

Development of manufacturing engineering program of Bulacan State University using employability tracer study

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ABSTRACT

Tracer study is one of the continuous quality improvement tools for curriculum development. The graduates are invited to answer the tracer form to determine their employability. Since the Manufacturing Engineering program in Bulacan State University (BuLSU) is the youngest engineering program, there is minimal data on graduates available, especially on the details of their first jobs, such as the first job related to the program, time taken to land their first job, gross monthly salary, and learning competencies. The demographic profile of the manufacturing engineering graduates from 2015 to 2019 is preserved and remains strictly confidential for the safety of their identification. Correspondingly, the study applied a cross-sectional retrospective survey method. Moreover, 67.41% of manufacturing engineering graduates responded. The employment rate of manufacturing engineering graduates was 93.38%, whereas regular or permanent in their current employment was 84.40%. Furthermore, data show that they are employed within less than a month, 50.97% of responses. Lastly, the primary learning competency that manufacturing engineering graduates consider is critical thinking skills, with a response rate of 86.11%, followed by problem-solving skills, with 81.94% responses, while third was communication skills, with a rate of 78.08%. Ultimately, the recommendations for further curriculum and program improvement are exhibited.

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1. INTRODUCTION

COVID-19 paralyzes the development of many countries. Particularly in the Philippines, a developing country, the impact is notable since government struggles to shift and deliver its transactions and services thru the online method. Manufacturing, retail-wholesale trade, and government services are the three sectors identified as directly and critically affected by the pandemic [1]. Aside from the low demand for products in manufacturing, the pandemic's ripple effect also hit local employment in the industry-manufacturing sector. For instance, in the garment manufacturing industry, less demand for garment products from buying countries like the United States and European countries results in cost-cutting or closing of some companies in Asian countries like the Philippines [2].

On the other hand, the efficient distribution of vaccines throughout the country, simultaneously implemented with the right government policies to fight COVID-19, resulted in a decrease in COVID-19 positive cases and death in the Philippines, as shown in the infographics by World Health Organization [3]. Additionally, the response and action of the private sector towards COVID-19 contribute to more aware and

vaccinated individuals. According to a survey conducted by Social Weather Station (SWS), last September 2020, 63% of the respondents believed that the private sector response to prevent COVID-19 spread was adequate [4]. In fact, from 33% last May 2021 down to 8% in December 2021, surveyed adult Filipinos answered do not want to have a vaccination [5]. The result implies that more Filipinos are confident about being protected by COVID-19 thru vaccines and understand its benefits. Accordingly, the reopening and full-scale workforce of most agricultural, services, and industry sectors decreased the number of unemployed from 3.23 million last July 2021 to 2.60 million this July 2022 [6]. Moreover, the industry sector, particularly manufacturing, obtained 41.7% of employed persons for July 2022 statistics [6], the target workforce market of manufacturing engineering graduates.

The Bachelor of Science in Manufacturing Engineering and Management (BS-MEM) program is duly approved by the Board of Regents Resolution #5-2007 to start its course offering at Bulacan State University (BulSU), Malolos Campus last AY 2007-2008. The first graduates of the program are batch 2013. There is a revision on the program name and simplified it into Bachelor of Science in Manufacturing Engineering (BS-MfE) implemented since 2017 graduates. The program received its certificate of program compliance (COPC) last May 2021 from the Commission on Higher Education (CHED). It also complied with Accrediting Agency of Chartered Colleges and Universities in the Philippines (AACUP) accreditation level II with effectivity from October 2021 to October 2025. Aside from BulSU, other Universities that offer the same program, such as De La Salle University (DLSU), Mapua University (MAPUA), Pamantasan Lungsod ng Maynila (PLM), and Far Eastern University (FEU), which are all known also for excellent tertiary education provider in the Philippines. The core design of the MfE curriculum in BulSU consists of major courses involving process improvement tools, statistical analysis and tools, machine design and systems, automation and robotic systems, and product design development. Furthermore, the program's target market for graduates is manufacturing, and their typical job assignments are related to product and process improvement, planning and development, quality control, research and development, logistics and supply chain, and automation & robotic systems.

