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The Efficiency of Using IMGSIE Methodology to Design Graduation Projects for Computer Networks Department Students

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كفاءة استخدام منهجية IMGSIE في تصميم مشاريع التخرج لطلبة قسم شبكات الحاسب الآلي

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Abstract:
Students who do not utilize a structured methodology often face challenges in effectively managing their projects and achieving desired outcomes. Without a clear framework, these students may experience difficulties in organizing their work, meeting deadlines, and ensuring the quality of their results. This highlights the necessity of adopting a proven methodology to enhance student success and consistency in project execution. This paper investigates the efficiency of employing the IMGSIE methodology in designing graduation projects for students in the Computer Networks Department. This paper proposes a new methodology named IMGSIE, which stands for Introduction, Method, Generalization, Specification, Implementation, and Evaluation. The paper aimed to evaluate the effectiveness of this methodology in enhancing the quality and innovation of the students' projects, especially in computer networks. Data was collected through a combination of project assessments, student feedback, and performance metrics. The results indicate a significant improvement in the overall quality and complexity of the projects, as well as increased student satisfaction and engagement. These findings suggest that the IMGSIE methodology is a valuable tool for guiding students through the complex process of project design, ultimately leading to more successful and innovative outcomes. Supervisors and students have already implemented this methodology through the distribution of two different questionnaires. The feedback was highly satisfactory, reflecting a positive response to the methodology's effectiveness for all students who used it.

Keywords: IMGSIE Methodology, IMGSIE Lifecycle, Research Methodology, Computer Networks.

الملخص
الطلاب الذين لا يستخدمون منهجية منظمة غالبًا ما يواجهون تحديات في إدارة مشاريعهم بفعالية وتحقيق النتائج المرجوة. في غياب إطار عمل واضح، قد يواجه هؤلاء الطلاب صعوبات في تنظيم عملهم، والالتزام بالمواعيد النهائية، وضمان جودة نتائجهم. وهذا يبرز الحاجة إلى اعتماد منهجية مثبتة لتعزيز نجاح الطلاب وتحقيق التناسق في تنفيذ المشاريع. تبحث هذه الورقة في كفاءة استخدام منهجية IMGSIE في تصميم مشاريع التخرج للطلاب في قسم شبكات الحاسوب. تقترح هذه الورقة منهجية جديدة تُدعى IMGSIE، والتي تعني المقدمة، المنهج، التعميم، التخصيص، التنفيذ، والتقييم. تهدف إلى تقييم فعالية هذه المنهجية في تعزيز جودة وابتكار مشاريع الطلاب، وخاصة في شبكات الحاسوب. تم جمع البيانات من خلال مجموعة من تقييمات المشاريع، ملاحظات الطلاب، ومقاييس الأداء. تشير النتائج إلى تحسين كبير في الجودة العامة وتعقيد المشاريع، فضلاً عن زيادة رضا الطلاب واهتمامهم. تشير هذه النتائج إلى أن منهجية IMGSIE هي أداة قيمة لإرشاد الطلاب خلال عملية تصميم المشاريع المعقدة، مما يؤدي في النهاية إلى نتائج أكثر

نجاحًا وابتكارًا. وقد تم تنفيذ هذه المنهجية بالفعل، مع توزيع استبيانين مختلفين على المشرفين والطلاب. كانت الملاحظات عالية الرضا، مما يعكس استجابة إيجابية تجاه فعالية المنهجية لجميع الطلاب الذين استخدموها.

الكلمات المفتاحية: منهجية IMGSIE، منهجية بحثية، دورة حياة IMGSIE، شبكات الكمبيوتر.

