activities, they transform these potentialities into realities by executing projects specifically designed for this purpose.

In this sense, this study aimed to evaluate some fundamental aspects of the course on Rami 4.0 architecture offered by the Campus Manaus Industrial District of IFAM. This article comprises this introduction, a theoretical framework on Rami 4.0 evaluation, extension, and architecture, the research methodology, the evaluation results, the conclusion, and the references cited throughout the text. It includes a) the sociodemographic characteristics of the participants (to compose their profile), b)

knowing the subjects discussed that were most interesting to them and those that are likely to be part of their portfolios of products and services to be offered to their applicants, and c) to know the degree of satisfaction with the course and what needs to be done to make the course even better.

2. Extension, Rami 4.0, and Evaluation

Rami 4.0 architecture is still a phenomenon little studied from the perspective of extension as one of the three core activities of Brazilian science and technology institutions. Consequently, there are still not enough theoretical elements for constructing a theoretical architecture that can be tested empirically, nor the possibility of theoretical-empirical schemes focused on the evaluation processes of professional training and qualification courses centered on this Industry 4.0 methodology. For these reasons, in this part, we will present the outlines of the theoretical frameworks used to carry out this exploratory study of an evaluative nature.

2.1 Extension activities

Perhaps the most accurate understanding of the idea and role of extension as a practice of Brazilian science and technology institutions is the act of extending, in the broader sense of the term. To expand, in this specific case, is to spread, encompass, and spread to a whole range, as suggested by the study by Bitencourt and Hoeller (2018). To transform this popular understanding into a theoretical field, it is necessary first to understand the idea of internal and external environments that every organization has. The internal environment is everything inside your physical space, which is delimited by institutional walls; the external environment is everything beyond that boundary. The extension can be understood as expanding the internal environment into outer space. Let's see how this is done from the point of view of science.

Augusto et al. (2019) show that extension is how institutions interact with other institutions. Although the definition of these authors is limited to higher education institutions, it can be said that extension is interaction. And not just with those institutions but all types of organizations and members of communities, neighboring or distant, in the same or various physical, extraphysical, and geographical spaces. Interactions occur through activities of different natures, such as teaching, research, culture, art, service provision and technology transfer. Private institutions, of course, almost always financially charge their extension interactions. However, as it is interaction, in the same way that the institution shares something with the external environment, the external environment also needs to share something in return for what it received, even if it is symbolic.

The extension can also be considered an opportunity (Araújo, Jucá & Silva, 2019). The assumption here is that institutions have solutions or are capable of solving the problems of their external environments. As an opportunity, it is necessary to understand the alternatives that can be operationalized to articulate institutional knowledge and knowledge with the supply of environmental needs. These demands are usually of a social, economic, cultural, or environmental nature, often in the form of threats, whose solutions are shared precisely in extension projects.

The most common way of understanding and practicing extension is as a two-way street (Pereira et al., 2018). This idea covers most of the conceptual specificities practically in the literature. The institution enters the external environment and allows the entry of the external environment to its borders. The reason for this exchange is to share opportunities. The institution has the opportunity to demonstrate the strength of its knowledge and technologies. In contrast, the external community has the opportunity to take advantage of this same knowledge and technologies to face the challenges it needs to face and overcome. And the more this two-way street is repeated, the more influential the institutional role becomes and the more accreditation the external environment will have in the institution.

Oliveira and Nascimento-e-Silva (2020; 2019) have developed studies focusing on the different roles and responsibilities that institutions have assumed in partnership with external institutional communities. One of his studies shows that it is often necessary for the institution to survey its external environment to know the demands and which of these it can commit to finding a solution (Oliveira; Nascimento-e-Silva, 2020a). He cites the case of an institution that operates in the North of Brazil that discovered several opportunities that, without the research carried out, it would hardly demand. The northern external environments are still fragile in forming extension partnerships. The other study shows that extension meets needs (Oliveira; Nascimento-e-Silva, 2019), but always in the form of a two-way street.

The extension concept of this study is to supply the needs of the external environment by an institution based on some counterpart. In the case of the project under study, the external community provided resources to achieve the project's objectives: train community members on the Rami 4.0 architecture and expand the institution's extensionist capacity.

