

# Digital simplification in project management: Development of the Critical Path Method in the current context

*Simplificación digital en la gestión de proyectos: Desarrollo del Método de la Ruta Crítica en el contexto actual*

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## ABSTRACT

Time management is one of the most prominent areas in projects, thus requiring innovative tools for effective development. In this regard, the present research aimed to describe the digital simplification of time management in projects through the digital Critical Path Method (CPM). To achieve this, a basic, descriptive, and quantitative study was conducted by implementing CPM on the Trello platform. As a result, it was observed that activities were reduced by 50%, and the level of digitization increased by 33%. In conclusion, digital CPM streamlined project time management, facilitating the optimization of human work in the current context.

**Keywords:** critical path method, digital simplification, project time management, current context, innovation.

**Clasificación JEL:** O22, O32, M11

## RESUMEN

La gestión del tiempo es una de las áreas más resaltantes en los proyectos, por lo que requiere de herramientas innovadoras para desarrollarse de una manera efectiva. En ese sentido, la presente investigación tuvo como objetivo describir la simplificación digital de la gestión del tiempo en proyectos a través del Método de la Ruta Crítica (CPM) digital. Para ello, se basó en un estudio básico, descriptivo y cuantitativo desarrollando el CPM en la plataforma Trello. Como resultado se obtuvo que sus actividades se redujeron en 50% y el nivel de digitalización se incrementó en 33%. En conclusión, el CPM digital simplificó la gestión del tiempo de proyectos permitiendo la optimización del trabajo humano en el contexto actual.

**Palabras clave:** método de la ruta crítica, simplificación digital, gestión del tiempo de proyecto, contexto actual, innovación.

**Clasificación JEL:** O22, O32, M11

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## 1. Introduction

The world has evolved significantly in recent years through advances in technology, involving different sectors of global importance whose activities are carried out through adequate project management to meet their objectives. This new era is led by Industry 4.0 focused on automation through different increasingly relevant technological topics, such as the Internet of Things or Artificial Intelligence (Xu *et al.*, 2018). In this sense, project management needs to adapt to these new technologies, thus being called Project Management 4.0, which is according to Simion *et al.* (2018), in its initial stage so many of its tools are still those of the previous generation, Project Management 3.0, where the first PMBOK (Project Management Body of Knowledge) guide and time management methods of projects such as the CPM (Critical Path Method).

Likewise, it is important to highlight that Project Management 4.0, according to Simion *et al.* (2018), focuses primarily on some of its components such as time management, costs, quality, equipment, communication, among others, highlighting the first of them. Time and its management in these times encompasses its optimization through automation, for which it requires certain methods and tools that make it possible.

So, when faced with project management aimed at a consolidated stage of current technology, it is essential to apply its methods in an efficient way that is proportional to it. In this way, the present research aimed to describe the digital simplification of time management in projects through the digital Critical Path Method (CPM), in comparison to its traditional version.

The relevance of addressing project management in this technological context,

according to the perspective of Hernández Sampieri *et al.* (2014), acquires relevance from different angles. In a social justification, the present research seeks to contribute to the development of modern society by proposing a more simplified and digital implementation of the Critical Path Method (CPM) in project time management through the optimization of human work with the significant support of a digital tool. Furthermore, it is justified in a practical way, since the research is positioned as a tangible response to the current demand for project management tools adapted to digitalization, being a practical and applicable solution for the changing world in which we live.

## 2. Literature Review

In principle, it is necessary to approach related concepts to understand the upcoming application to be shown.

According to Tereso *et al.*, (2019), there is no single definition for the term project; However, the common meaning is taken to be a set of temporary activities, with start and end times, and which are unique, so they require management.

A project seeks as its main objective to move from a current unsatisfactory situation to a desired future one, which may include resources and restrictions of different types (Cruz Montero *et al.*, 2020), all known as a temporary effort (Cañas *et al.*, 2016).

Every project presents difficulties, taken as challenges, and this is where project management, also known as project management or administration, appears (Cruz Montero *et al.*, 2020).

Project management is the process of planning, organizing, executing, monitoring, and controlling projects in order to achieve a

particular objective, through the well-known “iron triangle” made up of time, cost and quality (Radujković & Sjekavica, 2017).

This specific management allows managing resources, but also preventing risks that may appear at different times of the project, through the joint use of systems, techniques, and people (Cruz Montero *et al.*, 2020).

Years ago, project management was applied only in large companies; However, currently, every company can demonstrate

the benefits that its development provides (Pacheco Ruiz *et al.*, 2020).

