

# Shifting from a Software Developer to a Metaverse Developer Career: A Multimethodology Future Perspective

Mays Waleed Jarwan  
[Mais198410@gmail.com](mailto:Mais198410@gmail.com)

## Abstract

This study aimed at investigating the aspects controlling shifting from a software developer to a Metaverse Developer Career. For that, the researcher adopted the multimethodology approach using mixed methods between quantitative and qualitative research methodologies, as this type of research helps to reach a more complete picture of the problem, as it combines the benefits of the two methods. And despite the importance of the quantitative measures; the qualitative phenomenological approach remains the main pillar for identifying the phenomenon of interest and for describing it in this study. And therefore, this study will attempt to answer the following main question: what are the aspects controlling shifting from a software developer to a Metaverse developer Career? The remarkable content analysis related to phenomenology indicates the estimates of the study sample concerning the phenomenon of analyzing the aspects controlling shifting from a software developer to a Metaverse Developer Career. As the data show, the highest remarkable indication<sup>1</sup> concerning the phenomenon of analyzing the aspects controlling shifting from a software developer to a Metaverse Developer Career in the (Increasing performance efficiency) theme. Followed by the (will work on innovating the software developer profession) theme. And then followed by the (Enhancing the software developer profession) theme. And these results reflect the convictions and expectations of the study sample of programmers, developers, and computer specialists that the impact of implementing Metaverse technology will innovate the Metaverse Developer Career.

**Keywords:** Metaverse, Software Developer, Developer Career, Multimethodology.

**DOI:** 10.7176/CEIS/13-5-05

**Publication date:** November 30<sup>th</sup> 2022

## 1.1 Introduction

Software developers are the creative minds behind computer software. They create software that allows users to perform specific tasks on different devices, such as computers or mobile devices. And according to the Bureau of Labor Statistics, software developer employment is expected to grow 24 percent from 2016 to 2026, much faster than the average for all occupations. The employment of application developers is expected to grow by 31 percent, and the employment of system developers is expected to grow by 11 percent. The growth in opportunities for software developers is driven by increased consumer and business demand for software and the proliferation of downloadable applications for mobile devices (Beckhusen, 2016).

Software developers conceive, design, and build computer programs. Some develop new applications for mobile or desktop use, while others build basic operating systems. In either case, software developers identify user needs, create software, test new software, and make improvements. Working closely with computer programmers, software developers play critical roles in the computer systems, manufacturing, finance, and software industries (Moldon, Strohmaier & Wachs, 2021).

In our current era, there is tremendous importance for programmers and developers, especially because most of the products in this day are digital products - either mobile applications or websites - or even electronic devices where the Internet of Things (IoT) has made everything connected to each other. So, developing these digital and software products has become commonplace and necessary for any startup. Sometimes, everything is ready in terms of entrepreneurship, marketing, etc., and the matter remains pending on the professional developers who can build this software and communicate with the rest of the team members (Fernández-Rovira, Valdés, Molleví & Nicolas-Sans, 2021).

Software development is the process of creating a new software product (mobile application, desktop application, web application, website, etc.) with some added value and features. Software development ranges from developing an entirely new product, improving an existing product, or improving system technologies or methodology. In other words, through the new software products developed, changes can be made in the current market and give the user a better experience. Development and innovation pave the way for creating new products and providing benefits to customers. The software development process usually takes a holistic approach that includes many stages or procedures that culminate in creating a well-functioning software product (Martínez-Fernández, Bogner, Franch, Oriol, Siebert, Trendowicz & Wagner, 2022).

<sup>1</sup>Remarkable indications are determined based on the priority of repetition during the interviews.

Meta, formerly Facebook, has stirred up the technology market since its CEO, Mark Zuckerberg, announced the official transformation of his company from just a company that owns several social platforms, to a company that focuses on pioneering an entirely new market, which is the world of Metaverse. A collection of new technologies, products, and software that are paving their way into the new world. The company clarified that the new change in the company's direction towards the world of the "Metaverse" does not mean creating and developing an alternative world to escape from reality (Gorichanaz, 2022).

Zuckerberg expects that the world of "Metaverse" will become the dominant digital social communication between people around the world during the next five or ten years, which necessitates the need to develop the profession of software developers to keep pace with this new world.

### 1.2 Terminology

**Software:** A generic term used to describe a set of integrated computer operations to solve a mathematical problem, perform a statistical operation, correct an editorial formula, perform a specific operation, etc. The two main types of computer software are Application software and System software (Münch, Armbrust, Kowalczyk & Sotó, 2012).

**Software developers:** Software developers are the creative minds behind computer software. Some develop applications that allow people to perform specific tasks on a computer or other device, while others develop platforms that run devices or control networks (Vadlamani & Baysal, 2020).