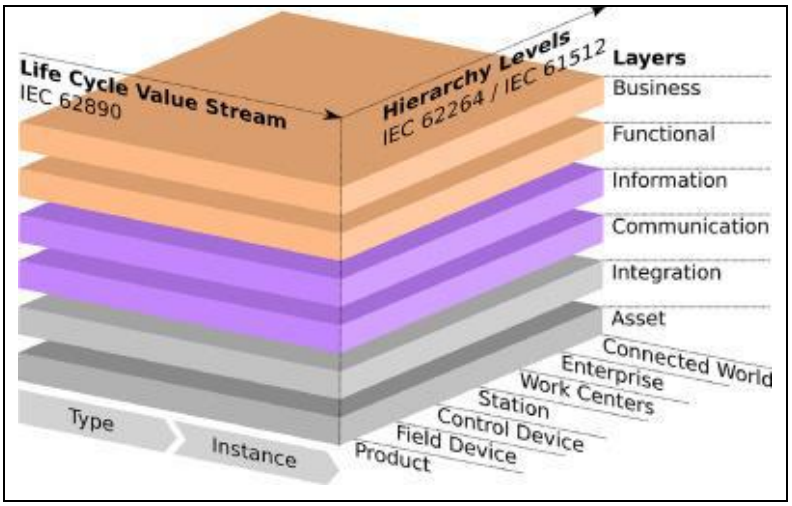
2.2 The Rami 4.0 architecture

The Rami 4.0 architecture can be understood as a reference model for implementing Industry 4.0 in a systematic, structured way (Cañas et al., 2022; Waters et al., 2022; Qureshi, Alaloul & Alzubi, 2022; Silva et al., 2023). A model is something that needs to be materialized. It is an abstraction that needs to be executed. It is the case of a technical drawing for the construction of physical facilities in a building or the materialization of production lines in a factory. Referential models, such as Rami 4.0, are referential. The referential term indicates that there is not necessarily a single way of doing all things related to production processes. On the contrary, being a reference means being a base, a signpost of what can be or is recommended. The reason for being referential is that reality is so diverse and unpredictable that it is impossible to build a non-referential model, that is, an imperative model, which is another way of saying obligatory.

It is necessary to have references, for example, to know what a quality product is or the elements and technologies that help organizations to reduce waste in their production lines. That's what Rami 4.0 is for: so that the entities that makeup Industry 4.0 have standards that allow them to connect internally and externally. A product is connected to its production line, which in turn is connected to an organization's production process, which is connected to other organizational units (marketing, human resources, finance, etc.), which are related to the organization's strategic management and so on, until the connection with the whole world. The Rami architecture presents referential models for these connections and interconnections to happen in consequent ways, as in the IR4.0 platform, which defines the communicational structure of CPS networks and collective languages (Quresh et al., 2022). Rami 4.0 does this in a structured way, facilitating the understanding of people and organizations in search of continuous improvement of production processes (Cisterna, Salimbeni, & Andaloro, 2020; Hosseini, Sauter & Kastner, 2022).

From a structural point of view, Rami 4.0 is three-dimensional, as seen in Figure 1. It was created to allow the classification, systematization, and development of Industry 4.0 technologies and new business models (Sousa, Mendonça & Machado, 2022).). Its triadic dimensions are the vertical network, product life cycles, and hierarchical layers derived from the Smart Grid Architecture Model (SAGM), as detailed in Hang et al. (2022).

Figure 1 - Rami 4.0 Architecture.



Source: Mantravadi et al. (2022).

Figure 1 shows the three-dimensional model organized around three axes (Zhang et al., 2022). The first axis is called hierarchy levels and deals with the different interconnection of all components of the production system, including information, machines, and people. It comprises six layers, each of which references a category of manageable system parts: product, the smallest unit, field device, control device, station, work centers, enterprise, and connected world. The second axis is called the life cycle and value chain. It refers to the extension and improvement of products, machines, equipment, and physical installations throughout the life cycle. The third axis is called the layers axis, and its challenge is to reference the device or process the mapping process. These layers originate from information and communication technologies, whose complexity was systematized into six: business, function, information, communication, integration, and asset.