The CHED mandate was to promote and ensure the quality of higher education institutions (HEI). They serve as the monitoring and governing body of tertiary education in the Philippines. One continuous quality improvement (CQI) tool was conducting and utilizing tracer studies [7]–[9]. According to Reyes and Salas [10], the CHED recommends yearly tracing of graduates. In the study of Sira and Valenciana [11], six months to three years is suitable. Since there is high competition among all produced graduates compared to the created opportunities by the industry [12]–[14], the HEI must secure the graduates by complementing the needs and demands of the industry [15]–[17]. This is one of the responsibilities of the university as they commit to excellent instruction [18], [19]. Correspondingly, it includes periodically improving the program's curriculum that matches the trends of technology utilized by most industries [20], [21], especially since the subject of this study is manufacturing engineering undergraduate inclined toward technology. Aside from the curriculum, it is also essential to improve and realign student outcomes suitable to the skillset needs [22]–[25]. One of the metrics to measure the program's curriculum effectiveness is through the graduate's employability or feedback using a tracer study [26]–[28]. The alumni response and their suggestions and recommendations should be assessed and considered for the development of the program [19], [29] not only the curriculum but also the ways and processes involving the department, for instance, the teaching strategy of faculty. Thus, graduate tracing is not new; in fact, it is widely used by many faculty researchers to improve their respective programs [30]–[33]. Since the BS-MfE program of the College of Engineering at Bulacan State University is the youngest engineering program offered, it is in high time and vital to conduct a graduate tracer study to assess the program's relevance and graduates' employability. The data gathered will be the primary information or inputs to revise the curriculum and create policies to improve graduate attributes and match the industry's demands.

2. RESEARCH METHOD

This tracer study for the employability of BS-MfE graduates utilized a cross-sectional retrospective survey method. The study was conducted at BulSU–Main Campus. Aside from the main campus, BulSU has six satellite campuses around Bulacan province, including Bustos, Hagonoy, Sarmiento, Meneses, Pulilan, and the forthcoming San Rafael Campus. Moreover, the BS Manufacturing Engineering program is under the College of Engineering and is exclusively offered only in the Main Campus in Malolos City of Bulacan. Additionally, there were 224 BS-MEM and BS-MfE graduates from 2015 to 2019. These graduates are identified and given survey questionnaires. The responses accumulated are 151 out of 224 or 67.41%, as shown in Table 1. The study utilized Slovin's formula to determine the accurate sample needed [24]. The result of the procedure is 144, which is the minimum required sample for the 224-population achieved by the study.

Moreover, most graduates worked within Bulacan province, some outside of Bulacan, and few outside the country. The data gathering transpired between March to August 2022. COVID-19 cases were prevalent during this time, and the survey questionnaires were given thru instant messaging (e.g., Messenger) for flexibility and ease of contact since, based on the experience of the researchers, low to no response rates were obtained thru emails, and text messages, or phone calls. Instead, the study utilized these low response rate methods as notifications or reminders for the graduates to answer the Google Form already given to their messengers.

The instrument used to gather data was the modified version of the BulSU tracer survey, derived from the graduate tracer survey questionnaire form of CHED Philippines. The Google Form content includes the following questions: i) their basic information, e.g., full name, age, address, gender, date of birth, civil status, contact number; and ii) employment-related information, e.g., employment status and classification, reasons for being unemployed or not yet employed, first job relation to their employment, first job gross monthly earnings, time take to land in their first job, and learned competencies useful to their work. Since the primary method of gathering data was through online formats, the researchers devised a revised version of the tracer study using Google Forms. The data are extracted and used in Microsoft Excel for managing, processing, organizing, and analyzing. The study used descriptive statistics to generate, collect, and summarize the data through frequency and percentage distribution tables.

Furthermore, to avoid ethical issues in the study, the researchers provided a section in the Google Form for the respondents' informed consent and data privacy. The respondents are informed on how their information is processed in this study. The researchers strictly preserve their information, and their identity will remain confidential. There are no respondents' names or content that leads to a specific respondent that were included in this study. Instead, the summarization and the presentation of the study results are general. Lastly, no person or organization is harmed during the study.