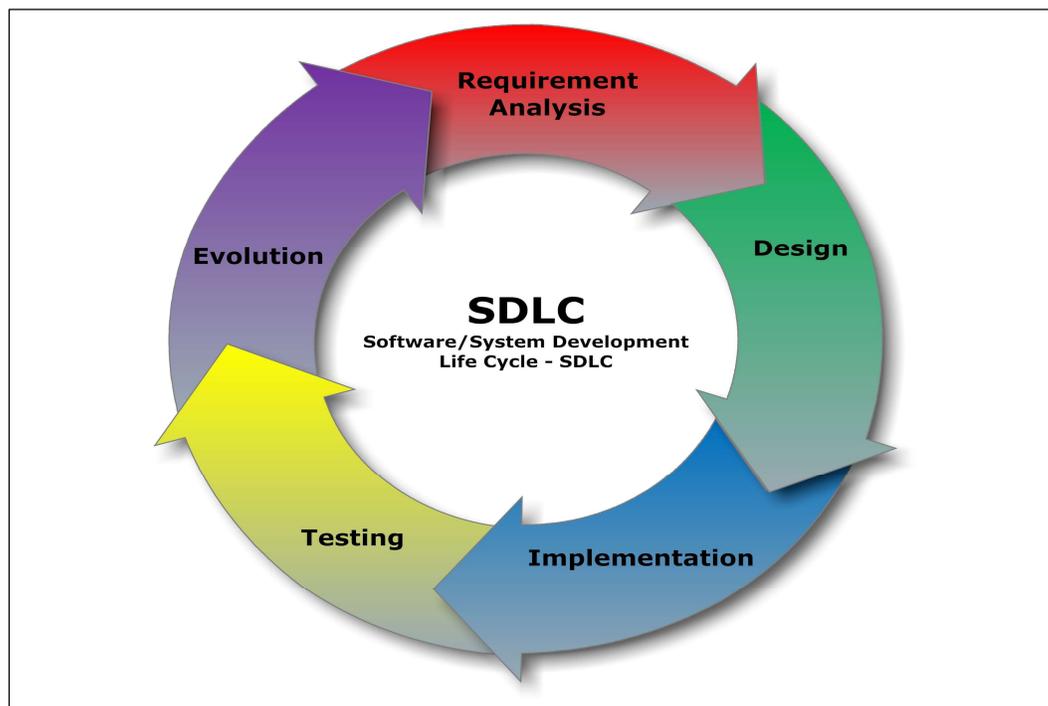
**Metaverse:** It is a digital space that is represented by digital representations of people, places, and things. In other words, it is a "digital world" where real people are represented by digital objects (Ng, 2022).

### 1.3 Literature review

Software is part of the Product. The product developer has a bigger role than the software developer. A software developer may work on a piece of software or some modules such as user interface or data analysis. A software developer may be restricted to a specific technology or programming language such as Python or Java, and may also be restricted to a specific role such as UI Developer, User Experience developer, Back-end developer, etc. They don't have to know the bigger picture of the product, its business model, its marketing, etc., while the product manager needs to know all of that because he/she is responsible for the product, not just its "technical" development (Kettunen, 2009).

Software developers are responsible for analyzing users' needs, then designing, testing, and developing software to meet those needs. As well as recommending upgrades to existing software and systems to clients by designing each piece of an application, or system and planning how the pieces will work together (Al-Saqqa, Sawalha & AbdelNabi, 2020).

The Software Development Life Cycle (SDLC) is a process used by the software development industry to design, develop, and test high-quality software. This course aims to produce a high-quality program that meets or exceeds customer expectations and reaches completion on time and at the requested price. This course consists of a detailed plan describing how to develop, maintain, replace, modify, or improve specific software. The life cycle defines a methodology for improving software quality and the overall development process (Akinsola, Ogunbanwo, Okesola, Odun-Ayo, Ayegbusi & Adebisi, 2020). And figure (1) represents a graphical representation of the various phases of the SDLC.



Source: [Mohamed Sami](https://melsatar.blog/tag/software-development-life/). <https://melsatar.blog/tag/software-development-life/>

Figure (1): Graphical representation of the various phases of the SDLC

The main task of the computer software developer lies in the development of computer programs to perform specific tasks in accordance with the needs of users. Software developers work in a wide range of fields, and sometimes their work is part of a team of IT experts. The main tasks of software developers include (Palombo, Tabari, Lende, Ligatti & Ou, 2020):

- Develop detailed software specifications in consultation with users.
- Determine the tasks and operations that the program will perform.
- Analyzing program instructions into their simple parts and translating them into programming language and logic.
- Devising possible solutions to some potential problems.
- Integration of all program elements and work on testing them.
- Test the program and ensure that the data outputs of the program work as agreed upon.

Moreover, the skills required for software developers are as follows (Hidayati, Budiardjo & Purwandari, 2020):

- Advanced level of programming and related technical skills.
- Creativity and innovation.
- Logical approach to problem-solving skills.
- Analytical and logical abilities skills.
- Care and attention to detail.
- Determination and perseverance.
- Possess communication skills, especially the ability to communicate information to non-technical colleagues in a simple and concise manner.

