

Knowledge Sharing and Lean Manufacturing in Companies: An Empirical Investigation

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Abstract: Manufacturing companies seeking to be competitive in the market must, in particular, accomplish time saving through precisely planned production processes. One of the main routes to reaching higher production efficiency is Lean Manufacturing (LM) by way of the methods and tools that it brings. However, the key to successful implementation of LM is the employees' approach to knowledge sharing, an essential component for continuous improvement. This paper is an empirical study whose purpose is to answer the following question: Is knowledge sharing more widely adopted (and if so, how exactly) by companies who have implemented Lean Manufacturing, compared to those who have not? As a result of literature studies, six types of knowledge sharing were identified, related to the way knowledge is shared (formal and informal knowledge sharing), knowledge sharing strategies (codification and personalization strategies) and the scope of knowledge that the company focuses on in its core business (broad and deep knowledge). The relation between the use of LM and knowledge sharing types was examined based on a questionnaire survey conducted among 219 small, medium and large manufacturing enterprises operating in North-West Poland. The data analysis was performed using the ANOVA and post hoc tests. The results demonstrated a significant correlation between the companies' use of the Lean Manufacturing concept and certain types of knowledge sharing. In particular, it was observed that, compared to the other companies, the companies showing wider use of LM practiced formal ways of knowledge sharing, used the knowledge codification strategy, and were more focused on development and dissemination of broad rather than specialized knowledge. The results also demonstrated that the knowledge sharing approach adopted by the companies was largely determined by other approaches and management methods. It also means that the processes related to knowledge sharing are components of Lean Manufacturing solutions applied in practice.

Keywords: Knowledge sharing, Lean manufacturing, Production companies, Formal and informal knowledge sharing, Codification and personalization strategies, Broad and deep knowledge

1. Introduction to Lean Manufacturing (LM)

Manufacturing enterprises operating in a highly competitive market have noticed that offering high-quality products with higher performance and shorter delivery lead times than competitors while reducing operation costs may become a key to their success. However, such measures have forced companies to seek far more flexible processes and a larger variety of products, which in turn has generated various wastes in the manufacturing processes (Cortez et al, 2020). An effective solution to these problems seems to be the Lean Manufacturing concept (Nallusamy, 2021).

Lean Manufacturing is a methodology of production management, which consists in proving value that is expected by the customer. From the customer perspective, value (in LM) is understood as everything for which a customer is willing to pay (Rodríguez et al, 2012). This refers for example to a physical process which actually transforms a product or service (e.g. welding, assembly) or to an activity done according to the "first time right" concept (i.e. flawlessly). However, any other activities which directly do not add value to the offered product or service are considered by the customer to be wasteful. Therefore, to meet the customer's demanding expectations, manufacturing companies seek the highest possible production efficiency which is obtained via continuous optimization of the manufacturing process by reducing redundant activities. Hence, Lean Manufacturing focuses primarily on reducing 7 wastes (*muda* in Japanese) from all company processes, such as: overproduction, inventory, defects, waiting time, transportation, motion and excess processing (Ohno, 2008).

What is interesting, since only recently the literature on the subject has been enumerating one more waste: non-utilized human talent or potential. The reason for earlier disregard of this waste among the 7 cardinal *muda* can probably be attributed to the Japanese culture. As suggested by Nicholas, for the Japanese, or more precisely the Toyota Motor Company, for a long time, recognizing employees as its most valuable assets and encouraging them to learn, develop their skills, and to engage in process-improvement activities (Nicholas, 2018) is something natural.

It is therefore worthwhile to view Lean Manufacturing from a wider perspective. On the one hand, LM is a concept of an approach to business operations management focused on improving the processes and taking measures aimed at elimination of redundant activities. On the other hand, LM emphasizes the importance of knowledge and skills of the people employed in the organization. Hence, it may be concluded that LM shows a

somewhat more extensive approach to business management, which contains elements of other concepts, e.g. knowledge management. An ability to gather and apply appropriate resources of knowledge and information plays an invaluable role in manufacturing companies (Berawi, Woodhead 2005; Cortez et al, 2020), hence this issue is an important focus of this study.

