Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Information Technologies

Diploma Thesis

Historicization of SAP systems within the VW Group

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

DIPLOMA THESIS ASSIGNMENT

B.Sc. Suprateem Dutta, Dipl. Ing.

Systems Engineering and Informatics
Informatics

Thesis title

Historization of SAP systems within the VW Group

Objectives of thesis

The main objective of the thesis is to describe the purposes for the historization of SAP systems and demonstrate the added value on a real case within the Volkswagen Group company.

The partial objectives are such as the following:
- to make an overview of the current approaches to the historization of SAP systems including the evaluation of their advantages and disadvantages;
- to develop an outline of a SAP historization project in the Škoda Auto organizational environment, design solutions, and select a technology for the historization of a 5 TB SAP ERP database;
- to evaluate results and propose recommendations.

Methodology

The methodology of this thesis is based on a thorough literature review and a case study of a SAP historization project in Škoda Auto, a Volkswagen Group company. The historization project will be outlined by following the methodological frameworks ITIL and Prince2. The technology will be selected upon assessment by applying a multi-criteria decision-making method. Accordingly, feasibility of the historization project will be evaluated and recommendations will be formulated.

The proposed extent of the thesis

60 – 80 pages

Keywords

Volkswagen Group, Škoda Auto, SAP, historization, legacy data, project methodology, case study.

Recommended information sources

Alfredo C.; Umeshwar D. Warehousing and Knowlege Discovery, 2012, LNCS:7448.
    https://link.springer.com/chapter/10.1007/978-3-642-32584-7_12
Bimonte S, Antonelli L, Rizzi S. Requirements-driven data warehouse design based on enhanced pivot
    tables. Requirements Eng, Springer, 2020. https ://doi.org/10.1007/s0076 6-020-00331 -3
Laura R. A Manager's Guide to Data Warehousing, John Wiley & Sons Inc, 2009.
    http://ebookcentral.proquest.com/lib/czup/detail.action?docID=469833
Omar E. B.; Khadija L.; Mohammed R. DAREF: MDA framework for modelling data warehouse
    requirements and deducing the multidimensional schema, Springer, 2020.
    https://link.springer.com/article/10.1007%2Fs00766-020-00331-3
Softlanding Systems,Inc. Application Decommissioning :The practical alternative to legacy 'life support',
    2020. https://www.softlanding.com/resources/

Expected date of thesis defence

2020/21 SS – FEM

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Prague on 13. 01. 2021

Declaration

I declare that I have worked on my diploma thesis titled "Historicization of SAP systems within the VW Group" by myself and I have used only the sources mentioned at the end of the thesis. As the Author of the diploma thesis, I declare that the thesis does not break copyrights of any of the resource materials as well as Volkswagen Group proprietary content.

In Prague on date of submission   31/3/2021

Acknowledgement

Historicization of SAP systems within the VW Group

Abstract

When something is introduced, one also must deal with getting rid of something. This is an architectural element where every company can benefit when resolved carefully, no matter if it is concerning to SAP or any other kind of application within the organizational environment. The thesis showcases how legacy ERP systems can be historized by getting decommissioned. There is a big inconsistency between the number of applications that have been developed and that have been retired indicating limited experience and available knowledge on the topic of application retirement which this thesis aims to address.

The selected supplier for an intelligent systems retirement application for Volkswagen Group is Data Migration Services AG who merges its application within Škoda Network to distribute a benchmark tool for all VW clients. The primary systems setup and decommissioning of live SAP subsystems will be recorded. Reviews from a use case will be drawn from this solution and utility, efficiency, and cost of ownership will be discussed. From this review, readers are expected to understand how to tackle ever-growing IT systems with their immense data ballast.

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1 Introduction

"Fifty percent of all IT systems in a medium to large enterprise company can be decommissioned." - Capgemini

In the world of today, adopting intelligent, dynamic, cross-functional business processes that deliver optimal seamless experiences is most desirable. But it is difficult to control the high data flow from heterogeneous and distributed operational sources in a production environment. Successful implementation and realization of an enterprise information system (ERP) play a key role in the effective management of data generating from end-to-end business processes. ERP system provides an enterprise-level of data management, transaction execution, and overall information transfer. The modern world also needs a business to evolve with a fast-adapting ecosystem to cope up with the rapid technical advent and a more competitive market. When traditional companies introduce a new SAP subsystem or similar within their IT infrastructure all usable and needful data from an older system gets migrated to the newer system while the older system is still maintained for compliance and business reasons.

This process keeps on repeating and the increasing data ballast turns the enterprise IT environment complex and bigger over time. Here comes the need for system retirement and data migration which eventually will decrease the operational costs while letting access to the legacy data until the retention period.

2 Objectives and Methodology

2.1 Objectives

The main objective of the thesis is to describe the purposes for the historicization of SAP systems and demonstrate the added value on a real case within the Volkswagen Group company.

The partial objectives are such as the following:
1. To make an overview of the current approaches to the historicization of SAP systems including the evaluation of their advantages and disadvantages.
2. To develop an outline of an SAP historicization project in the Škoda Auto organizational environment, design solutions, and select a technology for the historicization of a 5 TB SAP ERP database.
3. To evaluate results and propose recommendations.

This thesis aims to establish an overview of current approaches to systems decommissioning and legacy data accessibility including the evaluation of their advantages and disadvantages. Further by selecting technology for historicization, the research work aims to outline the design solutions and promote the necessity of historicization towards the digitalization of an enterprise company.

2.2 Methodology

The methodology of this thesis is based on a thorough literature review and a case study of an SAP historicization project in Škoda Auto, a Volkswagen Group company. The historicization project will be outlined by following the methodological frameworks ITIL and Prince2 and internal project methodology IT PEP. The technology has been selected as Proof of concept and the Pilot project as one step. A multi-criteria decision-making model is proposed while selecting the migration platform. Accordingly, the feasibility of the historicization project will be evaluated and recommendations for the next activities and retirement projects will be formulated. The methodology also comprises a coherent set of principles (industrialized process flows, frameworks, tools, and techniques) that can be used to retire those applications considered to be obsolete.

3 Literature Review

3.1 Legacy Systems and their historicization

3.1.1 What are legacy systems?

As defined by Gartner, a legacy application is "an information system that may be based on outdated technologies, but is critical to day-to-day operations."

With the introduction to newer systems within an organizational IT architecture, older information systems based on outdated technologies get stacked down in the loop while the workable data gets migrated to the newer systems to support business and legal needs. These systems which are just kept alive for compliance are termed Legacy Systems.(1) A legacy system is therefore the old system that we want to replace with a newer one. In the context of this thesis, the old system already has its successor (currently in productive use). So, this system "is only accessible but not productively used" – it means that this system "only use the hardware but without the load".(2)
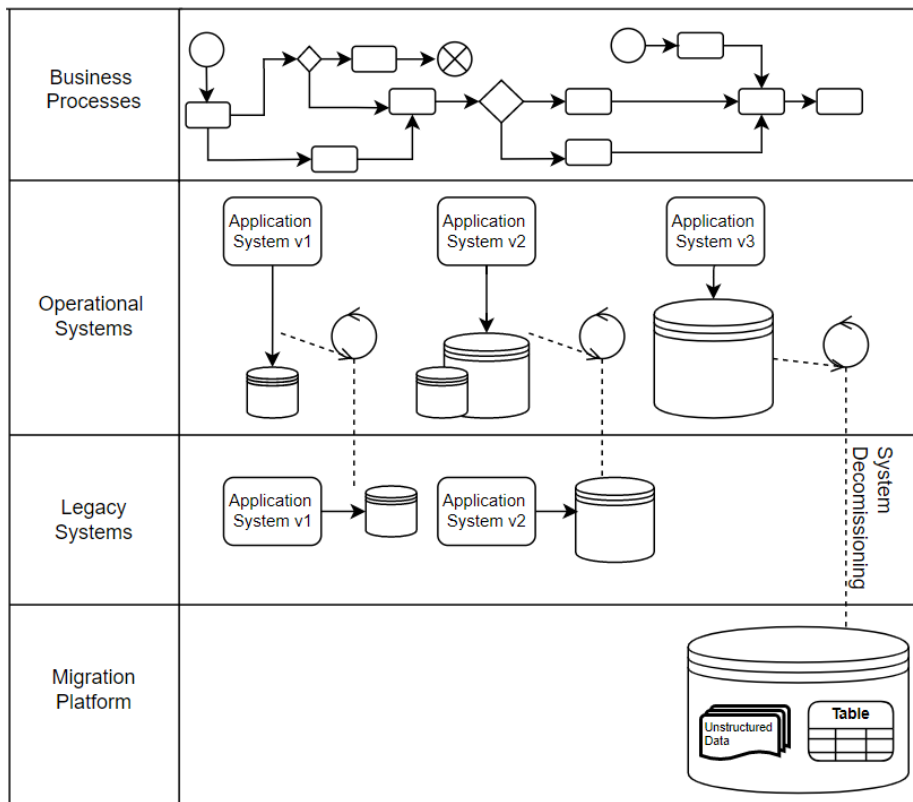
Figure 1: Legacy Systems, Source Author

3.1.2 Maintaining legacy systems in the dawn of digitalization

Currently, some fortunate companies are following their roadmaps to answer to agile, digitalization, and sustainability goals as well as to contribute to social

responsibilities like climate change, employee wellness, and customer experience. But there are companies too who are lacking legacy-modernization initiatives despite the risks of maintaining outdated software. The limitations of legacy systems are that they can be too complex to update, especially when connecting to new technology. With industry-leading security and mission-critical reliability, enterprise-grade cloud or on-premises systems paved the way to build powerful applications. In contrast, the legacy systems are old technologies like old SAP R/2, SAP R/3, or Oracle's JD Edwards or mainframes (infrastructures with COBOL or FORTRAN run applications) and are hard to manage since they are based on very old technology and when you look at the security requirements coming from a cybersecurity point of view it's very hard and very difficult to meet these security requirements.(2) Also, people, who know how these systems work may leave the company in the longer term, and last but not least to implement GDPR within those old systems is a nightmare. Eventually, the suppliers of older legacy systems are concluding service support agreements. So, to bridge the gap between current offerings and requirement of a digital-ready architecture, companies are slowly jumping into newer solutions. The right step to accelerate and simplify this transformation to an intelligent integrated enterprise environment lies with separating historical data from operational data and shutting down aging systems and subsystems which have been replaced by newer ones. Hence, while system historicization is an aftermath of digitalization within an organization, data migration is a new challenge for ERP implementations. (3)

