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Inês Rodrigues
CIICESI, ESTG /P.PORTO – Centro de Inovação e Investigação em Ciências Empresariais e Sistemas de Informação, Escola Superior de Tecnologia e Gestão / Politécnico do Porto

8210029@estg.ipp.pt

Wellington Alves
CIICESI, ESTG /P.PORTO – Centro de Inovação e Investigação em Ciências Empresariais e Sistemas de Informação, Escola Superior de Tecnologia e Gestão / Politécnico do Porto

wal@estg.ipp.pt

CONNECTING THE DOTS: HOW DOES LEAN THINKING CONTRIBUTE TO PROJECT MANAGEMENT?

Abstract: Lean Thinking (LT) is a philosophy that focuses on the development of initiatives to maximize customer value and minimize waste. LT was initially developed for manufacturing, but over the years its principles and tools have been adapted to other industrial sectors and functional areas, such as project management (PM).
Despite the potential benefits of linking LT to PM, there is limited literature examining the link between these topics when adapted to a variety of project contexts, still focusing on the execution of construction projects. Therefore, the proposed research aims to analyze the contribution of LT to minimizing waste in PM activities in order to increase project efficiency.
Having in mind the lack of research linking these two concepts (LT and PM), this research aims to review the literature related to LT and PM, and then conduct a bibliometric analysis to understand how this topic has grown over time. From the literature consulted lean thinking is proposed as a key aspect to support project managers in identifying the main waste originating in ongoing projects. The results will contribute to developing a conceptual model that aligns the LT tools and techniques with the PM practices. The proposed research aims to analyze the contribution of LT to minimizing waste in PM activities to increase project efficiency.

Keywords: Lean Thinking. Project Management. Lean Project Management. Efficiency.

1. INTRODUCTION

Lean Thinking (LT) is a philosophy that focuses on the development of initiatives to maximize customer value and minimize waste. This philosophy was initially developed for manufacturing, but its principles and tools have been adapted to other industrial sectors and functional areas, such as project management (PM). By eliminating waste in the work process, LT can create value and improve process efficiency (Anholon & Sano, 2016, pp. 1–4).
The principles and tools related to LT can therefore be applied to PM in order to improve the efficiency of the projects in different stages of application. The limited literature linking these approaches defends that the link between LT and PM, also known as Lean Project Management (LPM), can be a key strategy to improve project efficiency as it aims to manage and minimize waste and non-value-adding activities. Thus, when LT principles are applied in the project life cycle, it can contribute to support projects on minimizing waste in different phases of it (Oehmen et al., 2012).
This research aims to analyze the evolution of research into the contribution of LT to minimizing waste in PM activities in order to increase efficiency.

To achieve this purpose, the following specific objectives were addressed:

- To analyze the current literature on the topic of LT, PM, and the link between both;
- To identify the main industrial sectors that resort to LPM as a strategy to improve efficiency;
- To investigate the applicability of LPM as a strategy to improve efficiency in projects.

LT and its tools and techniques are already mature topics in the current literature, being commonly adopted in sectors such as manufacturing and construction as a means to minimize and increase efficiency in the work processes. However, the adaptation of LT to PM is a relatively new approach, which configures an opportunity for researchers investigating this topic. Within this context, this research aims to contribute to overcoming this gap in the literature.
This research is structured in four sections as follows: Section 2 introduces the theoretical background of concepts related to the research topic, such as PM, LT, and LPM; Section 3 presents the research methodology used in the study; Section 4 presents the obtained results with the analyses performed; and Section 5 summarizes the conclusions and points out further research directions.

2. THEORETICAL BACKGROUND

In this section, the theoretical background is discussed along with the three main concepts related to the research topic, namely Project Management, Lean Thinking, and Lean Project Management.