1. Introduction

The rapid advancement of computer network technologies has created a pressing need for educational methodologies that can effectively equip students with the necessary skills and knowledge. There is a massive change in the number of published scientific papers yearly [1]. Designing graduation projects that not only challenge students but also reflect real-world scenarios is crucial for preparing them for professional careers. There are numerous methods available to elicit requirements for IT projects from customers, executives, team members, agents, etc. [2]. In this context, a methodology presents a promising approach to enhance the educational outcomes for students in the Computer Networks department. The researchers provide the advantages and limitations of the methodologies [3]. The IMGSIE methodology integrates theoretical learning with practical application, promoting a comprehensive understanding of complex networking concepts. It emphasizes personalized learning paths, allowing students to explore specific areas of interest while ensuring a robust grasp of foundational principles. This adaptability is particularly advantageous in the dynamic field of computer networks, where emerging technologies continually reshape the landscape.

With several methodologies available, selecting the right one for an IT project is a significant challenge faced by IT engineers [4]. Despite the potential benefits of the IMGSIE methodology, its effectiveness in the context of designing graduation projects for Computer Networks department students remains underexplored. Computer networks projects as a special type of project are also required to be supported by project management processes [5]. This paper aims to evaluate the efficiency of using the IMGSIE methodology in this specific educational setting. By assessing the performance, engagement, and overall satisfaction of students who utilize this methodology for their graduation projects, we seek to determine its viability as a standard approach in computer network education The findings of this paper could have significant implications for curriculum design and pedagogical strategies within computer network programs.

By providing evidence-based insights, it aims to contribute to the ongoing efforts to enhance educational methodologies and better prepare students for the challenges of the modern digital landscape. To measure the quality and effectiveness of IMGSIE, and to highlight the challenges facing students and supervisors in charge of graduation projects, a comprehensive data collection process was conducted. A total of 120 students and professors, who are actively involved in the design of computer networks, were polled. This paper aimed to capture their experiences and evaluations regarding the success and quality of the IMGSIE methodology [6]. The insights gained from this data will provide a clearer understanding of how IMGSIE impacts the educational experience and the outcomes of graduation projects.

Today, with the highly developed technology used in computer networks selecting a suitable methodology has become very important [7]. This literature review sets the stage for the current study, which aims to fill this gap by evaluating the efficiency and effectiveness of the IMGSIE methodology in designing graduation projects for students in the computer networks department. By synthesizing existing research and identifying gaps in the literature, this paper contributes to the ongoing discourse on innovative educational practices in technical disciplines. This literature review provides a comprehensive overview of the existing research landscape related to instructional methodologies in computer network education and positions the IMGSIE methodology within this context. Educators in the field of computer networks are increasingly recognizing the need for adaptive and flexible educational methodologies that can accommodate the diverse learning styles and career goals of students.

In developed countries, mostly computer networks developing organizations are motivated to shift their developing activities globally [8]. The traditional lecture-based approach, while foundational, often falls short in preparing students for the complexities of modern network environments. As such, there has been a shift towards active learning strategies that encourage exploration and experimentation. This includes methodologies that promote self-directed learning, collaborative problem-solving, and the integration of real-world applications. Such approaches not only enhance knowledge retention but also nurture the critical thinking and adaptability required in the fast-paced field of computer networks.

To meet employers' expectations, baccalaureate IT programs should focus on learning experiences that integrate technical preparation with highly desirable professional skills [9]. In recent years, the concept of personalized learning has gained traction within educational research. Personalized learning models, such as IMGSIE, are designed to cater to individual student needs and preferences, offering flexibility in learning pace, content delivery, and assessment methods. By tailoring educational experiences to align with students' interests and career aspirations, personalized learning models have shown promise in improving student engagement and motivation. In the context of computer network education, where practical skills and industry relevance are paramount, personalized approaches like IMGSIE have the potential to significantly enhance learning outcomes and student satisfaction.

While project management methodologies have been used for a very long time and date back to organizations adopted the methods only half a century ago [10]. The integration of the IMGSIE methodology into the curriculum of the computer networks department addresses several critical challenges in contemporary higher education. Traditional educational approaches often struggle to bridge the gap between theoretical knowledge and practical application, particularly in technical fields like computer networks. IMGSIE offers a structured framework that not only encourages hands-on learning but also fosters creativity and innovation among students. By engaging in the design and implementation of real-world projects, students not only solidify their technical skills but also develop essential competencies in teamwork, project management, and problem-solving—skills that are highly valued in the industry.