3.2 Application Retirement

"Over time, applications can outlast their value to the business, eventually costing more to maintain than they are worth."– IBM

Application retirement is the complete removal of a museum of IT landscape discovered obsolete with outdated software and hardware still in use partially serving a less useful purpose, or productively.(4)Also termed system decommissioning was only an identified possibility, but by 2021 it becomes a necessity as companies recovered from their myopic vision of incorporating legacy systems within their DNA.(5) So why weren't they acting on it faster?
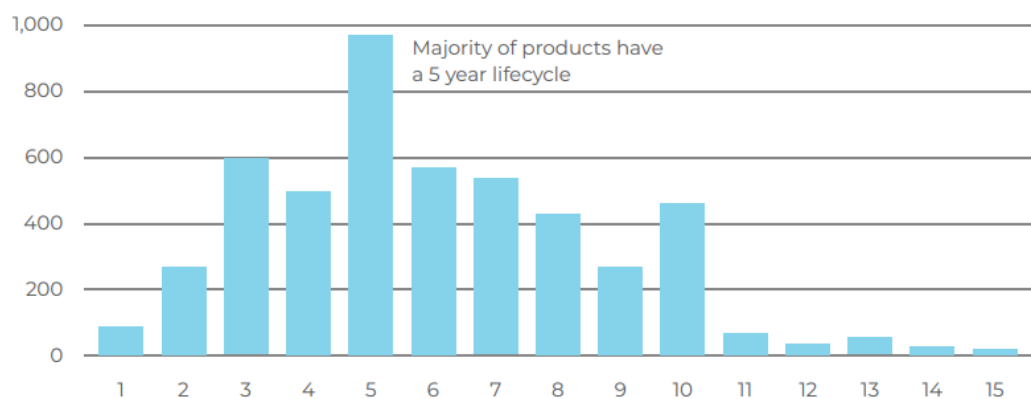
Figure 2: Lifecycle span of IT systems, 2018 Source: Flexera

Flexera in their Product EOL/EOS 2018 Report found that the majority of IT products have a five-year lifecycle.(6)

3.2.1 Drawbacks while retiring a legacy system

What are the restrictions to shut down legacy systems?

- It's not simple to just 'uninstall' a set of applications that have been part of an enterprise's technology landscape for years, perhaps even decades. Several factors like business processes, interdependencies between different applications, and their users need to be considered ahead of decisions and actions to be taken.
- Legacy IT strategy works well with quite a change in systems at one instance followed by long periods of static business scope which is not the case nowadays. Now, the goal is to chase the daily challenges and make continuous improvements, instead of waiting for the next wave of necessary changes.
- Legacy software built with some obsolete programming language can be a headache for developers since lesser documentation for software may be available and even skilled personnel for implementing changes on such a system may not be easily available.
- Legacy systems must be operational because during the transformation from one system to another the data structure changes so significantly that the revision does only accept these legacy systems for the revision itself.
- Upfront investments in terms of capital or manpower also make migration to newer systems a challenge for organizations.
- A dearth of experience in this domain has always ended up being the key to embracing legacy systems, leaving present concerns for a distant tomorrow because yesterday's habits and solutions are still working. When the intent to implementation takes a lot of time it helps nothing but discouraging employees to train for new skills. Also, older employees are technology-averse and or stereotypes who may face trouble reframing thereby inspiring internal resistance. (4, 5, 7)

3.2.2 Implementation advantages

Why is the need for system retirement?

- No more mismatch solutions– A business that was established years back is not the same the way it used to run before. Now it's hard for business communications between organizations and their(5) clients when a legacy system restricts itself from evolving with the technical advent. Compatibility issues can arise when businesses are stuck using older formats of files and data that may not be a choice of clients, partners causing the isolation of data share. Older applications and systems tend to have discontinued technical support that means the manufacturers stop supplying patches for vulnerabilities or no more spare parts are produced for the obsolete hardware. Again, certain security gaps, functionality gaps, or technical glitches are not

easy to fix due to the large, inflexible nature of older systems. Further a patch to a legacy fix is typically greatly delayed and far lower on the priority list because it is a much more toilsome task for developers.

- No more data silos– Data silos are byproducts of legacy systems since several older systems were never designed to integrate, and many legacy software solutions are built on frameworks that can't integrate with newer systems in the market. IT storage optimization can reduce the volume of data in production and maintain seamless data access. (8)

- Regulatory reasons – Legacy systems are risky, both from a legal and security point of view as they fail to stay compliant. Because of being very proprietary, which makes them difficult to change and customize, aging systems struggle from adapting to the lean IT concept. They are often not compatible with security features involving accessibility like multifactor authentication, single-sign on and role-based access. Legacy systems can also suffer from insufficient encryption methods. As they become vulnerable to ever-growing security threats a data breach can cost millions as well as prestige.(9) If the system supplier's license policy changes and license audits are pending over this long time or if tax auditors can no longer access all the data in their original business context the enterprise can be compromised.(10)

- Decrease operational costs – A multitude of legacy systems accumulated over decades, consisting of different generations of software and hardware from different manufacturers are expensive systems that cannot be operated in their original environment while only the data needs to be accessed currently. It is extremely expensive to attain continued maintenance and updates for such systems. So decommissioning these setups will free up the budget so that the resources and findings can be spent productively.(11) It becomes increasingly obscure to search and retain the right talent as the developers for a certain software might retire or switch to other technologies. Then obsolete systems may require dedicated staff training at an even bigger source of expense.(12)

- Next-generation adaptability– To stay competitive in today's world forward-thinking data integration solutions are most welcome as a company matures. In the case of rapid ERP or particular data storage for useful legacy data, moving to the cloud calls for thorough data scrubbing within a limited time to ensure data is accurate. Such a mechanism for data collection further lets us achieve instant access to clean data and insights that can help organizations make better operational decisions delivering Business Intelligence to the business functions, providing detailed analysis on company performance, connecting to BI Dashboard tools such as PowerBI or Tableau. As the data remains readily available and is archived securely and cost-effectively, it unlocks Big Data analytics, data mining opportunities, and retention compliance. A system with full API development lifecycle support is very useful. Previously, enterprises need to install additional plugins to their ERP systems for performance enhancement or feature extension. However, retiring those legacy systems to ERP solutions having such

functionalities built-in is a smart move. Artificial Intelligence (AI), Internet of Things (IoT), and other smart tech modules integrate within newer intelligent ERP (iERP) systems can give a positive dimension to an organization's profit score as it enables companies to automate their complex business processes. (4)

3.2.3 Application Retirement Framework

The methodology of application retirement as a whole consists of industrialized process flows, artifacts, frameworks, tools, and techniques when combined, address the solution as CIOs seek out the best path towards retiring applications.(13) The key to updating any legacy system lies in successful data migration with the primary goal of securing the data. From identifying which applications are to be retired to the successful implementation of decommissioning is outlined by the ITSM framework. ITSM (IT service management) refers to the structured methodologies and guidance that are directed by certain policies and based on experiences of the organization to design, plan, deliver, operate, and control IT services in the best possible way to meet the needs of a business. (4) Also, if multiple legacy systems within one corporation need modernization the required effort and time window for each system need to be planned separately based on priority.

A standard retirement framework has a mixture of people, processes, and technology in one place to churn out value to the business. It consists of four phases as follows:

1. Decide– This stage comprises a series of analyses whereby redundancy, retirement, and risk analysis are performed to identify and validate the applicant systems for decommissioning. This phase can take place either based on the recommendations of some exercise or, a client defines which application or applications need retiring.
2. Plan– This stage accounts for the preparation of workflows and analyses, the crucial ones being impact analysis, estimation analysis, and cost/benefit analysis. Recognizing the level of risk implied by the project, a plan for personnel reorganization can be devised. Depending on whether the emerging 'plan' contains sufficient financial benefit with minimal threat of disruption the acceptance or declination of the project may happen.
3. Design – This stage controls if the project proceeds to the next stage based on the approval of the architectural design by the client which facilitates the traceability of functionality and also provides test cases for ensuring a seamless workflow. The decision whether to proceed to the next phase depends on the architecture design being approved by the client.
4. Implement – The last step 'implementation' workflow is a series of checklists, test scripts execution, and re-skilling training for resources. Once this workflow is signed off, the client can successfully approve the retirement of the application or applications. The Application Retirement Framework diagram provides an overview of the processes and actions that make up this exercise.(14) In the context of this thesis, the complete decommission procedure will be implemented.
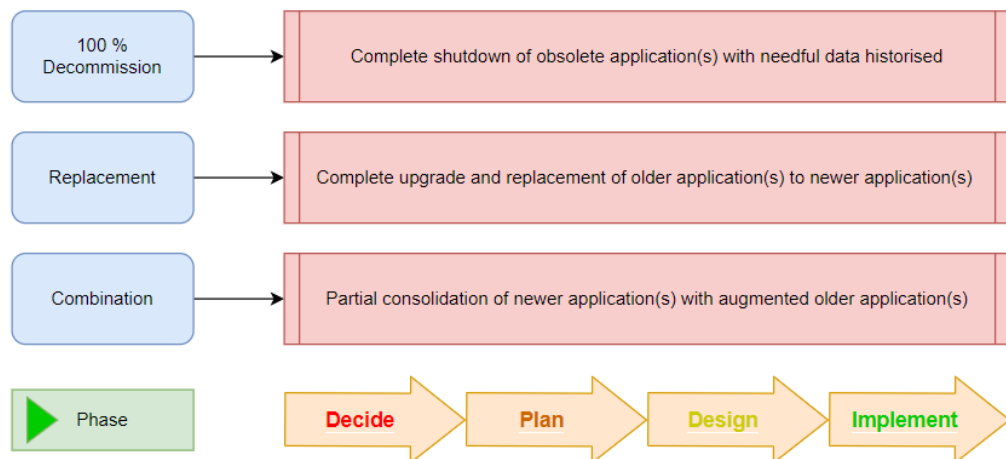
Figure 3: Retirement Framework, Source: Capgemini SE, Author

3.2.4 Retirement Strategies

By providing a structured approach to implementing application retirement, Application Retirement Methodology serves as a key enabler in simplifying and streamlining the application landscape. A simplified, streamlined application landscape improves IT ability to support the business and its ever-evolving needs. Using the methodology put forward in this paper, all of this can be achieved in a safe and controlled manner. With the new implementation done the smart approach lets stakeholders always have access to the data not migrated to S4 HANA since they are stored in some information platform over the next decades. Now it's the task of the retention management to delete personal data and comply with GDPR and big data. The retirement strategies according to the retirement framework (described in the last chapter) will be addressed below.

