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Implementation of Passage Planning to Support Safety: Case Study on MV. Pan Global

Moh. Aziz Rohman[1], Elnath Antaresia[2], Ida Umboro Wahyu Nur Wening[3*]
Politeknik Ilmu Pelayaran Makassar[1,2], Politeknik Penerbangan Makassar[3].

ida.umboro@poltekbangmakassar.ac.id.

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ABSTRACT

Shipping remains the primary mode of sea transportation due to its ability to move goods in large quantities at relatively lower costs compared to other transport modes. Passage planning, or voyage planning, is essential to minimize risks arising from navigational errors. This study employed a qualitative research method conducted during sailing practice on MV *Pan Global*, owned by STX Pan Ocean Ltd. The findings revealed several obstacles in implementing passage planning, including delays in chart corrections, lack of synchronization between passage plans and navigation equipment, limited availability of updated nautical publications, discrepancies between charted and actual navigation hazards, inadequate installation of navigation equipment updates, insufficient maintenance, and the use of equipment not compliant with established standards. To address these issues, the study proposes several solutions: ensuring timely requests to the company for necessary updates, consistently monitoring Notice to Mariners (NTM) online for chart corrections, enhancing the accuracy of nautical chart updates, installing modern navigation equipment with improved data-processing capabilities, conducting regular maintenance and inspections, and ensuring the use of navigation equipment in accordance with manuals and standard procedures.

INTRODUCTION

Sea transportation plays a vital role in both national and international trade, serving as the backbone of global logistics and supply chains. The majority of export and import activities worldwide rely on maritime transport, while only a small portion utilizes air or land transportation. Ships are chosen as the primary means of transporting goods due to their ability to carry large volumes efficiently and at relatively low cost compared to other modes of transport. According to the International Maritime Organization (IMO), more than 80% of global trade by volume is carried by sea, underscoring the importance of ensuring safe and efficient shipping operations.

To support the distribution of goods, effective voyage planning—commonly referred to as passage planning—is required. Passage planning involves determining the safest and most efficient route from the point of departure to the point of arrival, taking into account both navigational safety and operational efficiency. From a safety perspective, a well-prepared passage plan helps ships avoid hazards such as reefs, wrecks, or restricted waters, thereby ensuring the protection of human lives, vessels, and cargo. From an efficiency standpoint, careful planning reduces voyage duration, fuel consumption, and operating costs, aligning with both economic and environmental considerations. Nevertheless, safety remains the highest priority, as maritime accidents not only jeopardize lives but also undermine the trust of stakeholders in the shipping industry.

Maritime safety is influenced by three major factors: human, technical, and environmental conditions. Among these, human error is considered the leading cause of accidents at sea, accounting for approximately 80% of incidents (IMO, 2012). One of the key human-related factors contributing to accidents is the poor implementation of passage planning. Proper passage planning enables seafarers to anticipate challenges, make informed decisions, and respond effectively to unexpected conditions during voyages. As emphasized by Subardi (2013), the process of passage planning consists of four stages: planning, implementation, monitoring, and evaluation. Adherence to these stages is critical in ensuring that a voyage proceeds safely and on schedule.

Despite the recognized importance of passage planning, obstacles frequently arise in its implementation, particularly on commercial vessels. Common challenges include delays in chart corrections, outdated or incomplete navigational publications, lack of synchronization between passage plans and navigational equipment, and inadequate maintenance of essential tools such as radar and echo sounders. These issues not only compromise the quality of passage planning but also pose significant risks to maritime safety. Furthermore, limitations in training, supervision, and compliance with international standards exacerbate the problem, especially on ships operating under time or resource constraints.

In this context, the present study investigates the implementation of passage planning aboard the MV *Pan Global*, operated by STX PANOCEAN LTD. During onboard practice, several obstacles were observed in the preparation and execution of passage plans, including insufficient map updates, damaged navigation aids, and inadequate navigational publications. These issues illustrate the gap between theoretical guidelines and practical realities faced by seafarers.

Accordingly, this study is guided by two main research questions: (1) Why do delays in map correction frequently occur during voyages on the MV *Pan Global*? and (2) Why is the passage planning process not fully aligned with the required stages of planning? To ensure a focused discussion, the scope of this research is limited to the application of passage planning on the MV *Pan Global* and the operation and maintenance of navigational equipment onboard. By addressing these issues, the study aims to provide insights into the practical challenges of passage planning and to propose recommendations for enhancing navigational safety in maritime operations.