There is a big gap between the methodologies that focus on design computer networks and the great development in computer network field [11]. Moreover, the evaluation of educational methodologies such as IMGSIE is pivotal in advancing the field of computer network education. As technology continues to evolve at a rapid pace, educators face the constant challenge of keeping their curricula relevant and effective. The findings from this study will provide empirical evidence regarding the impact of IMGSIE on student learning outcomes and overall satisfaction. Insights gained from student feedback and academic assessments will inform educators and administrators on the efficacy of adopting similar methodologies in other technical disciplines or refining existing educational practices. Ultimately, this research contributes to the broader discourse on innovative pedagogical approaches that aim to prepare students for the complexities and demands of modern network environments.

2. IMGSI Methodology

During the last few years, there has been a real explosion in computational information technologies [12]. The methodology has become a vital work tool for people's daily tasks, so the demand for the use of this service increases as time passes 13]. Recently, significant research works have been presented to tackle the lack of methodologies used in the IT field [14]. In most cases, choices of the standard methodology must be made by the computer network department [15]. This methodology, referred to as IMGSIE, stands for introduction, methods, generalization, specification, implementation, and evaluation, as shown in Figure 1. It comprises six fundamental stages, each containing several key points and elements crucial for students to successfully complete the stage. It is important to note that not every point or element needs to be followed in each stage; their use depends on the project's nature and the relevance or alignment of the project's components. However, certain core elements, such as the introduction, problem statement, aims, and conclusion, are essential for every project or research effort.

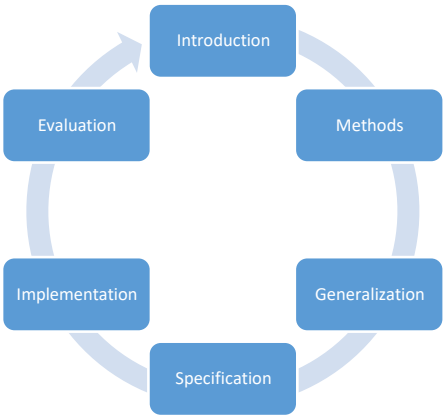

Figure 1: IMGSIE methodology.

IMGSIE is a flexible methodology designed to guide students and professionals through the process of conducting IT or AI projects.

2.1 Introduction

Introduction extracts data in the wider area of knowledge [16]. This stage involves laying the groundwork for the project. It includes defining the scope, purpose, and objectives of the project or research. A well-crafted introduction also includes a problem statement, which clearly identifies the issue the project aims to solve, and sets the context for the work to follow. The Initiation phase in the IMGSIE methodology is crucial as it sets the foundation for the entire project. This phase involves detailed planning and analysis to ensure that the project has a clear direction and is feasible within the given constraints. Here's a more in-depth look at the key components of the Initiation phase:

- Problem Identification
  Clearly define the problem or opportunity that the project aims to address. This involves understanding the current situation, identifying gaps or inefficiencies, and outlining the need for the project.
- Stakeholder Involvement: Engage with key stakeholders, such as clients, end-users, and team members, to gather their input and perspectives on the problem. Understanding their needs and expectations is critical for setting accurate goals.
- SMART Goals: Establish specific, measurable, achievable, relevant, and time-bound (SMART) objectives that the project will aim to achieve. These goals provide a clear target and help in evaluating the project's success.
- Scope Definition: Clearly define the scope of the project, outlining what will be included and excluded. This helps in setting boundaries and managing expectations.
- Technical Feasibility: Assess whether the project is technically viable. This includes evaluating the available technology, resources, and expertise required to complete the project.
- Financial Feasibility: Estimate the project's cost and determine if it is financially feasible. This involves creating a preliminary budget, identifying potential funding sources, and performing cost-benefit analysis.
- Operational Feasibility: Determine if the project can be integrated into existing operations without significant disruption. Consider the availability of personnel, the impact on current workflows, and the potential need for training.
- Risk Identification: Identify potential risks that could impact the project. This includes technical risks, financial risks, operational risks, and external risks such as regulatory changes.
- Risk Mitigation Strategies: Develop strategies to mitigate identified risks. This might involve contingency planning, allocating extra resources, or designing flexible project timelines.
- Identification of Stakeholders: Identify all parties who have a stake in the project, including clients, end-users, project team members, and external partners.
- Communication Plan: Develop a communication plan to keep stakeholders informed throughout the project. This includes defining the frequency and format of updates, identifying who will be responsible for communication, and determining how feedback will be handled.
- High-Level Requirements: Gather initial, high-level requirements for the project. These requirements provide a starting point for more detailed analysis in subsequent phases.
- Requirement Prioritization: Prioritize the requirements based on their importance and feasibility. This helps in focusing the project's efforts on the most critical aspects.
- Timeline and Milestones: Develop a preliminary project timeline, identifying key milestones and deadlines. This provides a roadmap for the project and helps in tracking progress.
- Resource Allocation: Identify the resources needed for the project, including personnel, equipment, and materials. Allocate these resources based on availability and project priorities.