Scenarios	Objectives	Tools & Techniques	Deliverables
Decommission	Removing obsolete applications whose removal does not impact the overall functionality of the enterprise	• Retirement Analysis Model • Effort Estimation Tool • 'Retirement Ready' Checklist • Data Archival and Backup Tools	• Business case for choice of 'Decommission' • Feasibility/Impact Analysis • Requirements Traceability Artifact • Customer Sign off on Retirement
Consolidate	Identifying and replacing old applications with new applications whose introduction ensures replication of existing functionality in the enterprise	• Functional Redundancy Analysis Tool • Risk Analysis Tool • Framework for selection between COTS/Build/Migrate • New Application Selection Framework • Effort Estimation Tool • Design Checklist • Testing & Data Migration Tools • 'Retirement Ready' Checklist	• Business case for choice of 'Replace' • Feasibility/Impact Analysis • Requirements Traceability Artifact • Application Architecture Design • Executed Test Scripts • Customer Sign off on Retirement
Replace	Aims to improve the application landscape by identifying and replacing old applications by augmenting the functionalities of other existing applications in the landscape	• Functional Redundancy Analysis Model • Target Application Selection Framework • Effort Estimation Tool • Design Checklist • Testing & Data Integration Tools • 'Retirement Ready' Checklist	• Business case for choice of 'Consolidate' • Feasibility/Impact Analysis • Requirements Traceability Artifact • Application Architecture Design • Executed Test Scripts • Customer Sign off on Retirement

Figure 4: 3 Major application retirement stategies, Source: Capegemini

For instance, Data Migration International's JiVS IMP will maintain one single layer of the information platform where the client can manage the retention rules and the lifecycle of legacy data as well as delete any personal data when needed or when retention period will over. This approach is helping to lower the TCO costs for the SAP S4 by up to 25 percentage so it's really impacting the whole project heavily. The identify-design-transform phases are free of choice approach and clients can use therefore the T-bone software from SAP or SAP landscape transformation or other partners Data Migration Services AG partnering with. A service aiming to identify data in installations that can be reduced because they are no longer needed for operational purposes will soon be combined into JiVS IMP itself. Additionally, after the migration of legacy data to JiVS, data will automatically be analyzed regarding its relevance for daily operations. The analytical possibilities currently offered as services will be a fixed part of the product soon. In another use case is M&A. During Merge and Acquisition Consolidation Process get fast insight in comparing new stream of data with data already present in landscape, with Master Data Governance Consolidation thereby also to be able to calculate and identify best records out of every identified group of duplicates <open.sap.com intelligent integrated enterprises> case the same approach can be also very valuable that you only hand over data really needed and to provide the historical data you know in a platform like JIVs. In the banking environment SAP is maybe not so in the focus but the banking applications are like Avaloque R in the case the same approach the same story and if you want to do it a pure decommissioning project like the housekeeping project yes there's just the JIVs component really needed to meet these requirements. every company who is facing the upcoming S4 implementation really should consider this as an option to get out the best.(3) Therefore, the Application Retirement

methodologies provides how to progress from identifying opportunities for application retirement to reaping tangible benefits. The methodology consists of industrialized process flows, artifacts, frameworks, tools, and techniques that, together, address many of the problems encountered.(15, 16)

3.2.5 Business Stakeholders

The business of all categories is under pressure to be more flexible, disruptive, and nimble. From digitalization to agility, legacy system decommissions to multi-cloud implementations; boards and executive teams responsible for day-to-day tasks from various business operations like sourcing, procurement, supply chain, finance, research and development, production, etc are being driven to action by today's technology trends that can potentially make a decisive contribution to the future performance of their companies and respective business models. When assigned the task of choosing and guiding an IT implementation (Application retirement in our case), teams generally start at the top with executive-level buy-in.(17) Chief Executive Officer (CEO) is someone responsible for transforming the company into a digital world helping to improve the products and growing the business but also looking for merger acquisition opportunities that are in his mind. Chief Information Officer (CIO) is responsible to implement any digitalization strategies. One element of thought for SAP clients is S/4 HANA as the foundation for the digital core and the stop of the support for older SAP platforms which is something that the CIO must have to deal with as well as the agility in the business automated applications and dynamic processes data that needs to be stored longer securely, with stability. CFO is responsible for cost maintenance in existing IT systems because they're adding new systems. Everywhere within companies is increasing with sometimes a near stagnant budget so money for operating the existing systems is depleting the whole IT budget. Cybersecurity and General Data Protection Regulations (GDPR) are also a concern for this person. The CFO along with the CMO (Chief Marketing Officer) has a combined role to select an application retirement tool based on cost estimations and budgeting as well as market survey. With this business transformation, the management aims to undertake changes at the top line or bottom line of its business processes. A communication plan must be undertaken by Chief Technology Officer (CTO) and CIO to empower employees to know the changes and implementation goals of the company. While retiring legacy systems, CTO is also the key person responsible in making sure if needful information got securely historicized aligned with business goals of being accessible. As the implementation progress, the core team based on different geolocations must be shared milestones, challenges, and setbacks by the CTO.(18)

3.2.6 **Extract Transform Load**
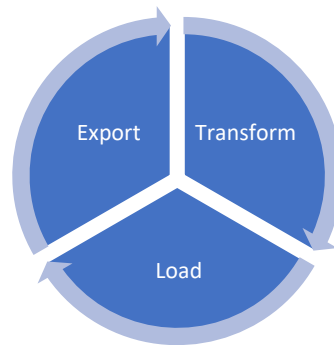
Figure 5: Export Transform Load mechanism, Source:Author

In computing, extract, transform, load (ETL) forms the fundamental procedure behind copying data from one or more sources into a destination system which represents the data differently from the source(s) with a goal to match the target system's required format. ETL is the key to legacy data management. At first step data from the target sources like ERP systems are extracted partially or full. Next, the transform function converts the raw data that has been extracted from the source server as it cannot be used in its original form.Transformation includes data cleaning, fformat revision, threshold validation checks, rstructuring, deduplication, margining, splitting, aggregating, etc. At last, the load function writes converted data from the staging area to a target database, which may or may not have previously existed. (19)

3.3 **Data Migration**

Switching from legacy systems to ERP requires collation, classification, and systematic migration of legacy data. This process referred to as Data Migration goes smoothly with cleaner data in a correct format.(20) The bimodal data model quite simply refers to the first element termed as useful data which when gets introduced to new systems only gets migrated into the new environment. These are typically the master data in their best quality but also the open items needed for the new application. The other element is the data defined as legacy data that we cannot migrate or don't want to migrate since these data can be redundant, incorrect, or just not useful for the organization's current business scope. For instance, SAP One Domain Model collects specific business objects into aligned objects based on common attributes or semantics to be used by SAP applications within its Integrated Intelligent suite which means all of those specific business objects used by older SAP systems may not find use in the newer applications.(17) Therefore master data of these business objects, transactional and event-based data created from these non-transformed business objects can either be stored in a separate database for audit purposes or is ready to be scraped if at all not needful. By reducing the amount of data, we don't blow up the systems and can achieve an agile and smart operative application. To avoid an immense depletion of budget, companies prefer to engage an internal resource to clean up legacy data.