Every year the digital industry advances and virtual reality is no exception. For example, the gaming industry has been testing the Metaverse trend for some time. And when Facebook changed its name to Meta, it brought the world's attention to Augmented Reality (AR) / Virtual Reality (VR) like never before. Now, big tech companies like Apple, Google, and Microsoft have been working on metaverse-related technology for years and believe that a metaverse is soon on the horizon. The metaverse technology market is expected to reach \$49 billion by 2022, with an annual growth rate of 40%. After the Internet, the metaverse has the potential to become the next technology platform to attract software developers and technology experts to an \$800 billion market opportunity (Dwivedi, Hughes, Baabdullah, Ribeiro-Navarrete, Giannakis, Al-Debei & Wamba, 2022).

Engineers, programmers, and developers will always be in demand in the metaverse. Open jobs are available in the metaverse at some of the world's biggest and most prominent companies, such as Facebook, Microsoft, Apple, and Snap, as well as some of the newest and most innovative metaverse companies, such as OpenSea, Roblox, The Sandbox, Decentraland, and Solana. There will not be a single metaverse, but rather a loose collection of metaverse experiences that you can connect with, whether through augmented reality (AR), virtual reality (VR), or blockchain. So, the metaverse involves so many different aspects of technology and culture that if you're looking for metaverse work, you may have a wide range of experiences and a diverse need for skill sets. And developers will need to master a variety of programming and development languages to help create the metaverse, whether you're coding for augmented reality (AR), virtual reality (VR), or blockchain/cryptocurrency (Allam, Sharifi, Bibri, Jones & Krogstie, 2022).

#### **1.4 Problem statement**

The trend of merging between the so-called "virtual reality" VR "and" augmented reality "AR" and extended reality "XR" has emerged, which in turn paved the way for the launch of the Metaverse project, which is based on seven elements: infrastructure such as cloud services and fifth-generation networks, and wearing assistive devices such as Virtual reality glasses, decentralization such as the use of blockchain and artificial intelligence, prestige computing such as 3D vision, and the creative economy, by enhancing the ability to design and build digital assets that turn into an exchange in electronic commerce, discover and build content that drives interaction such as digital ads, and virtual reality application experiences such as Games, work, events, shopping or education (Lee, Braud, Zhou, Wang & Hui, 2021).

Here comes the question about the possibilities and future opportunities that will change the nature of the profession of software developers as a result of entering the world of the metaverse. Hence, the problem of the current study arises, which is to identify the dimensions that will govern this change in the profession of software developers, in terms of the nature and determinants of this change, and its requirements. Therefore, this study will attempt to answer the following main question: *what are the aspects controlling shifting from a software developer to a Metaverse developer Career?*

#### **1.5 Research Methodology**

The qualitative approach is used in many fields in which statistical or quantitative measures cannot be used, due to the lack of feasibility in enabling the researcher to secure and explain the problems or the phenomena (Queirós, Faria & Almeida, 2017). Qualitative research has many directions, one the most important of which is Phenomenology (Khan, 2014); which represents a school of thought that studies the subjective experiences of humans, to know their perceptions, opinions, and expectations about a particular topic. Phenomenology is a philosophical concept and a research methodology, its structure is that basic human facts can only be accessed through inner subjectivity and that the person is an integral part of the environment, which is an approach that seeks to reveal the experiences of the respondents in a particular issue, throughout the awareness of the Researcher (Faisal, 2017).

The researchers adopted the multimethodology approach using mixed methods between quantitative and qualitative research methodologies, as this type of research helps to reach a more complete picture of the problem, as it combines the benefits of the two methods. And despite the importance of the quantitative measures; the qualitative phenomenological approach remains the main pillar for identifying the phenomenon of interest and for describing it in this study.

#### **1.6 Methods and Producers**

For achieving the research goals, the researchers seek to determine the philosophical assumptions of the phenomenological aspects that measure the aspects controlling shifting from a software developer to a Metaverse Developer Career. For that, data is collected from individuals (the study sample) with experience with the phenomenon using numerous in-depth interviews, observations, and documentation. And then deriving ideas from the analysis of phrases, developing a description of the structure and context, and understanding the phenomenon using a compound description.

##### **1.6.1 Study Sample**

The study population represented the software companies, and their number is (34). The study sample was selected from these companies (with a size of 50 individuals) by conducting interviews with programmers, developers, and computer specialists.

## 5.2 Interviews

The interviews were based on open-ended questions, where individual interviews were conducted for all members of the study sample, then focus groups were conducted according to the job title in the following distribution:

1. The first focus group for accountants (24 members).
2. The second focus group for auditors (15 members).
3. Third focus group for the financial managers (11 members).
4. The fourth focus group combines the three job titles (16 members).

### 1.6.2.1 Interview Questions

To explain the phenomenon, and to measure the aspects controlling shifting from a software developer to a Metaverse Developer Career; the interview questions focused on the level of awareness of the study sample members with Metaverse technology, and table (1) represents these questions.

