Optimizing Port Efficiency: Unveiling Disparities and Potential of Port Community System (PCS) Deployment at Port Qasim for Economic Growth and Technological Transformation

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Abstract

The integration of technology has demonstrated its capacity to enhance organizational operations and foster economic development. Just as in various other sectors, the maritime industry also demands the digitalization of its operations through an efficient and seamless IT system – known as the Port Community System (PCS). The PCS serves as a secure technological platform that facilitates the exchange of data and information flow among the myriad of public and private entities involved in seaport operations. This research endeavors to explore the disparities between the existing and proposed procedures at Port Qasim, with a particular focus on the implementation of the PCS within the framework of Port Qasim Authority. Employing structural equation modeling via PLS-SEM, the study collected data through a Likert questionnaire featuring a 5-point scale. This questionnaire was administered to 123 respondents, all of whom were esteemed port professionals at Port Qasim. The findings unveiled that the perceived impact of the introduction of the PCS holds a positive and significant influence over overall process efficiency and workflow.

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Correspondingly, the pre-requisite knowledge required is found to have a positive and significant relationship on perceived impact of PCS introduction at the port. Nonetheless, the correlation between the prerequisite knowledge and process efficiency was deemed insignificant. This implies that possessing prior knowledge of PCS doesn't inherently translate to increased process efficiency. Interestingly, this gap can be bridged effectively through targeted training sessions, enabling users to harness the full potential of the PCS without adversely affecting process efficiency. Nevertheless, with streamlined data exchange and efficient information flow, the PCS can reduce port congestion, enhancing trade operations and positioning Karachi as a competitive trade hub. Economically, this translates into increased trade throughput, improved logistics, and heightened business attractiveness.

1.1 Introduction

Seaports are essential for promoting global trade and economic expansion in a world that is becoming more interconnected and globalized. An intricate web of operations involving numerous stakeholders must be orchestrated for these crucial nodes of commerce to operate effectively. The marine industry is also employing digitization and altering traditional processes to transition towards a faster and more efficient flow of information, strengthening its network, like every other industry in the world that is using technology and various ICT and EDI applications. Moreover, Author[1] claimed that in a fast-paced and ever-changing ICT market, efficient chain wide integration and collaboration are vital to enable better supply chain performance. Hence, the flow of information regarding chain-wide activities among entities such as ships, hinterland transport networks and cargo stakeholders, is of utmost importance in ship-port relationships.[2] Moreover, ports around the world are now competing

[1] Zohaib, H. S., & Zaidi, S. S. (2022). Antecedents of maritime supply chain resilience affecting supply chain performance– an empirical study based on the pharmaceutical industry. GMJACS, 12(2), 81–101. https://doi.org/10.59263/gmjacs.12.02.2022.256

[2] Kaup, M., Deja, A., Ślączka, W., & Gróbarczyk, M. (2021). The port community system as an example of integration of port users. *Procedia Computer Science*, *192*, 4396-4405.

and utilizing technological advancement transforming in enhancing their port ecosystem. To ensure seamless collaboration among these stakeholders and streamline the flow of goods, the concept of a single window platform has emerged as a strategic solution. One of the tools that can be widely used for enhanced integration, collaboration and comprehensive port management is the Port Community System (PCS).[3] The PCS allows connecting all the entities of the maritime chain via a unique platform utilized for sharing information. [4] Without a doubt, the ports that have adopted PCS have seen their operations become considerably smoother and more efficient, transforming them into world-class ports.

Port Community Systems have become a staple technological platform used to exchange information between the public and private agents and entities involved in ship and cargo services within seaports. [5] PCS benefits not only the port but all the entities that are using the port ranging from ship owners, ship agents, customs, and terminal operators, to even private companies i.e., connects B2B, B2C and B2G services. Additionally, port collaboration's physical, information and financial flows are interdependent, thus causing a lot of coordination challenges for entities involved in the port operation. To address these challenges, port collaboration is commonly supported by a Port Community System (PCS), which is the state of the art in information systems and connects SC actors in port environments using inter-organizational services.[6]

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[3] Keceli, Y., Choi, H. R., Cha, Y. S., & Aydogdu, Y. V. (2008, November). A study on adoption of port community systems according to organization size. In *2008 Third International Conference on Convergence and Hybrid Information Technology* (Vol. 1, pp. 493-501).

[4] Brümmerstedt, K., Beek, M. V., & Münsterberg, T. (2017). Comparative analysis of synchromodality in major European seaports. In Digitalization in Maritime and Sustainable Logistics: City Logistics, Port Logistics and Sustainable Supply Chain Management in the Digital Age. Proceedings of the Hamburg International Conference of Logistics (HICL), Vol. 24 (pp. 59-76). Berlin: epubli GmbH.

[5] Jović, M., Aksentijević, S., Plentaj, B., & Tijan, E. (2021). Port Community System Business Models.

[6] Chandra, D. R., & Hillegersberg, J. V. (2018). Governance of inter-organizational systems: a longitudinal case study of Rotterdam's Port Community System. International journal of information systems and project management, 6(2), 47-68.