3.3.1 Legacy Data Lifecycle
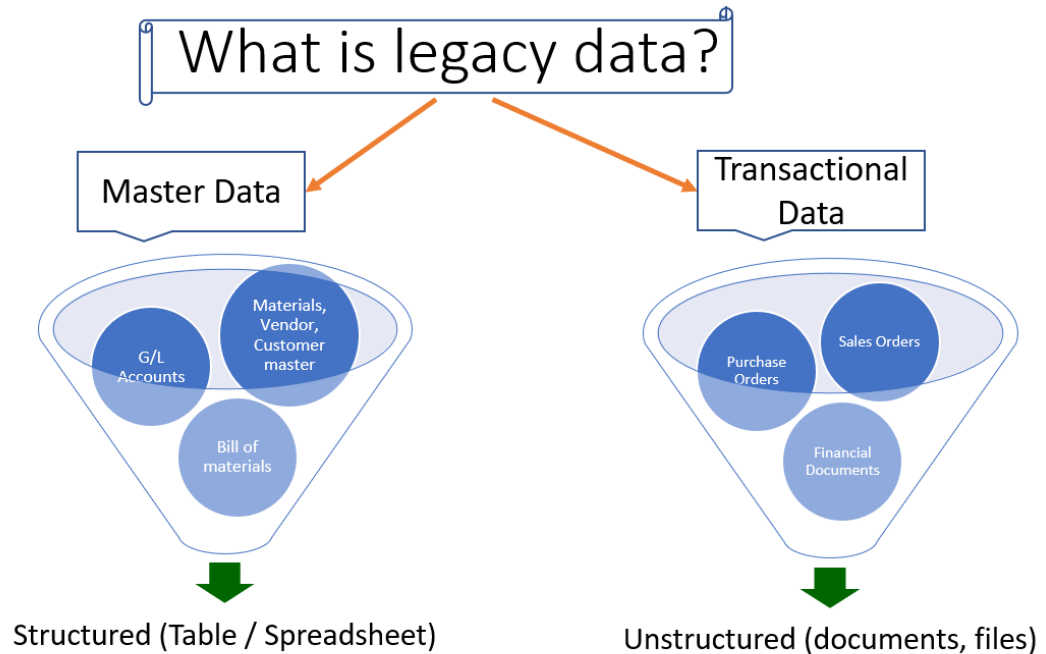
Figure 6: Legacy Data, Source: Author

Data can be structured or unstructured. Structured data is in table format and can be amended or searched by the query language. Common structured data models are relational, hierarchical, and linked. Unstructured data is documents and other files. Redundant data stacks up and makes the IT ecosystem bigger. Relevant data can be master data, transactional data, event-driven data as well as documents. After the system(s) to be decommissioned have been selected to proceed from intent to implement the data to be migrated must be updated to its best and secure form. To avoid bad data that can be a big fail point for newer complex systems, the following measures can be taken.(7)

1. Extract existing data- Data in existing legacy systems might be siloed, splintered, duplicated, or incomplete existing in a variety of data stores and a variety of formats. Migrating data out of a legacy system starts with making sure it can all be extracted safely.
2. Transform data- The data is transformed to match the newer formats based on the new system's requirements through data mapping. Rarely does data from legacy systems do an exact mapping to the new system. This step is vital to ensure that the new system understands the data from the legacy system.
3. Data cleansing- During the migration process, it is a good time to address any quality issues like cleaning data by getting rid of duplications, incomplete data, and improperly formatted data. For instance, a legacy system with phone numbers that contain dashes is incompatible with a new system that doesn't allow them.
4. Data Validation- It is crucial to make sure the processes go as planned. Once data is extracted, transformed, and cleaned, a sample set of data is imported to test for

problems and errors. This weeds out potential issues before the new system goes live.

Finally, when the data is ready for use all the data can be loaded into the new system and the retention management will take over.(21)

3.4 Data Retention Management

Organizations today must abide by strict sets of continuously evolving compliance regulations. For example, companies with customer data need to maintain well-governed records, which is much harder in outdated, siloed systems. So, a legacy system may not be equipped to meet such compliances but when upgraded or newer systems and applications must have complete data management and compliance visibility. Data retention management refers to end-to-end persistent data and records management outlined by retention policies, for meeting business archival requirements for an organization with a goal to keep what is needed.(7, 22) It is based on a set of guidelines to meet various complex compliance regulations by users, departments, keywords, phrases, attachments in a certain sector and not just by a generic date, that helps organizations keep track of how long information must be kept and how to dispose of the information when it's no longer needed. A data retention policy weighs legal and privacy concerns against economics and need-to-know concerns to determine the retention time, archival rules, data formats, and the permissible means of storage, access, and encryption as well as the purpose for processing the personal data. A good record retention policy can reduce legal risks and discovery costs, as well as recovery effort time while these data must be periodically reviewed and erased when the retention period is over or if unlawfully collected.(22, 23)

3.4.1 Challenges of Retention Management versus legacy systems

Being transparent about compliance processes helps the profitability of the organization as well as building trust with clients in the process but comes with several challenges. Compliance regulations like the GDPR (General Data Protection Regulation), GDPN (General Data Privacy Notice), for example, require a company to know (and justify) personal data they have, data storage location, who is accessing the data set as well as the timeframe for retention. Despite the apparent strictness of the GDPR's data retention periods, there are no rules on storage limitation unlike the GoBD that is the retention period for electronically storing organizational financial and legal records which when failed to pertain ends up in on-site compliance audits and inspections by the appropriate regulatory agency as well as penalties resulting in loss of brand reputation.(23) The German GoBD, (Grundsätze zur ordnungsmäßigen Führung und Aufbewahrung von Büchern, Aufzeichnungen und Unterlagen in elektronischer Form sowie zum Datenzugriff), became effective a little over two years ago and is specifically related to tax documentation. It replaced two prior requirements: one from 1995, the GoBS (principles of proper DV-based accounting systems), and one from 2001, the GDPdU (principles of data access and verifiability of digital documents). Companies are obliged to have data access up to 15 years in

CZ (up to 70 years in DE). A legal entity based in CZ is also threatened with a fine of up to CZK 200,000 under the Archiving Act for an offense of wrongfully damaging or destroying a document subject to a general archiving obligation.(24) Financial challenges in attaining compliance can be acute as companies not only need to spend capital in order to comply with regulations but also, churn out respective profit to appease stakeholders. To combine emerging regulations with business context, foreseeing compliance trends to integrate efficiently, and promoting the compliance culture throughout the organization are demanding goals to achieve for any organization.(25) Many legacy systems are unable to delete, and even for live systems, it's hard to manage the continuous life-cycle of personal data as per EU-GDPR guidelines. The basic problem of retention management if applied in legacy systems is that the lifecycle of data and documents containing personal data cannot be managed separately from the lifecycle of the systems. Inventory control of data for compliance in distributed productive systems which further will be extended as legacy systems is a challenging and costly task considering supportive technical system updates are normally not an easy option.(25)

3.4.2 Solution to Data Retention challenge

This problem can be solved by extracting the data and documents from any type of legacy system, like SAP subsystems, Baan, Peoplesoft, Microsoft Axapta, Oracle's JDE or in-house developments, etc., and store them in a modern, neutral format on a central platform retaining the business context. The goal here is to have for instance all invoices belonging to a customer address accessible in one hand while the relationships between the information must be also conserved like it has been in the original system(s). This is exactly the requirement of EU GDPR. At the end of the lifecycle, the relevant data and documents are suggested for deletion while a double-checking principle can prevent accidental deletion. Parallelly, the retention management can also prevent premature erasure like if there are legal disputes or future retention deadlines data and documents will be retained by the system. Therefore, historized data availability from user GUI and third-party systems can address such restricted retention, discovery, compliance, and legal hold capabilities with the review, retrieve, and export of data capabilities.(26, 27)

3.5 Enterprise Resource Planning

Enterprise resource planning (ERP) is defined as the ability to deliver an integrated suite of business applications that organizations use to manage day-to-day business activities such as accounting, procurement, project management, risk management, compliance, manufacturing, and supply chain operations. ERP tools share a common process and data model, covering broad and deep operational end-to-end processes that also includes enterprise performance management like planning, budget, predict, and report on an organization's financial results.(28)

3.5.1 Introduction to ERP

To ensure the required efficiency and optimal degree of automation of operations and business processes within an enterprise it is necessary to use modern tools of information systems. An Enterprise Resource Planning (ERP) system is such an essential enterprise information tool for any competitive production organization. Enterprise Resource Planning was born at the dawn of the new economic order to revive streamline business operations. The history of ERP dates back to a century behind when in 1913 a paper-based manufacturing system for production schedule was developed by engineer Ford Whitman Harris termed as the Economic Order Quantity (EOQ) model. In 1964 Black and Decker was the first company to adopt a materials requirement planning (MRP) solution combing EOQ concepts with a mainframe computer that settled the new standard in manufacturing until MRP II was introduced in 1983. (29)While MRP systems were devised only to plan the product requirements or parts acquisition from suppliers based on some master production schedule, MRP II featured "modules" as a key software architectural component with integrated core manufacturing components like purchasing, bills of materials, scheduling, and contract management. For the first time, different manufacturing tasks were integrated into such a robust system. ERP technology was dubbed obsolete during this New Economy until MRP II provided a compelling vision of how organizations could leverage software to share and integrate enterprise data and boost operational efficiency with better production planning, reduced inventory, and less waste (scrap). Looming of the industrial revolution and technological advent in the modern world needed a new paradigm for product manufacturing. The new category of business management software, enterprise resource planning (ERP) was coined by the Gartner Group in the 1990s that was capable to handle business activities beyond manufacturing, incorporating finance, customer relationship management, and human resources data.(12, 30) ERP systems can run on a variety of computer hardware and network configurations, typically employing a database as a repository for information.(31) From the 90s ERP grew rapidly allowing businesses to grow and gain resilience and agility and it evolved embracing the internet, cloud, and emerging technologies with newer features as well as security demands. At present, it's impossible to ignore the impact of ERP in today's enterprise world as such a tool simplifies the IT environment to make every business process transparent and more effective.