What is the Rami 4.0 architecture for in practice? Why empower people to master your logic schemes and tools? These two central questions can be asked and require at least approximate answers. The usefulness of this model is both scientific and operational. From a scientific point of view, it allows for discussing and developing knowledge around Industry 4.0 and its consequences. From a functional point of view, it provides standards that facilitate linking particular organizational objectives with the objectives of the entire supply chain and, by extension, consider environmental and social factors. The purpose of training for this other universe is to allow participants to become intimate with these logical schemes and tools that make factories and all kinds of organizations more competent (Mantravadi et al., 2022). As even cities are becoming more intelligent, training in Rami 4.0 is a kind of passport to the future that is already present.

2.3 Evaluation of extension training

Assessing is a step in the management process control sub-process (Nascimento-e-Silva, et al., 2020; Valle et al., 2020; Ferreira; Nascimento-e-Silva, 2020; Nascimento-e-Silva et al., 2013; Oliveira & Nascimento-e-Silva, 2020b). The logical scheme of any evaluation is to compare data from what was carried out with the parameters and indicators of a previous standard or foreseen objectives and goals contained in a specific plan which, when achieved, helps to reach the institutional objectives. Conversely, every organization has objectives and goals to be achieved through strategic schemes contained in a formal document, executed through specific projects with particular purposes that need to be compared with the results obtained.

To evaluate is to compare (Kholil, Rozi & Hayati, 2022; Hasibuan, Adisaputera & Yus, 2021). What is benchmarking? Actions, resources, processes, and results were foreseen and planned, with what was executed or achieved. That is why the evaluation sub-process is part of the control process, whose challenge is to ensure that what was foreseen is effectively implemented or achieved. The evaluation takes, for example, the number of expected participants who will complete training and compares it with the number of participants who completed the course. The result of any evaluation is not a number but a value judgment based on the comparison (Honcharenko & Honcharenko, 2021): achieved or not achieved, satisfactory or unsatisfactory, conforming or not conforming, in short, yes or no. Naturally, this value judgment cannot be made in any way; there must be specific criteria for it (Praja & Yudha, 2021). These criteria are standardization (Nascimento-e-Silva et al., 2013; Valle; Nascimento-e-Silva; Silva, 2020).

It may seem strange, but the central point of the entire evaluation process is the non-conformities, and the disapprovals, as can be attested from the studies by Liu et al. (2022) and Alsulami et al. (2022). But it is straightforward to understand why the assessment focuses on the weaknesses of an enterprise: the need to eliminate or reduce them. The less liability an enterprise has, the greater the chances of achieving success, almost always translated in terms of the satisfaction of those who receive the products or services that the project performed. The evaluation is therefore aimed at continuous improvement by reducing all weak points of some action or task. Without evaluation, there is no continuous improvement. And enhancements are one of the foundations of the Rami 4.0 architecture.

What gives assurance to the managing body of an extension project about the achievement or not of the foreseen objectives is the systematic planning of an evaluation process (Jimoh & Mamman, 2022; Osório & Bornmann, 2022; Nweke, 2021). This project needs to present clarity in the objectives of the evaluation, systematic collection, organization, and analysis of data, reasonable procedures for generating the results, comprehensive strategies for interpreting the results, and an operational scheme for the weaknesses found in the generated results. These requirements guarantee the consistency and validity (as well as the quantity and quality) of the changes that every evaluation process contains (Kuswari, Haerudin & Nugraha, 2022).