2.1. Project Management: an overview

PM refers to the business process that involves the application of knowledge, skills, tools, and techniques in order to manage the development of a unique product or service according to defined requirements, with a specific deadline, budget constraints, and established objectives that aim to satisfy the needs of stakeholders and achieve business value (Project Management Institute, 2021). PM is a widely applicable concept that encompasses a broad range of industries and sectors.
In the context of PM, it is essential to efficiently convert the project inputs into the expected outputs (Mishra, Sinha, Thirumalai, &Ven, 2020; Project Management Institute, 2021). According to Mishra et al., (2020) as PM enables the achievement of the pre-defined objectives associated with the project's output through the transformation of the inputs, this input-output transformation process is directly related to the project's efficiency. Frinsdorf, Zuo, &Xia (2014) state that in an efficient project all types of resources, such as human and physical resources are utilized in order to maximize the expected project outcomes within the planned schedule and budget. Liu & Cross (2016) defends that project efficiency is based on the application of efficiency-oriented measures that refers to the project team's ability to accomplish its objectives with minimal and optimal use of resources. According to Project Management Institute (2021), a project is efficient if its deliverables generate a positive output with the least amount number of input and effort needed. Therefore, it is possible to state that optimal resource management is crucial in achieving project efficiency, as it enables the optimal utilization of resources (Project Management Institute, 2017).

2.2. Lean Thinking: an overview

The first discussion of Lean originated in Japan in the late 1940s when Toyota Motor Company employees traveled to the United States to learn from the mass production system at Ford's plant and realized that this production system was loaded with waste. As a result of this experience, they developed the Toyota Production System (TPS), aiming to increase production efficiency and reduce costs by consistently eliminating all forms of waste, and activities that do not add value to the production process (Hines, Holweg, &Rich, 2004;Womack, Joes, &Roos, 1990).
Even though it system aimingd at TPS, there is no common definition of Lean. In fact, despite the existence of several studies on this topic, definitions of Lean methodology or its related concepts such as LT, Lean Production, or Lean Management vary according to the perspectives of the authors.
According to Rossini et al., (2022) Lean Production uses less of everything compared with mass production – half the human effort in the factory, half the manufacturing space, half the investment in tools, and half the engineering hours to develop a new product in half the time. Also, it requires keeping far less than half the needed inventory on site, results in many fewer defects and produces a greater and ever-growing variety of products.
Shah & Ward (2007) also defends Lean Management as a managerial system that integrates specific practices and techniques to reduce internal and external process variability.
The concept of LT is also defined by Pinto (2010) as a leadership and management philosophy that pursues the systematic elimination of waste, the identification, and creation of value, the continuous improvement of organizational processes, and quality management.
This research focuses on LT due to the fact that, as a philosophy, it is not directly applied to production systems, and it has a broader approach that can be easily adapted for different scenarios and contexts.

The key aspects of LT include the elimination of non-value-adding steps from the client's perspective (which can be configured as a type of waste) and the adoption of a continuous improvement mindset. The overall goal of it is to do more with less, by reducing unnecessary resources (Shah & Ward (2007); Jones & Womack, 2003). In the current literature, several have discussed the positive correlation between the implementation of LT and business efficiency (See (Anholon & Sano, 2016). The application of LT is based on a set of principles that focus on value creation and waste minimization: value, value stream, flow, pull, and perfection. By applying these principles organizations can specify a value, align and conduct value-creating actions in the best possible sequence without interruption and, consequently, execute them more efficiently (Jones & Womack, 2003).
Although LT originated in the manufacturing industry, it has evolved to be implemented in a variety of industries. LT began to place a greater emphasis on waste elimination, leading to a more strategic perspective and allowing it to be applied to diverse sectors and environments (Hines et al., 2004). It can be justified due to the fact that all systems have some type of waste, which needs to be eliminated to generate value (Mustafa & Bajjou, 2006).