Besides, authors [7] claimed that seaports must continuously improve their commercial and administrative operations to stay competitive. Similarly, Pakistani seaports still have a long way to go in adopting new ICT systems and other sustainable technological advancements. Out of Pakistan's three (3) port Authorities, only Karachi Port Trust (KPT) has put some effort to integrate itself with Electronic Data Interchange (EDI), However, Port Qasim & Gwadar Port Authority - have still a long way to go in this direction (USAID's Pakistan Regional Economic Integration Activity, (PREIA 2021). As observed externally, to date PQA is relying on the traditional/old school method of data collection, which not only is unreliable but is time taking and cuts down the efficiency of the port drastically. The port activities are being done in conventional ways with no automation and minimal digitalization. This reliance on conventional means of port operations may become a question of survival in future if the same practices are followed.

Additionally, Pakistan faces immense challenges in transforming its seaports and making use of modern systems for Port automation. There are three (3) port authorities and five (5) container terminals in Pakistan. The progress observed over the last twenty-five (25) years to date is only in terms of bringing Ship-to-Ship (STS) and Rubber-Tyred Gantry (RTG) cranes to container terminals. Just recently, work on Radio-Frequency Identification Devices (RFID), scanners, automated gates, and remote STS/RTG operations have begun but only on private entities and not on Government owned ports (USAID's Pakistan Regional Economic Integration Activity [PREIA], 2021).

Therefore, the research objective of this article is twofold. The first is to highlight the significance of PCS by understanding the role of PCS in facilitating efficient and secure information exchange and collaboration among various stakeholders in a port community at Port Qasim. Secondly, to examine the current state of information exchange

[7] Tijan, E., Jović, M., & Karanikić, P. (2019, July). Economic and ecological aspects of electronic Transportation Management Systems in seaports. In *Proceedings of the Maritime and Port Logistics Bar Conference* (Vol. 132).

and collaboration among the stakeholders and identify all the inefficiencies or bottlenecks, which can be resolved by deploying a Port Community System at Port Qasim. However, the deployment would reduce time and effort and make the operations smoother than ever resulting in increased port competitiveness and more ship calls. Thus, this paper identifies the bottlenecks and outlines the potential benefits of PCS adoption at the PQA.

1.2 Process Assessment

Port Operational processes are mapped by utilizing Business Process Modelling Notation (BPMN) 2.0 by Signavio. The scope of this study covers only 3 operational port processes as-is process (current) and proposed to-be process (future) for the same. However, more may be realized and analyzed for future studies. Processes that have been discussed in this study include Vessel Registration, Ship clearance and nautical services - port dues. The paper also comparatively analyzes the as-is process with the to-be processes to realize the gap between the current and the proposed methods.

1.2.1 Vessel Registration: (Current Process)

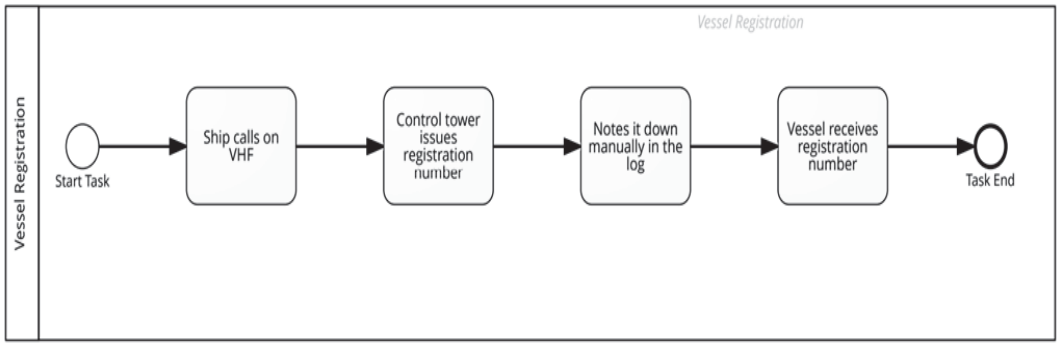

Figure 1- *Current Vessel Registration Process*

The current process of Vessel Registration is a series of processes (Figure 1), which is being followed despite having multiple handing over and taking over. A sequential process could create various bottlenecks such as vessel registration cannot be completed until the control tower issues a registration number and then archive it manually. The process is initiated by the vessel calling on VHF and

establishing contact with the port's control tower, which then issues the vessel a manually generated registration number and records it in the port's logbook. After receiving the registration number, the vessel then must wait for its turn at the anchorage to berth as per the allotted registration number. The process of vessel registration is quite simple, yet it has some drawbacks due to the non-digitalized approach. The delays and distortions in the VHF connectivity, manually written registration numbers (which could lead to undesired errors or confusion) and, manual record keeping instead of database management and cloud computing etc, may halt the process or make it inefficient.

1.2.2 Vessel Registration on PCS: (Proposed Process)

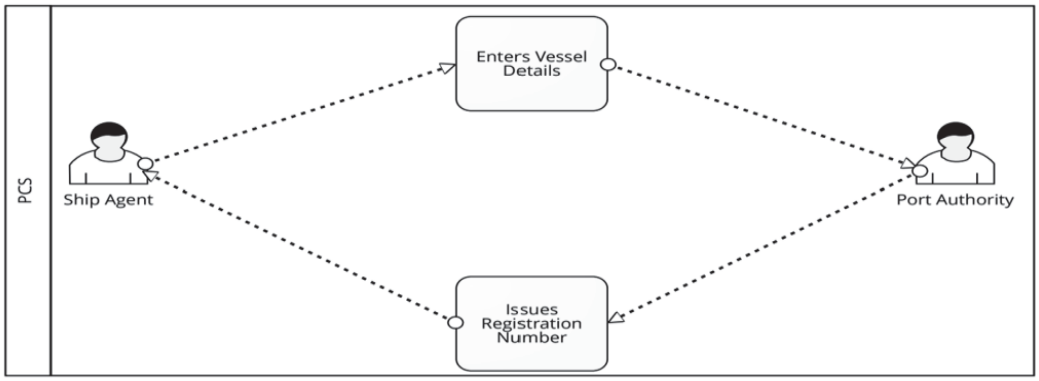

Figure 2- *Proposed Vessel registration Process deployed via PCS - mapped on BPMN 2.0*