2. Knowledge Sharing (KS) in Lean Manufacturing Contexts

Although there have been many independent studies on Lean Manufacturing and knowledge sharing in organizations, “studies that integrate lean thinking in dynamic knowledge research are still absent in the literature” (Tyagi et al, 2015). When analyzing the existing body of research related to knowledge management in Lean Manufacturing implementation, Zhang, Niu and Liu (2020) noticed that among 341 full-text academic articles from Science Citation Index Expanded, only 65 were empirical. Moreover, amongst them only nine articles were related to Knowledge Management. Furthermore, it is worth noting that the issue of knowledge in the Lean Manufacturing context was usually addressed in relation to the overall concept of Knowledge Management, and only in few cases in relation to the SECI model (e.g. Nordin et al, 2020, Tyagi et al, 2015, Lindlöf, Söderberg, Persson, 2013) authored by Nonaka and Takeuchi, which focuses on conversion of explicit knowledge into tacit knowledge (Nonaka, Takeuchi, 1995). Hence, a research gap was identified in the literature, as there are no research studies focused on selected processes of the knowledge management concept (i.e. the process approach) in the lean context, including i.a. the knowledge sharing process. Consequently, this paper is an attempt to bridge this gap.

Dombrowski et al (2012) claimed that “the development of a detailed reference model of knowledge flows is not possible so far, because Lean Production Systems implementation offers too many possible knowledge flows”. Moreover, they added that in such a case it might be worthwhile just to identify adequate methods for single knowledge flows. Also Babaei Meybodi et al (2018) drew attention to the fact that “the majority of the lean production execution processes explain sequences of required works, but they fall short of taking knowledge blending into consideration”. In view of the above, an interesting proposal of such a solution was presented in the study completed by Tyagi et al (2015) who indicate a specific list of lean tools/methods supporting the knowledge generated in SECI models. One of the findings of their analysis was that Scrum, PDCA, and the 5 Whys can fit and support knowledge creation and sharing mechanisms in every SECI model.

Vlachos et al (2019), in turn, found out in a single-case study analysis that knowledge sharing plays a key role when an organization wants to transform from the traditional to Lean Management. However, the authors stressed the need to depart from the more operational view of lean to a “softer” paradigm.

Also Zhang et al (2020) noticed that adoption of lean tools had a positive impact on knowledge acquisition, knowledge integration and knowledge application. The authors also noticed that knowledge is an indispensable factor in the application of lean tools. Due to the special importance of knowledge in Lean Manufacturing implementation, the following section deals with the definition of knowledge sharing and different approaches to it.

3. Knowledge Sharing in an Organization

In the literature on management, the term “knowledge sharing” is very often used interchangeably with “knowledge transfer”. However, it should be noted that many researchers increasingly oppose to taking this approach and propose that these terms be distinguished from one another. For example, Cavaliere and Lombardi (2015) pointed out that “while knowledge transfer describes the identical or partial replication of knowledge from one place to another, knowledge sharing is more than transferring knowledge: it is about creating it through social interaction”. Moreover, King (2006) underlined that knowledge may be shared in unintended ways (around a specific issue or otherwise), and, as knowledge sharing is a multi-directional process, usually there is no clear, a priori goal. A knowledge transfer, in turn, implies focus, a clear objective, and unidirectional communication of knowledge between individuals, groups, or organizations such that the recipient of knowledge has a cognitive understanding, has the ability to apply the knowledge, or applies the knowledge (King, 2006). Summing up: as opposed to a knowledge transfer, knowledge sharing focuses strictly on individuals (in particular on the knowledge sharer) and social interactions, and it concentrates on the mechanisms and practices of knowledge communication. It therefore entails the need to create appropriate conditions to entice employees to make decisions on communicating their personal knowledge, whereas in the case of a knowledge transfer more focus is laid on the knowledge recipient, i.e. whether the transferred knowledge has been effectively received. Therefore, in research on knowledge transfers it is important to pay attention to absorption capabilities and specificity of the recipient (Rudawska 2013).

4. Approaches to Knowledge Sharing

The literature on knowledge management comprises many research studies on various approaches to knowledge sharing in an organization. The studies most often show the approach using two independent, opposite types of knowledge sharing (Figure 1), characterized by specific features. Moreover, even though the scope is increasingly explored, it still has not been systematized.