The Initiation phase of a project is critical for laying a strong foundation for its success. It begins with Problem Identification, where the issue or opportunity is clearly defined, followed by Stakeholder Involvement to understand various perspectives and needs. SMART Goals are established to provide clear, measurable objectives. The project's Scope is clearly outlined, setting boundaries and expectations, while Technical, Financial, and Operational Feasibility are assessed to ensure the project can be implemented successfully. Risk Identification and Mitigation Strategies are developed to anticipate and manage potential challenges. The phase also involves identifying all Stakeholders and creating a Communication Plan to keep them informed. High-Level Requirements are gathered and prioritized to focus on key aspects. A preliminary Timeline and Milestones are established to track progress, and Resource Allocation ensures the right resources are available when needed. This phase ensures a structured, strategic approach to project planning.

2.2 Methods

Decisions for selecting methodology for IT projects are complex since there are many associated methods [17]. In this stage, the project's approach is detailed. This involves selecting the appropriate methodologies, tools, and techniques that will be used to address the problem identified in the introduction. It also includes designing experiments, collecting data, and deciding on the metrics for evaluating success.

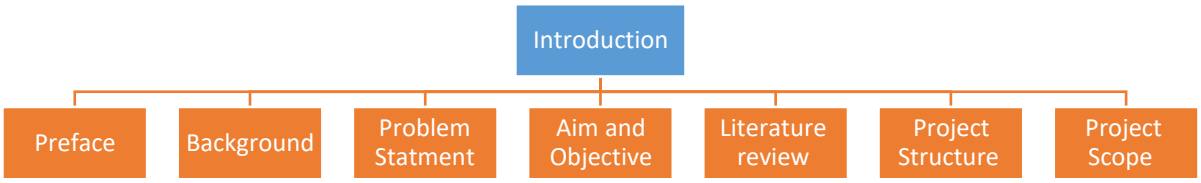

Figure 2: Main elements of the introduction phase.

The Methods stage of the IMGSIE methodology is crucial because it outlines the approach and techniques that will be employed to address the problem identified in the Introduction stage. This stage sets the foundation for how the project will be carried out, and it involves several key components:

2.2.1 Key Components of the Methods Stage

The first step is choosing the appropriate methodology or combination of methodologies for the project. This choice depends on the project's nature, objectives, and the type of problem being addressed. Common methodologies in IT projects might include Agile, Waterfall, or specific frameworks like Scrum for software development. In AI projects, this could involve choosing between supervised learning, unsupervised learning, reinforcement learning, or a combination of these.

Generalization: This stage focuses on developing general principles or frameworks based on the methods applied. The goal is to create models or theories that can be applied broadly, beyond the specific case being studied. In AI projects, this could involve creating a generalizable algorithm or model. Research methods are the strategies, processes or techniques used in the collection of data [18]. The Generalization phase centers on exploring the study topic broadly and gathering information from various perspectives. During this phase, the researcher examines the research problem in a comprehensive manner, considering all relevant aspects of the project's title without diving into specific details. For instance, if the project is titled "Internet of Things in Healthcare Systems," this phase would involve a wide-ranging exploration of the IoT's applications in healthcare, including general trends, potential benefits, and challenges, without yet focusing on the specific intricacies.