As compared to the current vessel registration deployed process, the proposed process (Fig 2) eliminates various bottlenecks and presents a digitalized/automated registration process. Although, a ship agent or ship master must enter vessel details on the portal which is then verified by the port authority and an automatically generated registration is provided to the vessel. This simplified process reduces the lead time of the vessel registration process and may record it in its PCS database for future usage.

1.2.3 Ship Clearance (Current Process)

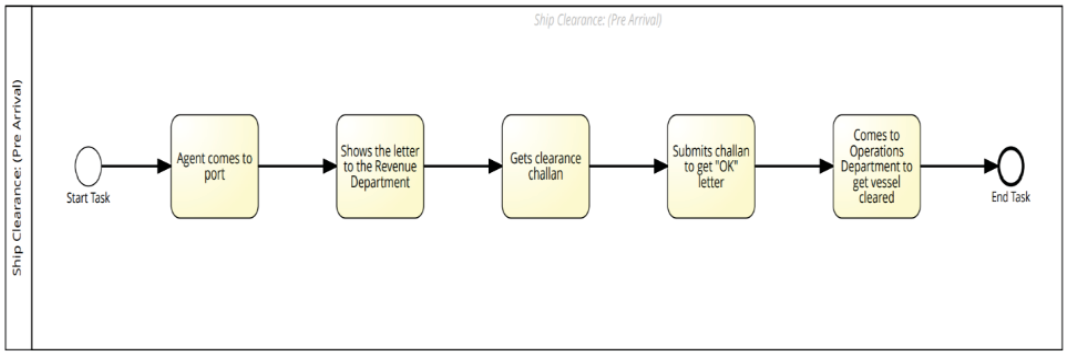

Figure 3- *Ship clearance current process*

Again, being a sequential process, ship clearance involves multiple port departments and personnel. Due to various entity involvements, a process becomes more delicate and becomes more prone to disruption by a small hindrance at any of the echelons triggering a domino effect in the entire procedure. In the case of conventional Ship Clearance process, the shipping agent is required to visit the port to present the letter to the revenue department to receive a clearance voucher. This voucher is paid by the custom clearing agent to the respective banking facility which is then transmitted to concerned department for further issuance of clearance letter (the clearance letter indicates that the vessel is cleared of all pending dues and is allowed to be berthed at the port). The clearance letter is then submitted to the Marine Operations Department to get the vessel cleared.

1.2.4 Ship Clearance (Proposed Process)

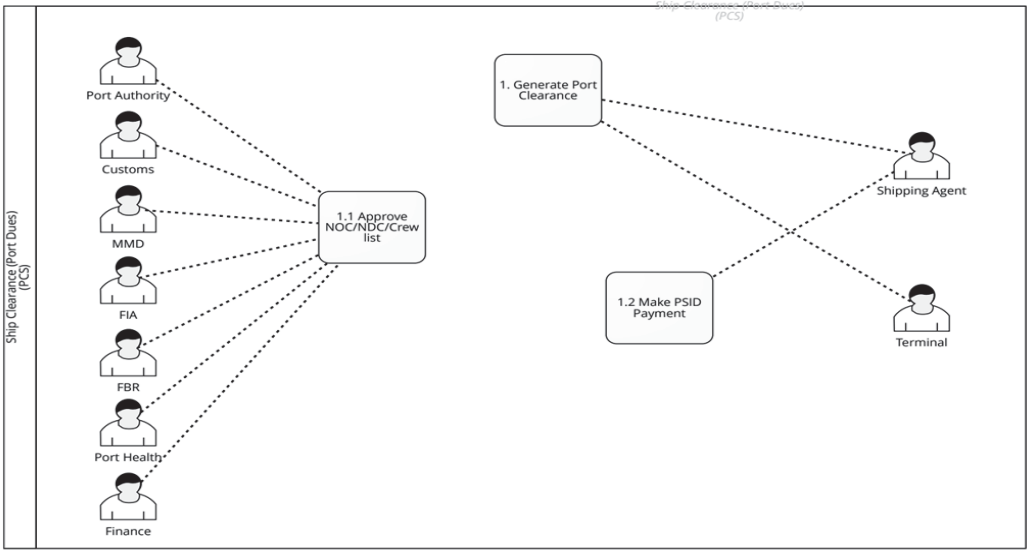

Figure 4- *Proposed ship clearance process deployed via PCS-mapped on BPMN 2.0*

The proposed method (Fig:4) of PCS makes ship clearance much easier as all the concerned departments including the port authority, customs, mercantile marine department (MMD), FIA, FBR, and Finance departments approve the NOC/NDC/Crew list simultaneously in real-time on a platform and can easily be accessed remotely.