Table (1): Interview Questions

No.	Question
1	With a yes or no answer, do you know what Metaverse technology is?
2	With a yes or no answer, do you know what the applications of Metaverse technology in the programming field are?
3	With a yes or no answer, does your company implement Metaverse technology in its system?
4	Discuss the following items: <ol style="list-style-type: none"> <li>1. Metaverse has the potential to enhance the software development profession by opening future opportunities.</li> <li>2. Metaverse could help software developers gain clarity over the available resources and obligations of their organizations.</li> <li>3. Successful software developers will be those that work on assessing the real innovation interpretation of Metaverse records, marrying the record to reality and valuation.</li> <li>4. Metaverse is a replacement for current technological and reconciliation work.</li> <li>5. To become truly an integral part of the technological system, Metaverse must be developed, standardized, and optimized.</li> <li>6. The parts of software development concerned with transactional assurance and carrying out the aspects controlling shifting from a software developer to a Metaverse developer Career will be transformed by development and smart contract approaches.</li> <li>7. Metaverse developer skills will need to expand to include an understanding of the principal features and functions of Metaverse.</li> <li>8. Metaverse will lead to more and more transactional-level developer Career being done.</li> <li>9. Many current-day software developer Career department processes can be optimized through Metaverse.</li> </ol>

### 1.6.3 Demographic characteristics of the study sample

The demographic characteristics of the study sample were distributed according to gender, age, years of experience, and job title.

#### 1.6.3.1 Gender

Figure (2) shows the distribution of the study sample by gender; where the percentage of females (%32) and the percentage of males (%68).

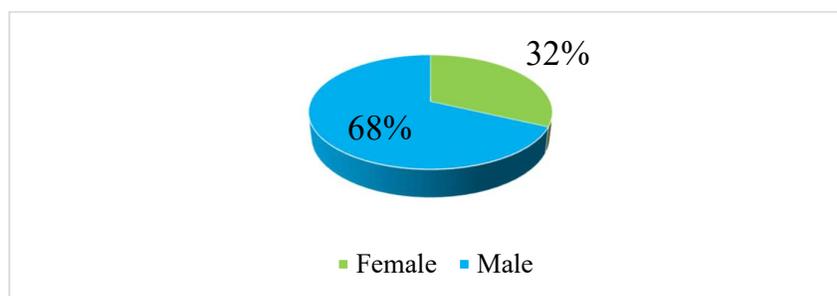


Figure (2): Distribution of the study sample by gender

### 1.6.3.2 Age

Figure (3) shows the distribution of the study sample by age; where the percentage of the age category (Less than 28 years) reached (23%), the percentage of the age category (28 - 40 years) reached (59%), and the percentage of the age category (More than 40 years) reached (18%).

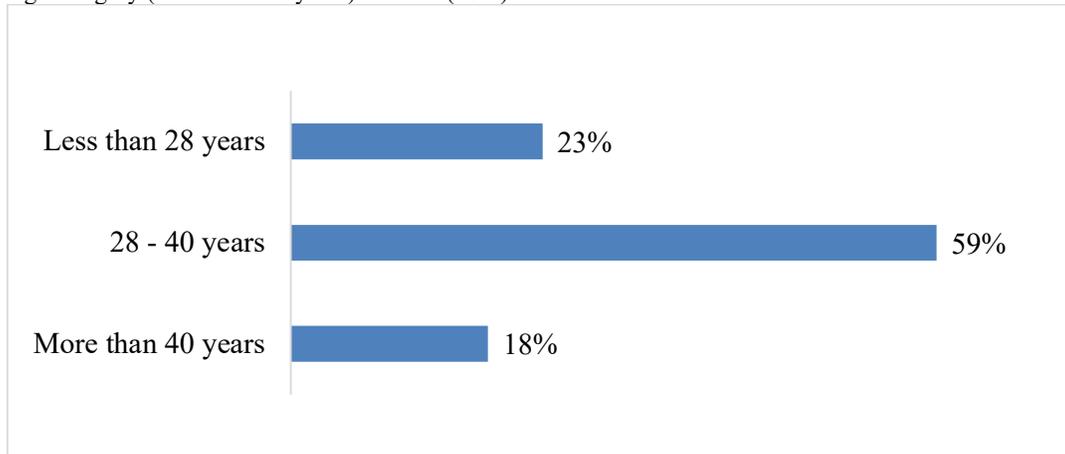


Figure (3): Distribution of the study sample by age

### 1.6.3.3 Experience

Figure (4) shows the distribution of the study sample by years of experience; where the percentage of the experience category (Less than 5 years) reached (21%), the percentage of the experience category (5 - 10 years) reached (44%), and the percentage of the experience category (More than 10 years) reached (35%).