3. RESULTS AND DISCUSSION

3.1. Respondents of the study

The program of Manufacturing Engineering was classified into two, covering 2015 to 2016 for BS-MEM, and 2017-2019 for BS-MfE. As shown in Table 1, the response rate yielded 67.41%, 151 respondents out of 224 total manufacturing engineering graduates. Moreover, the study utilized Slovin's formula to validate the sample size [24]. The result was $143.59 \approx 144$ respondents, with a margin error of 0.05, which shows that the study respondents meet the required sample size. In comparison with the respondents of other tracer studies in the engineering field conducted, 96.59% were achieved by Pontillas [20] of electrical engineering graduates, Locquias attained 47.87% of respondents from electronics engineering graduates [24], while 53.65% of industrial engineering graduates answered in the other study [34], and 42.86% computer engineering graduates responded in the previous study [35]. Furthermore, the response rate of the survey is indeed acceptable.

Table 1. Manufacturing engineering number of graduates and respondents from 2015-2019

Program	Batch	No. of graduates	No. of respondents	%
BS-MEM	2015	23	10	43.48
	2016	30	20	66.67
BS-MfE	2017	65	41	63.08
	2018	48	36	75.00
	2019	58	44	75.86
Total		224	151	67.41

3.2. Gender and civil status

For the gender category of the tracer study, most manufacturing graduates were male, which is 83 out of 151 or 54.97% of the total respondents, as shown in Table 2. Compared to the other disciplines, such as Flores *et al.* [7], mechanical engineering graduates, most respondents were male, with 83.50% result. In the study by Pontillas [20] among electrical engineering graduates, the dominant gender was also male, with a mark of 82%. Likewise, the survey among electronics engineers' graduates of [24] reveals 72.22% of male respondents. In the marine engineering field, it is expected to be a male-dominant program, as shown in the Galicia and Samillano [33], that 97% of the respondents were male. Similarly, according to [35] of computer engineering graduates, 62.96% were male. Moreover, in the program of industrial engineering, in the study by Curbano and Bustamante [34], the program was dominated by females with a result of 54.55%. Furthermore, the intensive work engineering disciplines were still dominated by male. On the other hand,

engineering field that deals mainly with process improvement, analysis, and experiments, like industrial engineering, are more popular with females. Since industrial engineering was an allied program of manufacturing engineering, many females also pursued the manufacturing engineering program. Along with Table 2 was the civil status of the respondents. Most manufacturing engineering graduates were still single, with a rate of 92.05% or 139 out of 151 respondents. Contrary to the result of Pontillas [20], married status is more significant than single with 66%.

Table 2. Manufacturing engineering graduates' gender and civil status

Program	Batch	No. of response	Gender				Civil status			
			Male		Female		Single		Married	
			f	%	f	%	f	%	f	%
BS-MEM	2015	10	5	50.00	5	50.00	9	90.00	1	10.00
	2016	20	12	60.00	8	40.00	15	75.00	5	25.00
BS-MfE	2017	41	22	53.66	19	46.34	35	85.37	6	14.63
	2018	36	16	44.44	20	55.56	36	100.0	-	-
	2019	44	28	63.64	16	36.36	44	100.0	-	-
Total		151	83	54.97	68	45.03	139	92.05	12	7.95

3.3. Employment status

The researcher divided the conventional employment status answer into three classifications, shown in Table 3. The classification of current employment status was employed, not employed but with previous employment, and never been employed. The revision will further analyze the details and serve as input for the program's improvement. Moreover, it is notable that most manufacturing engineering graduates who responded to the tracer survey are employed, which is 141 out of 151 or 93.38% employment rate. At this rate, the program is competitive and comparable to the other engineering disciplines, especially allied programs. These allied programs include electrical engineering, according to Pontillas [20] results revealed 98.73% employed, and according to Abana and Lorenzo [36] with a 100% employment rate. Likewise, in electronics engineering, the study [24] revealed that 91.67% are employed, and the result of the previous study [36] is an 88.57% employment rate. Another is computer engineering, a research study [35] got an 85.19% employment rate, and another study [36] obtained 92.06%. Lastly, according to Curbano and Bustamante [34], 44 out of 82 industrial engineering graduates' respondents are employed, a 100% rate.