According to Guevara *et al.*, (2017), there are a variety of standards and/or guides in project management, each led by an institution (see table 1). However, the Project Management Institute (PMI) is the world’s leading entity in project management and does so mainly through the Project Management Body of Knowledge (PMBOK), a guide that is currently in its seventh version, but having the sixth still in force (Cruz Montero *et al.*, 2020).

**Table 1.** Main Project Management’s Standars or Guidance

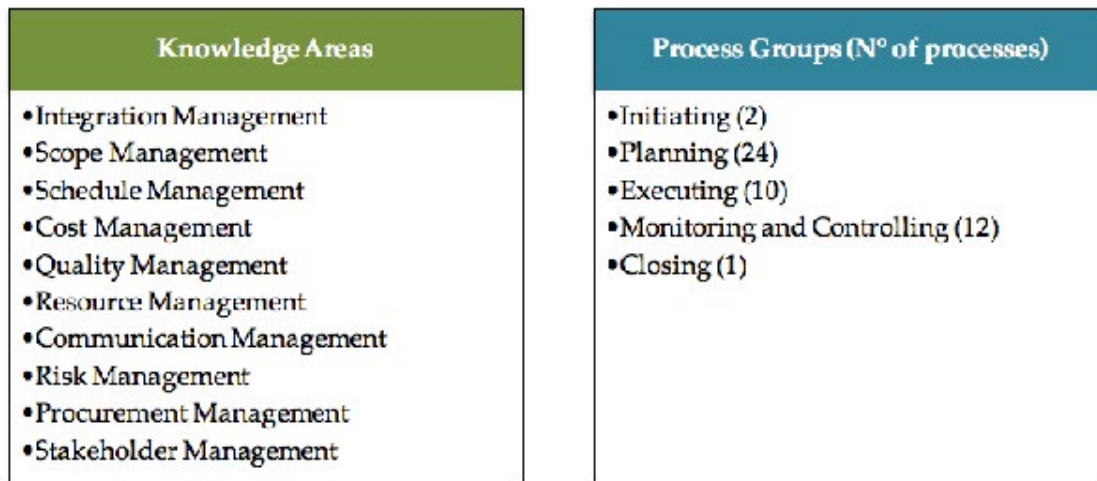
Instituciones Responsables	Standard or Guidance
Project Management Institute (PMI)	Project Management Body of Knowledge (PMBOK)
International Project Management Association (IPMA)	IPMA Competence Baseline
International Organization for Standardization (ISO)	ISO 21500:2012: Guidance on Project Management
Association for Project Management (APM)	APM Body of Knowledge (APM BoK)
P2M Project and Program Management for Enterprise Innovation (P2M)	Engineering Advancement Association of Japan (ENAA)

Source: Elaborated from Guevara *et al.* (2017).

The PMBOK in its sixth edition states that project management presents 10 areas of knowledge and 5 groups of 49 processes in

total (see Figure 1), which are related to each other.

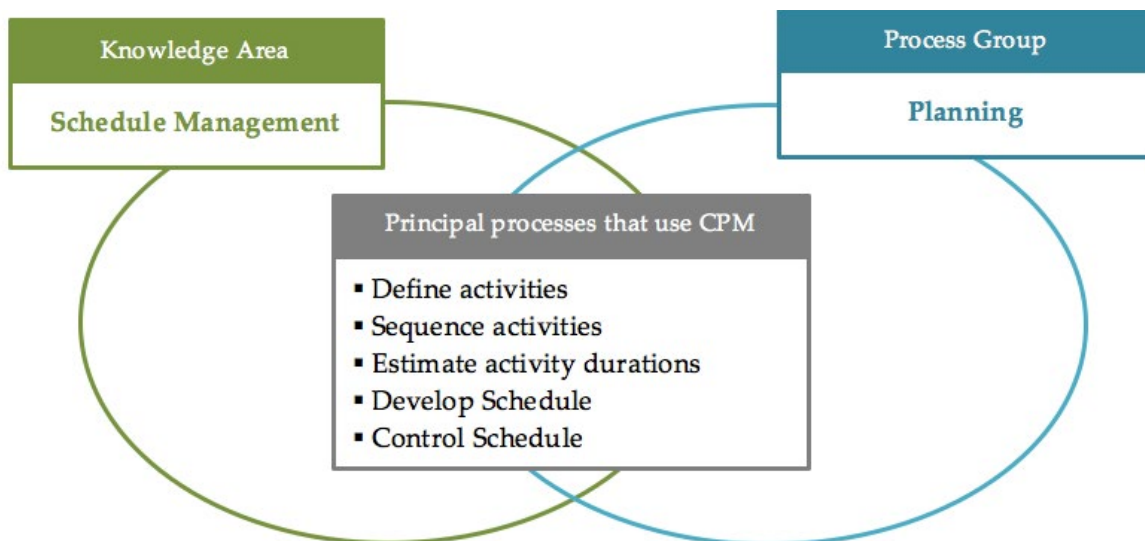
**Figure 1.** Knowledge areas and process groups of project management