3.5.2 ERP challenges for a manufacturing company in historicization context

ERP has come such a long way from its early inception days that the older versions are quickly becoming obsolete. The Data Migration challenge is to perform the systematic and secure migration of legacy data to new generation information management systems. As manufacturers are about to embark on their digital transformation journey in ERP implementations, they face difficulties to choose the best match of ERP solutions. The challenges are overviewed as follows:

1. Immature Cloud Solutions-
   Lack of IT expertise can be a solid reason for avoiding cloud-based implementations in some organizations.(31) A lot of ERP vendors are moving to the cloud for the first time. This creates gaps and efficiencies in terms of

suppliers' specifications and needs for enterprise systems deployment to allow a seamless digital experience with real-time data feeds. Moving an existing application to a cloud computing environment is far more difficult. Check Point Software Technologies LTD mentioned in their report that 68 percent of the organizations they surveyed ranked misconfiguration of the cloud platform to be the biggest threat of cloud implementations.(32) In a Software One report on cloud spending, 39 percent of those surveyed said connecting legacy systems was one of their biggest concerns when using the cloud as well 80 percent of enterprises struggle with cloud spend management.(33) According to the Cloud Security Spotlight report, 18 percent of the respondents indicated at least one security incident in the last 12 months with a significant rise in complex situations based on data privacy, data leakage, and breaches of confidentiality. Their report sums up the challenges with cloud migration for businesses with infrastructure security (43 percent), compliance (38 percent), setting security policies (35 percent), and security failing to keep up with the pace of change in applications (35 percent).(34) However if chosen carefully, the new ERP Delivery model of Software as a Service (SaaS) is a service in the cloud running on a network of remote servers that can liberate siloed systems to provide the business with the greatest data value. The software provider patches, manage, and update the software several times a year rather than an expensive upgrade every 5 to 10 years with an on-premises system. The cloud can reduce both operational expenses (OpEx) and capital expenses (CapEx) because it eliminates the need for companies to purchase software and hardware or hire additional IT staff. Businesses can pay exactly as per their use. These resources can instead be invested in new business opportunities, and the organization is always up-to-date on the most recent ERP software. Employees can shift their focus from managing IT to more value-added tasks such as innovation and growth.(35)

2. Too many scalable options-
   There are several systems nowadays to choose from as the best fit for a manufacturer than the past which may incur compatibility issues with company growth or changes. A lot to navigate and distinguish from options may sound interesting but can soon lead to the company's dismay and then further chasing and evaluating systems or technologies for the so-called perfect ERP ecosystem is a distraction to the manufacturer's primary accomplishments. Out-of-box client-specific ERP implementations offered as SaaS can shred operational costs and unexpected expenses over additional plug-ins. These new systems require some level of upkeep and maintenance which needs to get considered while budgeting for a new system. The point here is to decide on a suitable ERP option that can grow with the business.(36)

3. Technological Gaps-
   A lot of business functions are yet to be addressed by leading ERP vendors which manufacturers must be aware of before selecting an integration to integrate with the present legacy system. IoT, AI, automation when combined with ERP can open a vast range of possibilities. Legacy systems have always collected useful

data and organized them, but the next generation of ERP systems must be capable of analytics and data visualization. Organizations nowadays must incorporate ERP solutions supportive of Agile methodologies to avoid operational glitches and better manage their processes. Avoiding industry hoax referred to as "best practices" stated by vendors and diving deep to choose a system will let the manufacturer to a winning situation as vendors tend to mask the manufacturing deficiencies of their product.(12) An iERP solution can analyze historical data and combine it with information accumulated from several departments within an organization. It aids decision-making processes with accurate risk assessment and forecasting. AI, in addition to other next-gen technologies, when combined with ERP, can significantly enhance an organization's productivity and operational efficiency. Companies need to find ways to analyze the enormous structured or unstructured data collected from their business case and extract value out of it where AI-driven ERP systems can be used for data mining and big data analytics. They can also create workflows, reduce errors, lessen information loading time, and more. (6) Again as a best practice, it's good to consider estimations of end-of-support (EOS) and end-of-life cycle (EOL) while onboarding any new system in the organization IT space.(37)

4. Bad data-
   ERP implementation process can turn into a disaster if valuable data is lost or is inaccessible while migrating to a new business management solution. Termed Bad data is an important point of consideration that can be a big fail point for some ERP programs if the vendor is incapable to manage data integration without losing data quality or operational functionalities requested. Poor data quality can result in delayed migration project.(11, 17)

5. Change Management Issues-
   ERP adoption or upgrade is not just an IT priority since the new ERP system will impact many employees across many functions of the business of an organization. Building the right team members from key departments keeping in mind to involve employees who will use the system the most, is essential to for success of any specific ERP assessment. Even after successful data migration and all systems are operational it may happen the people affected by the new system don't embrace the change and prefer to do things the way they've always been done. Therefore, new implementations will be more effective if plans are present to address the change management for the processes and technologies, as well as the people. Encouraging employees to system training with feedback and reward programs for active suggestions to improvise can certainly change the game. Also, simultaneous modernization of legacy systems to new generation ERP must be avoided. (17) Interestingly organizational mergers and acquisitions, data center consolidation, etc. can accelerate the requirement to retire legacy and redundant applications.(8)

3.5.3 SAP systems from the historicization point of view

SAP and ERP are really interrelated terms on enterprise level nowadays. Gaining insight from data and acting fast on it yet efficiently has become ever more important.

During the challenging times especially with the occurrence of the 2020 epidemic, there's one company that has been constantly supporting its clients to face the huge impact that society and economy faced by providing powerful, quality applications available on-premise, in the cloud, and hybrid. Founded in 1972, now SAP SE (Systems, Applications, and Products in Data Processing) emanates as the market leader in Enterprise Application Software for around 50 years helping companies of all sizes, from all industries to run the world's most critical business processes integrated end-to-end, across the whole value chain at their best.(38, 39)

Companies aim to modernize their IT environments because there is a pressure from the providers of leading business applications, such as SAP as using on-premises ERP has its limitations including inflexibility, cost scaling, and lack of innovation. These firms plan to establish their new software generations based on the market standards as quickly as possible to replace the earlier versions. Therefore, cloud adoption is going to dominate the market in improving present-day ERP systems. (40) SAP SE had initially declared the final deadline for their mainstream support of all the existing ERP solutions to be maintained under their release-upgrade-maintenance agreement until December of 2025 although this magical milestone is recently increased to 2027 in response to customer requests. This includes SAP Business Suite 7 core applications, which are also core applications of SAP Business All-in-One, including:

- SAP ERP 6.0 (ERP Central Component, ECC 6.0),
- SAP CRM 7.0 (Customer Relationship Management),
- SAP SCM 7.0 (Supply Chain Management),
- SAP Supplier Relationship Management 7.0 applications,
- SAP Business Suite powered by SAP HANA.

Following this mainstream maintenance, from 2028 onwards SAP will offer optional extended maintenance support to customers for their Business Suite 7 core applications in longer conversion phases to SAP S/4HANA until the end of 2030. This comes with a premium of two percent points on the maintenance basis for all support offerings for the scope of SAP Business Suite 7. Customers may opt out for the extended maintenance, or where the extended maintenance has ended, will be provided with customer specific maintenance for their SAP Business Suite 7 applications. (41) However, this extended period is to let organizations comfortably rationalize complex landscapes with multiple ERP systems and re-engineer business processes and systems to prepare for the upgrade. Against this backdrop, around 50,000 SAP customers must migrate to the new software generation of SAP S/4HANA for which SAP SE has confirmed a "maintenance commitment" until 2040 to support organizations in becoming intelligent enterprises, support for new business models, investment protection, and planning stability; according to Michael Kleinemeier, member of the Executive Board of SAP SE, SAP Digital Business Services, and Thomas Saueressig, member of the Executive Board of SAP SE, SAP Product Engineering.(39) If there are older systems still existing in an organization like SAP R/3 4.6, 4.7, or ECC 5.0, or even a legacy mainframe R/2, they are running simply under customer-specific maintenance. When enterprises using the older versions of SAP ERP, will stop receiving updates and won't be able to make use of technical support. Practically, this means the enterprises that don't plan their conversion on time, or at all, will need to take over all the responsibilities and safety

of their information systems. Although the time to recover and adapt to change for organizations now seems to be far away, it is still necessary to consider the impact of migrating to S/4HANA not only based on finances but based on time and desirable productive achievements. With the milestone approaching, the capacities of competent and experienced partners are also growing who can guide through the migration.

3.5.4 SAP R/2, R/3, ECC, S\4 HANA varying factors

R/2 is a two-tier mainframe architecture that contains 2 layers.
- Presentation Layer
- (Application + Database) Layer

R/3 is a three-tier architecture (client-server version based on Unix/Linux/Windows) that contains 3 layers. In this thesis, a similar system will be decommissioned.
- Presentation Layer (User Interface- SAP GUI)
- Application Layer (Commands processing, logical decisions- ABAP)
- Database Layer (Data storage, retrieval, and management- RDBMS)

Here, R stands for "Real-time data processing". The first tier belongs to the client-side which allows access to the ERP system and exchange information with servers. The second and third tiers refer to constantly running servers, like an Application Server, Database Server, and Web server.(42) While SAP R/3 is meant for enterprises, smaller and medium companies may have SAP Business One built on the same concept of client/server but 2-tier architecture. SAP ERP Central Component (ECC) is the previous generation of ERP and an upgraded version of the R/3 platform. It is not a standalone product version but an application suite that runs on a third-party database like Sybase ASE, MS SQL Server, Oracle. It is different from SAP HANA which has its in-memory database. However, the ECC suite can run on the HANA database. Migrating to Business Suite on HANA boosts performance, and provides the same functionality as running ECC on traditional disk-based databases but, organizations can also upgrade to HANA systems with S/4HANA add-ons. SAP ECC users need to pass through Suite on HANA, and then undergo further transformations to reach S/4HANA and receive all the benefits of the Suite like flexible data modeling, real-time reporting, and numerous application-specific benefits as well as the modern Fiori User Experience (UX). Fiori UX offers users a more intuitive and efficient UX compared to the older SAP GUI. At present, developers in SAP rebuilt the applications from scratch based on their cloud integration strategy taking advantage of the power and innovative design of HANA using SAP One Domain Model as the one language to semantically connect business objects uniformly. The One Domain model acts as the common data model for all business objects within the complete scope of applications present in the business network. With an upgrade to this integrated intelligent ERP solution SAP customers will enjoy a set of common suite qualities:

1. **Seamless user experience** – Harmonized look & feel and navigation patterns
2. **One workflow inbox** – Central task management

