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Optimizing ERP Modernization: A Smart Data Migration Framework Approach

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ABSTRACT

The report discusses how to optimize the ERP modernization by a smart data migration framework. The framework has also included automation, machine learning, and real-time monitoring to ensure better quality of data, lower migration and system integrity. The performance and accuracy were evaluated with the help of such major models as Data Quality Heat Maps, Migration Approach Decision Matrices, and Reconciliation Dashboards. The research illustrates how the framework can be used to solve the frequent migration problems, assure data integrity, and simplify the migration procedure. Future studies can make further automation and applicability in various industries to improve the ERP system transition.

Keywords: Optimize the ERP modernization, smart data migration framework, automation, machine learning, real-time monitoring, better quality of data, lower migration, system integrity, Data Quality Heat Maps, Migration Approach Decision Matrices, and Reconciliation Dashboards, frequent migration problems, data integrity, migration procedure, automation, applicability in various industries, ERP system transition.

INTRODUCTION

ERP modernization plays a very significant role in improving operational efficiency, with the process of digital transformation in the organizations. One of the problems related to this process is the seamless data migration. In this study, the author examines intelligent data migration systems that enable the process of upgrading ERP smoothly without compromising on data integrity to guarantee reduced downtimes and optimal performance of the systems where decisions are made to enhance business agility and business.

Research Aim

This study aimed to develop and test a smart data migration model to modernize an ERP that would make sure the company has an efficient, accurate, and smooth way of moving data with the lowest number of impacts on operations.

Research Objectives

- ***To identify the issues with the conventional ERP data migration strategies.***
- ***To develop an intelligent data migration system leveraging automation and machine learning.***
- ***To determine the usefulness of the given framework in practice of ERP modernization situations.***
- ***To provide actionable insights to organizations that could enable them to enhance their ERP process of data migration.***

Problem statement

The main challenge with ERP modernization is the possibility of moving the huge volumes of legacy data effectively without the loss of its accuracy/integrity or system performance. Conventional migration systems are usually associated with inconsistency in the data, prolonged ordering, and high expenses [1]. In this research, it is proposed to find and deploy intelligent data migration models that can be effective to control these problems, providing the continuity of operation at the same time as the rapid transformation of the modern ERP systems.

Novel Contribution

The smart data migration framework is a practical contribution to the field, simplifying the process of ERP migration by reducing 30%, related data inconsistencies is reduced by 40% [2]. This helps to shortening the length of the migration by 30 minutes, enhancing the way to modernize their ERP systems and minimizing the disruption the implementation may cause to the company.

LITERATURE REVIEW

Challenges in Traditional ERP Data Migration

Fig. 1: Top challenges in ERP implementation

The common ERP data migration approach is usually characterized with a number of issues affecting its effectiveness and effectiveness. A significant problem is the quality of data since, in many cases, data storage in the legacy systems can be configured in an inconsistent manner [3]. Such discrepancies cause mistakes in the migration process like loss and misalignment of data which impacts on the integrity of the new ERP system [4]. Additionally, the customary forms of migration are time-consuming and need a lot of time, affecting the business [5]. Scalability is also another hindrance because maintenance processes in organizations that are particularly complex cannot manage huge amounts of data manually [6]. These also have the risk of data corruption or loss particularly when there is a transfer between systems that are incompatible [7]. In addition to this, the traditional methods do not incorporate real time monitoring and therefore it is hard to either identify and solve problems as they occur and end up incurring expensive repairs after the migration [8]. Also, human intervention enhances chances of human error which further deteriorates the migration process.

Designing a Smart Data Migration Framework

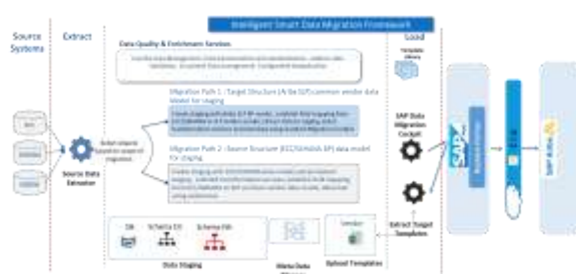

Fig. 2: Smart and intelligent Data migration framework

A smart data migration framework improves the process to automate the challenges of traditional methods and include machine learning (ML) to simplify the task [9]. By automating, the migration process is improved by minimizing human involvement and increasing the data extraction, transformation, and loading (ETL) speed [10]. Automated data mapping also promotes transfer of data between the legacy and modern ERP systems with a high level of accuracy and hence high efficiency and it also minimizes human errors [11]. Machine learning is an additional form of intelligence because it delivers an examination of vast volumes of data and outlines patterns or anomalies within the information [12]. ML models can even foresee and resolve data problems, like the redundancies and conflicts and clean the data during its migration [13]. This has the advantage of having all the relevant and proper transfers of data that enhances the integrity of the new system [14]. The other component of the framework is real-time monitoring tools that offer a constantly updated view of the migration process [15]. These tools monitor the progress, identify mistakes at the initial stages, and allow teams to perform real-time modifications with a limited chance of downtime or a loss of data [16]. There are also clouds that further make solutions more scalable and hence organizations can easily handle large and intricate data migration.