2.3. Lean Project Management: an overview

As part of LM, according to Aziz (2012), LPM can be defined as the application of LT in the context of PM, in order to improve project productivity by focusing on creating value and minimizing and preventing waste (p.75). Erne (2012) defends that LPM primarily is an important strategy to eliminate non-value-adding activities while optimizing value-adding and supporting ones and it focuses on generating maximum value with minimum effort (p.85). According to Ballard & Howell (2003), LPM differs from traditional PM not only in terms of its objectives, but also in the organization of its phases, since the interactions between phases, and the involvement of stakeholders in each phase is a key aspect to be considered.
Also, Gabriel (1997) defends that the lean approach when applied to PM leads to project success as well as improves quality, and contributes to achieving time and budget constraints. The author also defends that LPM can support organizations to achieving a higher level of commitment and motivation from the project team. The Project Management Institute (2021) defends that tailoring project processes can lead to positive project outcomes and emphasizes the implementation of Lean Production techniques, such as Value Stream Mapping which aims to measure the ratio of value-adding activities and non-value-adding activities as a potential method for achieving project optimization.
Despite the potential benefits of linking LT to PM, in the current literature there is a limited number of studies in the literature that have examined the link between these topics when adapted to a variety of project contexts, still focusing on the execution of construction projects (Otegi-Olaso, Cruz-Villalón, Fuertes-Ardeo, &Aguilar-Fernández, 2016). For instance, Ballard & Howell (2003)developed a model for construction projects, drawing on theoretical insights from the lean production methodologies utilized in other industries. These authors consider projects as temporary production systems, which means that the systems are structured aiming to deliver the product maximizing value and minimizing waste, they can be considered lean projects.
The adaptation of LPM to other sectors, such as the Information and Technology sector, was also studied, although with less emphasis. In fact, through a case study conducted in 2011 (see Staats, Brunner, &Uptown, 2011) the results showed that when implementing lean practices in software projects can lead to benefits such as hypothesis-driven problem-solving, streamlined communication, simplified processes, and specified tasks and also concluded that "lean software projects perform better than non-lean software projects."

3. RESEARCH METHODOLOGY

In this section, the proposed research methodology is presented according to the methodology proposed by Saunders, Lewis, &Thornhill (2009). The authors defend that scientific research should be defined considering aspects such as philosophy, approach, choices, and strategy. Regarding philosophy, the study is based on epistemology and positivism due to the need for valid information for the research and because a part of this information will be acquired through empirical research.
The scope of the research addresses the link between LT and PM in an organizational environment. Therefore, it is possible to support the research methodology approach on the following research questions that are aligned with the objectives of this article:

- How has this topic been addressed in the literature?
- What are the main industrial sectors in which the topic is studied or implemented?

The purpose of defining this research question is to understand how this topic has been explored in the literature, what has already been accomplished, and also to investigate the existence of a literature gap in the adaptation of LT to IT PM. The research methodology is based on two sequential phases, namely conducting a bibliometric analysis of the literature and performing a literature review.

3.1. Bibliometric analysis of the literature

Aiming to better understand the link between LM and PM, a bibliometric analysis of the literature was performed in order to determine the state of the art regarding these two approaches.
To collect the relevant data needed for the bibliometric analysis, the Scopus database was queried. This search was conducted using a set of search terms related to the link between LT and PM. In this research, the Scopus database was used as the main source of data. In order to find the dataset that better fit the link between the two approaches, a set of terms was then combined into a query and applied to the Scopus database. To ensure the relevance of the collected data within the scope of this research, additional criteria were defined (see Figure 1). As a result of these screening processes, the final dataset is composed of 118 publications.
Figure 1 shows the data collection workflow based on the application of the defined exclusion criterion.