Sea transportation remains indispensable to both national and global trade, carrying over **80–90%** of international cargo by volume and providing a cost-effective alternative to air or land transport (Maritime transport, n.d.; ZipDo, 2024). Despite being the most efficient mode, shipping still accounts for a significant portion of global greenhouse gas emissions, making efficiency and sustainability urgent priorities (Reuters, 2024). Effective voyage planning—or passage planning—is essential for ensuring safe and efficient maritime operations. The International Maritime Organization (IMO) established the Guidelines for Voyage Planning (Resolution A.893(21)), which mandate a structured, four-stage process: appraisal, planning, execution, and monitoring (Passage planning, n.d.). A properly crafted passage plan helps ships avoid navigational hazards such as reefs, collisions, or restricted zones, protecting lives, cargo, and the marine environment.

However, maritime safety remains a pressing concern, as **human error** is a major contributor to accidents at sea, with studies estimating its involvement in **75–85% of incidents** (Ozturk & Cicek, 2021). A Dutch study further found that nearly **96% of accidents** involved at least one human error, often as part of a chain reaction of failures (Pernica et al., 2023). That said, the oft-cited rule of "80% human error" lacks robust empirical evidence and should be used with caution (Grech, 2021). This raises concerns about how human factors—such as fatigue, insufficient training, and over-reliance on automation—interact with technical and environmental variables to shape navigational risk (Ozturk & Cicek, 2021). Addressing this complexity through empirical investigation is crucial for translating regulatory best practices into real-world safety performance.

The urgency of improving passage planning is closely linked to the growing complexity of maritime operations in the modern era. With increasing global trade, denser traffic in international shipping lanes, and

the rapid adoption of electronic navigational systems, errors in voyage planning can have more severe consequences than ever before. Even minor lapses in chart corrections or equipment synchronization can result in collisions, groundings, or environmental disasters. Moreover, stricter regulations from IMO and regional authorities demand higher compliance and accountability from shipping companies and crew members. Therefore, addressing the challenges in passage planning is not only a matter of operational efficiency but also a pressing requirement for international maritime safety and sustainability.

Despite numerous international guidelines and technological advancements, a significant research gap remains in understanding how passage planning is implemented in real-world contexts, particularly on vessels engaged in routine commercial operations. Much of the existing literature focuses on theoretical frameworks, regulatory standards, or technological innovations such as ECDIS, but relatively few studies explore the practical difficulties faced by seafarers during daily navigation. This gap is especially evident in the context of developing countries, where vessels often operate with limited resources, outdated equipment, or incomplete navigational data. By focusing on the MV *Pan Global* as a case study, this research addresses this gap by providing an empirical account of the actual obstacles encountered in the preparation and execution of passage plans. In doing so, the study contributes to bridging the divide between theoretical best practices and operational realities, offering insights that are both academically valuable and practically relevant for improving maritime safety.

METHOD

This study employed a qualitative descriptive approach, conducted during sea practice onboard the MV *Pan Global*, operated by STX Pan Ocean Ltd. The researcher acted as both observer and participant, collecting data in natural settings related to the implementation of passage planning.

Data collection was carried out through three primary techniques. First, **direct observation** was undertaken during the voyage to document the process of preparing and executing the passage plan, including chart corrections, synchronization with navigational equipment, and the utilization of nautical publications. Second, **in-depth interviews** were conducted with key officers, particularly the Second Mate (Mualim II), who is directly responsible for preparing and verifying voyage plans. These interviews explored challenges encountered in passage planning, such as outdated charts, limited publications, and malfunctioning navigational equipment. Third, **document analysis** was performed on ship records—including logbooks, corrected charts, nautical publications, and equipment maintenance reports—to validate the findings from observations and interviews.

Data analysis was carried out continuously throughout fieldwork. Observational notes, interview transcripts, and documentary reviews were systematically organized and coded to identify recurring themes and patterns. Thematic categories included delays in chart corrections, inadequacies in navigational references, synchronization issues between passage plans and navigational equipment, and equipment maintenance challenges. Triangulation across the three data sources strengthened the validity of the findings and ensured that the identified obstacles were not based on a single perspective. By focusing on the practical application of passage planning on the MV *Pan Global*, this methodological approach enabled the researcher to capture real-world challenges faced by seafarers and to propose solutions grounded in direct experience and documented evidence.