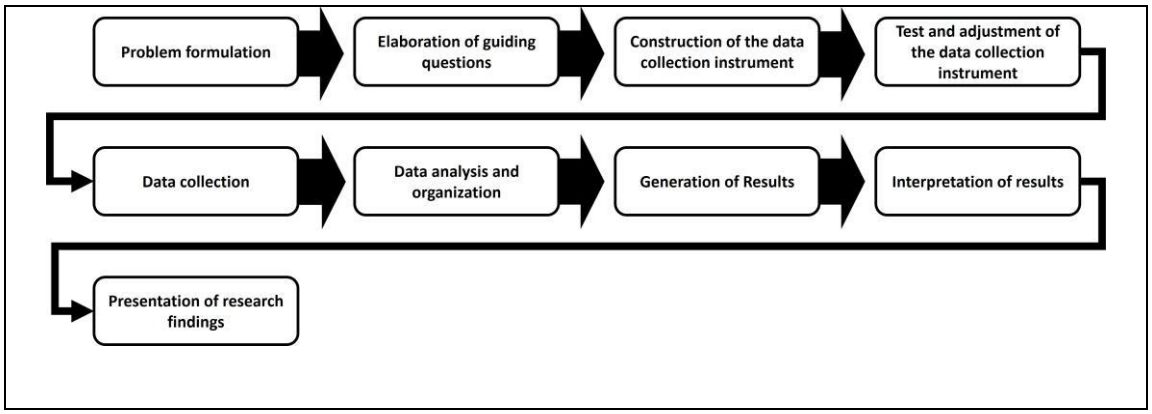
3. Research Methodology

The general objective intended by this investigation was divided into three smaller, well-defined goals, transformed into guiding questions: 1) what are the sociodemographic characteristics of the participants of the Rami 4.0 Architecture course offered by CMDI/IFAM? 2) How do participants rate critical aspects of the course content? 3) How do participants evaluate the learning received? The entire study design was designed to answer these questions.

3.1 Study design

The first step was formulating the problem, with the general objective intended to be achieved. Soon after, the guiding questions were elaborated, each focused on a specifically intended goal. Then, the data collection instrument was developed, with its appropriate dimensions and analytical categories, as recommended by the studies by Nascimento-e-Silva (2020; 2021a; 2021b; 2021c). The next step aimed to test the data collection instrument to ensure that it worked and measured what it intended to measure. Some aspects preventing its proper functioning were found, such as sociodemographic categories and the lack of clarity of some explanatory questions. Adjustments were made, and new tests were performed, assessing the instrument's adequacy to provide the results intended by the investigation.

Figure 2 - Study design.



Source: Prepared by the authors.

The fifth step was the data collection itself. It was carried out in the classroom with the presence of most respondents. The sixth step was analyzing the data and its consequent organization into some figure that summarizes them, as recommended by the scientific-technological method (Nascimento-e-Silva, 2020; 2021a; 2021b; 2021c). The seventh step was generating results aligned with the logic perceived after the data were organized. The eighth stage involved interpreting the results and comparing the empirical findings with the theoretical framework of reference. The ninth and final stage was the presentation of the results to the management body of CMDI/IFAM and sponsors.

3.2 Population and sample

The population of this study consisted of all participants of the Rami 4.0 Architecture course offered by the Manaus Industrial District Campus of the Federal Institute of Amazonas in the second half of 2022, with a total of 25 students. However, due to some dropouts and absences from classes, this number was reduced to 23. The sample consisted of 17 students at the previously scheduled class for proper data collection.

3.3 Data collection instrument

The questionnaire was the data collection instrument used, consisting of three parts. The first was a preamble, which explained the study's objectives, the way to complete the document, and the invitation for everyone to participate in providing data. Then came the sociodemographic questions (age group, sex, current professional situation, time since graduation, and time of professional experience), all closed questions. Then came the explanatory questions (whether or not he knew about Rami 4.0, the main reason that made him take the course, a subject considered the most exciting and important subject for his professional life), except for prior knowledge about Rami 4.0. The instrument ended with the evaluation of the course, composed of two questions: one about the participant's degree of satisfaction with the course and another about what the class should do to increase their degree of satisfaction.

3.4 Data collection strategy

Data were collected on the day and time agreed with the class. The researchers designed the questionnaire and slowly read each question. Respondents, in possession of an electronic copy, provided the requested answers for each question. Afterward, each reviewed their responses and sent them to the researchers' e-mail.

3.5 Techniques for organizing and analyzing data

Two were the techniques used to analyze and organize the data, performed simultaneously. For sociodemographic data and closed explanatory questions, data were analyzed based on their type and category. For example, the age group was cataloged as follows: when the first alternative was marked, the record was made with the number 1; if the second alternative was observed, the record noted the number 2; and so on. Each alternative matched its sequence number in the analytical categories. After all, responses were analyzed, the result was a table with numbers ranging from 1 (first alternative answer) to 5 (last analytical category for each question). Yes and no and equivalent questions had only two analyses: 1 (yes) and 2 (no).

The second technique was applied to the organization and analysis of textual data from the explanatory, open questions. In this case, the procedure was always to identify the answer's core. We preferred those corresponding to the subjects dealt with in the course and generally referred to specific content. Then these cores were noted, and statistics were performed to identify which were more repeated and which were unique, done with the help of a double-entry table (one for the response and the other for the frequency). For example, almost all the answers on the subject considered most interesting focused on big data, machine learning and computer vision, covered throughout the course. The same was true of the use they intended to make of the most crucial subject.