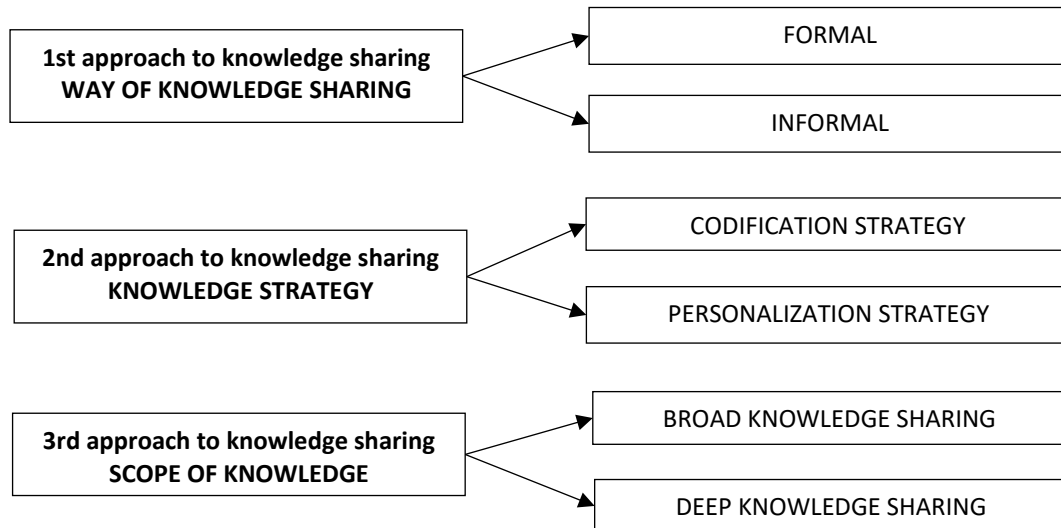


Figure 1: Approaches to Knowledge Sharing in Organizations

Each approach, including each type of knowledge sharing, has a different impact on employee behavior in the organization. In view of the above, the next section outlines various types of knowledge sharing.

4.1 Formal and Informal Approach to Knowledge Sharing

Formal and informal knowledge sharing refers to the situation and circumstances in which employees exchange knowledge among each other. A formal approach to knowledge sharing encompasses behaviors that are institutionalized by management by creating specific opportunities that enhance and enable knowledge exchange. These are practices (e.g. procedures, instructions, regular meetings, brainstorm sessions) and services (e.g. communication and resource sharing platforms), that have been designed and organized by the company in such a way that knowledge sharing or organizational learning occurs in a systematized way (Taminiau et al, 2009). Thus, these take the form of certain practices developed by the organization, which designate areas and channels of interaction as well as its frequency.

In turn, informal knowledge sharing encompasses all forms of knowledge sharing “by which individuals communicate on issues that are not directly laid down and governed by management” (Schwaer et al., 2012). These are resources (e.g. meeting room), services (e.g. chats, telephones), and activities (e.g. casual face-to-face conversations) (Taminiau et al, 2009). Employees voluntarily engage in these types of actions for the purpose of knowledge exchange, at the time and in the form that are the most suitable for them. It is a knowledge sharing system that often emerges ad hoc within an organization.

Rudawska (2019) noted that informal and formal mechanisms of knowledge sharing compete with each other, as according to her “while the informal mechanisms are used in current problem solving, the formal ones help create shared knowledge, develop a common language and the *who knows who* knowledge map”. It is also worth noting that the formal and informal types of knowledge sharing should blend with the adopted knowledge management strategy, for that reason the second approach was identified.

4.2 The Strategy for Knowledge Codification and Personalization

Hansen et al (1999) distinguished two knowledge strategies, namely codification and personalization. The knowledge codification strategy refers to the development of the electronic system that enables knowledge codification, storage, dissemination, and reuse (the “people-to-document” approach). In this strategy, the knowledge of how to work or how to behave in a specific situation is well-defined and it is shared in the formal way. In view of the above, employees know which documents they should use, where they can find them quickly

(easy access) and they remember to regularly document their work progress (storage). The codification strategy will therefore be applied in organizations that offer standard products and/or services, i.a. mass production, but also products that in fact are based on standardized components, e.g. Dell (Hansen et al, 1999).