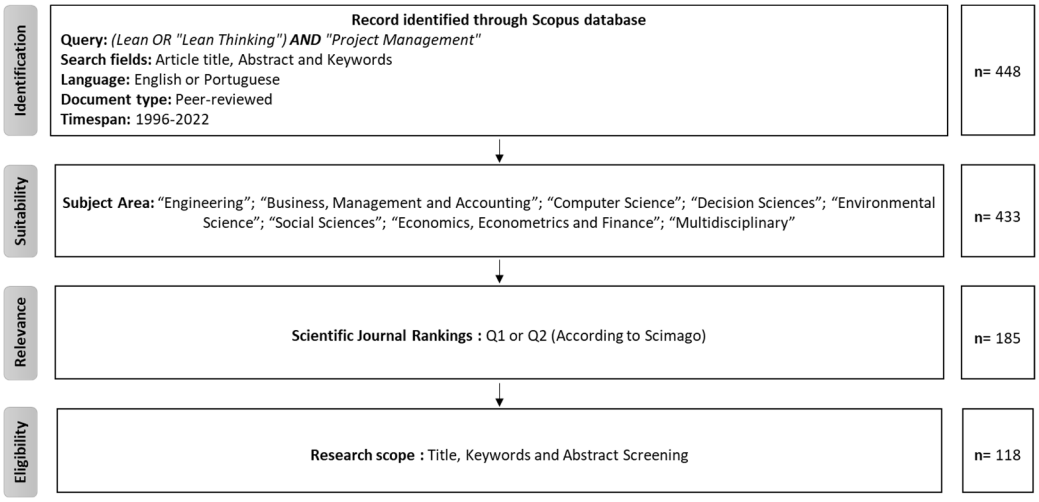

Figure 1: Data collection workflow.

This analysis was carried out with the open-source R-package bibliometrics and its web interface, biblioshiny. This bibliometrix R-package provides a set of tools for quantitative research in bibliometrics and scientometrics and supports a recommended workflow to perform bibliometric analyses (Belfiore, Cuccurullo, &Aria, 2022). The analysis of the collected data was based on the analysis of the scientific production, the trend topics, and the conceptual structure.

Based on the selected articles and on other relevant literature for the topic, the existing literature was reviewed and a content analysis was developed in order to better understand the research topic's theoretical background and also to find the answers to the above-defined research questions. An overview of the reviewed literature is presented in Section 2.

4. MAIN FINDINGS

4.1. Scientific Production

This section aimed to analyze the scientific production on the annual and country production for researches researchers focusing on connecting LM and PM The analysis of annual production helps to understand the theme's growth over time while analyzing country production provides insight into its global reach. By examining both types of production data, the study aims to comprehensively evaluate the theme's impact on a global scale and gain a more nuanced understanding of its evolution and contribution to scientific knowledge.
The annual scientific production analyses the number of publications produced per year. Figure 2 represents the growth of the annual scientific production of the collected data.

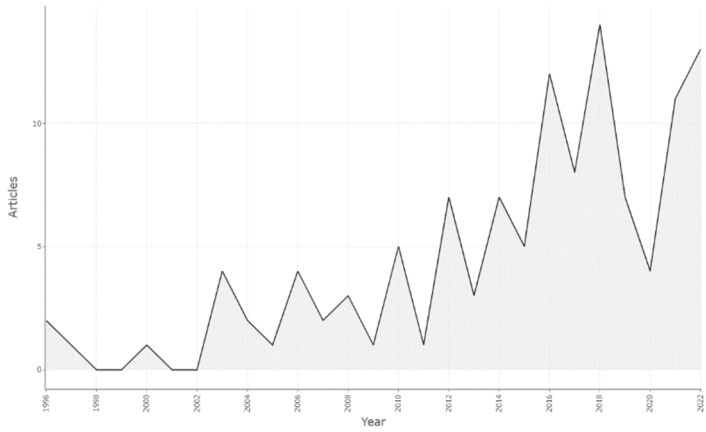

Figure 2: Annual Scientific Production.
Source: Bibliometrix

The results presented in Figure 2 show that the scientific production in the field showed peak production in 2016, 2018, 2021, and 2022, with 12, 14, 11, and 13 publications respectively. The years 1998 to 2002, had no published articles, while the number of annual publications ranged from one to eight in intervening years. After a considerable increase in publications since 2015, there was a sharp decline in 2020 but a significant rise between 2020 and 2022, indicating a growing interest in the link between LT and PM. Overall, the observed annual growth rate in publications was about 7.46%, which leads to the conclusion that, despite the fluctuations, the link between LT and PM has been increasingly explored in the literature over time.

4.1.2. Country scientific production

According to Belfiore et al., (2022), the Country Scientific Production measures the number of authors' appearances by country affiliations. Essentially, each article is credited to the countries of all its co-authors, resulting in the same article being counted as many times as there are authors involved.
In this research, for the topics selected the results to summarize the scientific production by country, and the most productive countries' production over time can be observed in Figure 3. In the figure, on the right side, the blue lines indicate those where research has been conducted, with darker shades reflecting higher levels of scientific output.