Table 3. Manufacturing engineering graduates' current employment status

Program	Batch	No. of response	Current employment status					
			Employed		Not employed (with previous employment)		Never been employed	
			f	%	f	%	f	%
BS-MEM	2015	10	10	100.00	-	-	-	-
	2016	20	20	100.00	-	-	-	-
BS-MfE	2017	41	40	97.56	-	-	1	2.44
	2018	36	33	91.67	3	8.33	-	-
	2019	44	38	86.36	-	-	6	13.64
Total		151	141	93.38	3	1.98	7	4.64

3.4. Classification of employment

The five-employment classification is shown in Table 4. Data unveils that most respondents are regular or permanent in their respective work, which is 119 out of 141 or 84.40%. Comparatively to the results from other allied disciplines, electrical engineering graduates from the study of [20] revealed that 56.41% are permanent, and 61.54% have permanent status in the study of [36]. In electronics engineering, previous research [24] revealed 50% were employed in permanent positions, and the study of [36] obtained 80.77% permanent employment status.

Additionally, computer engineering graduates in previous study [35] disclosed 85.19% are regular or permanent, and 56.89% in another study [36] are permanent. Moreover, the industrial engineering tracer study [34] discovered that 70.45% have permanent employment status. Compared to the results of the study from other disciplines, it is indeed that manufacturing engineering graduates penetrate the labor force market of the manufacturing industry, and the companies that recognize the graduates' abilities are increasing gradually.

Table 4. Manufacturing engineering graduates' employment classification

Program	Batch	No. of employed respondents	Employment classification									
			Regular		Temporary		Casual		Contractual		Self-employed	
			f	%	f	%	f	%	f	%	f	%
BS-MEM	2015	10	8	80.00	-	-	-	-	1	10.00	1	10.00
	2016	20	18	90.00	-	-	-	-	2	10.00	-	-
BS-MfE	2017	40	35	87.50	1	2.50	-	-	3	7.50	1	2.50
	2018	33	27	81.82	-	-	1	3.03	5	15.15	-	-
	2019	38	31	81.58	3	7.89	-	-	4	10.53	-	-
Total		141	119	84.40	4	2.84	1	0.70	15	10.64	2	1.42

3.5. Reasons why graduates are unemployed or not yet employed

Table 5 reveals the data of reasons why BS-MfE graduates were unemployed. The unemployed status was classified into two, namely i) not employed but with previous employment and ii) never been employed, as shown in Table 3. Additionally, the respondents may respond with multiple reasons why they are not employed. Moreover, the main reason for their unemployment is that they “didn’t look for a job yet” acquired data presented 5 out of 10, or 50%. Followed by “no job opportunities” and “family concerns,” which are 40%. Furthermore, the least reason responded was “no job opportunity” and “further studies,” which acquired 20%.

Table 5. Reasons why some manufacturing engineering graduates are not yet employed

Program	Batch	A	B	Reasons why some graduates are not yet employed											
				Further studies		Family concern		Health-related reason/s		No job opportunity		Did not look for a job yet		Qualifications did not fit for the job	
				f	%	f	%	f	%	f	%	f	%	f	%
BS-MEM	2015	-	-	-	-	-	-	-	-	-	-	-	-	-	
	2016	-	-	-	-	-	-	-	-	-	-	-	-	-	
BS-MfE	2017	-	1	-	-	1	100.00	-	-	-	-	1	100.00	-	-
	2018	3	-	1	33.33	1	33.33	-	-	-	1	33.33	1	33.33	
	2019	-	6	1	16.67	2	33.33	4	66.67	2	33.33	3	50.00	2	33.33
Total		3	7	2	20.0	4	40.00	4	40.00	2	20.00	5	50.00	3	30.00

A=No. of respondents not employed but with previous employment, B=No. of respondents never been employed

3.6. First job relation to program

The data gathered for the category of the “first job related to the program” is shown in Table 6. For the 2015 batch, only one respondent said that the first job was unrelated to the manufacturing engineering program. Then, all responses from batch 2016 affirm that their first job was relevant to the program. Moreover, 3 out of 40, or 7.50%, respondents from batch 2017 confirm that their first job was irrelevant to the program. While on the 2018 batch, only 1 response was recorded that the first job was unrelated to the manufacturing engineering program. Furthermore, in batch 2019, there was a slight increase in the number of graduates whose first job was unrelated to the program, which is 4 out of 38 or 10.58%. Accordingly, most of the respondents' first jobs are related to manufacturing engineering, resulting in 93.75% or 135 out of 144 responses.