3. **End-to-end process blueprints** – Implementable reference architectures
4. **Consistent and out-of-the-box security & identity management** – Central identity provisioning & authentication
5. **Coordinated lifecycle management** – Harmonized provisioning, setup & operations
6. **Embedded & cross-product analytics** – Holistic 360° business and customer view
7. **Aligned domain models** – Aligned business objects across applications(14, 36)
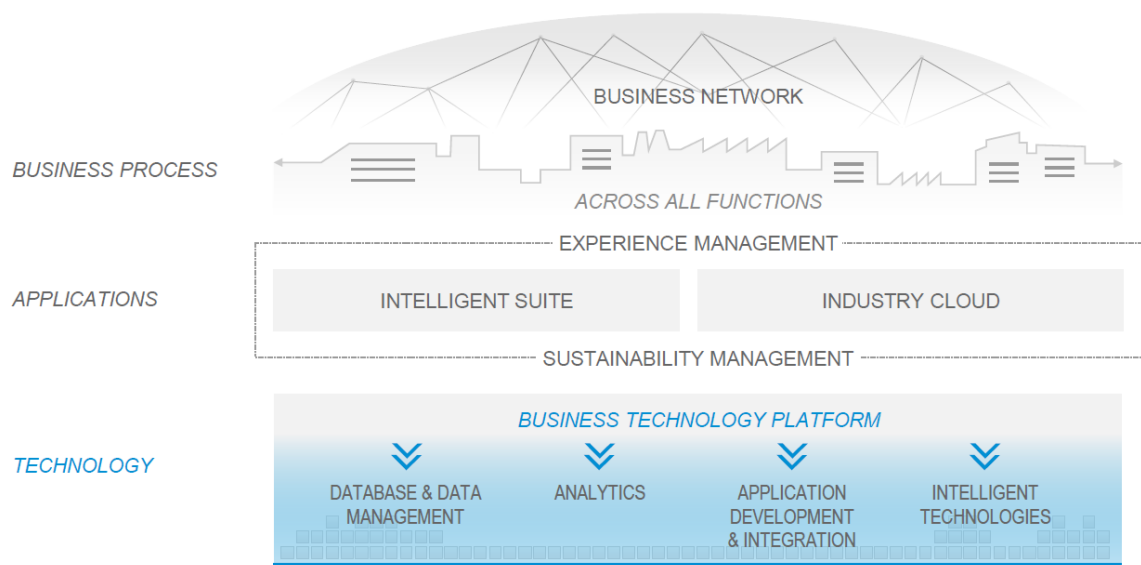

Figure 7: Intelligent enterprise resource planning, Source: SAP

3.5.5 Overview of Business Processes supported by ERP

A business process is a combination of activities and transactions that an organization conducts regularly to achieve business objectives. It can be simple (i.e. order fulfillment) or complex (i.e. new product development), short-term (i.e. employee on-boarding) or ongoing (i.e. regulatory compliance), function-specific (i.e. proposal management) or industry-specific (i.e. energy procurement). It can exist within a single department (i.e. billing), run throughout an entire enterprise (i.e. strategic sourcing), or extend across the whole value chain (i.e. supply chain management). The most innovative businesses are now embracing new business models and processes that drive superior value for their customers and employees to compete and win in a digital economy that is filled with challenges, opportunities, and risks.(36) ERP adoption needs a closer look at all the existing processes, with determining what works well, what can work better, and what the future needs of a specific organization may look like. While this evaluation can create opportunities to improve existing workflows, when a manufacturing company plans an ERP implementation, the primary motivations being business transformation, business process harmonization,

and the technology upgrade eventually lead to the replacement of the legacy system.(8) 77% of the world's transaction revenue touches an SAP system. SAP 's end-to-end suite of applications and services enables more than 440,000 business processes and public customers to collaborate and operate profitably, adapt continuously, and make a difference.(43)

3.6 Overview of a competitive system for System Historicization

At the moment, companies are heavily in the process of digitalizing their businesses to compete in the market. To support such an initiative of moving data to a digital core, several intelligent Migration platforms are offered by various vendors. In the context of this project, the shortlisted option for migration platform will be discussed below:

3.6.1 JiVS IMP

Data Migration Services AG was founded in1996. Headquartered in Kreuzlingen, Switzerland they started implementing the first projects locally where the approach was to migrate data from a mainframe system to a client-server technology in SAP. But the approach was only to move the required data to the new system until they come up with a solution where you can access the not migrated historical data out of the legacy systems. In the beginning, it was a Freyberg approach while by 2008 it evolved into a standard software package that led the prologue in simplifying their client businesses into an agile and intelligent enterprise.(3, 42)

3.6.2 Present state

JiVS IMP came into the limelight when it was nominated for the first time in Gartner's magic quadrant in 2014.(3, 42) By 2019, Data Migration Services AG already established its fame in the international market in their domain of migration services. Also known as Data Migration International they launched their JiVS IMP (Information Management Platform) which can load the data from any legacy system like Oracle's JD Edwards or SAP's ECC with just one click. The platform can manage structured and unstructured data and support multiple clouds and databases.

To answer the common question of what happens with the non-migrated data, the JiVS platform helps by loading the whole data to meet the compliance requirement and further decommissioning the legacy systems to eliminate the cost, the risk of maintenance and to have an easy possibility to access the data in the future with the JiVS platform meeting the cybersecurity on one single platform instead of multiple and different systems in the past. By doing this, the operational data and the historic data can be separated, and this is a fundamental strategic element of a company's success. JiVS IMP (Information Management Platform) is the third generation of software from the company Data Migration Services. The platform is the successor to the component-based prior version JiVS and especially to JiVS History, the most widely used component on the market.(15)

3.6.3 Advantages of JiVS IMP

Data Migration Services AG Services has been nominated for the implementation of their platform to be "game-changing" by Gartner having a professional experience of over 20 years with a gradually growing client base and 1000 real-life implementations across the globe. The platform is quite open for any modifications of any external components like AI, IoT, big data management, data analytics, continuous API development, etc. backed by its inbuilt retention manager capable of dealing with the EU-GDPR requirements and other Code of Obligations. Therefore their solutions are aimed to take the JiVS platform to the next level of commitment for its users.(3, 42) The platform offers, as standard, a wide range of interfaces to legacy systems from multiple providers, including Baan, Microsoft Axapta, Oracle ERP, Peoplesoft, and of course SAP. JiVS IMP can be implemented both in an in-house data center or in the public cloud. Supported environments include Amazon Web Services, the Google Cloud Platform, and Microsoft Azure. At the same time, customers can choose from a variety of popular database management systems (DBMS), from IBM Db2 to Oracle Database and Microsoft SQL Server to SAP IQ. JiVS's approach is to migrate only the needful master data and open items to the new ERP system hosted in the cloud or on-premise in their best quality at the press of a button. The data volume to be migrated can be reduced to the minimum. All historical data archived in JiVS IMP can be easily accessed over the years even with old legacy systems being turned off.

Why JiVS solution is an intelligent end-to-end information management tool?

- It is capable of proven large enterprise-level data extraction from any source system and delivering cloud deployment models with a strong focus on defined use cases: Application Decommission and Re- Platforming.
- Data storage fulfillment is capable of 100% of continuous relevant data migration and contributing to the lifecycle of data until the retention period.
- JiVS IMP's retention manager provides all the functions needed to meet the requirements of the EU GDPR for any type of legacy system.
- Promotes improvements to data quality with data governance on a centralized platform increasing operational efficiencies.
- Access via predefined business objects in the same data scope is possible while maintaining data quality and compliance.
- The structured mapping capability allows the configuration of dependencies between all sorts of business objects.
- Utilizing predefined as well configurable business objects the end-to-end scope of the managed data sets up the base for maximum transparency.
- Customizable environment for specific needs of an organization and allows integration of third-party applications.
- Fully functional support for SAP HANA; can retrieve object list with SAP and JiVS results
- Data available in accordance with IDW PS880 standards, i.e. when used properly, will enable accounting in accordance with the principles of proper accounting. Certified by auditors, it forms the foundation for 100% legal compliance while

providing 100% access to information for which there is no immediate operational need.

- It has over 2000 business objects in enterprise solutions and over 1200 for SAP systems alone which helps companies to transfer 100 percent of their historical data and documents from legacy systems.

JiVS IMP provides legal certainty across all legacy systems. However, the potential benefits are far greater. The ability to manage the entire lifecycle of corporate information is not limited to personal data but can be applied to all information, whether it originates from commercial systems such as ERP and CRM solutions or technical systems such as PDM or PLM. This also makes it possible to manage the lifecycle of the companies' crown jewels, their intellectual property, seamlessly and much more securely than in the legacy systems. This is because a central platform is easier and more effective to protect against cyber-attacks and to shield against vulnerabilities than many legacy systems, even if patches are supplied for these regularly. The approach of the JiVS solution that is offered currently, can reduce the IT operational costs by 80% or more compared to the operating costs for legacy systems and can lower the effort for data migration by 50%. This results to a much more agile IT landscape which can support a wide range of business requirements with a minimum of effort.(3, 15, 16)

3.7 Research Questions

1. Retiring legacy systems can be challenging. What is the scope of a historicization project?
2. How to retire a legacy ERP application and still keep the data easily and inexpensively accessible for reporting, regulatory compliance, and regular business needs? How do we access key information after the application has retired?

4 Practical Part

Involvement of the Author in the VW project entitles him as an intern in Skoda auto a.s. to support in project management and implementation of the JiVS pilot project FIC2007 by taking part in Proof of Concept, systems training organized by Data Migration International, preparation phase, software implementation, ROI calculations, and delivery. By participating in this project, the Author will be able to address research questions formulated in the literature review.

4.1 Current state analysis

4.1.1 Background of the organization

Škoda Auto a.s. is a well-established automaker in the Czech Republic founded in 1895 as Laurin & Klement and is now a complete subsidiary of the Volkswagen group of companies from 2000. Being a manufacturing company Volkswagen AG relies on ERP ecosystems heavily to compete in the prevailing market to avail better management of the manufacturing processes transformed to achieve effective seamless production engaged with sales, finance, and customers. SAP SE is the major provider of dedicated ERP solutions for VW. Škoda IT services are divided into two parts. SAP Group Competence Centre (GCC) provides VW internal clients different SAP ERP solutions and IT projects while Škoda internal IT services is offered by Škoda FIC.