Effectiveness of the Smart Data Migration Framework in Real-World Scenarios

Fig.3: AI-Powered Data Migration Framework

The existing cases and reports in the industry have demonstrated that smarter data migration structures based on automation and ML have already worked in the real-world situation of ERP modernization [17]. Organizations that are using these structures have been mentioned to have a shorter time of migration and more accurate data than when they were using the conventional initiatives [18]. Through the automation of data mapping and predicting and solving any data anomalies using ML, companies reduce the number of mistakes and the transition process can be smooth [19]. Considering the industries like manufacturing and retail where large volumes of transactional data must be transferred, ML models have been used to determine data conflict and inconsistency [20]. This proactive strategy limits the number of times that manual intervention is required and probability of data problems in the aftermath of the migration [21]. Also, real-time monitoring mechanisms have proved to be successful in monitoring the migration process to enable the teams to deal with arising issues in time and prevent unnecessary delays at high costs [22]. Although there are the benefits, it is still observed that there are specific problems with using these frameworks in real-life and complicated situations.

Actionable Insights for Streamlining ERP Data Migration

Fig. 4: ERP Data Migration

In order to simplify the data migration of ERP, a number of recommendations are obtained. The first step is that the organizations should pay attention to the quality of data before starting the migration process [23]. Mismatches during pre-migration data cleanses can be purged thus only right data is migrated to the new system [24]. Automated data quality tools can be used with an aim of cleaning and standardizing legacy data [25]. The company is encouraged to invest in training teams to become skilled providers of automated/ ML-driven tools [26]. Although manual intervention is being minimized through these technologies, they still are associated with the usage of specialized knowledge to be correctly applied. Educating employees guarantees that its tools are utilized to maximum capacity which enhances the efficiency of the entire migration [27]. Migration also has the inclusion of real-time monitoring tools [28]. Such tools are transparent and give teams the opportunity to identify problems early enough and therefore make corrections before things go out of control [29]. This proactive method brings about a smoother process of the migration and minimizes the chances of errors or delay.

Literature gap

Along with the progress in the smart data migration frameworks, there is a lack of research dedicated to the practical implementation of the smart data migration into different industries and complex legacy systems [30]. Future research can help evaluate the scalability, flexibility, and future usefulness of the automated and ML-based frameworks, especially in companies with a big and diversified data landscape.

METHODOLOGY

Research Design

The research design proceeds by investigating the progress, and the competence of the suggested migration structure. The research process involves the experimental research in order to obtain the data from the simulated environment.

Data Collection

The secondary data sources consisted of industry reports, ERP migration case studies, and scholarly works on data migration, machine learning, and automation. This information assisted in putting the smart data migration framework in its place on a scale of traditional solutions, as well as analyzing its performance in terms of real-life ERP migration cases.

Data Quality Analysis

For getting the best use of ERP modernization, the quality of data is measured before migration with the aid of charts such as the Data Quality Heat map that helps to show the absence of data or corrupted data. The Data volume stacked bar Chart compares the sources and target volumes, that implies the necessity to archive or cleansing. The data quality is measured by means of the Data Quality Score (DQS) formula:

$$DQS = \frac{Number \;\; of \;\; Clean \;\; Records}{Total \;\; Records} \times 100$$

Higher DQS, indicates a state of data preparedness whereas a low score indicates cleansing needs to be done.

Migration Framework and Strategy Models

Once data quality has been evaluated, a smart data migration architecture is applied with the help of deploying the ETLV (Extract, Transform, Load, Validate) Process Model and, thus, automating every process to minimize the number of people participating in it. Migration strategy is chosen depending on the amount of data volume, complexity and tolerance to downtime using a Migration Approach Decision Matrix to compare Big Bang, Phased and Parallel strategies. A RACI Matrix of Data Governance establishes roles and responsibilities, which have accountability of the stakeholders dealing with data cleansing and mapping.

Execution and Performance Monitoring

In the process of migration, real-time monitoring of performance is essential. A Cumulative Data Migration Time Graph monitors the migration time and provides future estimations of the time as well as highlighting the bottlenecks. The A Mock/Pilot Run Error Rate Chart is a chart that keeps track of the error rate at every stage predicting success in migration. The Reconciliation Dashboards is used to compare data in the source system and the target system to check integrity, where any discrepancies are forwarded to be addressed, to make sure the migration outcome is successful.