RESULTS AND DISCUSSION

Based on observations conducted on board the *MV Pan Global*, several challenges were identified in the implementation of passage planning, particularly during navigation through the Panama Canal. These challenges often resulted in delays, hull damage, and an elevated risk of collisions. Such findings are consistent with earlier studies highlighting how inadequate voyage planning and insufficient chart corrections remain critical contributors to navigational accidents (Barnett, Gatfield, & Pekcan, 2006; Chauvin, Lardjane, Morel, Clostermann, & Langard, 2013).

One major issue concerned delays in updating Notices to Mariners (NTM), which frequently led to incomplete or outdated navigational publications being available on board. As Grech, Horberry, and Koester (2008) emphasized, the accuracy and timeliness of nautical information are essential for safe navigation, and lapses in this process can substantially increase the likelihood of maritime incidents.

The study further revealed that reliance on incomplete and obsolete charts created inconsistencies between updated and older maps, generating confusion among officers during voyage execution. Similar problems have been documented in the maritime safety literature, where outdated charts have been directly

linked to groundings and navigational errors (Håvold, 2010; Hetherington, Flin, & Mearns, 2006). Moreover, discrepancies between charted navigation hazards and actual conditions at sea underscored the importance of continuous monitoring and verification, as recommended by IMO guidelines (IMO, 2010).

Another significant challenge observed was the lack of synchronization between passage planning and navigational tools, particularly the Electronic Chart Display and Information System (ECDIS). In several instances, errors in ECDIS installation and updating resulted in discrepancies between displayed charts and actual navigation conditions. Consistent with earlier studies, improper installation and insufficient updating of ECDIS undermine its reliability and increase navigational risks (Emy & Yeo, 2019; Wróbel, Montewka, & Kujala, 2017).

Maintenance of navigational equipment also emerged as a critical weakness. Irregular inspections and poor maintenance practices frequently led to malfunctioning systems, creating operational challenges for officers responsible for navigation. This finding supports Grech's (2016) observation that poor technical reliability, when combined with weak human–system interaction, contributes to unsafe conditions at sea.

In addition, the study identified inappropriate use of navigational tools that did not fully comply with international standards. The safe and effective use of radar, ARPA, GMDSS, and other navigational aids requires not only technical competence but also strict adherence to standardized operating procedures (Bhattacharya, 2012). On board *Pan Global*, limited crew training and inadequate familiarity with these systems often created confusion and inefficiencies in voyage planning and execution. This reflects broader trends in maritime safety research, where competence gaps and insufficient training have been recognized as recurring contributors to maritime accidents (Celik & Cebi, 2009; Chauvin et al., 2013).

Overall, the findings demonstrate that delays in chart corrections, incomplete publications, ECDIS synchronization failures, poor maintenance, and non-standardized use of navigational tools collectively undermine the effectiveness of passage planning. Addressing these issues requires continuous crew training, systematic equipment maintenance, and strict adherence to IMO standards, thereby bridging the gap between best-practice guidelines and operational realities at sea.

To address the recurring challenges identified on board MV *Pan Global*, particularly delays in chart corrections and incomplete publications, this study emphasizes the importance of aligning passage planning with the appraisal stage outlined in IMO Resolution A.893(21). According to the resolution, an effective passage plan requires the use of appropriately scaled, accurate, and up-to-date charts, supported by relevant nautical publications and notices to mariners. The appraisal process further involves considering a wide range of information, including permanent and temporary navigation warnings, radio navigation aids, routing guides, tidal and current tables, hydrographic and oceanographic data, climatological conditions, and weather-routing services.

In addition, operational factors such as traffic density, marine environmental protection zones, pilotage requirements, port information, and the availability of emergency response arrangements must also be incorporated into voyage planning. By systematically integrating these elements, navigators can minimize risks and enhance the safety of operations. However, observations on board indicate that these requirements are not consistently met due to delays in NTM updates, limited access to current publications, and inadequate communication channels between ship and shore. This gap underscores the need for stronger compliance mechanisms and improved information flow to ensure that the appraisal stage of passage planning achieves its intended role in safeguarding maritime safety.

