Implementation of Social Media as a Knowledge Catalyst

23

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23.1 Introduction

This paper sheds light on how the digital transformation changes traditional communication networks and how emerging social media tools provide benefits to workers in production environments. The fast development in information technology challenges the way of how firms operate (Mickeleit, Müller, & Atchison, 2012, p. 342). The skill requirements for job tasks and activities change, while conceptual work, interdisciplinary thinking and creativity become more important (Münchner Kreis e.V., 2015, p. 18). The importance of knowledge sharing and worker flexibility increases as well (Pfisterer, Streim, & Hampe, 2013, p. 5). The definition of knowledge by Probst et al. embraces this statement. Probst et al. define knowledge as the whole set of "skills and information, which individuals use to solve problems. This definition includes theoretical insights as well as every day and practical recommendations. (. . .) Knowledge therefore is personal." (Probst, Raub, & Romhardt, 2012, p. 23, translated).

According to an IAO study, 80 % of German manufacturing firms expect to qualify their staff in order to meet the requirements for flexibility and working with often changing tasks and assignments (Spath et al., 2014, pp. 86–87). The transformation also causes faster (consumer) demand changes. To adapt, firms have to establish processes for coordinating production and engineering. 75.9 % of the manufacturing firms in the study (Spath, Weisbecker, Peissner, & Hipp, 2013, p. 111) state that there should be a faster feedback loop for knowledge gained from daily operations (Spath et al., 2014, pp. 107–112). To address the growing demand for knowledge transfer social media tools can facilitate the sharing of knowledge among workers on the shop floor level. Social media are web-based

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platforms on which humans share ideas, thoughts and content (Scott, Engel, & Welter, 2014, p. 90). Researchers have been discussing the application of social media tools within firms for knowledge management purposes (see for example Levy, 2009, p. 128; McAfee, 2006, p. 23; Razmerita, Kirchner, & Sudzina, 2009, p. 1022; Schneckenberg, 2009, pp. 517–518) or their implementation in recent studies (Gretsch, 2015, pp. 29–38; Levy, 2013, pp. 752 f.). However, these studies focus on a general application of social media tools within worker-centric environments, lacking the needed specifications and requirements for production environments. As companies already released several tools in the last years providing knowledge management or social media functionalities, it is difficult to differentiate between the concepts implemented, the benefit they provide and their applicability in production environments. Even worse, the boundaries of social media tools on the one hand and information visualization tools for production on the other hand vanish as well. A classification for social media concepts therefore helps to provide insight about the benefits and limitations of their application. This leads to the following questions:

1. What are the key concepts of social media tools in production and what are the differences compared to traditional social media solutions?
2. How can firms identify use cases in which social media facilitates knowledge management?

To answer these questions, the authors propose a classification framework, based on previous work by Levy, McAfee and O'Reilly. The framework integrates different concepts of social media tools. Companies and researchers can use the framework as a navigator, in order to classify different tools, depending on their functionalities and features, to identify use cases and estimate the benefit of such implementations in production. This paper expands and simultaneously specifies the current approaches to worker-centric environments in production. For a basic understanding of the implications of knowledge management in production, the next section provides a summarized view of relevant literature. The following section then outlines the foundations of the framework. In the final section two use cases demonstrate the applicability of the framework.

23.2 Knowledge Management in Production Environments

Knowledge improves the competitive position: aggregating knowledge in times of high competition and environmental uncertainty and integrating it into an innovation process can lead to a sustainable competitive advantage (Nonaka, Takeuchi, & Mader, 1997, pp. 14–16). Drucker established the term "knowledge worker" (Drucker, 2010) to designate the key employee in today's firms. Traditional knowledge workers are employees working in marketing, in social media sectors, the creative industry and media. They require problem solving skills as well as a creative mindset. Consequently, engineers and software developers are also knowledge workers, because they need problem solving skills as an important part in their everyday work. Likewise, mechanics working on the shop floor or in warehouses need a well-developed set of problem solving skills to tackle the new production tasks (e.g., monitoring production processes) to adapt to changing demand patterns and to make decisions in a highly uncertain environment (Spath et al., 2013, pp. 107–112). The workers require task specific information and personalized visualizations of data (Spath et al., 2013, p. 17). Berawi and Woodhead (2005) elaborate that “Knowledge management in production systems produces a synergy between technology, behaviors, and human innovation that is necessary to compete and survive in the challenging global manufacturing marketplace” (Berawi & Woodhead, 2005, p. 256). More explicitly, they explain that “Knowledge management is now being recognized as a core skill of any successful manufacturing organization” (Berawi & Woodhead, 2005, p. 250).