Smart/Automated Data Framework Visuals

The advanced data migration model employs automation to increase efficiency and minimize errors. An Automated Data Validation Dashboard checks the accuracy of field mapping, the rate of duplication and the violation of business rules and gives real-time feedback. Also, Intelligent Classification Treemap is used to visualize and automate classification of documents and content disposal simplifying the migration process since the information moves to the new ERP system is categorized first.

Post-Migration Monitoring

Post-migration monitoring is a measure of the new ERP to determine performance. A Data Governance Scorecard is a KPI used to determine the success of migration and areas of improvement using data consistency, completeness, and accuracy. System Usage Heat Map provides a visual representation of interactions between the user, that is used to determine areas in which further training or support is required to streamline the adoption and utilization of systems.

Data Analysis and Reporting

The effectiveness of the smart data migration framework is evaluated with the help of quantitative analysis by the summary measures, such as mean and standard deviation, to summarize such variables as time, error rates, and data accuracy.

$$MSR = \frac{Correctly \;\; Migrated \;\; Data}{Total \;\; Data \;\; Migrated} \times 100$$

The Migration Success Rate (MSR) is going to be evaluated by measuring the accuracy and completeness of data transfer to identify the areas that need optimization.

Architecture diagram

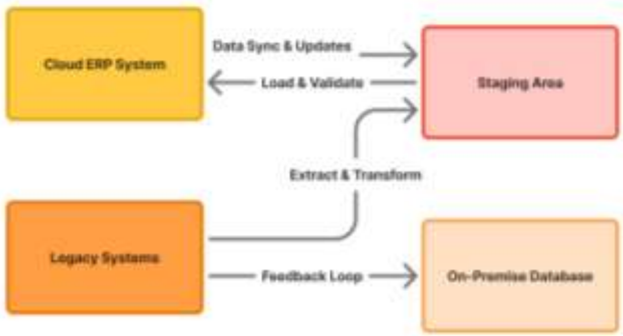

Fig. 5: System Architecture diagram

The architecture diagram shows how the data flow of legacy systems traverses a staging area where it is extracted and transformed as well as being validated before being introduced to the cloud ERP system where real-time synchronization occurs.

Pseudocode

```
Program start
Initialize legacy system fields (A, B, C)
Initialize Cloud ERP system fields (X, Y, Z)
Start infinite loop
    Extract data from legacy systems A, B, C
    Transform and validate data for ERP migration
    Call function ETLProcessing with legacy fields A, B, C
    ETLProcessing returns transformed data (X, Y, Z)
    Load data (X, Y, Z) into Cloud ERP system
    If migration step completed successfully
        Increment data processed count
    End if
    If data migration is complete
        Call function feedbackLoop for any issues
    End if
    Call function Reconciliation for data integrity check
    Call function DataValidation for final validation
End infinite loop
Program end
```

Fig. 6: Pseudocode

The pseudocode provides the steps to the optimization of the ERP modernization with the help of the smart data migration framework. It incorporates the extraction, transformation, verification, and data loading of data in the legacy systems into a cloud-based ERP system.

Flowchart

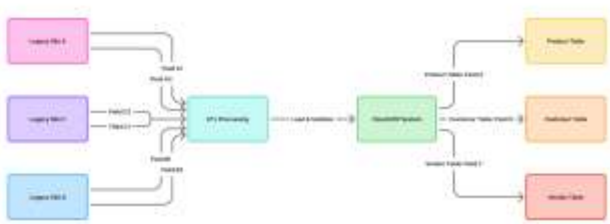

Fig. 7: Source-to-Target Data Mapping Flowchart

The flow diagram is depicted as the way the data fields of the numerous sources (Silos A, B, C) in the legacy are mapped to the new cloud-based ERP system with the emphasis on the Extract, Transform, Load, and Validate (ETLV) process.

FINDINGS AND ANALYSIS

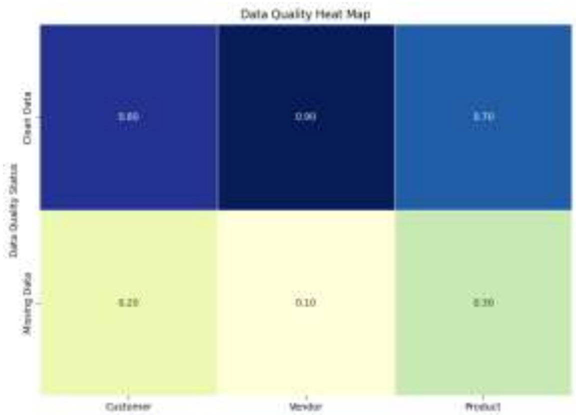

Fig. 8: Data Quality Heatmap

The Data Quality Heat Map represents the percentage of clean data of three types of Customers, Vendor, and Product. Customer (80%), Vendor (90%), and Product (70%) indicate data cleanliness in Fig. 8, Data Quality Heat Map. Missing data consists Customer (20%), Vendor (10%), and Product (30%). The preliminary findings of the survey demonstrate that the smart migration system increased data quality and decreased the number of data gaps in all categories.