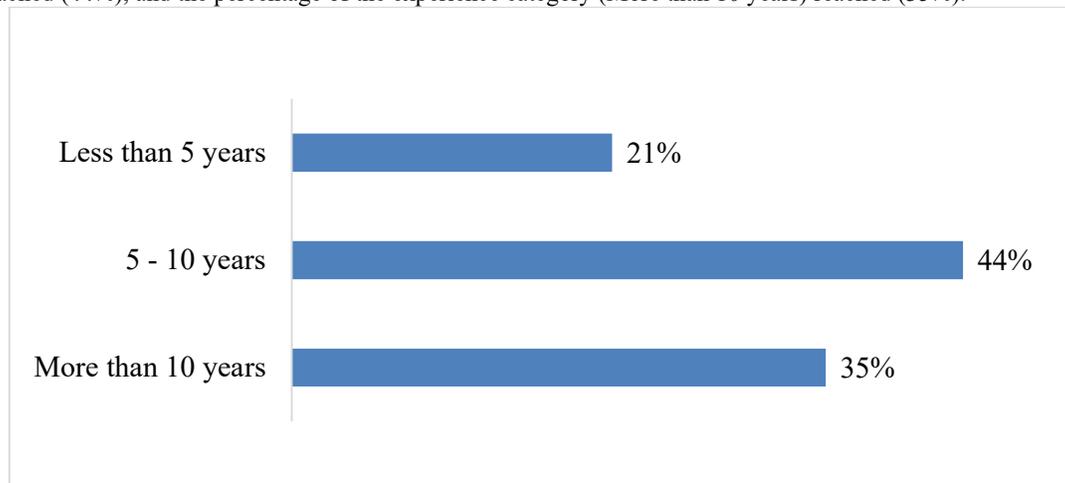


Figure (4): Distribution of the study sample by years of experience

### 1.6.3.4 Job title

Figure (5) shows the distribution of the study sample by job title; where the percentage of programmers reached (47%), the percentage of developers reached (29%), and the percentage of computer specialists reached (24%).

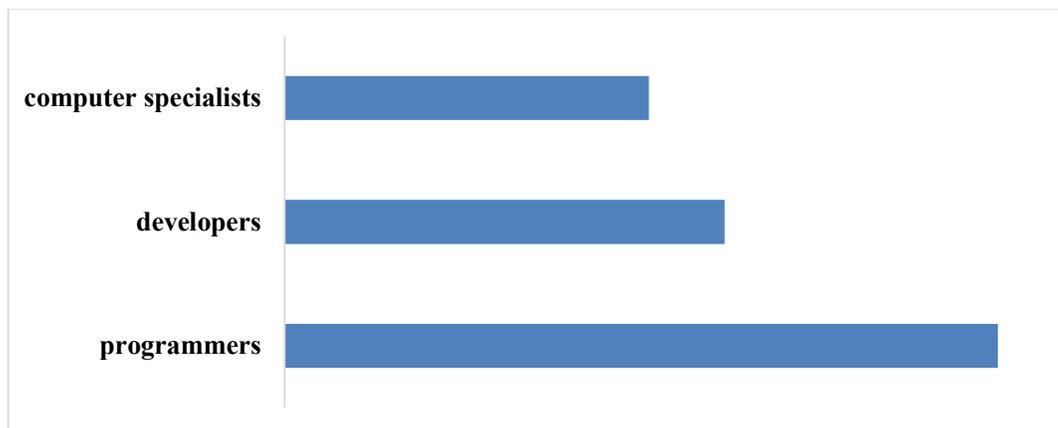


Figure (5): Distribution of the study sample by job title

### 1.7 Analysis and Discussion

With individual fifty interviews, and four focus group interviews, the respondents' answers to the first three (Yes or No) questions are shown in figure (6).

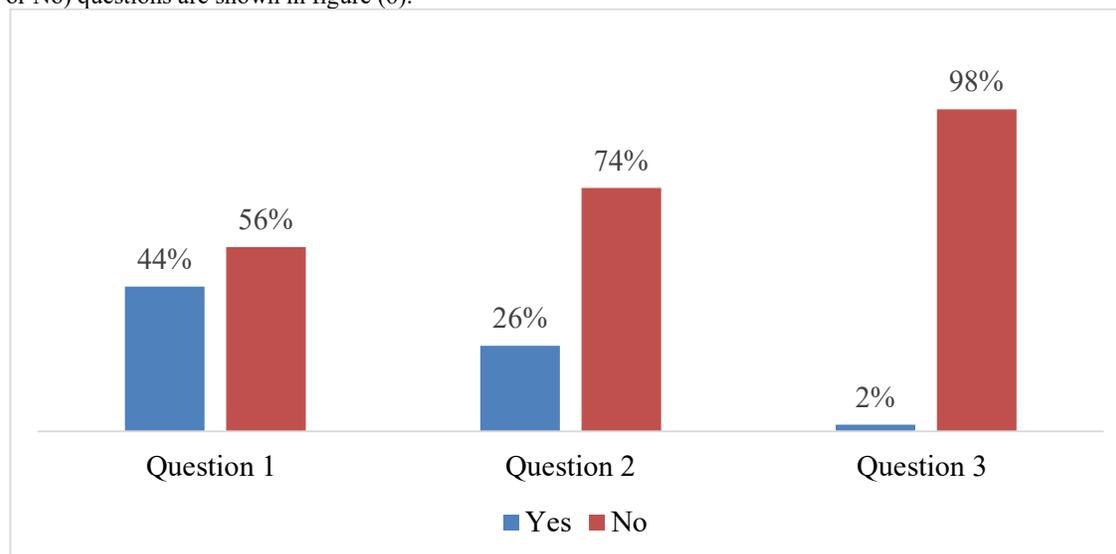


figure (6): Respondents' answers to the first three (Yes or No) questions

Concerning respondents' answers to the first question (do you know what Metaverse technology is?), data in figure (5) show that (44%) answered yes, and (56%) answered no. And this reflects almost equal awareness among the members of the study sample of the concept of Metaverse technology. But concerning respondents' answers to the second question (do you know what the applications of Metaverse technology in the programming field are?), data in figure (5) show that (26%) answered yes, and (47%) answered no. And this reflects a low percentage of knowledge among the members of the study sample of programmers, developers, and computer specialists about the applications of the Metaverse technology in the software field, specifically in the developer profession. More than that, and concerning respondents' answers to the third question (does your company implement Metaverse technology in its system?), data in figure (5) show that (2%) answered yes, and (98%) answered no. And this reflects that Metaverse technology in the programming field, specifically in the developer profession, has not been applied yet in Jordanian technological companies.