Source: PMBOK Sixth Edition

It is in the area of Schedule Management, where it focuses on time management; and that furthermore, in the group of Planning processes where the definition, sequencing and estimation of duration of activities appear, as well as the development and control of the schedule, all of them directly related to network methods such as CPM, the main ones being, but not the only processes (see figure 2).

**Figure 2.** Key processes in project management related to CPM



Source: Prepared from PMBOK Sixth Edition.

CPM is a method that allows projects to be managed from the planning basis, breaking them down into smaller time intervals, called activities, in a logical and systematized sequence (de Assis Mota *et al.*, 2006), which is why it is known as to many others as a network method (Marit *et al.*, 2020).

The CPM seeks to identify the critical path of a project in order to know the maximum time of the project and based on this make decisions before and during the project. In fact, CPM is a quantitative method used in programming and project management and in operations research for businesses that can be applied from a simple to a more complex level, as described by recognized authors over time on the topic as Gallagher & Watson (1982) and Anderson *et al.*, (2011).

This network model can be applied in different sectors, but they are widely used in the areas of construction, production, transportation, distribution and inventory.

In short, the CPM has a wide scope, but the most important thing is knowing how to develop and interpret it; For the first, there are different tools, from simple ones like using a sheet of paper to more advanced ones using current technology like Ms Project or other complementary ones like the one addressed in this research.

Being one of the pioneering methods of project management (Velez García *et al.*, 2018), CPM continues to form an important part of said management worldwide, much more so with current technology (Aliyu, 2013).

### 3. Methodology

The present research was basic, since it collects theory related to the Critical Path Method (CPM) in project management seeking to expand the knowledge of its methodology

in a digital version, without applying it to another variable; which is precisely what defines research of this type, according to Baena Paz (2017).

Furthermore, it was at a descriptive level; since, as Bernal Torres (2010) mentions, the detail of a certain object of study is shown, but the reason for the phenomenon is not sought to be explained; and this research aimed to describe the level of digital simplification of the CPM in its traditional and modern versions.

The research approach was quantitative, since it follows an order of development and presents quantitative variables (Hernández Sampieri *et al.*, 2014). In this case, the article is developed from ideation, problem statement, development of the theoretical framework, definition and application of methodology, obtaining results and their descriptive analysis, conclusion and final discussion. This approach also seeks to measure the research phenomenon according to its impact or magnitude; and in this article the level of digital simplification of the modern CPM was measured.

It is important to note that, in the development of this research article, the collection of data from a specific population or sample has not been involved. The research has focused on identifying the number of activities in project management in the traditional and digital versions of the Critical Path Method (CPM), without requiring the participation of individuals or a particular set of projects. Consequently, a sample selection process has not been applied nor has a defined population been considered in the conventional context of field research. The lack of data collection on a population or sample aligns with the focus of this research, which has focused on the quantitative

description of the activities involved in projects managed in a traditional and digital way, without involving the collection of data from people. or specific groups.

To carry out this study, indicators were used allowing a direct comparison between both versions of the CPM, through a simple comparative table (in MS Excel). The indicators that were established were 2:

- Number of activities: No. of activities to develop the CPM
- Level of digitalization: Number of activities that are developed through digital tools.

Data collection was carried out by reviewing and comparing the activities of the Critical Path Method in its traditional approach and in its digital version. For the latter, the CPM was developed through the online platform Trello; since it is one of the most appreciated tools for project management; in fact, trends on Google and Twitter position it that way (Matta & Marchesi, 2015; Özkan & Mishra, 2019). It is one of the few project managers that allows you to identify the critical path in a simple, automated way, with multiple plugins and for free.

In this way, Trello is the perfect tool to efficiently manage the time of a project for the development of this research.