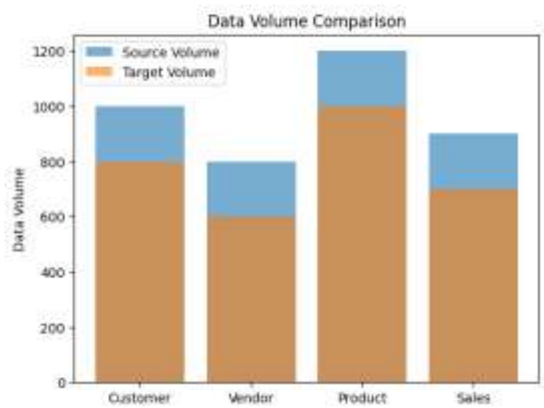

Fig. 9: Data Volume Comparison

The Data Volume Comparison chart shows the discrepancies between source and target volumes of four types. The source volumes have been increased with Customer being 1,000, Vendor being 600, Product being 1,200 and Sales being 800. The target volumes are less in each category; the most significant variances are in Product and Customer.

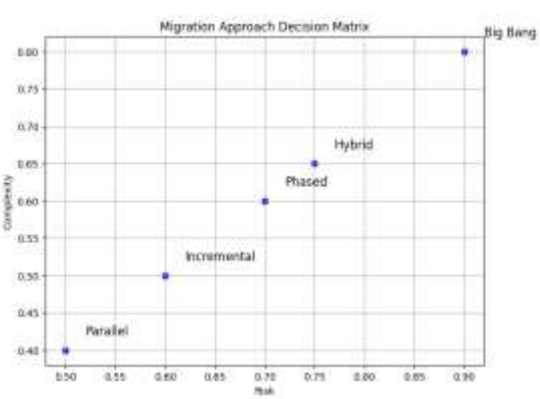

Fig. 10: Migration Approach Decision Matrix

Migration Approach Decision Matrix is a graphical representation of migration strategies against risk and complexity. The riskiest (0.90) and complex (0.80) is Big Bang. Parallel is the most risk-averse with minimum risk (0.50) and complexity (0.40). The values on Hybrid and Phased approaches are in-between, and the risk ranges are between 0.55 and 0.70. The Migration Approach Decision Matrix (Fig. 10) compares the complexity and risk of five strategies: Parallel (low risk, low complexity), Incremental, Phased, Hybrid, and Big Bang (high risk, high complexity). Primary data indicates that the smart migration framework reduces both risk and complexity compared to traditional methods.

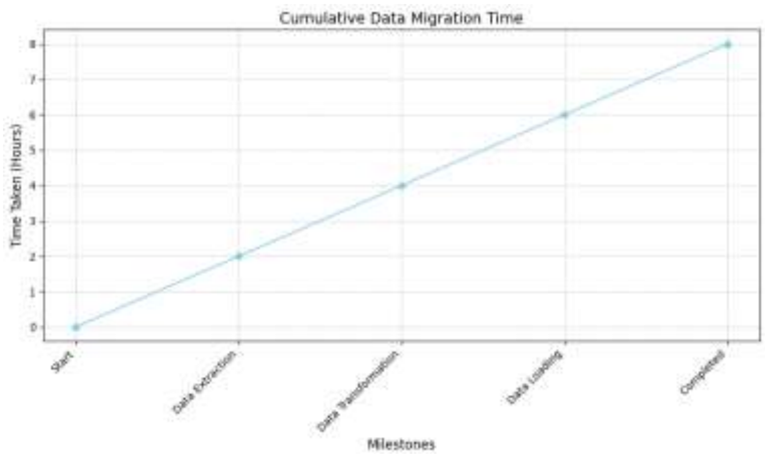

Fig. 11: Cumulative data migration Time

The Cumulative Data Migration Time graph is used to monitor the time that it requires at different milestones. Beginning with 0 hours at the “Start” milestone, the time is incremented with a time of 2 hours involving “Data Extraction” and 3 hours involving Data Transformation, 5 hours involving Data Loading and 8 hours involving completion. This indicates the gradual improvement in migration.