3.6 Techniques for generating and interpreting results

The results were generated following the type of data handled. Nominal data (sociodemographic and previous knowledge about Rami) were organized in frequency, seeking to know the modal class. Modal classes were interpreted as those with greater interest or concentration of responses. Then these results were compared with the theoretical frame of reference so that it was possible to know what they meant and their meanings.

Textual data were transformed into nominal. This process occurred due to the identification of their expressive nuclei. And nuclei, like all words and phrases, denote nominal data, so their modal classes can be known. For example, for the answer "I found machine learning to be the most interesting subject of the course" the core was "machine learning", while the answer "What impressed me the most was the fact that machine learning makes the machine very similar to the human being" also had "machine learning" at its core. From there, we proceeded to the interpretation as done with the sociodemographic results.

3.7 Study limitations

This study has two significant limitations. Firstly, the sample size. Faithful reproduction of the course assessment requires all participants to participate in the sample. And this is especially important in small samples, as was the case in this investigation. The participants who did not participate in the survey missed the course many times; others dropped out of the class. Probably their participation in the sample could also have skewed the results. The results achieved, therefore, despite not including the response of all participants, guarantee an accurate assessment of those who participated until the end of the course.

The second is due to the data collection procedure. There is always some possibility that researchers influence responses when they read and explain questions to respondents. This bias is possible in the case of closed questions, unlike open questions. However, due to the high maturity of the course participants and the time they were given to return the questionnaires, this limitation also does not significantly alter the results presented here.

4. Research Results and Discussion

Here are the findings of the field research, organized in three parts. The first presents the demographic aspects of the respondents, which help to compose the class profile. The second part focuses on understanding fundamental aspects of the course, such as reasons for participation and subjects considered exciting and essential. The third and last part shows the degree of satisfaction of the participants with the training and their recommendations for improvement for new classes.

4.1 Demographic aspects of respondents

The question that sought to find out about the age range of the respondents showed similar results between young people and adults. It can be seen that four respondents belong to the 25 to 30 age group and 4 to the upper range, from 31 to 35 years. The age group from 36 to 40 had 3 participants, with the majority belonging to the age group over 40, which was the modal class of the sample collected. These results indicate a balance across the age groups from 25 to 40 years, emphasizing the participation of professionals over 40. In addition, it is noticeable that professionals with experience maturity predominate when added to participants aged 31 or over, who are considered adults. Young adults aged 40 years or less were only 4 of the 17 components of the sample. It seems to confirm that Rami architecture attracts more attention from professionals with more experience and experience in life.

Regarding the profile of respondents by sex in the sample obtained, the predominance was of men, with 16 respondents, against six female participants. These results still indicate behavior that has been gradually modified in engineering and technology. The contingent of women has continuously increased, undoing the historical dominance of men in these formations and qualifications. Having 70% of participants with professional experience in a course focused on Industry 4.0 is a privilege that few institutions achieve. We sought to determine whether the participant performed any paid professional activity during the training. The results showed that 12 performed some type of professional activity, while 5 did not and were taking advantage of the time available for new learning that would allow them to strengthen their competitive power for a space in the labor market.

The answers obtained for the question that sought to know how long ago the participants had completed their undergraduate training were that, of the total number of participants, nine had less than five years of graduation, and seven completed their courses between 5 and 10 years. Four graduated between 16 and 20 years old. There is a balance between young professionals, with nine professionals with up to five years of graduation, and mature professionals, the eight who have completed their undergraduate courses for more than five years.

The results indicate that the young and the mature dared to step out of their comfort zones to enrich their stocks of knowledge and improve their skills. These results seem to indicate the search for new knowledge, skills, and horizons to be pursued in the case of young professionals. In the case of more mature professionals followed the consolidation in the form of deepening what they already mastered and who have some probability of expanding their scope of action.

The findings regarding the time of professional experience that the respondents have, in whole years, show that the predominant experience times were those of less than five years and 6 to 10 years, with 5 participants. These results indicate that 12 representatives of the sample have more than five years of experience, which constitutes an experienced group, with a high capacity to assimilate the course contents. There were three participants between 11 and 15 years old, and the age group was over 20 years old. Only one participant said he had between 16 and 20 years of professional experience.