1.2.5 Nautical Services (Current Process)

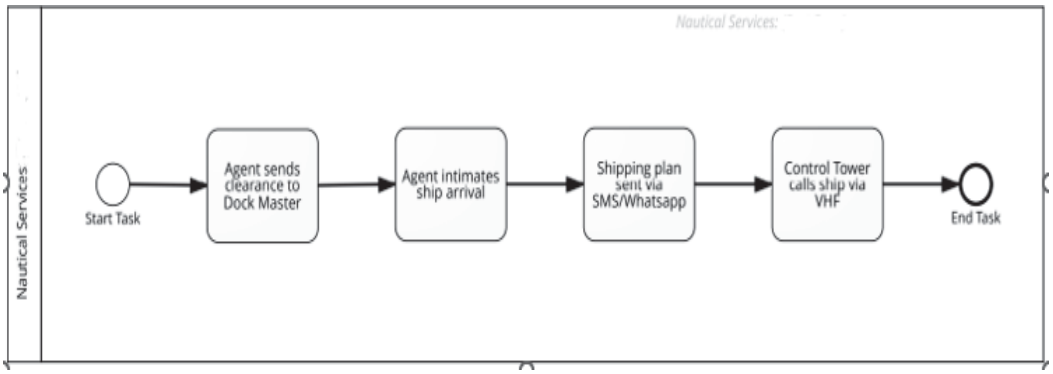

Figure 5- *Nautical Services (Current Process)*

To avail the nautical services at the port after clearing port dues, the agent sends a clearance letter to the Dock Master with the prior intimation of ETA (estimated time of arrival). Dock Master then designs a daily/weekly shipping schedule accordingly and circulates it via SMS, WhatsApp, or any other 3rd party communication application. The ship then waits for its turn to be called by the control tower via VHF for further maneuvering in the navigation channel for birthing.

1.2.6 Nautical Services (Proposed Process)

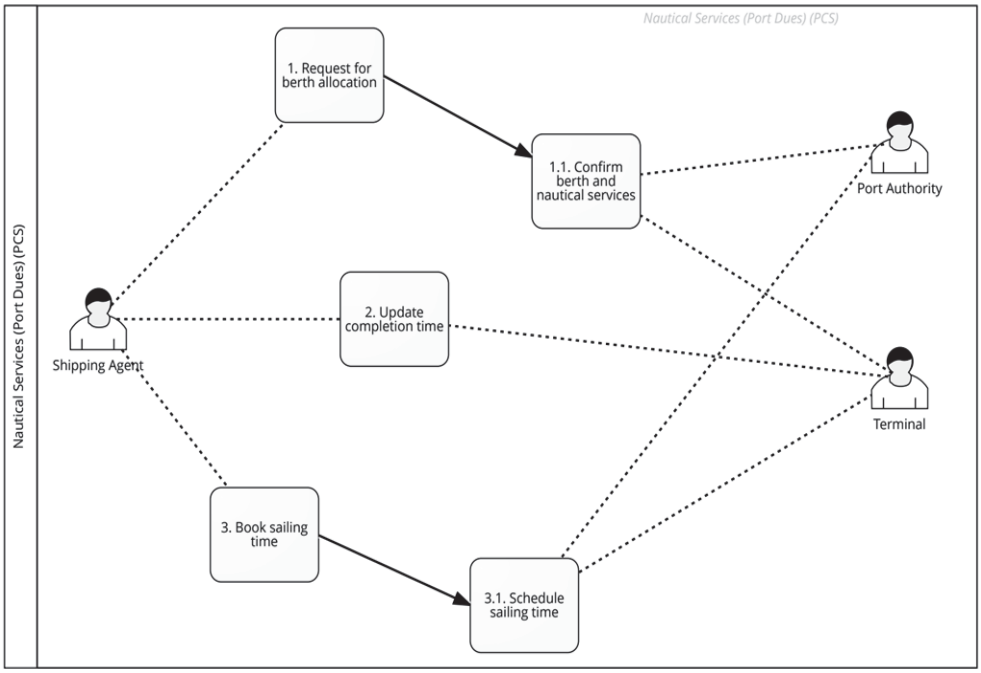

Figure 6- *Nautical services process deployed via PCS-mapped on BPMN 2.0*

Whereas the same process done through a PCS is fast and efficient, on the other hand, it simultaneously eliminates various entities and makes it more simplified. Ship agent requests for berth allocation through the portal and the port authority confirms it by cross-checking all the vouchers (dues) in a digitalized manner. After verification, the port authority accepts the request and inculcates it in the shipping plan and allows the ship for further navigation. In all this process the relevant terminal operator and ship agents are all kept in

the loop as shown in Figure 6 to get real-time information on the shipping plan for further smooth functioning of the operation.

1.2.7 Process Assessment Summarized

From the above illustrated, it is evident that significant resource saving may be achieved by the adaption of PCS as the process lead time is probable to get lower compared to that of the conventional process performed on legacy systems. Additionally, PCS simplifies the existing administrative procedures but also eliminates various bottlenecks from the port processes, by filtering out redundancies and connecting the relevant person to the concerned entity/department only.

The introduction of PCS is a step towards paperless and more efficient seaports, author[8] reported that not only it comes with the commercial benefit of lowered costs, but a greener approach. The implementation improves the flow of information among various entities, reduces communication delays and increases trade security. Furthermore, the deployment of the PCS within the port premises allows more volumes/TEUs to be catered within a specific period which leads towards the enhancement of the port competitiveness[9], resulting in a better corporate image. The use of such platforms has a huge economic/commercial impact, as they help increase the productivity and efficiency of the port.