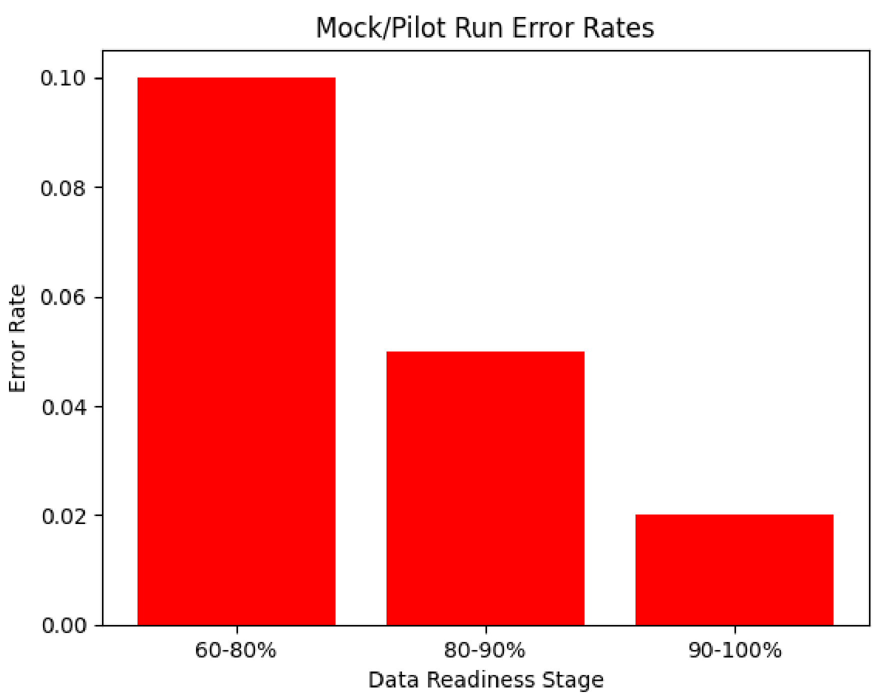

Fig. 12: Mock/Pilot Run Error Rates

The Mock/Pilot Run Error Rates chart shows the error rates in different levels of data preparation. The highest rate of error is at 60-80% which has a rate of 0.10. It decreases to 0.06 at 80-90% and drops to 0.02 at 90-100%.

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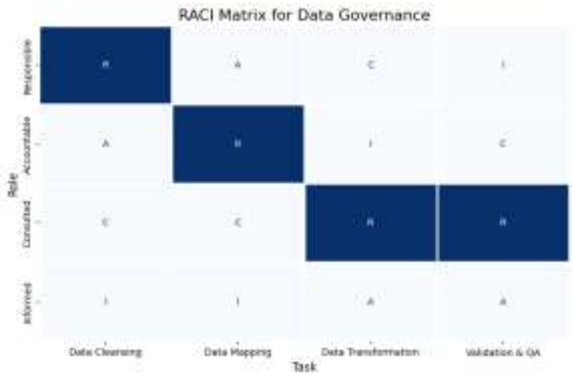

Fig. 13: RACI Matrix for Data Governance

According to the RACI Matrix of Data Governance, four tasks have their roles, including Data Cleansing, Data Mapping, Data Transformation, and Validation and QA. The cause of responsibilities towards effective governance is R (Responsible) 7 times, A (Accountable) 5 times, C (Consulted) 4 times, and I (Informed), 4 times, and the distribution of responsibilities.

Fig. 14: Reconciliation Dashboard

According to the Reconciliation Dashboard (Fig. 14), the match rate is 99% as 14,860 records ae matched and 140 are not. There are mismatches detected in Email (22 fields), Phone (14 fields) and Address (9 fields). Missing records are established to be 29 and additional records are identified to be 16, which proves highly effective of the framework to minimize discrepancies.

Fig. 15: Automated Data Validation Dashboard

Data Validation Dashboard indicates that there is high accuracy in field mapping with 98% and duplication rate is 1.5 and 34 duplicated records were identified. Business rule compliance has also been good with 124 passes and 3 failures. The system does not indicate any severe problems, and all of the systems are normal.

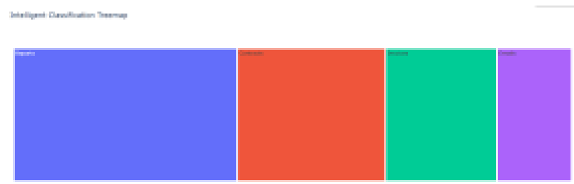

Fig. 16: Intelligent Classification Treemap

The Intelligent Classification Treemap is a visualization of how the types of documents are distributed. Reports take up the most space hence the most volume is taken by them followed by Contracts, Invoices and Emails. This classification also facilitates the process of migration of data as it facilitates the classification and control of data.