The answers to the question that sought to know whether or not the participants had prior knowledge about the Rami 4.0 architecture showed that only one had heard about this architecture. All the rest had their first contact through the course

offered by the Campus Manaus Industrial District of IFAM. Perhaps the fact that the new training attracted them also helps explain the high degree of completion and success of participants in this second group.

4.2 Course evaluation

The evaluation of the course was based on the search to know a) what led the students to take the course, b) what was the most exciting subject they saw in the course, c) what was the subject considered the most important among all the other subjects of the course and d) and how you intend to use this critical subject throughout your professional life. The results obtained for the question that sought to know what was the main reason for the participants to take the course are contained in Table 1. "Acquiring new knowledge" was the most frequent answer, with seven respondents, followed by the reason "to meet the demands of the labor market." Almost all of the other responses had only one respondent, but in one way or another, they also targeted one of these two most frequent responses. For example, making your resume more competitive is another way to meet the demands of the job market and improve your career and salary. Knowing new technologies is an example of "acquiring new knowledge."

Table 1 - The main reason for taking the course.

Reason	Frequencies
To acquire new knowledge	7
Meet labor market demands	3
Make your CV more competitive	1
Deepen knowledge about Rami 4.0	1
Discover new technologies	1
Get technical expertise	1
improve career	1
improve salary	1
Professional qualification	1
Total	**17**

Source: Data collected by the authors.

These results indicate that what must have attracted the participants was the potential that the Rami 4.0 course has to organize and give meaning to professional training in different areas of knowledge. Obtaining knowledge means, in large part, having information about something, knowing its logical schemes, applications, and things of that nature, eminently cognitive, without concern for acquiring skills. But things change when looking at alternatives aimed at strengthening the curriculum and competitiveness in the job market. The job market wants those who know how to do it, not those who have heard about it. Therefore, perhaps the answer "acquiring new knowledge" contains similarities such as "acquiring new skills" and its variants, such as "knowing how to handle new technologies" or "learning new techniques."

Regarding the question about the most exciting subject of the course, which is usually something that attracts a lot of attention for several different reasons, the results in Table 2 show that digital connectivity was the most frequent answer, with four respondents saying so. Synthetic biology and digital twins, both with two responses, were the other two most frequent subjects. All the others were exciting news for only one respondent.

Table 2 - The most exciting topic of the course.

The subject considered most exciting	Frequencies
Digital connectivity	4
Synthetic biology	2
Digital twin	2
Computer vision	1
Big data	1
Reference layers	1
EMA	1
Technological innovations	1
Integration between different technologies	1
Artificial intelligence	1
Manufacturing supervision systems	1
Leading technologies of the future	1
Total	17

Source: Data collected by the authors.

A closer look at the responses realizes that technology was a great success and aroused interest among respondents. Almost all the responses generated are either a de facto expression of technologies or are linked to them. Take the case of computer vision, artificial intelligence, and big data, which are technologies; Technological innovations and integration between technologies and reference layers are essential aspects of the technological and technological world. It signals course managers to plan more practices on the technologies so that the initial interest is maintained until the end of the course.

But why did these subjects become attractive to respondents? This question was formulated to try to understand this; whose answers are shown in Table 3. The only repeated answer was the one that showed that two people said they worked in the area and that this fact made the matter necessary. The wide variety of responses shows that the course presented many exciting subjects, which probably matched their particular wishes with what was worked on in training. It may also have been reflected in the topics chosen to prepare the final coursework.

Table 3 - Why do they find this topic the most interesting?

Why was it the most interesting?	Frequencies
Works in the area	2
Machine virtualization	1
Deals with a variety of subjects	1
Neural networks	1
Quality of life	1
Possibility of application	1
It involves the use of more excellent technologies so that	1
Protocol standardization	1
Due to the various existing protocols	1
Future of industries	1
Improves the life of society	1
Task management	1
Information Sharing	1
Direct application of technologies	1
Data analysis	1
Total	**17**

Source: Data collected by the authors.