Ensuring access to accurate and up-to-date navigational publications is essential for the safety of ships during sailing. Each requirement outlined in IMO Resolution A.893(21)—including charts, nautical publications, and notices to mariners—must be fulfilled to establish an effective passage plan. However, persistent challenges such as delays in chart corrections, incomplete publications, and discrepancies between charted and actual navigation hazards continue to undermine navigational safety.

One critical measure to address these challenges is the timely updating of Notice to Mariners (NTM) publications. This task is particularly important for officers responsible for chart corrections, as it directly influences the reliability of nautical charts and voyage planning. Effective implementation, however, depends on strong coordination between ship and shore-based company systems. Insufficient connectivity and procedural delays often hinder the timely provision of updates, a problem not unique to individual vessels but indicative of wider industry constraints. Strengthening ship–company communication channels and ensuring

that NTM updates are delivered consistently and in accordance with established procedures are therefore key to maintaining safe navigation.

In terms of familiarization with publications related to navigation, navigation equipment, such as the Radar manual book, the ECDIS manual book, and the nautical almanac, must be used to ensure that all provided publication tools can be utilized optimally and as appropriate. On board the MV. PAN GLOBAL has a pile of books, which results in stores being filled with unused books. The need to select books that are still used and unused so that the requests made by the ship to the company are not exaggerated. In addition to the demand for unnecessary books, there is still a need for old publications that can be repurposed. a) Always pay attention to NTM online to stay informed about new map corrections. In accordance with the Admiralty Nautical to Marines (NTM) standard issued by the United Kingdom, the UKHO contains eight corrections to NTM, namely: explanatory notes. Publication list, and Admiralty notices to mariners—updates to standard nautical charts; b) Accuracy of nautical chart correction. Information about correcting the nautical chart can be obtained in three ways: by using the NTM correction, as previously explained.

Use of Radio Navigation and Communication Systems for Chart Corrections

In addition to traditional NTM updates, several radio navigation and communication systems play a vital role in ensuring that navigational information remains accurate and up to date. Among these, NAVTEX, weather facsimile (weather fax), and Inmarsat C are particularly significant.

NAVTEX provides automatic broadcasts of navigational warnings, meteorological forecasts, and maritime safety information within a range of approximately 370 km from shore stations. As an integral component of the IMO/IHO Worldwide Navigational Warning Service (WWNWS) and a key element of the Global Maritime Distress and Safety System (GMDSS), NAVTEX ensures that vessels receive timely updates without cost to the user. Its reliability in disseminating critical information directly addresses the challenge of delays in manual NTM distribution.

Weather facsimile, although an older system, continues to be widely used due to its global coverage and ability to transmit detailed meteorological charts. These charts support voyage planning by providing essential climatological and oceanographic data, as recommended under IMO guidelines for passage planning. Regular maintenance and operational checks are required to ensure the accuracy of received information, thereby reducing the risk of navigation based on outdated or unclear data.

Inmarsat C complements these systems by offering two-way data communication that includes maritime safety information, chart and weather updates, and position reporting. Its approval under GMDSS and use in Vessel Monitoring Systems (VMS) make it one of the most versatile and reliable channels for ensuring continuous access to safety-critical information. Importantly, Inmarsat C reduces dependence on manual publication updates by providing direct electronic transmission of navigational data.

Together, these systems mitigate the risks posed by delays in chart corrections and incomplete publications. Their integration into voyage planning ensures compliance with SOLAS and IMO requirements while enhancing the reliability of navigational decision-making.

One of the key findings of this study is that passage planning on board did not fully align with the stages outlined in IMO Resolution A.893(21) on Guidelines for Voyage Planning. In particular, the execution stage was often compromised by limitations in the reliability and condition of navigational equipment. According to the IMO guidelines, “factors which should be taken into account when executing the plan, or deciding on any departure therefrom, include the reliability and condition of the vessel's navigational equipment.” This requirement emphasizes that successful execution of a voyage plan is inseparable from the operational readiness of the ship’s navigation systems.