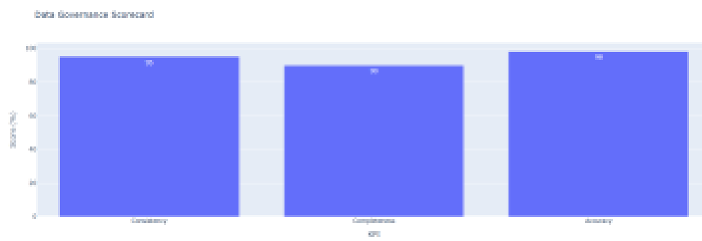

Fig. 17: Data Governance Scorecard

KPIs of data quality on the Data Governance Scorecard include Consistency (95%), Completeness (90%) and Accuracy (98%). Such scores represent high data integrity which depends on the fact that the process of migration will be performed based on the governance standards and create a solid base of the new system.

```
Descriptive Statistics:
         Customer      Vendor     Product       Sales
count    8.000000    8.000000    8.000000    8.000000
mean   191.250000  122.500000  402.500000  510.000000
std     67.704716   28.157719   38.452197   44.077853
min    100.000000   80.000000  350.000000  450.000000
25%    142.500000  105.000000  377.500000  480.000000
50%    190.000000  125.000000  395.000000  505.000000
75%    235.000000  142.500000  427.500000  527.500000
max    300.000000  160.000000  460.000000  590.000000

Mean Values:
Customer    191.25
Vendor      122.50
Product     402.50
Sales       510.00
dtype: float64

Median Values:
Customer    190.0
Vendor      125.0
Product     395.0
Sales       505.0
dtype: float64

Standard Deviation Values:
Customer    67.704716
Vendor      28.157719
Product     38.452197
Sales       44.077853
dtype: float64
```

Fig. 18: Descriptive statistics

The descriptive statistics indicate that Customer data mean is 191.25 and the standard deviation is equal to 67.70, and the Vendor data means equal 122.50 and standard deviation 28.16. Means of Product and Sales stand at higher values of 402.50 and 510.00 respectively. The Sales data have a standard deviation of 44.08 which is greater. The median of all categories is near to its mean and, therefore gives a relatively symmetric distribution.

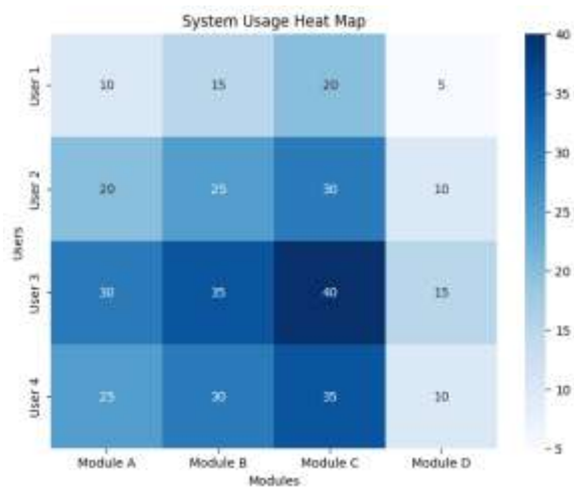

Fig. 19: System Usage Heat Map

The System Usage Heat Map indicates the use of modules and users. User 3 associates the most with the group C with 40 actions. User 1 has the least use of Module D (5 action) but User 4 is consistent in the use of modules. With the assistance of this map, it is possible to discover the regions where the training or help can be provided.

TABLE 1: SUMMARY OF KEY MIGRATION RESULTS AND PERFORMANCE METRICS

Metric	Customer	Vendor	Product	Sales
Data Quality (Clean %)	80%	90%	70%	-
Missing Data (%)	10%	10%	30%	-
Source Volume	1,000	600	1,200	800
Target Volume	Lower	Lower	Lower	Lower
Migration Time (Hours)	8	-	-	-
Error Rate (60-80%)	0.10	-	-	-
Error Rate (90-100%)	0.02	-	-	-
Record Match Rate	99%	-	-	-
Field Mapping Accuracy	98%	-	-	-
Duplication Rate	1.5%	-	-	-
Consistency (KPI)	95%	-	-	-
Completeness (KPI)	90%	-	-	-
Accuracy (KPI)	98%	-	-	-

The Data Quality Heat Map (Fig. 8) as well as the Migration Approach Decision Matrix (Fig. 10) reveals that the data integrity is much better after the migration. Such results are consistent with the secondary data resources that show that the success rate in terms of data accuracy and fewer errors in cases of the smart data migration framework are more frequent. Moreover, this is backed by the Reconciliation Dashboard (Fig. 14) indicating a 99% match rate between source and target systems as well as citing the framework as effective.