These results seem to indicate that the contents covered in the course caught the respondents' attention in a very positive way, which were transformed into first memories when asked why they were important. The fact that the answers are practically not repeated also signals the particularity of the most likely contemplated interests. However, it is not known to what extent or to what time. It's one thing for the subject to be interesting; it's another thing to be necessary. A topic may be interesting and catch someone's attention, but it may not be considered necessary.

Table 4 shows the results of the question that sought to determine which subjects covered in the course were considered necessary for the respondents' professional life. Again, here, a few responses were repeated. Equipment connectivity, three answers, process optimization, and big data were the only three subjects with repetition. All the others received unique, singular votes, probably corresponding to the particular interests of each participant.

Table 4 - A most important topic for their professional life.

The most crucial subject of Rami 4.0 for professional life	Frequencies
Equipment connectivity	3
Process optimization	2
Big data	2
Pathways to Industry 4.0	1
Cloud computing	1
OPC UA communication	1
EMA	1
Protocol implementation	1
Interconnections between different professionals	1
IoT	1
Work methodology	1
Integrated systems with machines	1
Data verticalization	1
Total	**17**

Source: Data collected by the authors.

Probably the essential issue is the ability of the Rami 4.0 architecture to enable the interconnection of people, information, machines, and production processes. Examples of this grouping are the answers about equipment connectivity, OPC UA communication, interconnections between different professionals, integrated systems, and data verticalization. Added to these subjects are others, such as cloud computing and big data. Perhaps the fact of witnessing logical schemes and demonstrations of a truly connected world impressed the participants in such a way that they led them to see that interconnection is a fact that most likely structures and will continue to structure present and future reality.

Table 5 shows the results of the question that sought to identify why the participants considered those subjects the most important for their professional life. Again, the answers were singular, not repeated. These reasons are centered on the reality of the Industry 4.0 phenomenon. There are possibilities for a) uses of the subjects in the metallurgical industry, b) working on installation projects and optimizing processes, c) in the technologies themselves, such as IoT, remote access, and artificial intelligence, or d) in what technologies can do and what the phenomena require to be done (such as agility and efficiency in the work process, analysis of large volumes of data and meeting deadlines). These applications do not disregard personal and professional factors, such as professional growth and the possibility of integrating and working with different professional segments.

Table 5 - Why do they consider this subject the most important for your professional life.

Why it's the most important for professional life	Frequencies
IoT communicates with machines to collect data and indicators for decision	1
Remote access	1
Agility and effectiveness in the process are priorities where you work	1
Agility in the work process	1
Analysis of large volumes of data for decision making	1
Subject to which he has dedicated himself in recent years	1
Data sharing between different workstations	1
Professional growth	1
Deadline accomplishments	1
It is essential for processes and improving their control	1
This layer contains guidelines for asset management best practices	1
There is great demand for data manipulation with AI	1
Integrate different professional segments	1
Process optimization with efficiency and quality	1
Ability to work on installation projects	1
Possibilities of use in the metallurgical industry	1
Protocol for joining different technologies regardless of manufacturer	1
Total	**17**

Source: Data collected by the authors.

These results signal the respondents' perception of a different and perhaps new world. Maybe the novelty does not lie in the fact that they have never heard of it but in understanding logical schemes that can be understood and empirically verified, especially considering that most respondents are integrated into the labor market. It is likely that now they had managed to understand why many things happen in a certain way, whose logic, before, was unknown to them. A particular sense was discovered with the informal data obtained from participants in informal conversations throughout the course.

Table 6 shows the results obtained for the question that sought to know what the course participants intended to do with that subject considered the most important. Again, here, responses were infrequent. Except for applying in the work environment, sharing knowledge, and analyzing data, all with two citations, the others presented only one answer. Two examples of uses and applications that would make these critical subjects learn could also be shown for this question.

Table 6 - Uses they intend to make of the most critical subject.

Uses they intend to make	Frequencies
Analyze data	2
Share knowledge	2
Apply to the desktop	2
Do another degree to delve deeper into Rami 4.0	1
Do full-time asset monitoring online	1
Apply new ways to automate	1
Apply with your customers	1
Helping the healthcare industry	1
Work with big data	1
Collect data	1
Work with connectivity	1
Create communication protocols	1
Working with Data Science	1
Develop improvement projects	1
Establish collaboration for technology	1
Smart factory	1
Take other Rami 4.0 courses	1
Working with digital twins	1
Work with IoT	1
Working with machine learning	1
Organize your workload	1
Reduce jobs in hazardous environments	1
Save files to the cloud to access them remotely	1
Work safely at work	1
Be a multiplier	1
Use data remotely	1
Implement computer vision in the production process	1
Total	**31***

* It allows two responses. Source: Data collected by the authors.