#### 1.7.1 Phenomenological Approach

A strategy for examining data is termed coding. Therefore, in open coding, it might comprise a sentence, a line from a transcription, a physical activity, or an acquisition of past components (Strauss & Corbin, 1994). And thus, the researchers will be using purposive sampling or what is also known as the theoretical sampling strategy to identify informers to participate in the current research. It engaged in selecting groups or individuals to be investigated based on their significance to research questions.

### 1.7.1.1 The Coding Process

Data are accumulated in four phases that differ in purpose and data collection strategies. Data analysis of the current study was completed by using (NVivo11)<sup>2</sup> to face the terms of "trustworthiness", "rigorousness", or "quality" of the data, therefore it is important that this is carried out in a thorough and transparent manner. Therefore, using software in the data analysis process has been thought by some to add accuracy to qualitative research. The present study used a four-stage data collection strategy summarized in table (2).

Table (2): Four Phases in Data Collection

Phase	Coding	Purpose	Interviews
1	Open	Categorizing codes within categories for advanced analysis	50 individuals and 16 in Focus groups
2	Axial	Specifying codes in detail; relay codes to one another to generate themes	
3	Selective	Creating a paradigm model and investigating themes relative to the model	
4	Selective	Testing, certifying, and explaining the paradigm model until saturated	

And table (3) shows 18 preliminary codes obtained from the interview sessions with each code representing a significant topic of discussion related to the aspects controlling shifting from a software developer to a Metaverse Developer Career. The researcher thus concluded that the focus group and individual interviews saturated the codes that were necessary to understand the phenomenon of analyzing the aspects controlling shifting from a software developer to a Metaverse Developer Career after similar themes emerged during the interviews.

Table (3): Obtained Categories and Themes

Categories	Themes
Antecedents	1- Weak knowledge of the relationship between Metaverse technology and Metaverse Developer Career
	2- The responsibility for implementing Metaverse technology is decided by the company
	3- Metaverse technology has the potential to enhance the software developer profession
	4- Metaverse is a replacement for current software programming
	5- Of course, Metaverse technology will work on innovating the software developer profession
	6- software developer profession will need to expand
Phenomenon: Positive sides	7- Enhancing the software developer profession
	8- Innovating software developer profession
	9- Increasing performance efficiency
	10- Increasing salaries
Phenomenon: Negative sides	11- Not using Metaverse technology in the software developer profession will weaken performance efficiency
	12- Weak performance
	13- Undeveloped software developer profession
	14- Increased costs
Consequences	15- Higher costs
	16- Technical lag
	17- More future complications
	18- Decrease market share

<sup>2</sup> NVivo is a software program used for qualitative and mixed-methods research. Specifically, it is used for the analysis of unstructured text, audio, video, and image data, including (but not limited to) interviews, focus groups, surveys, social media, and journal articles.

### 1.7.1.2 Study Paradigm Model

The model illustrated in Figure (7) is generated entirely by utilizing NVivo 11 as a result of themes established being linked together. These relationships of concepts are rigorously established based on the validation process in phase four of selective data analysis.