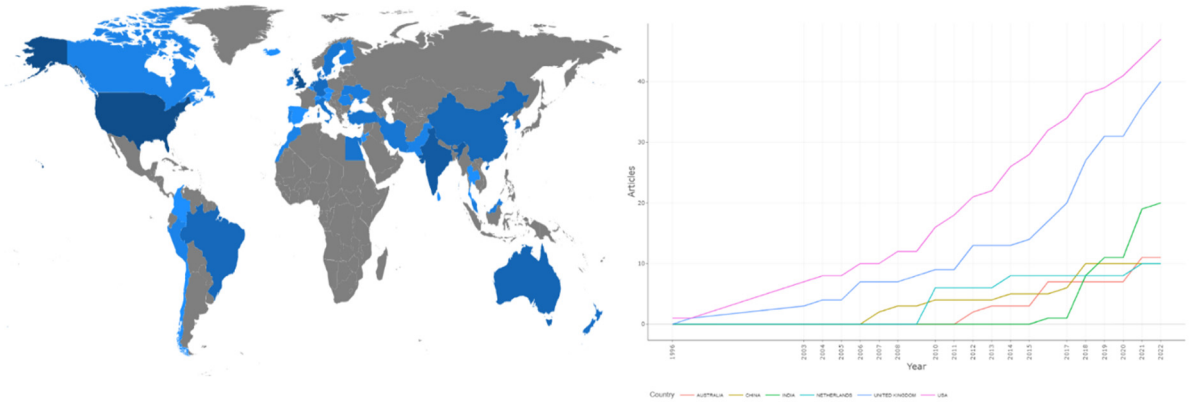

Figure 3: Country Scientific Production over time.
Source: Bibliometrix

The results also showed that by 2022, academic research devoted to linking the relationship between LT and PM has been conducted in over 40 countries, indicating that this topic remains a relatively specialized area of research. Based on the collected data, the countries that have made the greatest contributions to the literature on the link between LT and PM are the United States of America (47 authors collaborating), followed by the United Kingdom (40 authors), India (20 authors), Australia (11 authors), as well as China and the Netherlands (each with 10 authors).
The results indicate that all the analyzed countries have shown an overall increase in scientific production on the topic of the link between LT and PM, albeit at different times, which suggests that the link between LT and PM has garnered increasing interest and attention globally, as reflected in the growing body of research being produced.

4.2. Trend Topic

Regarding the trend topic analysis, it was conducted in order to visualize the temporal evolution of research topics related to the link between LT PM. Bibliometrix was used to create a trend topic graph that assigned each topic a year based on its distribution of occurrences over time. The graph is a scatter plot where each topic is displayed as a bubble proportional to its occurrence in the median year. From the Bibliometrix high-frequency word was extracted aiming to create a word co-occurrence matrix, and the median year was assigned to each topic based on its frequency distribution.
Figure 5 shows the temporal evolution of the research on the link between LT and PM. In the figure, the topics addressed by the research are indicated in blue bubbles with the size of the bubble being proportional to the topic occurrence in the median year.