The collected data were subjected to quantitative analysis. Descriptive statistics

were used to summarize the differences in the number of activities and level of digitization between traditionally managed CPM steps and those that used Trello. This analysis allowed us to objectively describe the impact of digital simplification on the steps of the Critical Path Method.

Because data collection was activity-focused and did not involve obtaining data from a population or sample of individuals, informed consent from participants was not required nor was an ethical concern related to data privacy raised. However, throughout the research the theory collected was appropriately cited and referenced, respecting their authorship.

The fundamental limitation of this study lies in its descriptive approach, since it does not allow us to delve into the underlying reasons behind the changes observed in the simplification and digitalization of the activities of the Critical Path Method, which is discussed at the end of the research.

#### 4. Analysis of Results

First of all, there is the traditional CPM, which can be developed through 8 activities. The first 4 do not require calculations, but rather logic and data order (see table 1); while for the next 3 the times are calculated (see table 2) until reaching the last activity where the critical path is identified (see table 3).

**Table 2.** Activities that do not require calculations

Nº	Activity	Development																																	
1	Identify activities	<table border="1"> <thead> <tr> <th>Actividad</th> <th>A</th> <th>B</th> <th>C</th> <th>D</th> <th>E</th> <th>F</th> <th>G</th> <th>H</th> <th>I</th> <th>J</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Actividad	A	B	C	D	E	F	G	H	I	J																						
Actividad	A	B	C	D	E	F	G	H	I	J																									
2	Estimate duration	<table border="1"> <thead> <tr> <th>Tarea</th> <th>A</th> <th>B</th> <th>C</th> <th>D</th> <th>E</th> <th>F</th> <th>G</th> <th>H</th> <th>I</th> <th>J</th> </tr> </thead> <tbody> <tr> <td>Duración (días)</td> <td>1</td> <td>3</td> <td>4</td> <td>6</td> <td>2</td> <td>4</td> <td>3</td> <td>5</td> <td>3</td> <td>2</td> </tr> </tbody> </table>	Tarea	A	B	C	D	E	F	G	H	I	J	Duración (días)	1	3	4	6	2	4	3	5	3	2											
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Duración (días)	1	3	4	6	2	4	3	5	3	2																									
3	Establish dependencies	<table border="1"> <thead> <tr> <th>Tarea</th> <th>Duración (en días)</th> <th>Predecesor</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>1</td> <td>-</td> </tr> <tr> <td>B</td> <td>3</td> <td>A</td> </tr> <tr> <td>C</td> <td>4</td> <td>B</td> </tr> <tr> <td>D</td> <td>6</td> <td>B</td> </tr> <tr> <td>E</td> <td>2</td> <td>C, D</td> </tr> <tr> <td>F</td> <td>4</td> <td>A</td> </tr> <tr> <td>G</td> <td>3</td> <td>F</td> </tr> <tr> <td>H</td> <td>5</td> <td>F</td> </tr> <tr> <td>I</td> <td>3</td> <td>G, H</td> </tr> <tr> <td>J</td> <td>2</td> <td>E, I</td> </tr> </tbody> </table>	Tarea	Duración (en días)	Predecesor	A	1	-	B	3	A	C	4	B	D	6	B	E	2	C, D	F	4	A	G	3	F	H	5	F	I	3	G, H	J	2	E, I
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G	3	F																																	
H	5	F																																	
I	3	G, H																																	
J	2	E, I																																	
4	Create network of activities	<pre> graph LR     A --&gt; B     A --&gt; F     B --&gt; C     B --&gt; D     F --&gt; G     F --&gt; H     C --&gt; E     D --&gt; E     G --&gt; I     H --&gt; I     E --&gt; J     I --&gt; J     </pre>																																	

Source: Self made

The activities shown do not require any calculation since they focus on assembling the network of activities with logical connections

and appropriate durations, so that the time calculation can begin with them.

