Scoping Review of the Work Measurement for Improving Processes and Simulation of Standards

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Abstract. Any company, regardless of size, must consider in order to overcome the economic situation caused by the pandemic the process innovation and resource-saving parameters. Methodologies such as work measurement should be used to generate efficient and reliable information through which timely decisions are made. The current research addressed a scoping review of the literature on the most used techniques for determining standard times. Therefore, thirty-three scientific articles were selected to answer the three research questions posed on this study. In addition to the results, it was determined that the use of predetermined time systems are instruments that allow the quantification of a job before executing its production. Indeed, it allows the combination of techniques to develop predetermined systems that are linked to a specific activity. Furthermore, with the use of these techniques, the expense used to develop a new product can be reduced, and the production and administrative processes can be optimized.

Keywords: Work measurement · Time studies · Predetermined time system · MOST · MODAPTS · MTM

1 Introduction

Competitiveness forces every company to develop systems and processes that meet the needs in the environment of each business and allow establishing strategies that control human and material resources. This is created to maintain or improve product costs, profitability and permanence in the market in the long term [42].

Currently, the competitive environment is not the only obstacle that companies must face, it must be borne in mind that the crisis caused by COVID 19 has caused a worldwide change in the economic, labor and productive fields [32].

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The measure taken for the mitigation of the virus cause an interruption of the productive activities therefore, the decrease in the demand for products and services. Almost no company was prepared to face a total disruption, affecting the gross fixed capital formation, loss of economies of scale, and even manufacturing smaller production batches [30].

Therefore, the crisis due to the pandemic accelerated the changes that companies should have adopted a decade ago. Today those changes were observed with virtual negotiations, the rise of e-commerce, and home office [8]. The last of the changes mentioned is a concrete reality that companies are already using today. However, what happens with the areas that need to record information directly from production? How can you issue data on products that are not developed or released? These are the questions that make companies research for ways through which they can issue efficient information to make timely decisions. That’s when professionals must innovate in their processes and methodologies, leading to saving money and time.

The transformations that must be adopted require working together to adapt and improve existing methodologies. The study of work is a methodology used to determine standard times that have evolved and adapted to the environments of each company. Indeed. It has allowed the issuance of information without having timed the process [1]. Taking into account that some of the traditional methodologies may not be able to face the new reality in organizations, the knowledge of new techniques should be expanded, focusing on progressive digitization to achieve productive results [16].

The aim of this research is to present a scoping literature review to show updated information on work measurement techniques. These techniques, despite being developed long ago, could be adapted to current reality, allowing the establishment of standards, either by a system of predetermined times or by direct observation of activities.

The remainder of this article consists of 5 sections: Sect. 2 describes the methodology based on which the most relevant articles were chosen. Section 3 describes the literature review. Section 4 discusses and analyzes the results. And finally, in Sect. 5 the conclusions and future research implications are evidenced.

2 Article Selection Methodology

The review and selection of articles were carried out through the application of three phases: as an initial step, three research questions were asked, later, based on keywords a search for information was done, and finally, in the last step, by using a selection criteria the most relevant literature was determined.

2.1 Research Questions

Three research questions were posed (see Table 1). They became a guide in the literature search process. The questions focused on the measurement of work to emphasize its importance, as well as discovering the techniques which are currently giving giving results.
### Table 1. Research Questions

| Questions                                                                 | Goals                                               |
|--------------------------------------------------------------------------|-----------------------------------------------------|
| 1  What is the authors’ perspective on the measurement of work?         | Demonstrate the importance of work measurement      |
| 2  What are the most widely used work measurement techniques today?     | Identify the techniques with the greatest application|
| 3  Can a job be measured and analyzed using various techniques?          | Demonstrate whether joint work between techniques can be used for better analysis |

#### 2.2 Data Collection

The following keywords were used to search the literature corresponding to the measurement of work: work measurement, time studies, predetermined time system, methods-time measurement, Maynard operation sequence technique, the modular arrangement of predetermined time standards, preset timing standards, time formulas, production, and manufacturing. In the search engines, a variation or combination of the keywords was used in order to obtain articles referring to the use of work measurement techniques.

The literature search was performed in eleven databases (see Fig. 1), resulting in a total of sixty-four documents in English and Spanish corresponding to articles, articles published in conferences, books, and reports; The documents found correspond to articles published from 2000 to 2019.