Moreover, in contrast to the current processes, the proposed processes are not series which actuate various operations simultaneously rather becoming a bottleneck for the proceeding tasks. Thus, making the process faster, more efficient, and smoother. As authors [10] claimed that EDI tools and applications provide a faster and more efficient exchange of information, lower the overall operational

[8] El-Miligy, B. (2013). Enhancing the efficiency of the supply chain documentation flow through the application of an e-business model: a case study of Alexandria Port (Doctoral dissertation, University of Huddersfield).

[9] Abdallah, R., Besancenot, J., Bertelle, C., Duvallet, C., & Gilletta, F. (2023). An Extensive Preliminary Blockchain Survey from a Maritime Perspective. Smart Cities, 6(2), 846-877.

[10] Obara, P. M., Kiplagat, L. J., & Okidi, A. N. (2010). The Benefits and Challenges of Electronic Data Interchange. Implementation and Application at Kilindini Water Front Project in Kenya. African Journal of Business & Managemen, 1, 212-236.

cost, reduce lead time, and improve data sharing among departments and significantly decreases human errors.

2.1 Hypothesis Development

2.1.1 Perceived Impact of Introduction of PCS and Process Efficiency

By introducing the concept of a Port community system within a port, the diverse parties/stakeholders such as port authorities, carriers, and freight forwarders may be brought to one platform for fulfilling the need for standardization, which results in the smooth and transparent flow of information. [11] This eventually results in the improved efficiency of work and output of the port. Furthermore, author [12] stated that Port Community System is a single platform that can be introduced for the purpose of comprehensive port management. Hence it implies the fact that for the purpose of improving the process efficiency at the port; the introduction of PCS plays an essential role in it. Therefore, it may be hypothesized as

H1: Perceived impact of introduction of PCS has significant impact on process efficiency.

2.1.2 The Prerequisite Knowledge Required to operationalize PCS and Process Efficiency

Having prerequisite knowledge about a subject can be advantageous for the better understanding and implementation of it however it doesn't imply the fact that desired results cannot be achieved without having the prerequisite knowledge. Keceli stated that PCS has already been implemented in various ports in Europe, where they have been operated as tailor-made solutions to the ports' complicated processes. This may allow other ports to gain sufficient

[11] Srour, F. J., van Oosterhout, M., van Baalen, P., & Zuidwijk, R. (2008). Port community system implementation: Lessons learned from international scan. In Transportation Research Board 87th Annual Meeting, Washington DC.

[12] Keceli, Y., Choi, H. R., Cha, Y. S., & Aydogdu, Y. V. (2008, November). A study on adoption of port community systems according to organization size. In *2008 Third International Conference on Convergence and Hybrid Information Technology* (Vol. 1, pp. 493-501).

knowledge to successfully deploy PCS at their ports. However, if individuals, organizations, port authorities and other stakeholders linked to the port community systems possess the required level of understanding and skillset to effectively utilize and leverage the capabilities of the PCS, the port operations are more probable to experience positive outcomes. Hence, it may be posited that:

H2: Prerequisite knowledge required to operationalize PCS has a satisfactory impact on the overall process efficiency.

2.1.3 Prerequisite Knowledge Required and the Perceived Impact of Introduction of PCS

In recent years, maritime supply chain and port management have evolved tremendously, backed by the rapid growth and integration of information and communication technologies. Port Community System all over the world are linked with and come under the umbrella of ICTs. authors[13] claims that the evolution and understanding of ICTs has encouraged a more integrated port community. Furthermore, PCS often require integration with existing systems and the ability to interact with various digital platforms used by various stakeholders. These integration protocols and interoperability require sufficient pre-requisite knowledge for deployment as well as for smooth deployment of the PCS at the port. Therefore, it may be hypothesized as:

[13] Caldeirinha, V., Felício, J. A., Salvador, A. S., Nabais, J., & Pinho, T. (2020). The impact of port community systems (PCS) characteristics on performance. Research in Transportation Economics, 80, 100818.

H3: The prerequisite knowledge required has a positive impact on the introduction of PCS.