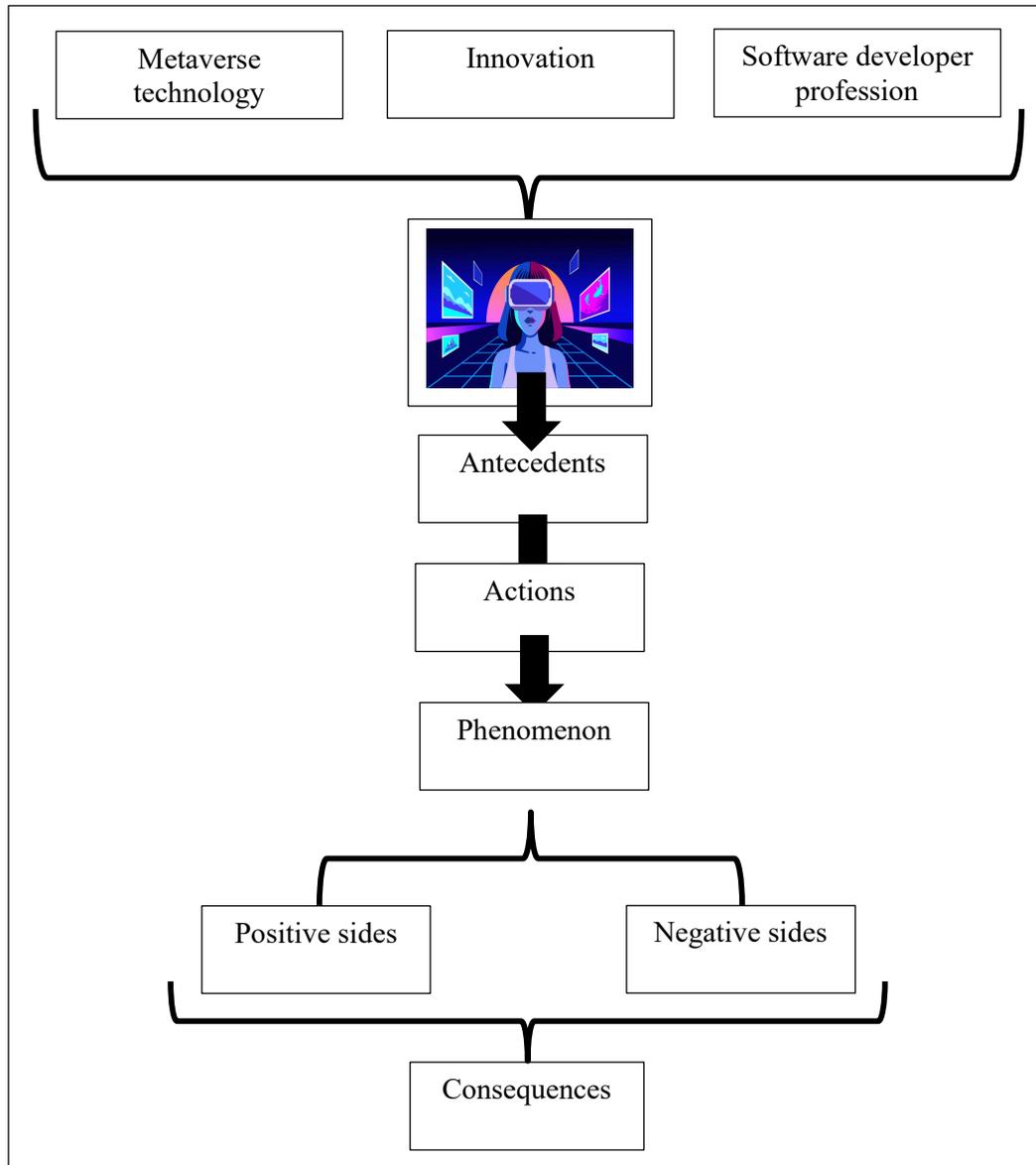


Figure (7): Paradigm Model

### 1.7.2 Content analysis related to Paradigm Model

Table (4) below shows the frequencies<sup>3</sup> and percentages of the responses of the study sample related to the aspects controlling shifting from a software developer to a Metaverse Developer Career.

<sup>3</sup> Frequencies do not depend on the size of the study sample, but rather on the frequency of responses to each member of the study sample during the interviews.

Table (4): Frequencies and percentages of the participants' responses

Categories	Themes	Total	
		N	%
Antecedents	Weak knowledge of the relationship between Metaverse technology and Metaverse Developer Career	33	15%
	The responsibility for implementing Metaverse technology is decided by the company	21	10%
	Metaverse technology has the potential to enhance the software developer profession	40	19%
	Metaverse is a replacement for current software programming	29	14%
	Of course, Metaverse technology will work on innovating the software developer profession	51	25%
	software developer profession will need to expand	34	16%
Total		208	100%
Phenomenon: Positive sides	Enhancing the software developer profession	45	23%
	Innovating software developer profession	67	34%
	Increasing performance efficiency	52	27%
	Increasing salaries	33	16%
Total		197	100%
Phenomenon: Negative sides	Not using Metaverse technology in the software developer profession will weaken performance efficiency	59	28%
	Weak performance	71	33%
	Undeveloped software developer profession	44	21%
	Increased costs	39	18%
Total		213	100%
Consequences	Higher costs	41	17%
	Technical lag	55	23%
	More future complications	61	25%
	Decrease market share	81	35%
Total		238	100%

Data in the previous table show the frequencies and percentages of the participants' responses upon the categories and themes related to the aspects controlling shifting from a software developer to a Metaverse Developer Career, and highlighting these results:

- In the category of antecedents, the theme (Of course, Metaverse technology will work on innovating the software developer profession) is ranked with the highest percentage of (25%). This shows that the estimates of the study sample reflect their convictions of implementing Metaverse technology in the programming field will lead to the development and refinement of the Metaverse Developer Career.
- Furthermore, in the category of antecedents, the theme (Metaverse technology has the potential to enhance the software developer profession) came second with a percentage of (19%). This reflects that the estimates of the study sample express their future expectations of implementing Metaverse technology in the programming field, as it will lead to the development and refinement of the Metaverse Developer Career.
- Also, in the category of antecedents, the theme (The responsibility for implementing Metaverse technology is decided by the company) is ranked with the lowest percentage (10%). This reflects that the estimates of the study sample placed the responsibility of implementing the Metaverse technology on the company's management, and ignored the individual responsibility of programmers, developers, and computer specialists to express the desire to develop work systems by adopting new technologies.
- In the Phenomenon: Positive sides, the theme (Innovating software developer profession) is ranked with the highest percentage of (34%). This reflects that the estimates of the study sample emphasize that, one of the important advantages of implementing Metaverse technology in the programming field is innovating the Metaverse Developer Career.
- In the Phenomenon: Negative sides, the theme (*Weak performance*) is ranked with the highest percentage (33%). This reflects that the estimates of the study sample emphasize that, one of the disadvantages of not implementing Metaverse technology in the programming field will weaken performance.