![Fig. 1. Number of documents per database](image-url)
2.3 Selection of Information

The selection criteria applied in the classification of documents are detailed below. First, articles that were not published in the last five years were initially discarded. Regarding books, this criteria was not used on them, since the methodology was discovered years ago. Therefore, the books used in this review correspond to the ones published from 2000 to 2009. The second classification criterion was based on giving relevance to the articles or books according to the answers of the three research questions.

Based on the two criteria mentioned above, 33 articles published between 2015 and 2019 were selected (see Fig. 2), 24 from which are in English and 9 in Spanish. Besides, from a total of 10 books, 7 books were selected. Figure 3 shows that most of the articles were found in the databases: Scielo, ScienceDirect, and Scopus.

Fig. 2. Select articles by year

Fig. 3. Articles selected by database
3 Analysis by Topic of Literature

3.1 Contextualization of Work Measurement

All companies that offer a product or service need to measure, control, and improve the use of resources to have a proper management of them. Human resources play an important role in the industrial cost, thus the following questions arise: is the time of the operators being used efficiently? Is each operation carried out at the correct time? Does the administration have solid information for production plans and incentives? [13]. These questions have arisen throughout industrial evolution, which has led to the investigation and verification of a useful methodology for the administration and operation of human resources.

According to R. García, with the application of work measurement, the efficiency of workers can be controlled and increased [13]. A. Lago considers measurement as one of the necessary supports for increasing productivity [9]. A. Jananía mentions that a work measurement is a tool that has been continually improving and recognizes it as a necessary instrument to obtain better performance from machines and equipment [18]. Finally, F. Meyers believes that it is an aid for managers to make important decisions intelligently even before production starts [28].

It should be borne in mind that the measurement of work is a methodology that is complemented by the study of methods. Measuring work tries to reduce or eliminate activities that cause downtime while studying methods that aim to reduce the content of work by eliminating unnecessary movement [7]. In conclusion, the working method must be improved or standardized to be able to measure it.

The measurement of work can be defined in different ways and according to the perspective of each author, but in the definition of several authors, it can be seen that the following words are repeated: execution time, trained worker and established procedures [7,13,18,31]. For the development of this article, the definition issued by the International Labour Organization (ILO) will be considered: The measurement of work is the application of techniques focused on determining the time that a qualified worker executes a defined task, carried out according to a preset execution [19].

3.2 Benefits of Work Measurement

The information generated by the measurement of work and the establishment of time standards is not only helpful for the productive area, but the benefit is also evident for other systems of the company such as cost, planning, and even budgeting. The most representative benefits are discussed below:

The fundamental principle in the industry is that the operator has an adequate payment and that the company receives a reasonable workday. Therefore, setting a standard time with precision allows us to increase the efficiency of the machinery and the operating workers, hence the benefit of both participants is
achieved [31]. In the same way, the implementation of standard times has a benefit in the goals about the consumption of materials, resource distribution, and the expectation of execution time [7]. That is, time and dependent variables are participants and executors in determining the standard cost.

Based on standard times, controls over labor can be established, thus maintaining standard costs [19]. The relationship between time and standard production sets cost as an indicator of productive efficiency in the company. Furthermore, using the standard labor time, the cost of a prototype that is planned to be produced, and whose operations will be similar to the current ones can be determined [13].

Standards can be used as indicators of performance levels, whether individual or collective, manual or intellectual, that operators can achieve considering human capabilities and personal restrictions [7]. Besides, they provide information with which the production program can be elaborated, including data on the machines and manpower necessary to fulfill the work plans and take advantage of the installed capacity [19].

In short, the measurement of work presents benefits to the entire company, and it can even reduce operating costs. According to Meyers, in organizations that operate without time standards, a performance of 60% is characteristic; if time standards are set, performance improves to an average of 85%, representing an increase of 42% [28].

3.3 Measurement of Work by Direct Observation

Time study is a direct measurement technique used to determine as accurately as possible, based on several observations, the time required to carry out a task with pre-established standards [13]. Here are some articles that have used the technique of direct observation by timing activities to obtain benefits:

E. Polanco et al. [34] reviews how companies look for the most appropriate way to integrate or improve direct observation tools. The research details the necessary steps to apply a time study and the possible implications when implementing it. The study concludes that when standardizing time there is a basis for work scheduling, standard cost calculation, and implementation of incentives. The information presented in the article serves as a guide for executing time and motion studies.

One of the objectives of the study of work is to increase productivity, for this reason in a footwear production company, when using management tools in conjunction with the study of methods and times, it was evident that the areas were not balanced. In this company, the work was balanced using standard times. As a result, an increase in productivity of 5.49% was obtained [2].