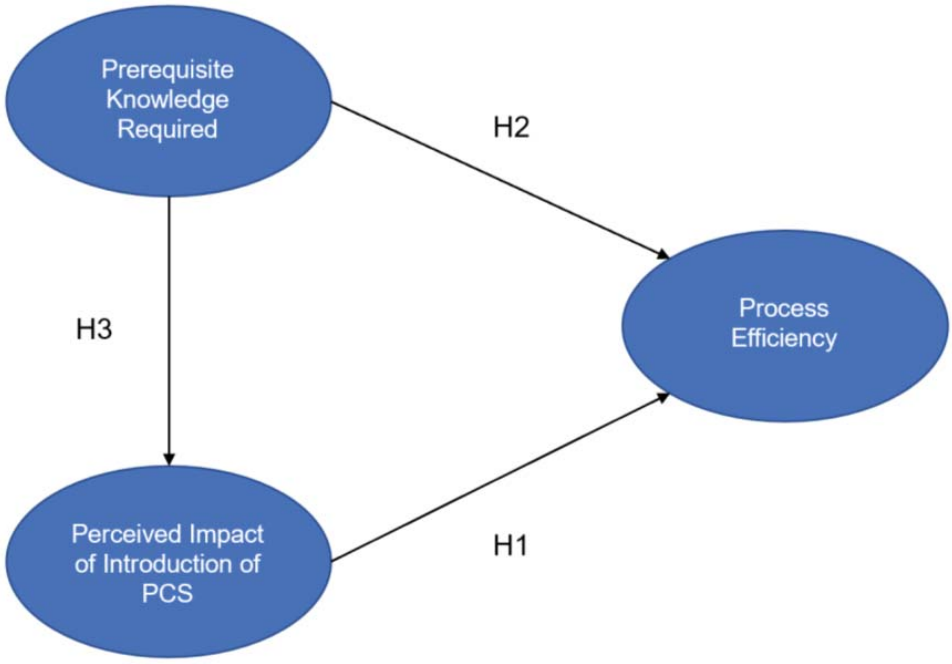

Figure 7- *Conceptual framework depicting the relationship of prerequisite knowledge required, perceived impact of introducing PCS at the port and port process efficiency.*

3. Research Methodology

The purpose of this study is to highlight the importance of the Port Community System (PCS) to strengthen information exchange and collaboration among stakeholders at Port Qasim, and it also seeks to identify gaps that can be resolved through PCS deployment. The gap is realized via process analysis performed on Business Process Modeling and Notation (BPMN 2.0) by Signavio. The current and proposed processes are presented for gap realization.

Furthermore, for correlational based research, data gathering and analysis, a quantitative method is used. An online based Likert-scale questionnaire survey is used to collect data. The questionnaire is intended to analyze stakeholder responses regarding

PCS implementation and potential benefits. The Daniel Sooper calculator is used to establish the sample size of 123 respondents, ensuring enough representation from relevant departments at Port Qasim Authority. The data collected for this study is primarily quantitative, and the analytical approaches used include Partial Least Squares Structural Equation Modelling (PLS-SEM) with Smart PLS software. Moreover, the statistical software SPSS is used to do reliability analysis. These software tool options are well-suited to the study's specific requirements and properly align with its aims.

4.0 Data Analysis

4.1 Demographic Analysis

It is evident from the demographic analysis of the respondents that the majority of the research participants were postgraduates (68.8%), whereas the remaining few of them (31.3%) were graduates. Additionally, 43.8% of the respondents belonged to the age group of 41-50 years, 40.6% were from the age bracket of 31-40 years, and 12.5% were from 51-60 years. Lastly, 28.1% of the respondents were found to have professional experience of more than 20 years, 9.4% had 16-20 years of experience, 34.4% had an experience of 11-15 years, and 28.1% of the respondents had less than 10 years of experience.

Table 1: Respondents' demographic profile

		Count (123)	Table N % (100%)
Age	21-30	0	0
	31-40	50	40.6%
	41-50	54	43.8%
	51-60	19	15.6%
Qualification	Graduate	38	31.3%
	Postgraduate	85	68.8%
	Doctorate	0	0
Professional Experience	1 to 5 Years	15	12.5%
	6 to 10 Years	19	15.6%
	11-15 Years	43	34.4%
	16-20 Years	12	9.4%
	Above 20 years	34	28.1%

4.2 Pilot Testing

Before running a full-scale analysis, pilot testing was performed on 16 responses using IBM SPSS 24.0. The results motivated to perform further analysis because the values calculated met the required benchmark and the attained values lied between 0.7-0.9.

Table 2: Reliability Analysis

Variables	No. of Items	Cronbach`s Alpha
Prerequisite Knowledge Required	4	0.725
Perceived Impact of PCS Introduction	4	0.729
Efficiency	4	0.849

Table 3: Cronbach's Alpha value of all the variables collectively

Cronbach`s Alpha	No. of Items
0.901	12

4.3 The Measurement/ Outer Model

4.3.1 Factor Loadings

The association between the variable and its accompanying indicators is determined by factor loadings or outer loadings. The factor loadings should have a minimum value of 0.70. The values of outer loadings for all items in this study are larger than 0.7, indicating a correlation between the indicators and the constructs.

Table 4: Factor loading

	PE	PIIP	PKR
PE1	0.806		
PE2	0.862		
PE3	0.803		
PE4	0.834		
PIIP3		0.794	
PIIP4		0.823	
PIIP5		0.852	
PKR1			0.754
PKR2			0.713
PKR3			0.787
PKR4			0.699

4.3.2 Internal Consistency Reliability

It measures the relationship between the indicators of similar constructs. Authors [14]stated that composite reliability (rhoc) is one of the primary measures to evaluate internal consistency, whose value must exceed the minimum threshold of 0.70. Moreover, Cronbach's alpha is used as an alternative measure, which follows the same threshold as that of composite reliability. [15] Table 4.4 shows the values of both the measures of internal consistency reliability, and it is

[14] Bagozzi, Richard P., and Youjae Yi. "Specification, evaluation, and interpretation of structural equation models." Journal of the academy of marketing science 40 (2012): 8-34.

[15] Hair Jr, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2021). A primer on partial least squares structural equation modeling (PLS-SEM). Sage publications.

evident that the model meets the required benchmark of indicators' reliability.