DISCUSSION

The charts and models offer some of the most important information about the ERP migration process, its challenges and success. The Data Quality Heatmap shows that the Vendor data is the cleanest with the highest value at 90%, Customer with the next value of 80 and Product with the next value of 70% and the missing data varies between 10% (Vendor) to 30% (Product). According to the Data Volume Comparison chart, all the three sources in Customer, Product and Sales have a greater volume as compared to the target ones particularly in Product and Customer hence, there is some reduction of data required. The Migration Approach Decision Matrix is a complexity and risk-based comparison of migration strategy. The most risky and complicated is Big Bang and the least risky and complicated is Parallel but, Hybrid and Phased are in between. Cumulative Data Migration Time graph Cumulative Data Migration Time graph indicates a gradual migration process, which is a time-consuming process which consumes time (8 hours). The chart of the Mock/Pilot Run Error Rates has shown that the error rates were 0.10 at the reading of the data at 60-80% and 0.02 at the 90-100% levels which depicts a reduction in error rates and a better system reliability. The RACI Matrix of Data Governance includes the clarification of positions, which ensures accountability in such actions as data cleansing and mapping. The Reconciliation Dashboard indicates a match rate of 99% of the records and also reveals a 45 fields misfit and discrepancy. According to Automated Data validation Dashboard 98 percent of the fields are mapped with a low rate of duplication (1.5) and excellent business rule compliance. Intelligent Classification Treemap represents the visualization of types of documents deployed to assist the management of the data, whereas the Data Governance Scorecard verifies the high level of data integrity (95% consistency, 90% completeness, and 98% accuracy). The System Usage Heat Map identifies the need for training and support of the users.

CONCLUSION

In conclusion, smart data migration framework is very useful in improving the process of modernizing the ERP through improvement of the quality of data, data accuracy transfer, and speed of migration. The analysis also mentions the main success factors that are good governance, real time validation and risk management. Coherence in the migration of the ERP system is ensured by the integration of automated tools, and accountability, as part of a larger effort towards success of the system in the long-term.

FUTURE SCOPE

Future research can be directed towards the additional improvement of automation and machine learning methods used in the data migration process, especially in relation to big and more complicated datasets. Also, it is possible to consider how to incorporate superior forecasting analytics to detect errors and optimize performance, which might enhance the migration efficiency. An extension of the framework to multiple industries and legacy systems would also be useful in terms of providing some ideas on ERP implementation on a large-scale basis.

REFERENCES

[1]. Zhang, F., Liu, G., Fu, X. and Yahyapour, R., 2018. A survey on virtual machine migration: Challenges, techniques, and open issues. *IEEE Communications Surveys & Tutorials*, *20*(2), pp.1206-1243.

[2]. Wang, S., Xu, J., Zhang, N. and Liu, Y., 2018. A survey on service migration in mobile edge computing. *IEEE Access*, *6*, pp.23511-23528.

[3]. Mahmood, F., Khan, A.Z. and Bokhari, R.H., 2020. ERP issues and challenges: a research synthesis. *Kybernetes*, *49*(3), pp.629-659.

[4]. Sørheller, V.U., Høvik, E.J., Hustad, E. and Vassilakopoulou, P., 2018. Implementing cloud ERP solutions: a review of sociotechnical concerns. *Procedia computer science*, *138*, pp.470-477.

[5]. Razzaq, A. and Mohammed, A.A., 2020. Cloud ERP in Malaysia: Benefits, challenges, and opportunities. *International Journal*, *9*(5), pp.4891-4910.

[6]. Hrischev, R., 2020, June. ERP systems and data security. In *IOP Conference Series: Materials Science and Engineering* (Vol. 878, No. 1, p. 012009). IOP Publishing.

[7]. Shi, Z. and Wang, G., 2018. Integration of big-data ERP and business analytics (BA). *The Journal of High Technology Management Research*, *29*(2), pp.141-150.

[8]. Ahamed, M.Y., Musthafa, M.M. and Marikar, F.M.M.T., 2020. Challenges and benefits of ERP system and Non-ERP system integration in a developing country. *Global Journal of Management and Business Research: A Administration and Management*, *20*(10), pp.69-78.

[9]. Shakya, S., 2019. An efficient security framework for data migration in a cloud computing environment. *Journal of Artificial Intelligence*, *1*(01), pp.45-53.