Specification: The Specification phase is a critical stage in the methodology, often considered the heart of the project. It involves providing detailed information about the project's title, such as the technologies used, its history, applications, and key features. Unlike the previous phase, which offered a broad, general overview from various perspectives, this phase delves deeply into the specifics, focusing on the core aspects of the project. This is where the project narrows down from general principles to specific implementations. It involves detailing the technical specifications and precise instructions needed to apply the generalizations from the previous stage to the particular project. This could include system architecture, algorithms, data processing techniques, and other specific technical details.

Implementation: In this stage, the specifications are brought to life. The project is built and deployed in its intended environment. This could involve coding, configuring hardware, integrating systems, and ensuring that all components work together as planned. This stage is critical for moving from theoretical or model-based work to practical application. After thoroughly studying and correctly understanding the problem and project objectives, the Implementation phase begins. Researchers must select the appropriate techniques for applying the practical aspects of the project. The choice of technique depends on the project's type and nature. Key elements of the Implementation stage include:

- Determining hardware and software requirements.
- Carrying out the actual implementation using physical devices, equipment, tools, and software.

- Implementing the project using emulation and simulation software when necessary.

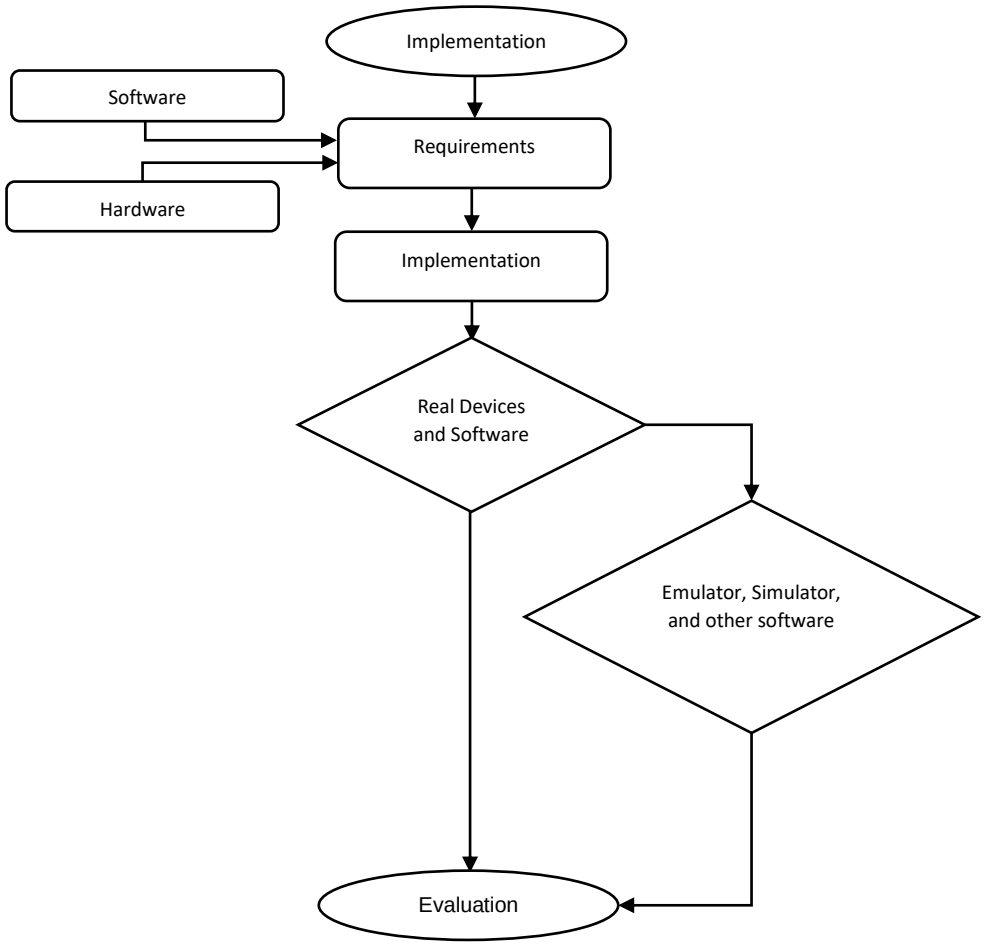

Figure 3: Flow chart illustrates the implementation process.

To summaries, the Initiation phase of a project is critical for laying a strong foundation for its success. It begins with Problem Identification, where the issue or opportunity is clearly defined, followed by Stakeholder Involvement to understand various perspectives and needs. SMART Goals are established to provide clear, measurable objectives. The project's Scope is clearly outlined, setting boundaries and expectations, while Technical, Financial, and Operational Feasibility are assessed to ensure the project can be implemented successfully. Risk Identification and Mitigation Strategies are developed to anticipate and manage potential challenges. The phase also involves identifying all Stakeholders and creating a Communication Plan to keep them informed. High-Level Requirements are gathered and prioritized to focus on key aspects. A preliminary Timeline and Milestones are established to track progress, and Resource Allocation ensures the right resources are available when needed. This phase ensures a structured, strategic approach to project planning.