**Table 3.** Activities that require calculations

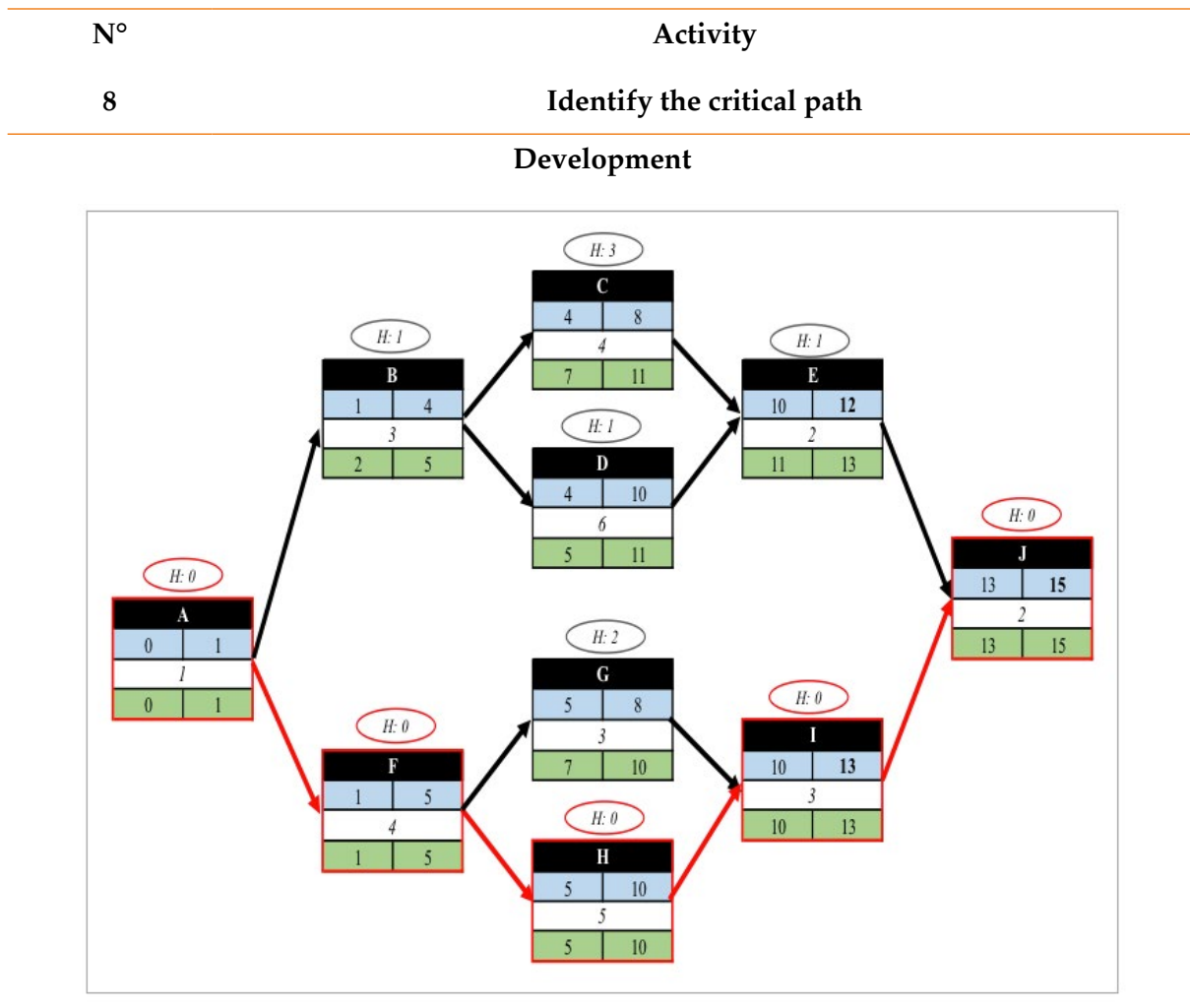
N°	Actividad	Desarrollo
5	Calculate early start and end	<p>The diagram shows activity A as a table with early start 0, early finish 1, and duration 1. It branches into activity B (early start 1, early finish 4, duration 3) and activity F (early start 1, early finish 5, duration 4).</p>
6	Calculate late start and end	<p>The diagram shows activity A with early start 0, early finish 1, duration 1, late start 0, and late finish 1. It branches into activity B (early start 1, early finish 4, duration 3, late start 2, late finish 5) and activity F (early start 1, early finish 5, duration 4, late start 1, late finish 5).</p>
7	Calculate clearances	<p>The diagram shows activity A with early start 0, early finish 1, duration 1, late start 0, late finish 1, and clearance H: 0. It branches into activity B (early start 1, early finish 4, duration 3, late start 2, late finish 5, clearance H: 1) and activity F (early start 1, early finish 5, duration 4, late start 1, late finish 5, clearance H: 0).</p>

Source: Self made

In these activities, the early and late starts and finishes are calculated, and through them, the slack, with which the critical path can finally be identified, since it is routed by those with a value of 0.