The personalization strategy “seeks to capture and share tacit knowledge that resides in human minds, behavior, and perception” (the “person-to-person” approach) (Chang, Yen, 2019). In this strategy, knowledge is mainly obtained from experienced and qualified co-workers, and also via face-to-face help provided by experts (Choi, Lee, 2003). The strategy consists in obtaining and sharing tacit knowledge first and foremost via informal social interactions (Choi, Lee, 2002). The personalization strategy works perfectly in organizations that offer personalized and innovative products and/or services. In this kind of organization, people in search of innovation must share their knowledge that would otherwise “get lost” in the documented form (Hansen et al, 1999).

4.3 Broad and Deep Knowledge

The third approach draws attention to the knowledge scope on which the organization focuses in its core business operations, therefore a distinction was made between broad knowledge and deep knowledge. Broad knowledge “refers to the extent to which the firm’s knowledge repository contains distinct and multiple domains” (Zhou, Li, 2012). This means that the enterprise taps into heterogeneous knowledge, which in turn translates into creating more diversified products (Asoh, 2004). Also Yang et al (2016), when analyzing the impact of the knowledge scope on the product efficiency, noticed that due to “broad knowledge covering various areas, a firm can gain new ideas, insights and expertise from multiple disciplines”.

The idea of deep knowledge sharing “refers to the level of sophistication and complexity of knowledge in key fields” (Zhou, Li, 2012). Deep knowledge should be understood as homogeneous, complex and unique knowledge in a given area. De Luca and Atuahene-Gima (2007) stated that technical knowledge depth is the amount of within-field knowledge the firm possesses. Hence, as Asoh (2004) pointed out, this type of knowledge sharing applies to more specialized products.

5. Research Methods and Data Collection

In order to collect the research data, a structured and standardized questionnaire was applied. The survey encompassed two interviewing techniques: CAWI (*Computer Assisted Web Interview*) and PAPI (*Paper&Pen Personal Interview*). The survey involved small, medium and large production companies operating in North-West Poland. The reliance of the research on industrial enterprises was due to the fact that this sector employs the highest number of people (both on the national and regional scale). Moreover, the selected kind of business operations is also connected with the complexity of their technological processes that require specific standards of conduct and continuous improvements. Hence, an issue of key importance for them should be developing appropriate attitudes so that employees readily share their knowledge. The survey questionnaire was addressed to persons who manage and/or co-manage the industrial enterprises (i.e. the ones that coordinate other people’s work, e.g. production managers). A total of 643 survey questionnaires were distributed and 254 were returned. Finally, 219 correctly completed questionnaires were used for the purposes of the research study (the total response rate amounted to 34%).

To examine the six types of knowledge sharing, 27 measurement items were adapted from the existing scales found in the literature. The tool for measuring the formal way of knowledge sharing contained four statements, based on Willem and Buelens (2007), Wei and Li (2014), and Schwaer et al (2012). A sample item was: “I usually share my experience in a meeting or through other official channels” (Cronbach’s $\alpha=0.714$). The variable regarding the informal way of knowledge sharing was also measured using four statements based on Yi (2009) and Schwaer et al (2012). These included e.g. “I usually spend time in personal conversation (e.g., discussion in hallway, over lunch, on the telephone) with others to help them with their work-related problems” (Cronbach’s $\alpha=0.741$). The tool for measuring the codification and personalization strategies encompassed the total of ten statements, five for each of the knowledge sharing type, based on Choi and Lee (2002), Azyabi et al (2012) and López-Nicolás and Meroño-Cerdán (2011). For the codification strategy, (Cronbach’s $\alpha=0.884$) the statements included e.g. “Results of projects and meetings are regularly documented in my company”, whereas in the case of the personalization strategy (Cronbach’s $\alpha=0.745$) e.g. “It is easy to get face-to-face advice from experts in my company”. Broad knowledge sharing was measured with five items (Cronbach’s $\alpha = 0.728$) and deep knowledge sharing was measured with four items (Cronbach’s $\alpha=0.447$). In both cases, the statements were taken from the studies by Zhou and Li (2012), Asoh (2004) and Azyabi et al (2012). With regard to broad knowledge, there were statements such as “The company focuses on organizing trainings to support employees in performing multiple tasks”, and in the case of deep knowledge - e.g. “The company invests in developing specialized professional

skills". The five-point Likert-type scales were used in the questionnaire, ranging from "1" (totally disagree) to "5" (totally agree). As for measures in the area of Lean Manufacturing, they were examined in the context of the degree of LM implementation in the given enterprise, therefore the surveyees were asked to select one out of five statements as follows: "I don't know what LM is", "no interest in LM", "preparing for implementation of selected LM tools and methods", "yes, we're applying selected LM tools and methods" and "yes, we fully implemented LM".