Companies can only create value from knowledge of employees, if this knowledge is integrated in or related to the products of this company (Teece, 2000, p. 37). Furthermore, products must meet customer demands regarding quality, functionality, on-time delivery, and budget. Thus, the production process itself has to be flexible and yet stable enough to meet these requirements. If this is not the case, the competitive advantage of a firm possibly deteriorates. Indicators of this decline are, in terms of knowledge management activities,

a) “unspecific work descriptions,
b) noncompliance to standards,
c) low quality services and products, and
d) ethical issues” (Berawi & Woodhead, 2005, p. 251).

Managing relevant factors of knowledge management in production systems is highly important for the firms’ success (Berawi & Woodhead, 2005, p. 253). These factors include performance and ability topics, such as innovation, information management and organization on the one hand, and changes in the environment, the stakeholder expectations as well as the company progress and the skill and experience of the firm on the other hand (Berawi & Woodhead, 2005, p. 253). Researchers in production management, especially lean manufacturing experts, recognize workers’ knowledge and the organization of information as an important factor for an efficient production flow (see for example Takeda, 2013, pp. 5–6; Töpfer, 2009, p. 3). Stocker draws the same conclusion concerning the importance of knowledge management in production. He also states that there is a significant lack in production-centric knowledge management literature, even though these settings require different approaches than standard working environments. He also suggests using web 2.0 technologies (Stocker, Brandl, Michalczuk, & Rosenberger, 2014, p. 209). However, it yet has to be described, how social media concepts can connect and enable knowledge sharing to fit the role of a knowledge catalyst in worker-centric environments. The next section introduces this approach.

23.3 Social Media for Knowledge Management Purposes

23.3.1 Social Media

O'Reilly introduced the concept of social media in 2005. He presents a set of necessary prerequisites and competencies for social media or Web 2.0 tools, summarized as follows:

1. "Lightweight user interfaces and development models
2. Services, not packaged software, with cost-effective scalability
3. Users Add Value
4. Trusting users as co-developers
5. Network Effects by Default
6. Harnessing collective intelligence
7. Control over unique, hard-to-create data sources which get richer the more people use them
8. Software above the level of a single device" (O'Reilly, 2005, p. 5).

To understand the key concepts behind social media tools, the definition provided by Scott et al. (2014) emphasizes the sharing and social aspect of the tools more strongly than the competencies introduced by O'Reilly. Their focus lies on enabling people to share ideas and thus, knowledge. Levy's Knowledge Management 2.0 approach (Levy, 2009, p. 128) and MacAfee's Enterprise 2.0 concept (McAfee, 2006, p. 23) provide key concepts and frameworks, which can also work for a general understanding of how companies can use social media tools in production environments.

23.3.2 Levy's Knowledge Management 2.0

Levy identifies key principles, which match knowledge management tools and Web 2.0 concepts. Further, she states that these tools have to co-evolve within a company to facilitate knowledge sharing functionalities (Levy, 2009, p. 129). Her concepts of web 2.0 technologies in the realm of knowledge management are:

a. "WEB as a platform
b. Service development
c. Active participation of users
d. The perpetual beta
e. The service improves automatically, the more it is used
f. Collective intelligence (the long tail)
g. Content as the core
h. (Rich user experience development via small modules)" (Levy, 2009, p. 130).

Levy mentions that the user experience of the tool is not an important factor for knowledge management activities. Nevertheless, both Levy und O'Reilly consider enriched user experiences for social media tools to help establish the tool. Levy further elaborates that social media tools generally fit into knowledge management activities, though their success is highly dependent on a trust and partnership culture within firms. Tools also often lack the user base to harness the collective intelligence (Levy, 2009, p. 132). She points out some key aspects and similarities of social media and knowledge management, namely the information sharing and self-structuring aspects for knowledge workers. These concepts are highly focused on traditional knowledge management activities and therefore on traditional working environments. It has yet to be proven, whether they fit into production environments.