**Table 4.** Traditional critical path identification



Source: Self made

This implies that any delay in the activities such as a calculator or Microsoft Excel, as on the critical path will directly affect the total estimated duration of the project. detailed in Table 4.

The 8 activities are developed manually, however, some of them can use digital tools

**Table 5.** Level of digitalization of traditional CPM

Nº	Activities	Digitized	Tools used
1	Identify activities	No	-
2	Estimate durations	No	-
3	Establish dependencies	No	-
4	Create activity network	No	-
5	Calculate early start and end	Yes	Calculator or MS Excel
6	Calculate late start and end	Yes	Calculator or MS Excel
7	Calculate clearances	Yes	Calculator or MS Excel
8	Identify critical path	No	-

Source: Self made

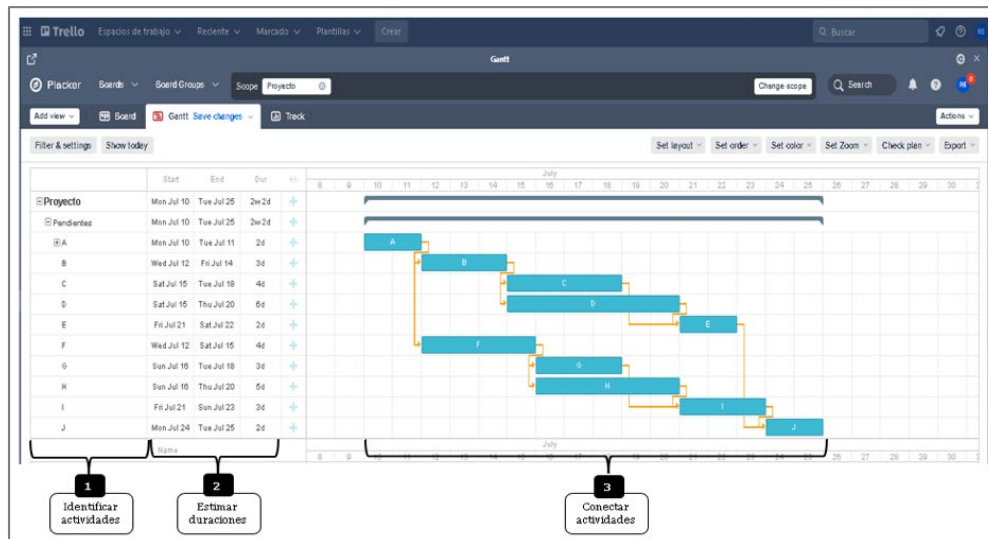
As can be seen, of the 8 activities necessary to identify the critical path of a project, in the traditional version, only 3 of them are digitized; that is, 37.50 %.

In contrast, the development of digital CPM is analyzed, specifically using the Trello

platform with its PowerUp called Placker. This tool will be simply named “Trello” in order to facilitate writing and understanding.

The digital CPM is developed through 4 activities as follows in Trello:

**Figure 3.** Activities prior to identifying the critical path



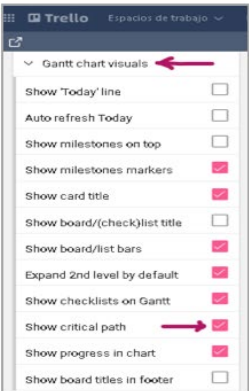
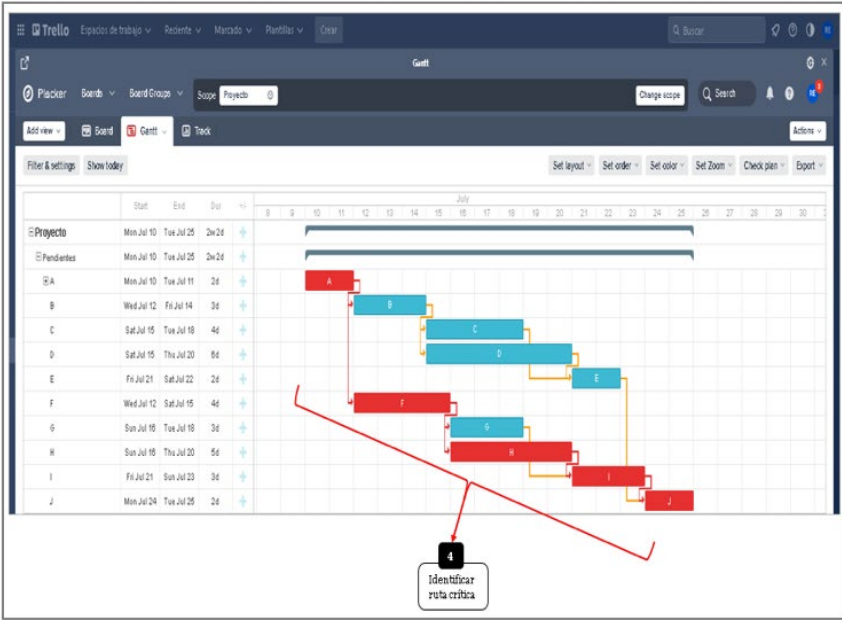
Source: Self made