The statistical analysis started with examining the validity of the survey questionnaire by means of the Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). The completed analysis at the level of the measurement model verification rejected only one type of knowledge sharing, i.e. deep knowledge (which did not meet the criteria of convergent and discriminant validity). Next, for all the statements which were not rejected as a result of CFA, an analysis of measurement reliability was conducted applying Cronbach's α , standardized α , and Composite Reliability (CR).

Table 1: Reliability Measures for the Measurement Model

Types of knowledge sharing	Cronbach's α	standardized α	CR
Formal approach to knowledge sharing	0.714	0.718	0.728
Informal approach to knowledge sharing	0.741	0.744	0.744
Codification strategy	0.884	0.886	0.786
Personalization strategy	0.745	0.763	0.877
Broad knowledge	0.728	0.731	0.747

As for the five types of knowledge sharing shown in Table 1, all of them met the reliability criteria, i.e. exceeded the assumed threshold value of 0.7 for both Cronbach's α and standardized α (Taber, 2018) as well as for CR >0.6 (Lombardia et al, 2019).

6. Results

In order to show correlations between various types of knowledge sharing and the Lean Manufacturing concept, all the analyses were done with the use of the ANOVA test and the post hoc Scheffe test. The ANOVA (Analysis of Variance) test showed significant relationships between various degrees of engagement in Lean Manufacturing in five types of knowledge sharing, i.e. excluding the informal knowledge sharing. Next, in order to examine the detailed relationships, the multiple comparison test (i.e. post hoc Scheffe test) was performed. The obtained results are presented in Table 2.

Table 2: Types of knowledge Sharing in Relation to Degrees of Engagement in Lean Manufacturing – Results of the Post Hoc Scheffe Test Analysis

	Types of knowledge sharing				
	Formal KS	Informal KS	Codification strategy	Personalization strategy	Broad KS
Engagement in Lean Manufacturing	F=5.910; p=0.000	F=1.871; p=0.117	F=4.413; p=0.002	F=3.517; p=0.008	F=3.746; p=0.006
I don't know what LM is {1}	$\bar{Y}=2.686^{(5)}$	$\bar{Y}=3.765$	$\bar{Y}=3.219$	$\bar{Y}=3.990^{(3)}$	$\bar{Y}=3.295^{(5)}$
no interest in LM {2}	$\bar{Y}=2.780^{(5)}$	$\bar{Y}=3.760$	$\bar{Y}=3.520$	$\bar{Y}=4.073^{(3)}$	$\bar{Y}=3.250^{(5)}$
preparing for LM implementation {3}	$\bar{Y}=2.542^{(5)}$	$\bar{Y}=3.740$	$\bar{Y}=3.117^{(5)}$	$\bar{Y}=3.458^{(2; 4)}$	$\bar{Y}=3.417$
yes, selected LM tools {4}	$\bar{Y}=3.146$	$\bar{Y}=3.776$	$\bar{Y}=3.676$	$\bar{Y}=3.985^{(3)}$	$\bar{Y}=3.561$
yes, fully implemented LM {5}	$\bar{Y}=3.733^{(1; 2; 3)}$	$\bar{Y}=3.250$	$\bar{Y}=4.040^{(1; 3)}$	$\bar{Y}=4.000$	$\bar{Y}=4.067^{(1; 2)}$

Note: {1,2,3,4,5} – significant difference between groups based on post hoc test $p < 0.05$

It was found that the enterprises which had fully implemented LM tools and methods were characterized by a far more formalized approach to knowledge sharing ($\bar{Y}=3.733$) compared to the companies that were still preparing for LM implementation ($\bar{Y}=2.542$), were not interested in the concept ($\bar{Y}=2.780$) or did not know about LM ($\bar{Y}=2.686$).