23.3.3 McAfee's SLATES

McAfee (2006) employs a more technical approach. He introduces a technology concept, called SLATES, which stands for

i. Search,
ii. Links,
iii. Authorship,
iv. Tags,
v. Extensions and
vi. Signals (McAfee, 2006, pp. 23–25).

The first two terms emphasize the value of links for searching through content. Links provide, for example, a measure for the relevance of the search result. McAfee describes Authorship as a way to enable users to create content by themselves. Additionally, users can apply tags to structure information. This aspect embraces the collective intelligence of the user network. Extensions in this case refer to tools and algorithms, which can help to search for information more precisely or to share relevant content. RSS feeds implement the feed signals to the reader that there is new content available.

For a classification framework in production, there are still too many fuzzy boundaries. For example, Levy does not specify the platform character of her framework and it does not become clear how to implement her framework for social media tools. The study also lacks specifications of the necessary design elements for these tools. Conversely, McAfee's SLATES incorporates the technological components to build an application, but does not specify the benefits of social media concepts for knowledge workers in production environments. Thus, there is a need to define more clearly what a social media application for production workers is. Which functionalities should a social media tool provide on a minimum level? What technological concepts should developers and companies use? The next section will describe the methodology to find answers to these questions.

23.4 Methodology

The methodology of this paper consists of two steps. One of the key aspects is to provide a general understanding of how companies can use social media concepts in worker-centric environments for knowledge management applications, especially on shop floors. Accordingly, the authors develop a framework based on Levy's conceptual approach, O'Reilly's Web 2.0 definition and McAfee's technology SLATES. The framework combines organizational and technological perspectives and integrates these perspectives into one coherent framework. O'Reilly's study embraces the key concepts of today's Web 2.0 and social media applications. It works as a foundation for the concepts of other authors. McAfee's focus on technological concepts demonstrates the value and impact of technology applications regarding the purposes of the tool. He approaches the technology not as an end by itself, but on a conceptual, general level, which means that the framework can integrate SLATES as well. Levy emphasizes social media and knowledge management aspects and therefore provides a well-founded view of the organizational perspective. Levy and McAfee already consider social media tools for knowledge management activities, so the authors expect a general fit of the researchers' concepts.

The second step is the application of this framework as a proof-of-concept. The authors of this paper analyze and categorize two case studies that describe tools for production environments. Based on their classification, they deduce a general interpretation of how manufacturers can apply social media concepts in production environments.

23.5 Integrating the Classification Framework for Social Media in Production

To integrate the various concepts of the three studies[1] mentioned above, the authors reorganize the core functionalities of the concepts and assign them to generic categories. The method allows to compare the different aspects and to detect functional similarities. The next paragraph introduces the categories, the assignments and the integrated key ideas.

All three studies recognize the *platform character (Table* 23.1*, 1)* of social media tools, even though there are some specifics, varying in terms of implementation. Besides the technical focus from O'Reilly and McAfee (bullet ii, see chapter before), Levy regards the application platform as a central location (bullet a.), where everyone connects to and shares ideas or content. Her idea is about the way of enabling users, about the benefits the tool provides in terms of knowledge management functionalities.

[1]See chapter *Social media for knowledge management purposes.*

Table 23.1 Generic categories

ID	Category	Integrated
1	Platform character	2, 7, H, a), ii
2	Services (specific, lightweight)	1, 2, 7, H, b), g), i, ii, iv
3	User participation	3, 4, c), h), iii, iv
4	Perpetual beta	1, 4, d), vi, v
5	Network effects	4, 5, 7, e), ii, vi
6	Collective intelligence	6, f), v, iv, ii

O'Reilly's scalable services (bullet 2) are assigned to several categories. Scalable services are important for the platform character of a tool, because they allow accessing the functionality of the platform on-demand.[2] This allows the orchestration of services for lightweight, flexible programs and thus, social media tools. Developers can also reuse these old services for platform-independent implementations of new tools and applications.

O'Reilly, Levy and McAfee all focus on *user participation*. Users not only create knowledge or content, they also share the content. Additionally, social media tools enable new ways of direct communicating between two persons, like the expert finding tools described by Gretsch (2015, pp. 68–74). These integrate the community building functions of social media tools (Razmerita et al., 2009, p. 1033). O'Reilly extends user participation to the actual development of the tool itself. [3] This works hand in hand with the *perpetual beta (Table 23.1, 4)*, which means that the developers can update the tool much more often and that there is no or nearly no stable release.