The previous figure shows the first 3 activities, where the project activities are identified, their durations are estimated, and they are logically connected just by joining

the nodes of the activity bars. The first two per se do not mean digital activities, but the third does.

Finally, the critical path of the project configuration called “Gantt chart visuals” in, is identified in a simple way, only by activating the “show critical path” filter in the as specified in Table 5.

**Table 6.** Digital critical path identification

Filter settings	Result
	

Source: Self made

Below is the detail of the 4 activities based on their digitization:

**Table 7.** Digital CPM digitization level

Nº	Activities	Digitized	Tools used
1	Identify activities	No	-
2	Estimate durations	No	-
3	Connect activities	Yes	Trello (with bar nodes)
4	Identify critical path	Yes	Trello (with filters)

Source: self made

In this sense, it is obtained that 2 of the 4 activities required to develop digital CPM are digitized, which represents 50 %.

The following table compares the levels obtained for each version of the CPM.

**Table 8.** Traditional CPM vs digital CPM

CPM version	Number of activities	Digitization level
Traditional	8	37.50 %
Digital	4	50.00 %
Improvement	-50 %	+33 %

Source: self made

As a result, it was obtained that the digital version allows the CPM to be simplified, since the number of activities required for its development was reduced by 50 %. In addition, this contributed to the percentage or level of digitalization of activities increasing by 33 %.

The results obtained in this research provide a clear and valuable vision of the impact of digital simplification on the time management of a project, through an innovative version of the Critical Path Method (CPM).

The significant reduction of 50 % in the number of activities necessary for the development of digital CPM, in relation to its traditional version, shows us the benefits in terms of agility in time management, considering that projects are changing and must be adapted agilely, including any deadline adjustments that may be made.

Likewise, an increase in the level of digitalization of activities by 33 % was evident. This reflects a positive adaptation to current technological environments that are constantly evolving using modern tools that allow it.

It is necessary to emphasize that digital CPM should not necessarily replace its traditional version, but rather complement it;

Well, as Bayu & Kurniawan (2018) mention, the collaboration between both versions will allow the adaptation to be more manageable as time passes.

For example, in the traditional version you can use MS Excel, which is a current and digital software, as well as MS Project, and these can carry out adequate management. However, the attributes of the era of automation and artificial intelligence can be taken advantage of when using tools like Trello, since being a cloud platform allows you to configure alert notifications, display settings and integrations with other management platforms such as Airtable, Zappier, Slack, among many more that make it possible to have a completely automated environment between all the project's interested parties.

As it is noticed, digitalization not only makes it easier to identify the critical path of a project, but its impact is more far-reaching. It remains a challenge for future research to analyze the improvement that digital CPM can bring about, but also the use of digital technologies per se, through Trello or another similar platform that is appropriate, in other areas and processes of project management.

## 5. Conclusions, Limitations and Implications

In summary, the research has managed to clearly describe the digital simplification of time management in projects through the Critical Path Method (CPM), adapted to a digital version; reducing 50 % of its activities and increasing its level of digitalization by 33 %. These results lead to an improvement that is in line with current technological solutions.

The relevance of these findings lies in the potential of technology to simplify and improve traditional project management activities, obtaining much more agile time management. However, it is important to recognize that this study presents the basis so that future research can give greater consistency to the effect of digital CPM on different variables such as time (efficiency), organizational change, return on investment or data security.

This research points to the need to embrace digital solutions, inviting professionals in the field to consider adopting similar approaches for the benefit of human development, as this is no longer part of the future, the time is now.

## References

Aliyu, A. (2013). Project Management using Critical Path Method (CPM): A Pragmatic Study. *Global Journal of Pure and Applied Sciences*, 18(3–4). <https://doi.org/10.4314/gjpas.v18i3-4.11>

Anderson, D. R., Sweeney, D. J., Williams Thomas A., Camm Jeffrey D., & Martin Kipp. (2011). *Métodos cuantitativos para los negocios* (Cengage Learning, Ed.; 11th ed.). <http://latinoamerica.cengage.com>

Baena Paz, G. (2017). *Metodología de la Investigación* (Grupo Editorial Patria, Ed.; 3rd ed.).