Table 6. Manufacturing engineering graduates' first job related to the program

Program	Batch	No. of respondents with experience or first job	First job related to the program			
			Yes		No	
			f	%	f	%
BS-MEM	2015	10	9	90.00	1	10.00
	2016	20	20	100.0	-	-
BS-MfE	2017	40	37	92.50	3	7.50
	2018	36	35	97.22	1	2.78
	2019	38	34	89.47	4	10.53
Total		144	135	93.75	9	6.25

3.7. First job gross monthly earnings

The “first job gross monthly earnings” results are exhibited in Table 7. This category is divided into six salary ranges in Philippine Peso units. Data results reveal that P10,001 to P15,000 was the usually offered salary for fresh manufacturing engineering graduates, followed by P15,001 to P20,000, close enough to the

previous range and one level higher. Also, there are few salary offers for some fresh graduates in the two-level higher salary range compared to the usually offered salary, while few but notable responses for the highest range. Compared to the graduates of other engineering disciplines, the average salary range of their graduates is between P15,000 to P20,000 [20], [24], [34]. This indicates that the salary of fresh graduates of manufacturing engineering is competitive with other engineering disciplines.

Table 7. Manufacturing engineering graduates' first job gross monthly earnings

Program	Batch	A	Gross monthly earnings (first job)											
			Less than P5,000		P5,001- P10,000		P10,001- P15,000		P15,001- P20,000		P20,001- P25,000		More than P25,000	
			f	%	f	%	f	%	f	%	f	%	f	%
BS-	2015	10	-	-	1	10.00	4	40.00	3	30.00	2	20.00	-	-
MEM	2016	20	-	-	1	5.00	8	40.00	6	30.00	3	15.00	2	10.00
BS-MfE	2017	40	-	-	3	7.50	14	35.00	19	47.50	3	7.50	1	2.50
	2018	36	-	-	-	-	15	41.67	14	38.89	5	13.89	2	5.55
	2019	38	-	-	2	5.26	19	50.00	11	28.95	4	10.53	2	5.26
Total		144	-	-	7	4.86	60	41.66	53	36.81	17	11.81	7	4.86

A=No. of respondents with experience or first job

3.8. Time took to land their first job

The data results for the “time it took the graduates to land their first job” are exhibited in Table 8. Data reveals that manufacturing engineering graduates at Bulacan State University are employed within less than a month with a rate of 73 out of 144, or 50.97%, or one to less than six months with a rate of 40.97%. In the electrical engineering graduates, the tracer study conducted by [20] and [36] reveals that their graduates landed their first job within seven months to one year, and seven to nine months, respectively. Moreover, the study of Loquias [24] disclosed that their electronics engineering graduates took seven months to 1 year to land their first job, similar to Abana and Lorenzo [36] in which graduates took more than nine months. Then, in computer engineering, according to Alejo *et al.* [35], their graduates landed their first job between one to six months, the same case with Abana and Lorenzo [36], which reflects a similar length of time. Furthermore, compared to the other allied programs, manufacturing engineering graduates of BulSU may land their first job within less than six months.

Table 8. Manufacturing engineering graduates' time took to land their first job

Program	Batch	A	Length of time it took the graduates to land their first job											
			Less than a month		1 to 6 months		7 to 11 months		1 year to less than 2 years		2 years to less than 3 years		3 years to less than 4 years	
			f	%	f	%	f	%	f	%	f	%	f	%
BS-	2015	10	4	40.00	4	40.00	-	-	1.00	-	1.00	-	-	
MEM	2016	20	8	40.00	10	50.00	1	5.00	1	5.00	-	-	-	
BS-MfE	2017	40	18	45.00	17	42.50	3	7.50	1	2.50	-	-	1	2.50
	2018	36	22	61.11	12	33.33	-	-	2	5.56	-	-	-	
	2019	38	21	55.26	16	42.11	-	-	1	2.63	-	-	-	
Total		144	73	50.70	59	40.97	4	2.78	6	4.17	1	0.69	1	0.69

A=No. of respondents with experience or first job

3.9. Graduates' competencies

Table 9 reveals the data on competencies that manufacturing graduates find helpful for their employment. Competencies are identified according to six categories. In addition, the respondents may answer with more than one competency.