Another case study is presented in the company CIAUTO, in which time studies are carried out to determine production standards and balance the assembly line of the M4 model car. Based on the study of times, it was determined that the stations have a shorter time than the cycle time. Thus, the analyzes leaded to organize the workers so that the activities are carried out evenly on both sides of the vehicle [5].
Direct observation is not a specifically applied technique at a production level, that is why in Fratello Vegan Restaurant a study of times and movements is proposed. Its focus is to optimize resources and normalize operations in a service company. The purpose was to minimize the dissatisfaction of the clients concerning the delay on the service due to a long time in the preparation of the dishes. The research proposes improvements in the efficiency of the chefs, the location of the materials used in the kitchen. It mainly concludes that the cost analysis must be related to the time taking so that in this way the demand and the resource are necessary analyzed by determining whether or not it is appropriate to continue offering certain products [27].

Another case of time measurement application can be seen in a distribution system of a marketer. The research uses direct observation and determination of times with a stopwatch for 15 days. The data was collected and analyzed through descriptive statistics which allowed the development of a system that supports the planning and ordering of routes, thereby achieving delivery times to each of the clients [14].

The articles presented are a methodological guide on how to carry out a study of work with the direct observation technique by timing. Besides, they provide guidelines for calculating the adequate number of observations to ensure the reliability of standard or standard times.

3.4 Work Measurement Using Methods Time Measurement (MTM - Synthetic Method)

This section will state articles related to one of the first techniques of predetermined times. Methods time measurement (MTM) bases its methodology on decomposing the task into elements and measuring them using units of time measurements (UTM), then each UTM is added to obtain the total time of a process.

P. Kuhlang [23] and M. Koptak [22], in their investigations, use the MTM technique to determine times and improvements in logistics systems. In both articles, they selected this technique because of the notorious benefits of its application and the increase in productivity, especially in manual operations. P. Kuhlang concludes the work with a 43% increase in productivity and a reduction in the basic time from 18.35 to 13.69 min in the preparation and packaging of the spare parts operations, while M. Koptak obtained a reduction of 0.52 min in the cycle time.

On the other hand, M. Manns et al. [26], H. Tinoco et al. [41] and A. Bellarbi [4] focus their investigations on the application of the MTM methodology with digital analysis tools. The first researcher used time measurement methods in conjunction with data mining to estimate the time and sequence of operations on an assembly line, thereby successfully predicting assembly operations 237 times.

H. Tinoco et al. [41] In their research, they propose the automation of the MTM methodology using a motion capture system embedded in a virtual environment. In the case study, an assembly process is generated which does not consider the principles of the economy of movement. Each movement was recorded
using an thermographic camera, passive markers, and video analysis software to subsequently analyze them using an algorithm. The automation of the methodology allows classifying some quantifiable aspects that are not easily identified in the traditional analysis of times and movements.

Similarly, A. Bellarbi [4] also focused their research on the automation of the MTM methodology. The article presented a system capable of automatically generating the MTM code using only the head and both hands in a virtual environment. Then, they divided the gestures made by the person and classified them into elementary movements using a decision tree algorithm. The purpose of the created system was to use it to train technicians or to help experts in the identification of the MTM code in industrial productions.

The articles presented above detail the application of the MTM methodology in real industrial systems as in virtual environments, but there is also research in which MTM is used to validate new time study methodologies. This is how M. Faber [10] in his article presents a revision on the accuracy of the methods time measurement human work design (MTM-HWD) with MTM-1. The case study has data from 62 German companies in which the two methods were used, and a strong linear relationship was obtained as a result. The method could be used in the design of human-oriented jobs, in fields of research on human-robot collaboration, exoskeletons, learning forecasts, and job rotation.

Similarly, F. Morlock et al. [29] In their article, they promote the use of the methodology in the design of workplaces. The research presents the teaching process used in the learning factories at Stellenbosch University in South Africa, which considered the basic and necessary knowledge to apply MTM with the objective already described while emphasizing the usefulness of the methodology to manage production times.

3.5 Measurement of Work Using Modular Arrangement of Predetermined Time Standards (MODAPTS - Synthetic Methods)

The following articles mention the results revealed with the application of the MODAPTS technique, it was considered appropriate to expand the theoretical framework on this technique because its use is beneficial to establish standards before starting production, even if there are no machines or work established cells.

The predetermined time systems are techniques used to establish standards. The systems describe the work according to the basic methods, the time of each movement is searched, and the individual times are added to obtain the necessary time for the entire work [28].