Table 5: Internal Consistency Reliability

Variables	Cronbach Alpha	Composite Reliability
Perceived Impact of PCS Introduction	0.765	0.863
Pre-req Knowledge Required	0.725	0.828
Process Efficiency	0.849	0.882

4.3.3 Convergent & Discriminant Validity

There were two types of validities assessed: convergent and discriminant validity. Convergent validity discusses the convergence of the construct that indicates the variance of the indicators. It is quantified using the AVE value (Average Variance Extracted), which must be at least equal to or greater than 0.5 indicating that the construct explains 50% of the indicators' variance (Hair et al., 2021). Table 4.5 shows the AVE values, indicating that the proposed model meets the prerequisite and has acceptable convergent validity.

Table 6: Convergent Validity evaluated via Average Variance Extracted

Constructs	Average variance extracted (AVE)
Perceived Impact of Introduction of PCS	0.678
Pre-req Knowledge Required	0.546
Process Efficiency	0.683

Discriminant validity shows the measures of construct that theoretically should not be highly corelated to each other. To assess discriminant validity of the structural model, Fornell and Larcker's criteria and the Heterotrait-Monotrait (HTMT) ratio are evaluated. The Fornell and Larcker criterion employs that the values of the AVE

square roots of variables should be greater in comparable pairings than in different ones.[16] Furthermore, HTMT criteria require the values of distinct pairs to be less than 0.85.[17] Tables 7 and 8 present the findings for the current model, which show that both requirements are met adequately, manifesting the existence of discriminant validity.

Table 7: Discriminant Validity (Fornell-Lacker Criterion of Constructs) *

	PIIP	PKR	PE
PIIP	0.824		
PKR	0.380	0.739	
PE	0.405	0.226	0.826

Table 8: Discriminant Validity (Heterotrait–Monotrait (HTMT) Ratio) *

	PIIP	PKR	PE
PIIP			
PKR	0.496		
PE	0.472	0.278	

***Note:** PIIP=Perceived Impact of PCS Introduction, PKR= Pre-req Knowledge Required, & PE=Process Efficiency.

4.4 The Structural or Inner Model and Path Analysis

The path analysis results show the relationship between the factors that influence one another at a given level of significance. This significance level is chosen at 5% in the current study, and the analysis is performed with bootstrapping iterations of 5000. The Table 9 exhibits the relationship between the independent and dependent

[16] Chin, Wynne W. "The partial least squares approach to structural equation modeling." Modern methods for business research 295, no. 2 (1998): 295-336.

[17] Henseler, Jörg, Christian M. Ringle et Marko Sarstedt. « A new criterion for assessing discriminant validity in variance-based structural equation modeling ». Journal of the Academy of Marketing Science 43, no 1 (2014), 115-35. doi:10.1007/s11747-014-0403-8.

variable where PIIP on PE ($p<0.05$, $\beta=0.373$) and PKR on PIIP is found to positive and significant ($p<0.05$, $\beta=0.380$) whereas the impact of PKR on PE is positive but found to have insignificantly linked up with each other ($p>0.05$, $\beta=0.085$).

Table-9: Hypotheses Testing*

Path	Coefficient	P-Values	Result
PIIP → PE	0.373	0.000	Supported
PKR → PE	0.085	0.418	Not Supported
PKR → PIIE	0.380	0.000	Supported

***Note:** PIIP=Perceived Impact of PCS Introduction, PKR= Pre-req Knowledge Required, & PE=Process Efficiency

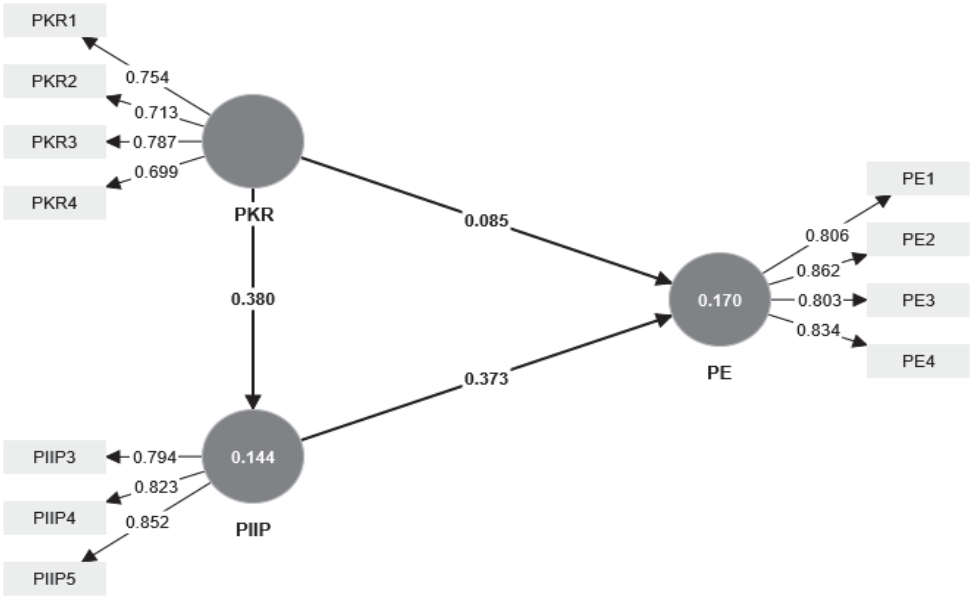

Figure 3: ***PLS-SEM model after bootstrapping***

5.1 Conclusion

The maritime sector is heavily relying on ICTs and digitalization due to which improvisation at offshore as well as onshore sides is a compulsion. To remain competitive in the entire port cluster, ports are utilizing technological advancement to attract more TEUs and thus more shipping lines. This study emphasizes the

significance of PCS deployment at PQA for the optimized operability of the port and its terminals. With improved processes, the PQA will experience smarter and more efficient port operations resulting in more market share and thus profitability.