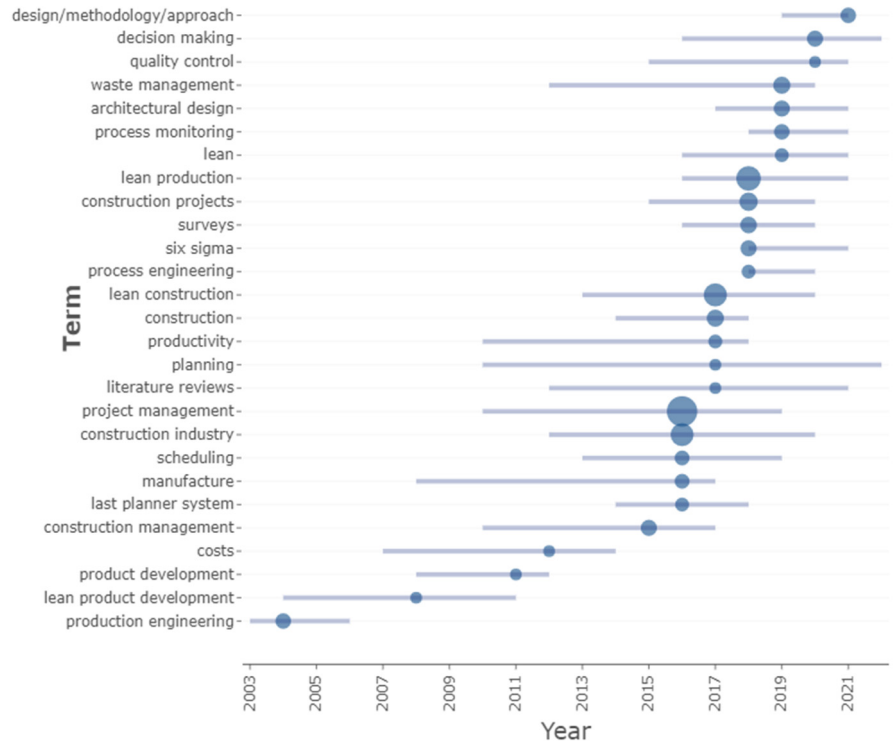

Figure 5: Trend Topics.
Source: Bibliometrix

The research topic that has been most frequently explored regarding the link between LT and PM was "project management". This topic was observed to have occurred with a frequency of 74 between the years 2010 and 2019.
Between 2013 and 2022, the prevailing research themes concerning the link between LT and PM are primarily associated with the construction industry. In fact, the topic of "lean construction" is ranked as the third most frequent topic of research during this period. In addition, over time it is possible to observe several other topics that relate to the link between LT and PM within the construction industry, such as "construction industry", "construction projects", "construction" and "construction management".
The production sector also shows relevance with "lean production" as the second most frequently occurring topic. Hence, it can be presumed that the predominant themes in the research on the link between LT and PM overtime are primarily linked to the construction industry. Additionally, there appears to be a lack of investigation into the application of these themes to other industries and sectors, providing an opportunity for future research.

4.3. Conceptual Structure: Thematic Evolution

In this paper, a conceptual model structure analysis was also performed. This analysis adopts a co-word network analysis and clustering approach to explore the relationship between keywords within the research topic and the content of the collected dataset (Donthu, Kumar, Mukherjee, Pandey, &Lim. 2021).
In bibliometric analysis, co-occurring keywords in a document can be analysed using a Louvain clustering algorithm to identify distinct themes within a particular field. This results in a thematic map that provides insights into the current state and future sustainability of the research field. The thematic map in this study was developed based on clusters of Keywords Plus and their interconnections to obtain themes characterized by density and centrality. The results showed

that centrality indicates the relevance of a theme in the research field, while density measures the cohesion between nodes and the theme's degree of development (Belfiore et al., 2022; Donthu et al., 2021).
Figure 6 summarizes the thematic map is divided into four quadrants based on the density and centrality of the clusters. The upper right quadrant (Q1) contains the motor themes that are highly relevant and well-developed. The upper left quadrant (Q2) has niche themes that are highly specialized but less relevant. The lower left quadrant (Q3) displays emerging or declining themes that are poorly developed and low relevant. The lower right quadrant (Q4) has basic underlying themes that are relevant but not well-developed. (Aria et al., 2020; Belfiore et al., 2022; Cahlik, 2000)
Each cluster in the thematic map represents a unique theme and is labelled with the most common word in that cluster. The size of each bubble indicates the relative frequency of the words within the cluster.