The predetermined time systems have evolved over the years. As a result, by using motion sensors, depth sensors, color cameras and a set of microphones, which provide captures of movements in three dimensions, the development of a software that analyzes movements and assigns a time using the MODAPTS technique has been developed. To evaluate the results, tests were carried out on the assembly of an electrical harness, and the results were compared with those
obtained by an analyst. The hypothesis test determines that the data can be assumed to be similar [24].

B. Alkan et al. [1] conducted a research project, it proposes a method to evaluate the complexity of manual assembly using a description of operations based on the modular arrangement of predetermined time standards (MODAPTS), which together with virtual the manufacturing tool (vueOne) generated a model that helps to identify and compare the complexity of work to determine an optimal approach. The analysis using predetermined times helps to identify problem activities before start-up, making it possible to obtain a reduction in costs and an increase in operating efficiency.

Similarly, S. Wu et al. [43] discusses a connection between motion analysis technology (PCA) and MODAPTS to optimize the predetermined time system. When using the PCA technology a precision of 80.08% was obtained in the determination of the times. In addition to a substantial saving in the execution time since the traditional method used 1 h, and with the implementation of technology, it is reduced to three minutes.

There are other application approaches, in which C. Erliana et al. [15] employs the MODAPTS technique to reduce working time in cement packaging. The research aims to compare the established processes with the standard time that can be determined by applying the system. The results gathered range from the decrease in cycle time to the fulfillment of the requested production.

In the same way, I. Siregar [39] carries out an analysis of the working method of an operator in a foundry company. The investigation is carried out since the company started to present losses due to the production process. The MODAPTS technique is used to improve the working methods and calculate the processing time. As a conclusion it was claimed that there is a difference of 126.65 s between the actual and the proposed method, the difference is produced by the operator making unnecessary movements in the work and consequently, there are losses and high production costs.

The articles reviewed have presented research on how the MODAPTS technique allowed to determine times and to analyze established methods to improve them. These methods are subsequently executed by trained and qualified workers therefore, the operational knowledge that workers acquire from years of experience is invaluable to a company.

Based on the high value of technical knowledge L. Liu et al. [25] proposes a concept of empirical operational knowledge directed to engineering (OEK) to describe and design a framework to acquire the operations of qualified technicians. The MODAPTS technique is used to segment the operating process into basic movement elements and the variable precision set algorithm (VPRS) to extract the technician’s content. The objective achieved was to provide a system that focuses on the transfer of tacit knowledge.

The use of the MODAPTS technique in the different application approaches has given excellent results in previous investigations, but A. Chan et al. [6] conducted a research on the comparison in the estimation of times of two industrial assembly tasks. It was concluded that the times performed by estimation
are lower than the real ones, but are higher than those determined using the MODAPTS technique. The researchers concluded that participants had difficulty determining times on tasks that required more precise handling.

3.6 Work Measurement Using Maynard Operation Sequence Technique (MOST - Synthetic Methods)

Another technique to determine times by using synthetic methods is the Maynard operations sequence technique (MOST), S. Rahman et al. [37] use the technique in the sewing section of a garment company to identify non-value-added activities and minimize bottlenecks to improve productivity and reduce cycle time. The investigation reduced the total time from 139 s to 109 s, increasing the production from 600 pieces to 1600 pieces. The general sewing base (GSD) technique can also be applied in garment companies since this technique was developed with the MTM base data and has formulas and operations for sewing garments. Thus, it was possible to achieve a standard time that takes into account variations such as the number of stitches, seam length, revolutions per minute of the machinery [40].

D. Patel [33], A. Karim [21], Y. Fang [11] researched production lines, the objective they sought was to reduce operating times and control the cost of labor. Through the application of the MOST technique and the analysis of cycle times and bottlenecks, they achieved the stated objective. D. Patel concludes that most of the labor was saved time (65% reduction in time) and increased productivity, also it is emphasized that by applying the techniques, production time can be obtained before manufacturing really begins. A. Karim achieved a reduction of more than 2 min in cycle time and an increase in performance of 29.63%. Finally, Y. Fang affirms that the technique is very useful, but it is limited in the aspects of mitigating operator fatigue and improving processes by controlling working hours.

P. Karad et al. [20] analyzes the use of MOST in an automotive company for the assembly of the rear floor. This technique allowed to redesign the processes and analyze the proper flow, thus reducing the workforce from 17 to 11 people, because the required quantity can be met in a single production turn, and a reduction of 1.91 min was also achieved in cycle time. Similarly, M. Jadhav et al. [17] used the technique in an automotive company to analyze the real data in comparison with the estimates, achieving the reduction of a production shift because the demand is fulfilled in one turn.