The graduates considered the most critical thinking skills as the main competency with an 86.11% response rate, followed by problem-solving skills with 81.94% of respondents, and third was communication skills with a rate of 78.08% response rate. As engineering graduates, the manufacturing engineering program curriculum deals with the technologies utilized by manufacturing companies, process improvement tools, international and local standards, research & development, which improve their critical thinking, problem-solving, and communication skills. Thus, these competencies are expected to be their edge and valuable for their job.

Table 9. Manufacturing engineering graduates' competencies learned in college that they find helpful in their job

Program	Batch	A	Competencies learned in college that graduates find useful in their job											
			Communication skills		Information technology skills		Human relations skills		Problem-solving skills		Entrepreneurial skills		Critical thinking skills	
			f	%	f	%	f	%	f	%	f	%	f	%
BS-	2015	10	9	90.00	2	20.00	5	50.00	10	100.0	1	10.00	9	90.00
MEM	2016	20	16	80.00	9	45.00	12	60.00	16	80.00	4	20.00	18	90.00
BS-	2017	40	31	77.50	10	25.00	18	45.00	33	82.50	4	10.00	33	82.50
MFE	2018	36	29	80.56	18	50.00	19	52.78	32	88.89	11	30.56	33	91.67
	2019	38	26	68.42	12	31.58	18	47.37	27	71.05	9	23.68	31	81.58
Total		144	111	77.08	51	35.42	72	50.00	118	81.94	29	20.14	124	86.11

A=No. of respondents with experience or first job

4. CONCLUSION

Tracer studies are essential for developing the program curriculum since they provide feedback from the graduates, and the inputs gathered in this study will help address curriculum issues or adjust and improve it to harmonize the demand for skills in the manufacturing industry. In this study, the following data are extracted from the tracer form: i) the number of respondents (BS-MEM and BS-MFE); ii) gender & civil status; iii) employment status; iv) employment classification; v) reason being unemployed; vi) first job relevance to program; vii) first job gross monthly earning; viii) the time took to land in their first job; and ix) competencies useful for work. There are 224 graduates distinguished from 2015 to 2019, 151 or 67.41% responded in this study, comprising 83 males and 68 females, which also consisted of 139 were still single, and 12 were already married. Additionally, the program is indeed employable, with a data result of 93.38% employment rate, consisting of the regular or permanent status of 84.40% responses, which supports the data result that graduates' first jobs are relevant to the program response rate of 93.75%. Moreover, for the time it takes to land their first job category, data shows that they are employed within less than a month or one to less than six months, with a response rate of 50.97% and 40.97% respectively, with a usual gross monthly salary offered in their first job of Php 10,001 to Php 15,000, with a rate of 41.66%, succeeded by Php 15,001 to Php 20,000, which takes 36.81%, followed by notable responses with more than Php 25,000 with a recorded response of 4.86%, which means that the manufacturing engineering program has the potential and capability to meet the demand for higher positions or complex work in the company. The primary learning competencies that manufacturing engineering graduates consider and help them in building their professional careers are critical thinking, problem-solving, and communication skills, with response rates of 86.11%, 81.94%, and 78.08%, respectively.

Furthermore, the result of the study formulates the following recommendations or policies: i) Continue conducting school-to-school promotions for more comprehensive connectivity among senior high schools (K11 and K12) and disseminate information regarding the manufacturing engineering program to boost program commercialization; ii) Periodically subject to curriculum review by the program stakeholders: alumni, industry representatives, faculty, and academic leaders for the program's continuous quality improvement through updating the course offerings paralleled to the latest technology or trends; iii) Conduct a tracer survey or study every one to two years after graduation and consider formulating a form that covers both the tracer and the program's educational objectives (PEOs), the amalgamation of the two forms (tracer and PEO) encourages the graduates to answer surveys and avoid redundancy of contents for the creators; iv) Assess and scrutinize the BS-MFE assigned fieldwork during immersion by providing a comprehensive list of manufacturing companies and assigned fields of work by the coordinator to ensure accurate and maximum relevance to program experience; Lastly, v) industry immersion for faculty shall be conducted to improve the knowledge and adapt the latest developments of technology and trends for the inputs in curriculum development. Finally, the study result reveals that the manufacturing engineering program at Bulacan State University is indeed employable.

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