Network Effects (Tables 23.1, 5) describe the effects that the amount and quality of the information the tool provides increases, the more users are actively involved. As a result the service improves and the content grows with increasing user numbers (Levy's bullet e., McAfee's bullet iv, above.). More users can also help to develop the tool by adding their expertise. Users in need of support in their work process can access a large base of potential experts. It is obvious that network effects require a minimum of user participation, because without user-generated content, there is no knowledge to share and to provide. This means, the users have to cooperate and communicate on an organizational level. Additionally, developers have to implement the technical features for information sharing, for example through links. This is even more important for the harnessing of *collective intelligence (Table 23.1, 6)*, for example the self-structuring of user knowledge and linking this knowledge with tags (McAfee, 2006, pp. 23–25). Through harnessing collective intelligence, more users add knowledge and extensive insights into a large number of topics (Levy, 2009, p. 130; Razmerita et al., 2009, p. 1026).

[2]This is similar to the cloud computing paradigm, where supposedly every functionality of software or information systems can be provided as a service (XaaS).

[3]This refers to bullet 3 and 4 of O'Reilly in the chapter *Social media for knowledge management purposes*.

Table 23.2 Social media classification framework

Layer	Aspects		
Technological layer	Service architecture	Data driven	Lightweight interfaces
Integration layer	Network effects	Collective intelligence	Platform character
Organizational layer	User participation	Content sharing	Collaboration

Harnessing collective intelligence is not exclusively about using user knowledge for specific activities. Harnessing collective intelligence also emphasizes on the metadata, which is part of the participation process of the users. The social media tool automatically collects and analyzes data on locations, routes or skill profiles to optimize certain job tasks on shop floor level (O'Reilly, 2005, p. 5).

Table 23.1 shows the integrated concepts.

Not only do these concepts lead to the use of social media tools. It is also essential how these concepts interact. Therefore, the framework (Table 23.2) provides three layers, which help companies and researchers to understand the interplay and the focal point of the concepts. Focusing on each layer, the authors can analyze tools, whether they fit the requirements for a social media tool and whether companies can use them in production environments. The first layer focusses on the technological concepts and stacks used. The integration layer describes the Web 2.0 concepts of the analyzed tool, while the organizational layer targets the knowledge management aspect and differentiates between different use cases.

23.5.1 Technological Layer

In the technological layer, service development is a distinctive factor of a social media tool. On shop floor level, this offers the opportunity to exactly implement the functions needed. Services provide these functionalities if requested "on-demand". Through the client–server principle, the device for the worker can be very small, because the computation executes on the server. Other applications can reuse these services, thus allowing for lightweight interfaces. However, lightweight interfaces also represent a well-defined user interface through which the user calls the information s/he needs without having to navigate through several tables. The application should be heavily data driven and provide information about the production process as well as about certain activities, products and machines. This is what Levy called "content driven" (see above and Levy, 2009, p. 130). It is also necessary to provide a database for metadata and user-generated content in order to analyze these data-rich environments for hidden patterns or optimization possibilities, thus, for harnessing collective intelligence. Storing user data and a service-architecture satisfy the technical requirements for the categories collective intelligence, user participation and the service employment. However, there are downsides regarding the perpetual beta (Table 23.1, 4) and the reuse of services (Table 23.1, 2) as well. Based on Berawi's analysis for production systems (Berawi & Woodhead, 2005, p. 251), one of the main goals of a social media tool in production is to comply with standards and quality assurance, thus supporting the stability of the process. This implies that the data has to be accessible at all times, so the perpetual beta is feasible, or at least, there is more management overhead expected for using this concept.

23.5.2 Organizational Layer

There are several similar concepts involved in *the organizational layer* when addressing user benefits. The focus lies on user participation and collaboration, which corresponds to the traditional goals of knowledge management. The common concept of user participation is that the users of the tools create content, structure content through tags (McAfee, 2006, pp. 23–25) or are even engaged in the development process of the tool (O'Reilly, 2005, p. 5). For distinction purposes, the authors divide participation into content creation, content sharing functionalities and direct collaboration. Content creation includes, for example, designing a product or writing a text. Content sharing includes posting text such as comments on websites or sending pictures. Collaboration captures that worker actively help each other in a peer-to-peer fashion.