4.1.2 IT methodologies in VW

VW internal IT methodologies are known as IT-PEP. They are prepared based on the template/framework for best practices of ITSM termed as ITIL3. IT-PEP is built on PRINCE2 project methodology and optimized for VW project management. It has two kinds of process models. The new and strongly recommended model is based on Agile while the standard Waterfall model is used where we know what we want (target systems), how to do it (migration tools), and, what to achieve (migration source). IT PEP contains guidelines for all project phases and templates for mandatory documentation within Škoda auto (for general reference *see section* 8.2). IT-PEP defines a pilot project to be a time-limited activity undertaken to create a unique product or service limited by three interacting attributes - time, scope, and cost. The project has a set start and end dates, has a set goal, quality, schedule, and phases. All key and child milestones, minimum assignment requirements, risk elements and constraints and required delivery components must be bonded within the guidelines.

Based on their cost, the projects are divided into four categories A-D according to IT-PEP. The classification of the project into one category takes place in the pre-project phase and the finalized with tailoring of the project.

Category	Project Budget
A	The cost of the project is more than € 4,000,000
B	Project costs are greater than € 1,000,000 and less than € 4,000,000
C	Project costs are greater than € 250,000 and less than € 1,000,000
D	The cost of the project is less than € 250,000

Table 1:Project Budget, Source - Author, as per VW IT-PEP

4.1.3 Scope of the problem

Housekeeping of SAP systems is relatively expensive since it requires the regular implementation of enhancement packages, service packages, SAP Notes, maintaining the security of data, and other activities. It is economically advantageous to migrate needed data to some standard storage (viz. MS SQL, Oracle). VW had been planning on system migration from 2019 but due to reasons like change management in organizational level, the project was postponed. Finally, to meet the business needs and operational budget VW group finalized a goal to establish a platform for decommissioning several SAP systems within the VW group by early 2021. The correct strategy for VW is to engage an internal resource to clean up legacy data to avoid a drain on the budget. For this purpose, a competitive contender from its group of companies was chosen. Then, the systems that are not used productively anymore will be grounded. But the relevant user data needs to be stored for legal requirements until their considered retention period. For this, a migration platform needs to be outsourced from the market options hosted in the internal client's IT environment. It will serve for decommissioning the systems spread within VW Group in the future. After a migration, data will be stored in the platform's database and accessible to the client. Further, the legacy systems can be turned off. Initially, there are no connections operated between any migration platform and any other legacy systems to be migrated within the VW IT environment since such a platform was not established until 2020.

Strategic planning is an organization's procedure of defining its strategy, or direction, and making results on distributing its resources to follow this strategy, as well as its capital and people. The following SWOT analysis depicts on what grounds VW chose Škoda to be their internal client offering data migration and system decommissioning services by hosting some external migration platform.(44)

Strengths	Weakness
1. VW Group is one of the largest automakers by sales with a huge profit margin. 2. VW has a big multinational market as well as subsidiaries resulting in wider business opportunities. 3. Brand Recognition by the world's market.	1. IT Systems within the VW group of companies are being updated frequently to stand comparative to the market ending up stacking immense data and legacy systems behind. 2. Although the Governance within VW has central mandatory parts, Data Governance and compliance are country-specific crucial terms business data from various sources must oblige to.
Opportunities	Threats
1. SAP Group Competence Centre has been set up in Škoda and successfully delivering SAP solutions to the VW group. 2. SAP GCC department in Škoda has experience with Data Volume Management, Data Archiving, and disaster recovery for ERP solutions. 3. Expense of labor for similar experienced professionals is lower in CZ in comparison to Germany.	1. IT Budget can be compromised. 2. Useful business data being lost, or damaged can cost several million. 3. Cyber threats and security of data in legacy systems that are incompatible with the security patches are a big issue. Also, migration pilot project will have first time Authorization settings which must be deeply tested in connection to business rules and GDPR to be perfect.

Table 2: SWOT Matrix, Source: Author, as per Škoda guidelines

4.1.4 AS-IS

Škoda GCC being chosen as the provider of application shutdown services, all other departments within Škoda and all subsidiaries of VW group are its clients. Departments outside Škoda are in different networks, separated by firewalls and Demilitarized Zones. All business functions within these departments have their own ERP systems and plugins which may need to be replaced. In the context of this thesis, we will discuss the pilot project where VW wholly owned luxury car subsidiary Audi AG is the first internal client with its AP1 system destined to be retired. Here, the SAP R/3 4.6 is the AP1 system that is not used productively anymore.
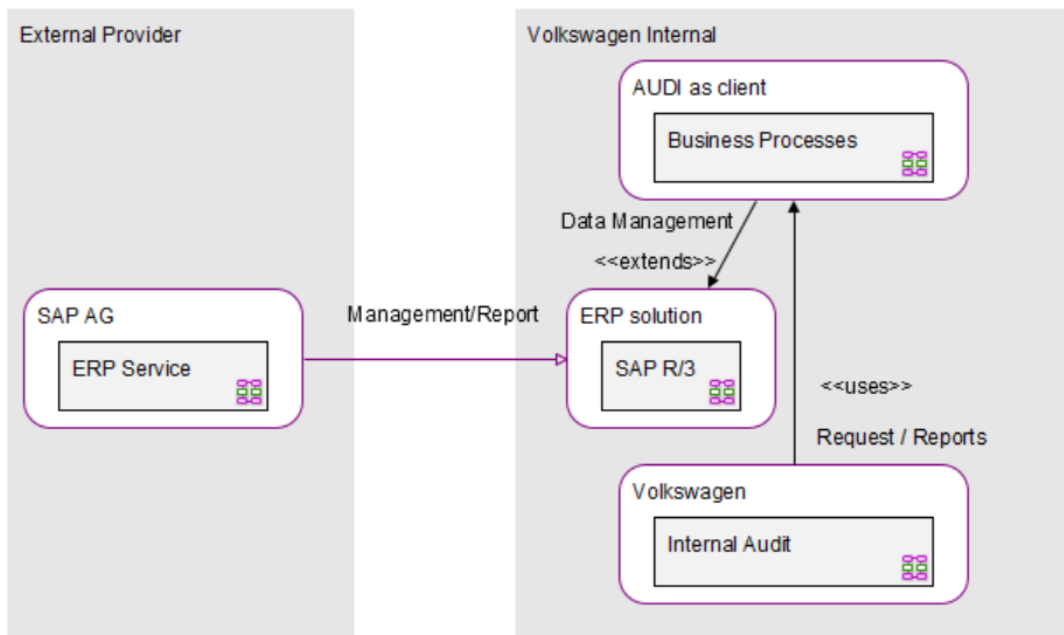
Figure 8:Current State/ AS-IS Architecture Model, Source: Craftcase tool, Author

4.2 Requirement analysis

This service provided by Škoda consists of technical setup, data migration, and application support until the end of lifecycle of data, while responsibility for the correctness of retention periods and data selected (in case of selective approach) remains on the customer's side i.e. Audi.

4.2.1 Overview of selection criteria for migration platform

VW had a set of requirements which were the key performance indicators and must be met, to get selected as the migration platform. The Knock-out criterions are as follows:

1. Solution must support Application Retirement along with Data Migration, Document Archiving, Data Provisioning and Retention Management in a single product.
2. Experienced solution to historize non-SAP Systems like JD-Edwards, Lotus Notes, Jira, Oracle Baan, etc.
3. 100% data availability to ensure zero risk.
4. System capable of providing data compliance based on several geolocations: like fulfilment of German audit standards (IDW-PS 880, GoBD, GoBS), along with GDPR
5. Competitive Price and service support; VW aimed for a solution with lowest budget possible.
6. Predefined views to access ERP data which customer wants to retain from their legacy system as features to the new migration platform.
7. Neutral data format, readable with standard software for average business users.(44)

4.2.2 VW client AUDI requirements

Audi governance team was requested to provide their list of requirements for the connection setup. A change request form was prepared for this request, with the following attributes.

Parameter	Attributes	AP1
Legacy System	Name of Manufacturer	SAP
	Location	Audi, Ingolstadt
	Installed Version	R/3 4.6c
	Internal Business Knowhow available	Yes, *Keyuser per used Module*
	Internal technical Knowhow of Legacy System available	No
	Name the used business modules/areas	SAP FI, CO, SD, PP, MM
	How long must the legacy data be kept?	Finance data 10 years, material info 10 years
	Data privacy relevant for GDPR, CCPA, etc.?	Yes
	Deletion of personal data according GDPR, CCPA?	Yes
	Number of legal entities within System	1 Mandant
	Standard Content available	SAP ERP
	Expected category of application	Advanced
	If Advanced expected number of complex reports	*unknown*
Database System	Name of Manufacturer	IBM
	Installed Version	DB2 v9.7.0.4
	Volume of Database in Giga Byte (uncompressed)	150 GB
	Database compressed Yes/No	Yes
	Number of tables?	31131
	Internal Database Knowhow available	yes (DBA)
	Used character set	ISO 8859-1 (Code page: 1100)
	Multilanguage support	DE / EN
	Network connectivity	1 Gbit/s
	Database access possible	Yes
	If no direct access possible can CSV Export be made for Reports?	Yes
	Data is stored in a transparent form	Yes
Operating System of Database Server	Name of Manufacturer	IBM
	Installed Version	AIX 6.1
	Language	EN
Other	Number of connected archiving Systems	0
	Name of connected archiving Systems	*null*
	Number / Volume of stored documents/data	*null*
	Only if SAP: Are there ADK-Files and if yes do they need to be stored as well?	Yes, *35 files can be deleted because of out-of-date, rest must be stored*
	If ADK-Files must be store: Number and volume of ADK-Files	None
	Optional Data Verification between Source-DB and Target-DB	Not Required

Table 3:Questionnaire answered by AUDI for Project requirements, source: Author, as per Škoda guidelines

4.2.3 Data Preparation for migration

The potential first step is to perform housekeeping to get rid of the existing legacy systems to release the money and the resources and to sort data from the older systems. Secondly, we need to identify which working data shall be migrated to the newer application system (S/4 or C/4 HANA for instance) to continue business processes and which data needs to avail retention in the selected migration platform. After considering the high-value data, in a detailed design phase the data cleansing takes place and data quality is defined on an item level, redundant data is scrapped, and lastly one can then transform the best quality data into the target application for instance with the client's choice of transformation component that can be part of the migration tool or can be the SNP T-bone software or any other SAP landscape transformation partners from SAP supported clients. After that, we can proceed to load existing SAP system data to the new ERP system as well as needful historical data to the migration platform.