The results of the study demonstrate that the success probability of PCS implementation at PQA is considerably high. As the respondents were quite sure about the fact that the introduction of the PCS at PQA would lead to efficient and transparent port operations. However, it was notified that a sufficient level of IT knowledge and skills are required for the successful implementation, operationalization and thus utilization of the PCS at the port. However, the PKR is insignificantly related to PE as the usability of the PCS can be acquired via training session and would not affect the process efficiency at all as the process has already been mapped during implementation phase. Furthermore, the study also includes revamping of 03 key processes: Vessel Registration, Ship Clearance & Nautical Services (port dues) which also accentuates that the entire value chain visibility would be enhanced making processes smarter, reducing delays, and promoting overall efficiency by eliminating the bottlenecks and redundancies. Moreover, the port may get value-added benefits from PCS as it also allows cargo tracking and tracing capabilities, enhanced vessel traffic management, improved chain wide logistical coordination, e-payment and invoicing methods.

In consideration of the current practices at PQA, the port is still using traditional methods that need to be transformed into a single window operation. The transformational changes would require ample time for its full-scale deployment, but they will bring tremendous benefit to the stakeholders of the port value chain. Nevertheless, the entire maritime industry is transforming and becoming more and more smarter i.e., the ships are getting smart which in turn demands the ports to modify the conventional port processes to technologically enabled port operations. The future demand for smart shipping will cause the PQA to lose the entire smart ship volume subjected to no advancement or innovation adoption by the port authority. The zero or minimal adoption will raise the question for survival of Port Qasim as this will induce operational inefficiencies, reduced transparency and

ultimately hinder the port's ability to fully capitalize on its trade potential. Therefore, the deployment of a Port Community System at Port Qasim, Karachi is crucial for the future growth and success of the port. By taking this initiative, the port can attract more shipping lines and create opportunities for increased business. It is essential to act swiftly to ensure that Port Qasim remains competitive and appealing to the shipping industry. With the implementation of a Port Community System, Port Qasim can streamline its operations, improve efficiency, and ultimately enhance its position as a key player in the region's maritime trade.

5.2 Recommendations

The paper has provided valuable insights into the potential benefit of the deployment of PCS at PQA. It is highly recommended to the PQA take considerable measures regarding the PCS deployment at the port. Based on the finding and the current status of the port operation, the following recommendation is put forth to guide the successful implementation of the PCS at PQA and to ensure its optimal impact on port processes.

- To better compete global market, the port suggested building the reliability of the PCS regardless of the cost incurred as the enhanced security and better networking compatibilities must be fully addressed for successful deployment and operability of the port. Moreover, privacy measures such as encryption implementations, access controls, and authentication protocols, must be taken into consideration to safeguard sensitive information.

- Comprehensive stakeholder engagement is recommended to connect all of the entities on a single platform including government agencies, terminal operators, shipping lines, freight forwarders, customs officials, and trucking companies. Therefore, a shared understanding of PCS objectives will be essential in securing their participation and commitment.

- A comprehensive need assessment and development of a user requirement document covering the entire end-to-end chain of

the port logistics is suggested. Moreover, customized PCS deployment is also recommended in consideration of the unique characteristics and challenges of the PQA.

- Establishing a system for ongoing performance monitoring and continuous improvement of the PCS is recommended. Additionally, to identify areas for optimization and improvement via collecting regular feedback from port users and stakeholders.

- The module for continuous vessel monitoring solutions could be proposed to be integrated with PCS to monitor the daily vessel activities at the port and its premises.

- The PCS may be integrated with ERPs of the industries i.e., major stakeholders of the port, inter and intra port connectivity via EDI (Electronic Data Interchange) and cloud-based computing may be utilized for enhanced communication and collaboration between various ports in the cluster.

- PCS may be equipped with advanced analytics and reporting capabilities that enable port authorities to identify potential risks and take proactive measures to mitigate them. This can improve the overall safety and security of the port.

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Appendix-I

S.No	Perceived Impact of Introduction of PCS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	The introduction of PCS would make our work easier than before at Port Qasim.					
2	I believe that the use of the PCS would improve the integration between port users and the hinterland at Port Qasim.					
3	I believe that with the implementation of PCS there would be transparency in the system.					
4	The introduction of PCS would bring about the right/competent people for the right job.					

	Prerequisite Knowledge Required	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
5	My knowledge of IT systems is in line with port activities.					
6	I am well aware of the functionalities of the Port Community System.					
7	I have had a similar platform usage experience in the past.					
8	I possess the right/appropriate level of skill/qualification required to operationalize the PCS.					
9	The use of PCS would accelerate access to data and information flow between integrated transport actors in the premises of Port Qasim?					

10	The PCS would enable the simplification of administrative procedures at Port Qasim?					
11	The use of the PCS would reduce cargo handling/turna round time at Port Qasim?					
12	The implementatio n of the PCS would considerably improve the competitivenes s of port user companies and its stakeholders at Port Qasim?					

Appendix-II