Evaluation: The final stage involves assessing the project's outcomes against its initial goals. Evaluation includes testing the implemented solution, collecting data on its performance, and analyzing whether it meets the project’s objectives. Feedback is gathered, and the project is reviewed for lessons learned, which can inform future projects. Figure 4: The main elements of the evaluation phase. Key elements of the evaluation stage include:

- Testing and Quality Assurance
- Post-deployment testing is crucial to ensure that the implementation is successful and that the system operates as expected in the live environment.
- This includes functional testing, performance testing, and user acceptance testing (UAT). Any issues identified during testing are addressed, and the system is fine-tuned to ensure stability and reliability.

- Successful implementation also requires that end-users are adequately trained to use the new system or solution. This involves creating training materials, conducting workshops, and providing ongoing support to help users adapt to the new tools or processes.
- User support is essential for addressing any challenges users might face during the initial stages of using the new system.
- If the project involves replacing or upgrading an existing system, data migration might be necessary. This process involves transferring data from the old system to the new one, ensuring that all data is accurately moved without loss or corruption.
- Data migration also includes validating the integrity of the data after migration and ensuring that it is accessible and usable in the new system.
- After the system is implemented, ongoing monitoring is essential to ensure that it continues to function correctly and efficiently. This includes tracking system performance, identifying potential issues, and performing regular maintenance tasks.
- Monitoring tools and dashboards are often set up to provide real-time insights into the system's operation, allowing for proactive management.
- Comprehensive documentation is essential during the Implementation phase. This includes documenting the deployment process, configuration settings, integration details, and any customizations made.
- Documentation serves as a reference for future maintenance, troubleshooting, and potential upgrades.
- Gathering feedback from users and stakeholders is crucial after the implementation. This feedback helps identify areas where the system can be improved or adjusted to better meet the needs of the organization.
- Based on the feedback, iterations or updates may be necessary to refine the system and enhance its performance or usability.
- During implementation, risks such as system downtime, data loss, or integration failures must be managed. Contingency plans should be in place to address these risks and ensure minimal disruption to the organization.
- Having a rollback plan is also important in case the implementation encounters significant issues that require reverting to the previous state.

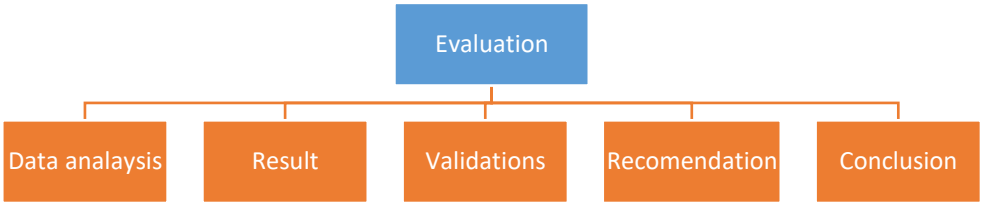

Figure 4: The main elements of the evaluation phase.