To address these challenges, the adoption of updated navigation tools such as the Electronic Chart Display and Information System (ECDIS) is essential. ECDIS provides integrated digital charting, route monitoring, and safety alarms, and its use is mandated under SOLAS Chapters V/19 and V/27, subject to IMO performance standards. However, observations during field practice revealed that ECDIS was not always kept up to date, reducing its effectiveness in supporting safe navigation. Furthermore, while alternative systems such as the Electronic Chart System (ECS) and Raster Chart Display System (RCDS) are sometimes used, these do not fully comply with IMO criteria, despite meeting ISO or IHO requirements. Their limitations highlight the need for ECDIS to be properly maintained and synchronized with Electronic Navigational Charts (ENCs), which must be continuously updated and validated.

These findings indicate that the misalignment between voyage planning and IMO guidelines primarily results from outdated or inadequately maintained equipment. Regular updates, systematic maintenance, and adherence to international standards are therefore crucial to ensure that navigational tools can effectively support the execution stage of passage planning and enhance maritime safety.

Regular maintenance of navigational equipment is essential to ensure reliability and operational safety during voyages. Field practice revealed several gaps in the implementation of maintenance routines. For example, steering gear inspections and emergency drills—required every three months—were not always systematically recorded in the logbook. In some cases, lubrication checks and manual-to-automatic steering transitions were inconsistently performed, which could compromise maneuverability in emergency situations.

Similarly, while GPS and ECDIS equipment require careful handling and protection against environmental conditions, improper storage and cleaning practices were observed. In one case, GPS units were transported without adequate protective packaging, increasing the risk of physical damage. Furthermore, cleaning and storage were often conducted without following manufacturer-recommended procedures, which may affect long-term performance.

For VHF radio systems, disturbances were sometimes addressed through trial-and-error troubleshooting rather than systematic diagnostic procedures, leading to delays in identifying the root cause of equipment failure. Such practices highlight the need for structured maintenance protocols, consistent logbook documentation, and regular crew training. Strengthening these aspects would minimize the risk of navigational equipment malfunction and enhance overall maritime safety.

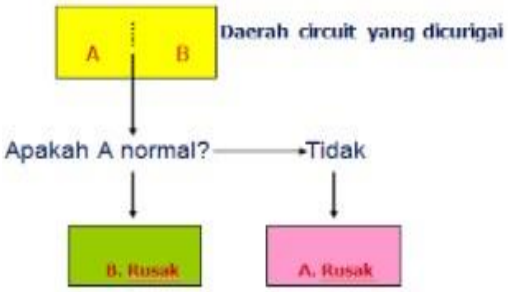

Figure 1 Restricted area damaged

Accurate voltage levels are essential for the reliable performance of navigational and communication equipment. During sea practice, voltage checks were conducted to ensure that transistors and other active components were functioning within operational limits. Several challenges were observed, including unstable voltage supply and improper grounding procedures, which increased the risk of equipment malfunction or signal interference. These findings highlight the importance of routine voltage monitoring using standardized instruments, such as multimeters, and the need for consistent maintenance practices to ensure navigational safety.

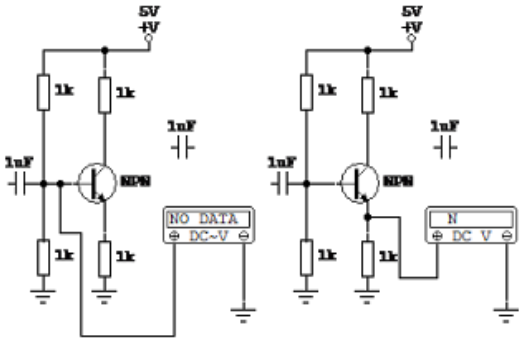

Figure 2 Voltage measurement on components

NAVTEX plays a critical role in providing maritime safety information, including navigational warnings and weather forecasts. However, during sea practice it was observed that improper maintenance and irregular

cleaning could reduce the reliability of the equipment. For example, failure to follow proper handling guidelines or exposure to extreme temperatures risks damaging sensitive components. In addition, steering gear—essential for maneuvering and emergency response—was found to be vulnerable when routine checks and operational tests were not consistently performed. Such shortcomings highlight the importance of adhering to IMO-recommended maintenance standards and conducting regular feasibility tests to ensure that both NAVTEX and steering gear remain fully operational. Strengthening crew training and compliance with procedural manuals is therefore crucial to supporting passage planning and enhancing maritime safety.