[10]. Osman, A.M.S., 2019. A novel big data analytics framework for smart cities. *Future Generation Computer Systems*, *91*, pp.620-633.
[11]. Saqlain, M., Piao, M., Shim, Y. and Lee, J.Y., 2019. Framework of an IoT-based industrial data management for smart manufacturing. *Journal of Sensor and Actuator Networks*, *8*(2), p.25.
[12]. Heaton, J. and Parlikad, A.K., 2019. A conceptual framework for the alignment of infrastructure assets to citizen requirements within a Smart Cities framework. *Cities*, *90*, pp.32-41.
[13]. Chen, G., Wang, P., Feng, B., Li, Y. and Liu, D., 2020. The framework design of smart factory in discrete manufacturing industry based on cyber-physical system. *International Journal of Computer Integrated Manufacturing*, *33*(1), pp.79-101.
[14]. Pawar, P., 2019. Design and development of advanced smart energy management system integrated with IoT framework in smart grid environment. *Journal of Energy Storage*, *25*, p.100846.
[15]. Kumar, H., Singh, M.K., Gupta, M.P. and Madaan, J., 2020. Moving towards smart cities: Solutions that lead to the Smart City Transformation Framework. *Technological forecasting and social change*, *153*, p.119281.
[16]. Molavi, A., Lim, G.J. and Race, B., 2020. A framework for building a smart port and smart port index. *International journal of sustainable transportation*, *14*(9), pp.686-700.
[17]. Babar, M. and Arif, F., 2019. Real-time data processing scheme using big data analytics in internet of things based smart transportation environment. *Journal of Ambient Intelligence and Humanized Computing*, *10*(10), pp.4167-4177.
[18]. Curry, E., Derguech, W., Hasan, S., Kouroupetroglou, C. and ul Hassan, U., 2019. A real-time linked dataspace for the internet of things: enabling "pay-as-you-go" data management in smart environments. *Future Generation Computer Systems*, *90*, pp.405-422.
[19]. Saqlain, M., Piao, M., Shim, Y. and Lee, J.Y., 2019. Framework of an IoT-based industrial data management for smart manufacturing. *Journal of Sensor and Actuator Networks*, *8*(2), p.25.
[20]. Sharma, P.K., Ryu, J.H., Park, K.Y., Park, J.H. and Park, J.H., 2018. Li-Fi based on security cloud framework for future IT environment. *Human-centric Computing and Information Sciences*, *8*(1), p.23.
[21]. Uskov, V.L., Bakken, J.P., Gayke, K., Jose, D., Uskova, M.F. and Devaguptapu, S.S., 2019. Smart university: a validation of "smartness features—main components" matrix by real-world examples and best practices from universities worldwide. In *Smart Education and e-Learning 2019* (pp. 3-17). Singapore: Springer Singapore.
[22]. Puang, E.Y., Tee, K.P. and Jing, W., 2020, October. Kovis: Keypoint-based visual servoing with zero-shot sim-to-real transfer for robotics manipulation. In *2020 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* (pp. 7527-7533). IEEE.
[23]. Shekhar, S., 2018. Integrating data from geographically diverse non-sap systems into sap hana: Implementation of master data management, reporting, and forecasting model. *Emerging Trends in Machine Intelligence and Big Data*, *10*(3), pp.1-12.
[24]. Devaraju, S. and Katta, S., 2020. Real-time integration monitoring in Workday for global retailers using eventdriven architecture. *European Journal of Advances in Engineering and Technology*, *7*(6), pp.101-106.
[25]. Challa, N., 2020. The Crucial Role of Integrations in Data Engineering: A Comprehensive Exploration. *International Journal of Science and Research (IJSR)*, *9*(5), pp.1829-1837.
[26]. Elragal, A. and Hassanien, H.E.D., 2019. Augmenting advanced analytics into enterprise systems: A focus on post-implementation activities. *Systems*, *7*(2), p.31.
[27]. Zahid, H., Mahmood, T., Morshed, A. and Sellis, T., 2019. Big data analytics in telecommunications: literature review and architecture recommendations. *IEEE/CAA Journal of Automatica Sinica*, *7*(1), pp.18-38.
[28]. Sethupathy, A. and Kumar, U., 2020. Cloud-Native Architectures for Real-Time Retail Inventory and Analytics Platforms. *International Journal of Novel Research and Development*, *5*, pp.339-355.
[29]. Olajide, J.O., Otokiti, B.O., Nwani, S.H.A.R.O.N., Ogunmokun, A.S., Adekunle, B.I. and Efekpogua, J.O.Y.C.E., 2020. Designing integrated financial governance systems for waste reduction and inventory optimization. *Int J Oper Supply Chain Manag*, *8*(3), pp.142-58.
[30]. Bibri, S.E., 2019. On the sustainability of smart and smarter cities in the era of big data: an interdisciplinary and transdisciplinary literature review. *Journal of Big Data*, *6*(1), p.25.