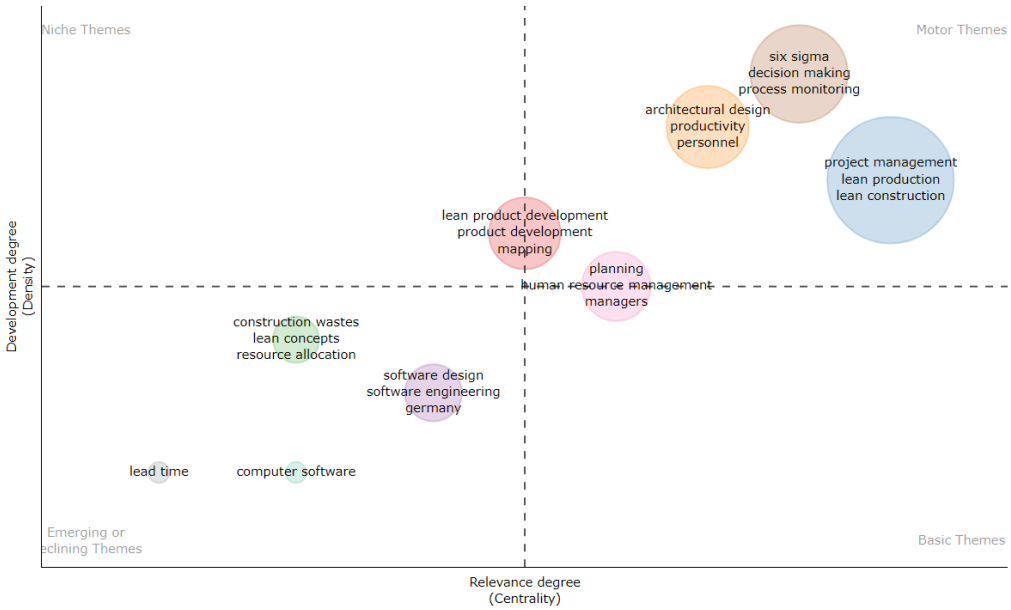

Figure 6: Thematic Map.
Source: Bibliometrix

Figure 6 presents the Thematic Map for the collected database, and for all the clusters identified, those that are most relevant to the research topics are related to:

- The construction area, with the themes “construction wastes” in Q3 and “lean construction” in Q1;
- The production area, with the theme “lean production” in Q1 and “lean product development” and “product development mapping” between Q1 and Q2;
- The IT area, with the themes “software design”, “software engineering” and “computer software” in Q3;
- The PM area, with the themes “project management” and “decision making” in Q1 and “planning” between Q1 and Q4.

Regarding the construction area, it is possible to conclude that “lean construction” is one of the main themes regarding the link between LT and PM. On the other hand, the theme “construction wastes”, which is mostly in line with LT adapted to PM as a way to minimize waste, was identified as emerging theme.
Concerning the production area, the theme “lean production” was also one of the motor themes regarding this research topic, and the themes “lean product development” and “product development mapping” are split between Q1 and Q2, which implies that it is not only is one of the main themes but also that it is a niche theme that presents a high level of development and specialization.
Figure 6 shows that themes related to software (an intrinsic concept to the IT area) are emerging themes, which shows that the link between LT and PM adapted to software design and engineering has been increasingly explored.
From the analysis developed, the results showed that for the themes directly related to the PM area, such as "project management" and "decision making" (a concept interrelated with PM) are also the major topics in this field of study. It can also be observed that the theme "planning" (directly related to PM) was the main study theme identified, and it is considered a foundational and transversal theme. In sum, the themes “project management”, “lean construction” and “lean production” remains the leading themes within the field.

5. CONCLUSIONS

This research seeks to investigate the current state of the art regarding the link between LT and PM. To this end, a bibliometric analysis of relevant research publications was conducted, with the goal of providing insight into the existing

literature on the research topic. Through data collection and the analysis of its scientific production, trend topics, and conceptual structure and several key pieces of information were drawn from this study.
The analysis showed a growing interest in the research topic, with a marked upsurge in the number of publications exploring the connection between LT and PM in recent times. However, the dominant research themes were found to be linked to the construction industry and the production sector, indicating a dearth of research regarding the applicability of this research topic to other industries and sectors. The limitations of the study include the restricted size of the collected database, and future investigations may aim to include other sources of equally valid data to obtain more precise findings. Overall, the study highlights an opportunity for researchers to investigate the applicability of the link between LT and PM to different industrial sectors and functional areas. In doing so, it can contribute to supporting projects and companies in maximizing efficiency through the minimization of waste during their activities.

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