Although GPS provides reliable positioning through satellite signals, improper configuration or delays in updating waypoints were identified as obstacles during voyage planning. These issues can create inconsistencies between the intended route and real-time vessel positioning, increasing navigational risks.

The Electronic Chart Display and Information System (ECDIS) is a critical tool for modern navigation, providing digital charting functions that enable accurate route planning and monitoring. During field practice, several challenges were identified, including incomplete configuration of safety parameters (e.g., safety depth, contour, and deviation limits) and limited use of its warning and annotation features. Such gaps may compromise the effectiveness of ECDIS in supporting safe navigation. Similarly, the use of VHF radio for distress communication was observed to require strict procedural adherence. While the system enables rapid transmission of distress signals, lapses in crew readiness and delayed acknowledgement from coastal stations were noted as potential risks. These findings emphasize the need for continuous training in both ECDIS route planning and VHF emergency communication to ensure operational reliability and maritime safety.

In practice, the NAVTEX system is essential for transmitting and receiving navigational warnings and weather information. However, during sea practice, operational challenges were identified, such as delayed message updates, weak signal reception in certain areas, and difficulties in ensuring that received messages were correctly synchronized with passage planning. These limitations can reduce the effectiveness of NAVTEX in supporting safe navigation.

CONCLUSION

Based on the analysis and discussion, this case study demonstrates that the implementation of passage planning plays a critical role in enhancing navigational safety, as evidenced on board the MV Pan Global. Several obstacles were identified in the preparation and execution of passage plans, including delays in chart correction, incomplete and outdated nautical publications, limited synchronization between passage plans and navigational equipment, and insufficient maintenance of navigation systems. These issues pose significant risks to maritime safety and highlight the urgent need for systematic improvements. The findings reaffirm that accurate and up-to-date nautical charts, reliable navigational tools, and strict adherence to international standards and procedures are essential for effective passage planning. Strengthening crew competence through continuous training and ensuring compliance with planning protocols are equally critical to reducing operational risks during voyages.

From a practical perspective, the study contributes to understanding how shipping companies and ship operators can address recurring safety challenges by prioritizing timely chart updates, adopting modern navigational technologies, and enforcing preventive maintenance schedules. From a theoretical perspective, it underscores the importance of integrating human, technical, and procedural elements in maritime safety management. Nevertheless, as a case study focused on a single vessel and specific sailing practices, the research may limit generalizability. Future studies should expand the scope to multiple ships, routes, and environmental conditions to validate the results and to explore the integration of digital navigation tools and real-time meteorological data into passage planning.

In conclusion, this case study on MV Pan Global demonstrates that robust passage planning is an effective proactive measure to minimize navigational risks and ensure safer maritime operations. Addressing the identified challenges will not only improve the safety performance of individual vessels but also strengthen broader industry practices in line with international maritime safety standards.

Recommendation

Based on the findings of this case study, several recommendations can be proposed to enhance the effectiveness of passage planning and promote safer maritime operations. Shipping companies should prioritize systematic and timely updates of nautical charts, Notices to Mariners (NTMs), and related

publications, supported by reliable ship–shore communication systems, to minimize delays that compromise navigational safety. Preventive maintenance of navigational equipment, including GPS, ECDIS, radar, ARPA, and GMDSS, must be strictly enforced through scheduled inspections and timely repairs to avoid equipment failures during voyages.

Standardization of passage planning in accordance with IMO Resolution A.893(21) and SOLAS requirements is also essential, particularly in the appraisal and execution stages. The use of non-standard navigational systems should be avoided, and only equipment that complies with IMO performance standards should be employed. Crew competence remains a critical factor; therefore, continuous professional training, including simulation-based exercises, is recommended to strengthen officers' proficiency with modern navigation systems and minimize human error. Finally, the integration of digital and real-time data into passage planning—such as automated chart updates, weather routing, and tidal current prediction—can significantly enhance situational awareness and reduce risks associated with outdated or incomplete information.

Implementing these recommendations will enable shipping companies and maritime stakeholders to improve navigational safety, reduce operational risks, and align practices with international maritime safety standards, thereby contributing to safer and more efficient global shipping operations.

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