The results listed in Table 6, in a way, summarize all the learning and the entire programmatic content of the course in its theoretical and practical aspects. These results seem to indicate that professional training was successful. The success is confirmed by the fact that there was no predominance of one subject over the others, as it also seems to happen with a certain normality, especially when the teacher has a preference for one of them. Some uses are markedly professional, such as being a multiplier, in the sense of teaching others what has been learned. Still, most are notoriously directed towards providing services, especially technical consultancy, either internally in the company or externally, who you know, like a new entrepreneur.

4.3 Assessment of the satisfaction with the course

The results obtained for the question sought to know the respondents' degree of satisfaction or dissatisfaction in relation to the Rami 4.0 course. First, the dissatisfaction alternatives (wholly or predominantly) were not considered. On the other hand, there were 13 responses indicating degrees of satisfaction, with seven being largely satisfied and six completely satisfied. The results are completed by the finding of 4 respondents who said they were neither satisfied nor dissatisfied. It can also be seen that the modal class is the "mostly satisfied" alternative, which is the one whose frequency is higher. The median of the data was calculated since it is noted that this is not a standard, Gaussian distribution, with a value of 4, which also confirms that the alternative "mostly satisfied" divides the sample into two homogeneous parts.

These results indicate several fundamental aspects from the point of view of an evaluation scheme, as shown in the literature review (Kholil et al., 2022; Hasibuan et al., 202)1. The first is a good contingent of course participants whose satisfactions (or dissatisfactions) are practically non-existent. They are indifferent. Indifference represents needs that have not been adequately met. Managers need to listen to indifferent participants to improve training. The second thing is this: it takes effort from managers and professors to transform indifferent respondents into satisfied ones. It will compose a new majority of course participants whose needs have been completely satisfied. And the third aspect discovered is, of course, that the training needs to be remodeled its teaching-learning process changed, which is the way of transforming this type of operation, making it necessary to apply the fourth stage of the control process as a component of the management process (Valle et al., 2020; Ferreira, Nascimento-e-Silva, 2020; Nascimento-e-Silva et al., 2013). But what to improve? This is what the next question was designed for.

The data also showed the significant improvement that the course needs to provide. Almost all respondents said it is more practical, with 12 responses. The analysis of the other responses also moves in this direction. For example, the response application at CMDI means to practice the course content on campus. At the same time, the response Laboratory 4.0 also signals, in this sense, to have a laboratory space where you can practice what is theoretically taught. The same thing happens with the information that it is necessary to increase the workload of the course precisely to allow a more significant workload focused on practice, which consequently forces a change in the teaching methodology.

These discoveries are both exciting and natural. They are natural because they are part of the consequences of any planned action that does not reach the fullness of its objectives, forcing the application of replanning (Guo et al., 2022; Di Lillo, Di Vito & Antonelli, 2022; Nash et al., 2022; Lager, Spampinato & Papadopoulos, 2022). They are interesting because they confirm that technical training focused on complex knowledge and skills, as is all Rami 4.0 content, often needs to change the teaching strategy's order. In these cases, it is fascinating to start with the applications, especially when the participants already have solid professional backgrounds and even though they have never heard of any item in the syllabus of the course. There are several possible combinations for the construction of a teaching-learning strategy. Sometimes it is necessary to alternate practices with theories or whatever is more advanced. But the logic schema starts with showing some logic schema, demonstrating it in practice, and then dedicating considerable time to practicing it to gain skill and consolidate it in the participant's mental structures.

5. Conclusion

The evaluation of the Rami 4.0 architecture training course offered by the Manaus Industrial District Campus of IFAM showed that it is necessary to work more on the theoretical aspects of the syllabus. In general, the participants showed satisfaction with the course. However, it is still required and possible to increase the degree of pleasure even more, mainly

because many participants were indifferent, and the majority evaluated themselves only as largely satisfied. It is possible and necessary to make an effort to migrate assessments of indifference to delight.

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