- In the consequences category, the theme (*Decrease market share*) is ranked with the highest percentage (35%). This reflects that the estimates of the study sample emphasize that, one of the disadvantages of not implementing Metaverse technology in the programming field will decrease the market share.

### 1.8 Conclusion

The remarkable content analysis related to phenomenology indicates the estimates of the study sample concerning the phenomenon of analyzing the aspects controlling shifting from a software developer to a Metaverse Developer Career. As the data show, the highest remarkable indication<sup>4</sup> concerning the phenomenon of analyzing the aspects controlling shifting from a software developer to a Metaverse Developer Career in the (Increasing performance efficiency) theme. Followed by the (will work on innovating the software developer profession) theme. And then followed by the (Enhancing the software developer profession) theme. And these results reflect the convictions and expectations of the study sample of programmers, developers, and computer specialists that the impact of implementing Metaverse technology will innovate the Metaverse Developer Career.

### References

- Akinsola, J. E., Ogunbanwo, A. S., Okesola, O. J., Odun-Ayo, I. J., Ayegbusi, F. D., & Adebisi, A. A. (2020, July). Comparative analysis of software development life cycle models (SDLC). In *Computer Science On-line Conference* (pp. 310-322). Springer, Cham.
- Allam, Z., Sharifi, A., Bibri, S. E., Jones, D. S., & Krogstie, J. (2022). The metaverse as a virtual form of smart cities: Opportunities and challenges for environmental, economic, and social sustainability in urban futures. *Smart Cities*, 5(3), 771-801.
- Al-Saqq, S., Sawalha, S., & AbdelNabi, H. (2020). Agile Software Development: Methodologies and Trends. *International Journal of Interactive Mobile Technologies*, 14(11).
- Beckhusen, J. (2016). *Occupations in information technology*. US Department of Commerce, Economics and Statistics Administration, US Census Bureau.
- Dwivedi, Y. K., Hughes, L., Baabdullah, A. M., Ribeiro-Navarrete, S., Giannakis, M., Al-Debei, M. M., ... & Wamba, S. F. (2022). Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, 66, 102542.
- Fernández-Rovira, C., Valdés, J. Á., Molleví, G., & Nicolas-Sans, R. (2021). The digital transformation of business. Towards the datafication of the relationship with customers. *Technological Forecasting and Social Change*, 162, 120339.
- Gorichanaz, T. (2022). Being at home in the metaverse? Prospectus for a social imaginary. *AI and Ethics*, 1-12.
- Hidayati, A., Budiardjo, E. K., & Purwandari, B. (2020, January). Hard and soft skills for scrum global software development teams. In *Proceedings of the 3rd International Conference on Software Engineering and Information Management* (pp. 110-114).
- Kettunen, P. (2009). Agile software development in large-scale new product development organization: team level perspective.
- Lee, L. H., Braud, T., Zhou, P., Wang, L., Xu, D., Lin, Z., ... & Hui, P. (2021). All one needs to know about metaverse: A complete survey on technological singularity, virtual ecosystem, and research agenda. *arXiv preprint arXiv:2110.05352*.
- Martínez-Fernández, S., Bogner, J., Franch, X., Oriol, M., Siebert, J., Trendowicz, A., ... & Wagner, S. (2022). Software engineering for AI-based systems: a survey. *ACM Transactions on Software Engineering and Methodology (TOSEM)*, 31(2), 1-59.
- Moldon, L., Strohmaier, M., & Wachs, J. (2021, May). How gamification affects software developers: Cautionary evidence from a natural experiment on github. In *2021 IEEE/ACM 43rd International Conference on Software Engineering (ICSE)* (pp. 549-561). IEEE.
- Münch, J., Armbrust, O., Kowalczyk, M., & Sotó, M. (2012). *Software process definition and management*. Berlin, Heidelberg: Springer Berlin Heidelberg.
- Ng, D. T. K. (2022). What is the metaverse? Definitions, technologies and the community of inquiry. *Australasian Journal of Educational Technology*, 38(4), 190-205.
- Palombo, H., Tabari, A. Z., Lende, D., Ligatti, J., & Ou, X. (2020). An Ethnographic Understanding of Software (In) Security and a {Co-Creation} Model to Improve Secure Software Development. In *Sixteenth Symposium on Usable Privacy and Security (SOUPS 2020)* (pp. 205-220).
- Vadlamani, S. L., & Baysal, O. (2020, September). Studying software developer expertise and contributions in Stack Overflow and GitHub. In *2020 IEEE International Conference on Software Maintenance and Evolution (ICSME)* (pp. 312-323). IEEE.

<sup>4</sup>Remarkable indications are determined based on the priority of repetition during the interviews.