Bayu, R., & Kurniawan, D. (2018). The Combination of Critical Path Method and Online Project Management Tool to Improve Accuracy of Project Schedule. *Prosiding Simposium IATMI*, 937–944.

Bernal Torres, C. A. (2010). *Metodología de la investigación* (PEARSON EDUCACIÓN, Ed.; 3rd ed.).

Cañas, C. A. L., Gómez, Á. S., & PARDO, R. (2016). Diseño de una Oficina de Gestion de Proyectos (PMO) en la Universidad EAFIT para la ejecución de Proyectos de C&T con Recursos Públicos. *Revista ESPACIOS | Vol. 37 (Nº 13) Año 2016*.

Cruz Montero, J. M., Guevara Gómez, H. E., Flores Arocutipa, J. P., & Ledesma Cuadros, M. J. (2020). Áreas de conocimiento y fases clave en la gestión de proyectos: consideraciones teóricas. *Revista Venezolana de Gerencia*, 25(90), 1315–9984. <https://www.redalyc.org/articulo.oa?id=29063559017>

de Assis Mota, A., Moreira Mota, L. T., & Morelato Franca, A. L. (2006). Modelagem de planos de recomposição de sistemas elétricos como grafos CPM/PERT. *Revista Controle & Automação*, 17(4), 437–445.

Gallagher, C. A., & Watson, H. J. (1982). *Métodos cuantitativos para la toma de decisiones en administración* (McGRAW-HILL, Ed.).

Guevara, J. D., Bello, N. A., García, O. A., & Abuchar, A. (2017). Aproximación PMBOK a la estructura de la gestión de proyectos. *Tecnología, Investigación y Academia*, 5(1). <http://revistas.udistrital.edu.co/ojs/index.php/tia/issue/archive>

Hernández Sampieri, R., Fernández Collado, C., & Baptista Lucio, M. del P. (2014). *Metodología de la investigación* (McGRAW-HILL, Ed.; 6th ed.).

- Marit, I. Y., Nursanti, E., & Vitasari, P. (2020). Analysis of time acceleration using Critical Path Method (CPM) to increase motorcycle maintenance in authorized service station. *IOP Conference Series: Materials Science and Engineering*, 885(1), 012059. <https://doi.org/10.1088/1757-899X/885/1/012059>
- Matta, M., & Marchesi, M. (2015). Understanding Approval Rating of Agile Project Management Tools Using Twitter. *10th International Joint Conference on Software Technologies (ICSOFT)*, 1–6. <http://www.google.it/trends/>
- Özkan, D., & Mishra, A. (2019). Agile Project Management Tools: A Brief Comparative View. *Cybernetics and Information Technologies*, 19(4), 17–25. <https://doi.org/10.2478/cait-2019-0033>
- Project Management Institute. (2017). *Guía de los fundamentos para la Dirección de Proyectos (Guía del PMBOK)* (Project Management Institute, Ed.; 6th ed.). Project Management Institute.
- Radujković, M., & Sjekavica, M. (2017). Project Management Success Factors. *Procedia Engineering*, 196, 607–615. <https://doi.org/10.1016/j.proeng.2017.08.048>
- Simion, C.-P., Popa, Ștefan-C., & Albu, C. (2018). Project management 4.0 - Project management in the digital era. *Proceedings of the 12th International Management Conference "Management Perspective in the Digital Era,"* 93–100.
- Tereso, A., Ribeiro, P., Fernandes, G., Loureiro, I., & Ferreira, M. (2019). Project Management Practices in Private Organizations. *Project Management Journal*, 50(1), 6–22. <https://doi.org/10.1177/8756972818810966>
- Velez García, S., Zapata Cortes, J. A., & Henao Rosero, A. (2018). Gestión de Proyectos: origen, instituciones, metodologías, estándares y certificaciones. *Entre Ciencia e Ingeniería*, 12(24), 68–76. <https://doi.org/10.31908/19098367.3818>
- Xu, L. Da, Xu, E. L., & Li, L. (2018). Industry 4.0: state of the art and future trends. *International Journal of Production Research*, 56(8), 2941–2962. <https://doi.org/10.1080/00207543.2018.1444806>