3.7 Combination of Direct Observation Methods with Synthetic Methods

The separate application of synthetic methods and direct observation methods become an excellent tool to obtain improvements in productivity and economic savings. In this section the benefits that would be obtained by combining the techniques of the study of work will be presented. In that way, it will be possible to analyze production time and compare with a pre-established method.
A. Pusvanasvaran et al. [36] in his research highlights the use of the implementation of the Maynard operation sequence technique (MOST) associated with the direct measurement technique by timing to reveal hidden waste in the dry packaging operation in electronic industry. The study of times determines the real cycle time and with the help of the MOST technique, the equation of the worker’s performance is calculated to be able to track or monitor the daily performance of the workers.

V. Polotski et al. [35] propose an approach that combines the MODAPTS technique with statistical techniques that use the real data obtained with time measurements with a stopwatch. The approach allows to establish a system that can be used for estimating times in projects that contain operations of a different nature. The proposed method breaks manufacturing operations into a series of tasks with experimentally identified times, achieving not only point estimates but also performing linear regression models.

J. Ruíz et al. [38] employ the study of times by stopwatch for the determination of standards in the filling process, later the study of process optimization is performed through the application of MOST and MTM techniques. It is concluded that time analysis is an adequate instrument to set standards and analyze improvements that reduce downtime and therefore the cost of production.

The previous articles give a clearer view of what has been exposed in the work measurement techniques segment, due to the verification that can be done by combining each one (direct timing and predetermined systems) and the use of regression model systems that can be established to estimate the times of any type of activity and it is also possible to issue relevant information to productive capacities without the need to have a work cell implemented.

In addition to the benefits obtained by estimating times, it should be noted that these assessments are of vital importance for the costing of the product. A. Ganorkar et al. [12] propose an investigation in which the MOST technique and time formulas are used to determine the practical capacity of the activities. The information generated is used by the activity-based costing system to determine the cost of the product and analyze improvements. The results obtained range from the timely analysis of the information to the cost reduction due to the decrease in productive time.

Most of the articles that use the combination of methodologies have obtained good results, but it must be considered that the predetermined systems focus on estimating the time of manual operations, and the implemented system may not fully adapt to the analyzed process. This is how F. Assef [3] in his research combines the MODAPTS technique, direct observation, and simulation of processes in an automotive assembly industry. The work concludes that predetermined time systems are an excellent tool when the product is in the phase of design. However, other types of variables (operator conditions, mobility of tools, a field of vision) must be taken into account since they may limit the execution of the work and the increase in real-time.
4 Discussion and Results Analysis

The literature review presents a favorable panorama in the application of predetermined time systems to simulate standards without starting manufacturing. Hence these techniques can be considered as useful instruments to control the expense of companies when developing new products, to improve the operations already established, to serve as information for the cost analysis. What is more the systems discussed in this article could become a basis for developing proposals that meet the needs of each organization, such as the GSD system developed for companies of clothing.

Based on the second research question, it was possible to verify that the most widely used techniques at present are mostly made up of the classification of synthetic methods (see Fig. 4): MOST (8), MODAPTS (9), MTM (8), GSD (1). Last but not least, the traditional method of direct observation: the study of times (5). This means that organizations are focusing on optimizing their processes using pre-established methods.

In contrast it should be noticed in two articles [6,21], some recommendations were reflected. They were about the determination of standards for pre-established times since the calculated time was much less than the real-time. That why the operation analysis that require more meticulous treatment should be carefully done. Likewise, it was mentioned that predetermined time systems must be improved so that operator fatigue can be considered as a factor.

In addition to what has been already mentioned, it was possible to determine that the techniques corresponding to the synthetic method were investigated.
throughout the period with which the articles were classified, having an increase in 2019 with 4 research articles (see Fig. 5). The study of times as an individual application was only reviewed in articles published in the years 2017 and 2019. However, it is observed in Fig. 5 that the combination of methodologies has a wide field of research, that is to say that, having as a basis the technique of direct observation in conjunction with any of the predetermined time techniques can generate new systems.

![Fig. 5. Work measurement methodologies](image)

Most articles were analyzed or applied worldwide, very few were investigated in South America, so it can be inferred that professionals in this sector are not familiar with the analysis and application of predetermined time systems. It would be very convenient to expand research in this field since the benefits are tangible in all areas of organizations, particularly in the control, optimization, and management of labor costs.