23.5.3 Integration Layer

Some concepts emphasize organizational as well as technological aspects. The technological foundation of the platform character for example includes the light-weight interfaces and the service architecture of the tool. Additionally, the platform character defines the single access-point for users to work with this tool, similar to *facebook*'s main page, where information from different sources is aggregated and visualized. Therefore, the authors compose an integration layer, which works as a bridge between the bare technology and the user-based, i.e., organizational concepts. Due to the network effect, users benefit from the larger amount of information while larger amounts of metadata help to improve the optimization algorithms. To utilize the effect, developers should integrate it with user participation or content sharing in order to enlarge the network. A one to one relation for content sharing, like direct messaging of pictures, does not provide any network-related benefits. Nevertheless, companies can realize network effects through tracking many users to derive profiles in working environments. Additionally, the integration of metadata and data from user participation leads to new opportunities for harnessing collective intelligence through algorithms. As mentioned above, harnessing collective intelligence is heavily data-focused and can provide huge benefits to workers, for example, through providing the best help description for a specific task. The centrality of an application characterizes the platform character of a tool. Users access the platform through a central point on a web-server. Users connect to the application via a device with a suitable user interface, e.g., mobile phones or tablets.

Using their framework the authors evaluate two case studies whether the provided tools can be applied as social media tools for knowledge management purposes.

23.6 Social Media Concepts in Production: Case Studies

The authors use two case studies to test and explicate the functionality of the developed framework. The cases introduce two tools developed by Fraunhofer Institute for Industrial Engineering (IAO) in Stuttgart. They focus on enabling workers on shop floor level to participate in the decision making process in production and help to provide and to distribute additional task information. The tools are

1. EPIK and
2. KapaflexCy.

The authors of this paper describe the main functionalities of these tools, the ideas behind the tools and their main use cases. Afterwards the authors use the developed framework from Table 23.2 to categorize them.

23.6.1 Functionalities of Case 1: EPIK

The IAO describes EPIK on their web page and in articles (Fraunhofer-Institut für Arbeitswirtschaft und Organisation IAO, 2012a; Spath et al., 2013, pp. 69–71). The tool is a mobile task manager for production environments. Workers can organize their tasks through a task list, which provides information about how and where to carry out the work.

Based on the skill profile of a worker, the tool shows only relevant information of this task to the worker (e.g., a highly experienced worker only receives condensed instructions). EPIK matches the worker's abilities and expertise with the skills the machine requires. Afterwards EPIK sends the tasks to the worker, who in turn can confirm the task through a human-machine interface. Additionally, the tool provides communication functionalities, e.g., a comment function for tasks. Furthermore, workers can share comments among each other and send help requests to co-workers if they need support for specific tasks. These, in turn, can accept or decline the request. The IAO optimized the tool in terms of user experience and usability (Spath et al., 2013, pp. 69–71). It also includes a location and routing functionality for workers (Fraunhofer-Institut für Arbeitswirtschaft und

Organisation IAO, 2012c) to navigate through the plant or warehouse to find certain products or facilities. Implementation in Java offers platform-independence (Fraunhofer-Institut für Arbeitswirtschaft und Organisation IAO, 2012b).

23.6.2 Categorizing Case 1: EPIK

EPIK uses a database for the task information and is therefore data driven. It also provides a light-weighted web-interface for the user. It encourages user participation through comments on tasks which the worker can share. The tool provides functionalities similar to expert finding tools with a call button for help requests. It lacks collective intelligence features; however, it clearly embraces the network effect. Summarizing it can be stated that EPIK provides most of the functionalities and concepts of social media tools on a smaller scale and can be applied for more specific use cases.