Figure 4 outlines the main components of the evaluation phase, which include data analysis, results, validations, recommendations, and conclusions. In this phase, data is analyzed to derive insights, and the results are presented for further interpretation. Validations are then conducted to ensure the accuracy and reliability of the findings. Based on the validated results, recommendations are provided for future actions or improvements. The process concludes with a summary that encapsulates the key findings and overall implications of the evaluation, offering a clear direction for subsequent steps.

2.2.2 Key Considerations of using IMGSIE methodology

- Flexibility: While each stage contains several key elements, not all elements are mandatory for every project. The applicability of specific elements depends on the project's nature, making IMGSIE a versatile methodology that can be tailored to various types of projects.
- Core Elements: Regardless of the project's specifics, certain elements are universally required, such as the introduction, problem statement, objectives, and conclusion. These components ensure that the project has a clear direction and measurable outcomes.
- Educational Focus: IMGSIE is particularly useful in educational settings, guiding students through the complexities of project work by providing a clear structure. It helps students understand how to transition from theory to practice and ensures that they cover all essential aspects of a project.

- By following the IMGSIE methodology, students and professionals can systematically address the various stages of project work, from initial idea to final evaluation, ensuring a comprehensive approach that is both structured and adaptable to different project needs.

3. Data Collection

To assess the quality and effectiveness of the IMGSIE methodology, questionnaires were administered to both supervisors and students directly involved in IT projects, The number of participants in the survey, including students and supervisors (100). These questionnaires aimed to gather insights on various aspects of the methodology, including its applicability, ease of use, and overall impact on project outcomes. By collecting feedback from those with firsthand experience in implementing IMGSIE, the study was able to evaluate the methodology's strengths and identify areas for potential improvement.

To measure the quality and effectiveness of the IMGSIE methodology, a detailed survey was conducted involving both supervisors and students who were directly engaged in IT projects utilizing this approach. The questionnaires were designed to capture a wide range of perspectives, focusing on key factors such as the methodology's structure, its ability to guide project completion, the clarity of its stages, and its overall impact on project success. Supervisors were asked to evaluate how well IMGSIE facilitated project management, including aspects like time management, resource allocation, and the systematic progression through each phase. They also provided feedback on how effectively the methodology supported students in understanding and applying complex concepts. One of the most important questions were taken from each questionnaire as follows:

The first questionnaire (answered by supervisors)

Q1- How effective do you find the IMGSIE methodology in organizing and structuring the graduation project?

In this question, supervisors were allowed to select multiple answers. The analysis of the results, as illustrated in Figure 5, revealed the following: 42.5% of responses indicated that "Extremely effective," 22.5% cited "Very effective," 17.5% noted "Moderately effective," 15.0% mentioned "Slightly effective".

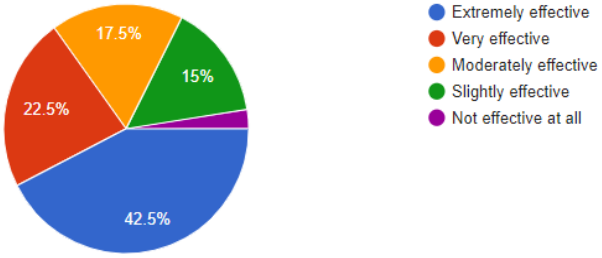

Figure 5: The percentage of the organizing and structuring the graduation project.

Q2- How did the IMGSIE methodology impact your ability to manage time during the project?

In this question, supervisors were allowed to select multiple answers. The analysis of the results, as illustrated in Figure 6, revealed the following: 47.8% of responses indicated that " Improved time management significantly," 32.6% cited " Improved time management somewhat," 15.2% noted " Had no impact on time management ".