Moreover, the companies that had fully implemented Lean Manufacturing used the codification strategy to a greater extent ($\bar{Y}=4.040$) than the enterprises still preparing for LM implementation ($\bar{Y}=3.117$) or those not knowing what Lean Manufacturing means ($\bar{Y}=3.219$).

In turn, among the enterprises which were not interested in LM, the knowledge personalization strategy was applied to a greater extent ($\bar{Y}=4.073$) in comparison with the companies that were still preparing for LM implementation ($\bar{Y}=3.458$). The enterprises that had already implemented selected LM tools ($\bar{Y}=3.985$) also used the personalization strategy to a greater extent than the companies that were still preparing for LM implementation.

The data analysis has also shown statistically significant differences in the extent of knowledge used. The enterprises that had fully implemented Lean Manufacturing used broad knowledge more often ($\bar{Y}=4.067$) than the companies that showed no interest in the LM concept ($\bar{Y}=3.250$) or did not know about LM ($\bar{Y}=3.295$).

7. Conclusions

The specificity of industrial enterprises, production processes complexity, and also the ageing society contribute to the fact that nowadays organizations increasingly often take more and more interest in knowledge sharing, and first and foremost in the ability to identify the process within the organization. Each organization has its own, learned and practiced, individual way of knowledge sharing. Nevertheless, the results of this study have shown that companies that had implemented the Lean Manufacturing concept were characterized by a far more formalized approach to knowledge sharing, application of a knowledge codification strategy and use of broad knowledge, compared to the enterprises that were still preparing for LM implementation, did not show interest in LM or did not know the LM concept.

It is worth noting that Lean Manufacturing is a concept connected with measurement, control and continuous implementation of improvements in production processes. In view of the above, companies that have implemented the LM concept will keep striving for unification and replication of the hitherto developed organizational solutions in a formal manner, i.e. communicating the knowledge via reports or exchanging information and best practices within the framework of IT systems adapted specifically for this purpose. Moreover, in addition to providing space for formal knowledge sharing among the employees, organization of regular meetings or teleconferences ensures a specific rhythm of work.

An important role in Lean Manufacturing is played by the knowledge codification strategy which makes it possible to write down the obtained results of meetings, studies, projects, experiences or insights of employees, so that it is feasible to quickly retrieve and standardize them. In production enterprises, collection of data regarding the production process, the process analysis and the ensuing documentation are aimed at "structuring the knowledge and (...) presenting it in an accessible form so that it is comprehensible for all the employees" (Kałkol, 2010). Thus, the strategy of codification of various LM tools prevents the knowledge dispersion e.g. in case an employee suddenly quits the company. What is more, the strategy helps retain the process repeatability, as it makes it possible to write down the detailed knowledge regarding performance of individual operations by employees directly involved in production (e.g. development of standard operating procedures).

It has been further found that broad knowledge is used more than deep knowledge in production companies which implemented Lean Manufacturing. This means, among other things, that enterprises with the implemented LM concept encourage their employees to obtain universal competences and skills so that they are able to work in various positions. Thus, any unplanned absence will not disturb the rhythm of work.

This research study provides information on various approaches to knowledge sharing emphasized by enterprises that have implemented the LM concept. Moreover, the presented data analysis is appropriate and consistent with the idea of Lean Manufacturing. Therefore, from a practical viewpoint, enterprises planning to switch to Lean Manufacturing should pay attention to various possibilities of knowledge sharing and focus in particular on those that are strongly connected with LM, whereas the companies that are already operating in accordance with the LM concept should make sure the said types of knowledge sharing are continuously improved and enhanced, e.g. via creating appropriate corporate policies.

This study has several limitations that also suggest directions for future research. Firstly, the research sample is limited only to companies operating in North-West Poland. In addition to that, the sample firms operate only in the production sector. For this reason, it would be advisable to conduct future research with a research sample based on various sectors from various countries, which would make it possible to carry out comparative analyses and provide a more international perspective to the subject. Secondly, this study was performed only at the organization level and was based on information obtained from key persons in the entities, predominantly the owners and line managers. Future research studies should also be multi-level, which would make it possible to unearth any differences in the types of knowledge sharing at various positions within the organizations. Thirdly, the analyses described herein constituted a part of a larger research project where the Lean Manufacturing concept was not examined in detail. However, the obtained findings have shown there is a research gap in this area.

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