### 4.1 Challenges

All the research work mentioned in this article, applied methodologies that can become a fundamental part of any type of organization. Therefore, in this section, the articles which supported their research on real cases and which were verified in controlled environments or other than productive activities will be exposed. In the same way, the reasons for jointing the methodology with other tools will be exposed.

For the analysis method of work by direct observation, five articles were reviewed from which one of them [34] was used to methodically expose the
study of times by chronometer. Therefore, this research does not have an application at the industrial level. The following articles \cite{2,5,27}, used the sequence of steps necessary for the correct execution of the methodology in real cases. To recap, they considered the formulas for calculating the optimal number of samples, as well as the selection of a qualified operator, the standardization of the process and the operations studied. Another aspect of an application in real cases was evidenced in the article \cite{14}, in which the methodology was correctly used, focusing on improving the activities carried out in a logistics process.

The article \cite{29} did not apply MTM in a real case but it studied the theme and the necessary factors that should be considered when teaching the methodology. On the other hand, articles \cite{10,26,38}, correctly used this methodology in real cases of companies and even compared the results of productive activities with the use of new methodologies of predetermined times. By the same token, the use is evidenced in articles \cite{22,23}, since in these investigations each of the phases of MTM is executed correctly and systematically. The only difference is that the case studies were carried out in logistics operations.

On the contrary, the investigations \cite{4,41}, validate their objectives with the MTM methodology with simulated cases or in controlled environments, in which through digital applications they represented manual activities. The two articles correctly use the methodology, but in the last one, the activities that do not add value to the process (waiting) are not purified, thus causing the estimated time not to approximate reality.

Articles \cite{1,6,24} are aligned to the same perspective. In these investigations the execution of the MODAPTS methodology in controlled environments is validated, the articles mentioned already focused their studies on the development of technological improvements that will optimize the correct application of predetermined time systems. In other words, this type of research allows the generation of tools that facilitate the application of any system in a real environment. Thus, reducing the execution error that a less-qualified technician may commit when using any system with predetermined times.

Seen in this way, technologies will provide substantial support for the study of work. However, at the moment articles \cite{15,25,35,39} mention that the phases are still correctly used to estimate time using MODAPTS. In these investigations, the methodology is applied in real case studies, seeking the objective of continuous improvement. Another example of analysis is evidenced in the article \cite{3}, this study analyzes the estimated times in a real case by using MODAPTS and direct observation. In the investigation the correct application of each of the methodologies is observed, it is vital to take into account that for the execution any type of system must have prior knowledge of the process to be studied in order not to estimate or consider operations that do not add value.

Besides, it should be noted that in the review of articles corresponding to the MOST methodology, all the investigations have validations in real case studies, thus obtaining benefits with time and cost of production. In summary, from the total of thirty one articles, nineteen of them are investigations applied to real cases of production companies, three articles study real cases but of logistical
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The literature review suggests that from the total number of articles analyzed in sixteen of them, the methodology is not combined with another type of tools, while in twelve articles there is a mixture of work-study methodologies with statistical tools, virtual analysis, meta-mechanisms, movement analysis, among others.

The need to integrate instruments to the case studies analyzed in this article depends on the type of objective being sought. On the one hand, it is evident that in investigations in which it is necessary to estimate a production time or compare existing times with a pre-established standard any of the described methodologies can be executed. On the other hand, when estimated times are the focus, improving processes or operations, innovating in existing methodologies, adapting the methodology to a specific process, a combination of techniques with tools must be carried out. As a result, it will improve research and generate new knowledge and applications in the industrial field.

5 Conclusion and Future Research Implications

The articles presented in this literature review emphasize the importance of the productive and managerial level of the implementation of work measurement with any of the existing techniques. Besides, to the benefits and applications
described, it can be concluded that the techniques of predetermined times would be part of the industry and today would be an important instrument to face the new production horizon after the pandemic. The application cases demonstrated that increasing productivity is the consequence of continuous improvement and an innovative approach.

A very important issue that has been mentioned throughout the review is the cost of the product, all companies need to generate new offers with more competitive costs, and a main component of the cost is the time spent by the labor force. Therefore, companies need to determine the productive time. Therefore, the combination of techniques fosters the time estimation to be as reliable as possible. However, it is important to keep in mind that predetermined systems are designed to analyze manual operations by expanding research topics to develop tools that encompass machine conditions. In the case of the execution of MOST in the assembly lines, it could be studied how the system behaves in the mixed assembly models.

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