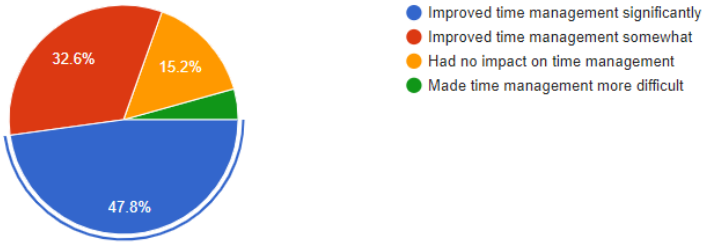

Figure 6: The percentage of manage time during the project

The second questionnaire was answered by the students who completed their graduation projects by using the IMGSIE method.

Q1- Did the IMGSIE methodology help you to clearly define the objectives of your project?
In this question, students were allowed to select multiple answers. The analysis of the results, as illustrated in Figure 7, revealed the following: 55% of responses indicated " Yes, very much," 30% cited " Yes, somewhat," 10% mentioned " Not much ".

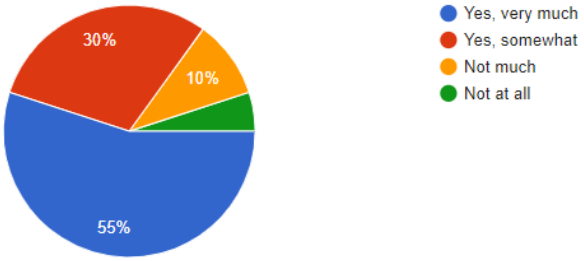

Figure 7: The percentage of IMGSIE clearly define the objectives.

Q2- How did the IMGSIE methodology impact your ability to manage time during the project?
In this part, students were allowed to select multiple answers. The analysis of the results, as illustrated in Figure 8, revealed the following: 60% of responses indicated" Improved time management significantly," 20% cited Improved time management somewhat," Had no impact on time management".

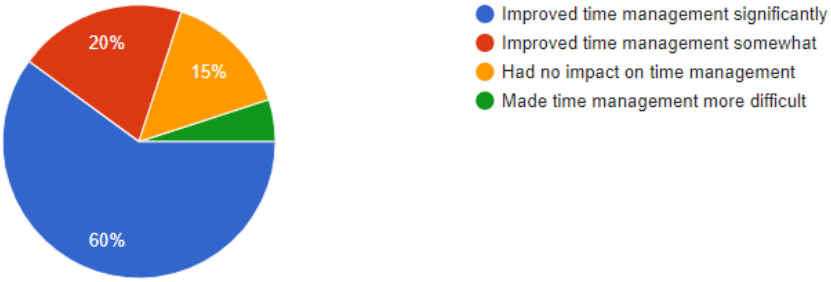

Figure 8: The percentage ability to manage time during the project

4. Conclusion

In conclusion, this paper has comprehensively evaluated the IMGSIE methodology's effectiveness in managing IT projects by gathering feedback from both supervisors and students actively engaged in such projects. The findings reveal that IMGSIE provides a structured and systematic approach to project management, offering clear guidance through its stages—Introduction, Method, Generation, Specification, Implementation, and Evaluation. The methodology's strength lies in its ability to facilitate a thorough understanding of project requirements, promote systematic development, and ensure comprehensive evaluation. Supervisors highlighted its utility in enhancing project organization and resource management, while students appreciated the clarity and practical applicability of the methodology, which helped them navigate complex project tasks. However, the study also identified areas where IMGSIE could be refined, such as improving the flexibility of certain stages and enhancing user support during the Implementation phase. These insights suggest that while IMGSIE is effective, there is room for further development to address specific challenges encountered by users. Overall, the IMGSIE methodology proves to be a valuable tool for managing IT projects, providing a robust framework that supports both theoretical and practical aspects of project execution. Future research could explore the adaptation of IMGSIE for different types of projects or its integration with other project management frameworks to further enhance its applicability and effectiveness.

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