23.6.3 Functionalities of Case 2: KapaflexCy

KapaflexCy stands for "capacity flexibility within cyber-physical systems" (Gerlach, 2012, p. 1). It is a mobile solution for the planning of worker capacities on shop floor level (Spath et al., 2013, pp. 72–73). Spath describes that it works as a platform, to which everyone can connect through an app on a mobile device. Associated with the worker is his or her personal skill profile, or competence profile. Actual order demands set the operation time of the machines in every production shift. To operate the machines, a worker needs a specific skill profile. Additionally, the capacity of a specific worker with the required skill profile should be available to finish the production order in time. The machine communicates the actual demand of skills directly to the platform. A network connects every machine and integrates them into the cyber-physical system. The machine uses this network to transfer the demand to KapaflexCy (Gerlach & Rosenbusch, 2013, pp. 4–6) and requests specific skills for particular timeslots. Using the app workers enter their personal capacity and availability. Based on machine and worker constraints (capacity, availability, skill profiles, and time accounts) a scheduling algorithm selects and assigns the workers to the tasks. The algorithm balances the employment of the workers, so that no one feels ignored or omitted. In any case workers have the final say by accepting task assignments or initiating coordination processes among themselves. The IAO implemented the application platform with Java, so companies can use the tool on most devices (Gerlach & Rosenbusch, 2013, pp. 1–4).

23.6.4 Categorizing Case 2: KapaflexCy

KapaflexCy provides a lightweight interface on the technological level which workers can access through various devices as well as web services. It is data driven and combines worker profiles and machine data. On a personal level, it encourages participation and collaboration. The scheduling and capacity planning algorithm makes use of a huge dataset, provided by users. Increasing utilization through workers highly improves the results of the calculation in the integration layer. Therefore, it strongly uses the network effect. The scheduling algorithm works as an extension introduced by McAfee (see above). It also harnesses collective intelligence. KapaflexCy provides a platform for discussing demands and facilitates self-organization on the shop floor level. The tool has a comparable specific use case in production environments, whereas its key concept, enabling worker flexibility, can be adapted to various other situations.

23.7 Discussion and Conclusion

Social media tools for production environments provide knowledge management functionalities (Stocker et al., 2014, p. 209), especially for collaboration and ad-hoc help, as the EPIK case demonstrates. Frameworks for social media implementations for common knowledge workers, e.g., employees working in offices, use a more general approach in connecting workers' needs and knowledge management functionalities, similar to newsfeeds, wikis, blogs or instant messaging. The traditional knowledge worker paradigm (Gretsch, 2015, pp. 68–74; Levy, 2013, pp. 742–743) where workers can use notebooks or wide screen solutions is often the foundation of such tools. Expanding this paradigm to workers in production environments, the authors sought to find the key concepts of social media tools in production and their differences to traditional social media tools. They propose a framework for the classification of social media implementations in professional environments. Organizations can use the developed framework to analyze the concepts of social media solutions as a key enabler to knowledge management. The framework was evaluated through applying it to two case studies from production settings.

This study shows that social media tools in production also apply concepts of traditional social media tools. Especially social media concepts such as creating and sharing knowledge can improve the quality of production processes (Berawi & Woodhead, 2005, pp. 249–256). They help to harness workers' knowledge and provide functionalities for self-organization within production settings. These environments often lack the possibility of accessing websites or programs through notebooks and desktop computers. Instead, mobile devices dominate the shop floor. Therefore, knowledge management solutions focus on platform independent service solutions, as demonstrated by EPIK and KapaflexCy. Their platform character enables a wide range of data driven services. Consequently, the integration of machine-data into these platforms enhances the utility of the tools. In contrast to traditional social media platforms, which strongly emphasize human communication, manufacturers design and implement these tools for specific use cases. Their features will be more distinct than the known B2C platforms. Comparing the user bases of open social networking sites to the examined platforms, the user base in closed environments is much smaller, thus they lack metadata and large-scale collective intelligence functionalities. It has yet to be evaluated, whether generic platform solutions similar to Facebook and Sharepoint can be used in production environments.

Identifying use cases for social media tools to help facilitate knowledge sharing is another important issue for companies. In order to help manufacturers understand the benefits of social media concepts, the developed framework provides a solid foundation for examining complex worker-centric production processes. The actual implementation and the utilization of such tools highly depend on their usability. Both evaluated tools use touch screens and mobile apps for accessing their functionalities. However, in environments where hands and fingers are gloved or dirty, companies have to consider other ways of interacting with the device. Firms need a deep understanding of their production environment, its specifications and requirements, before considering social media tools as knowledge catalysts.

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