Škoda GCC is only responsible for copying data from the legacy system to migration platform chosen without any differences, while internal customers are responsible for data quality and transformation and, or to be defined by separate project terms. All technical preparation is accomplished by Škoda FIC with request of Škoda GCC.

4.3 Selection of solutions

Based on the requirements, supplier portfolio, and positive collaborations, four migration products were shortlisted for the knock-out. The shortlisted contenders for the migration project of VW were:
   a) ILM, SAP
   b) JiVS IMP, Data Migration International
   c) ViewBox, AvenDATA
   d) InfoArchive, Opentext

The criterions for VW have been outlined in the previous chapter which the stakeholders and/or decision-makers tend to value differently. Therefore, a Multi Decision Criteria Analysis (MCDA) framework is used for concluding from the complex decision-making situations with multiple and often conflicting objectives. First POC (Proof of Concept) was done in 2019 where JiVS solution was the winner. With cooperation of VW governance team Škoda GCC remade the POC considering updated market situation of migration tools.

The Analytic Hierarchy Process (AHP) is used to calculate the weightage of the criterions and guide in choosing the best product in the following steps:

1. Creating Hierarchical structure

   The criterions are based on the seven KPIs discussed in the previous chapter in selecting a migration platform. There are four alternatives, each alternative has their own value of criteria associated with them.
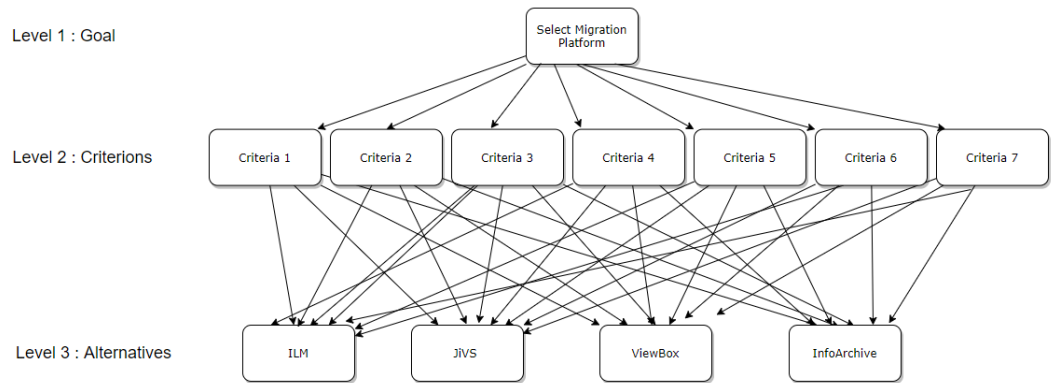
Figure 9:AHP- Hierarchy structure, Source: Author

2. Determine the relative importance of different attributes or criteria with respect to the goal based on the scale of relative importance.

How important is Criteria 1 relative to Criteria 2?	Index Assigned
Equal	1
Moderate	3
Strong	5
Very strong	7
Extreme	9
Intermediate Values	2,4,6,8
Inverse comparison	1/3,1/5,1/7,1/9

Table 4:Scale of relative importance, Source: Author, as per Škoda guidelines

The intermediate values can be used to represent shades of judgement between the five basic assessments. If the judgement confirms that Criteria 2 is more important than Criteria 1, then the reciprocal of the relevant index value is assigned. Then the pair wise matrix can be established filling any one half of the pair of the criteria. All criterions will always rank equally when compared to themselves, and the other half of the pair is just the reciprocal of the first pair. Knock out indexes 1 to 7 are criterions C1 to C7 (*see section* 4.2.1).

A1	C1	C2	C3	C4	C5	C6	C7
C1	1	1/3	1/5	1/4	5	3	2
C2	3	1	1/5	1/5	6	4	5
C3	5	5	1	2	9	7	8
C4	4	5	1/2	1	9	7	8
C5	1/5	1/6	1/9	1/9	1	1/3	1/5
C6	1/3	1/4	1/7	1/7	3	1	3
C7	1/2	1/5	1/8	1/8	5	1/3	1

Table 5: Pair wise comparison matrix, Source: Author, as per Škoda guidelines

In the above matrix the indexes were specified after consulting with Skoda governance team and project manager of JiVS Pilot project.

3. Determine the weights

Further we can standardize the matrix and calculate the weights for each criterion in the following steps:

    I.   Calculate the geometric mean of each row in the matrix
    II.   Total the geometric means
    III.   Normalize each of the geometric means by dividing by the total of geometric means
    IV.   Consistency check of the scores on each criterion was performed. The consistency ratio was below 10 percentage and therefore weights were acceptable.

A1	C1	C2	C3	C4	C5	C6	C7	Normalize	Weights
C1	1.00	0.33	0.20	0.25	5.00	3.00	2.00	0.905724	0.08
C2	3.00	1.00	0.20	0.20	6.00	4.00	5.00	1.463795	0.13
C3	5.00	5.00	1.00	2.00	9.00	7.00	8.00	4.253746	0.38
C4	4.00	5.00	0.50	1.00	9.00	7.00	8.00	3.380015	0.30
C5	0.20	0.17	0.11	0.11	1.00	0.33	0.20	0.223012	0.02
C6	0.33	0.25	0.14	0.14	3.00	1.00	3.00	0.550421	0.05
C7	0.50	0.20	0.13	0.13	5.00	0.33	1.00	0.427376	0.04
							SUM	11.20409	1

Table 6: Standardized matrix and weights of criterions, Source: Author, as per Škoda guidelines

4. Determine the best alternative

Now, to calculate overall weighted score a questionnaire was filled in collaboration with stakeholders to rate each criterion as per their importance.

Therefore, Overall Score = Rating * Weight

Rating	Description
0	No fit
0.5	Low fit
1	Fit
1.5	Good fit
2	Excellent fit

Table 7:Criterion Rating Chart, Source: Author as per Škoda guidelines

Decision Model		ALTERNATIVES							
		SAP ILM		JiVS IMP		Avendata		Infoarchive	
Criterion	Weight	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Criterion 1	0.08	2	0.161677	1.5	0.121258	0.5	0.040419	0.5	0.040419
Criterion 2	0.13	1.5	0.195972	2	0.261297	2	0.261297	1	0.130648
Criterion 3	0.38	2	0.75932	2	0.75932	0.5	0.18983	1.5	0.56949
Criterion 4	0.30	1.5	0.452515	2	0.603354	2	0.603354	2	0.603354
Criterion 5	0.02	0.5	0.009952	1.5	0.029857	1.5	0.029857	2	0.039809
Criterion 6	0.05	1.5	0.07369	2	0.098254	1.5	0.07369	2	0.098254
Criterion 7	0.04	2	0.076289	2	0.076289	2	0.076289	2	0.076289
Total	1.00	**11**	**1.729417**	**13**	**1.949628**	**10**	**1.274736**	**11**	**1.558264**

Table 8: MCDA score card for competing systems, Source:Author as per Škoda guidelines

From the table above, it can be observed that Data Migration product JiVS IMP was the winner and OpenText from Info Archive and ILM from SAP were the close competitors. These values were made as of 2020 and market situation is changing every time. However, the deal of JiVS solution was a perfect match to VW's requirements of low-cost multipurpose information management platform. Initial cost of JiVS solution is very high but over the years there will be significant saving of resources as the legacy systems go offline.

4.4 **Implementation of JiVS IMP within Škoda Enterprise**

JiVS Intelligent Management Platform is a new customizable out of the box solution selected for the retirement of SAP or non-SAP systems of companies within VW Group. As per requirements of Volkswagen, JiVS is a specialized solution for:
1. Data Migration
2. Application Retirement
3. Retention Management (topics are discussed in the previous chapter)

There are two migration possibilities:

1. **1:1 migration** - all of the data from a legacy system are migrated into the JiVS platform (the usual approach of the basic table view, and in the context of this project)

2. **Selective migration** - data for migration selected by applying a filter on a specific client, business objects, tables, attributes, and, records (selecting two tables with references and SQL functions possibility, or creation of customized programs with its own formatting.)

It works with both structured data (tables) and unstructured data (documents). It provides retention management and a tool for data identification (to find a data related to specific business object). JiVS has more than 2000 predefined reports for both SAP and non-SAP systems. Reports cover standard auditing requirements - it has passed the certification regarding IDW PS880 auditing standard. In case of customer's need it is possible to create additional reports which is done by JiVS internal tools, JiVS View Designer and JiVS Report Writer.(45)

4.4.1 Proof of Concept (POC) Estimation

Here, Škoda Auto a.s will play the internal client for hosting the JiVS platform for all of VW group. SAP is an interesting partner of Data Migration Services AG as SAP leverages the JiVS approach for their customers, Škoda Auto a.s. and Volkswagen Group in this case. Despite various use cases of JiVS, a system retirement will be used only (the others being system rightsizing, mergers and acquisitions, transformation to SAP S/4 HANA and securing GDPR compliance). Out of all the tiers from a legacy system landscape only a productive system is relevant, which means that development and quality/test systems tiers will not be considered for this migration. The current architecture model of Audi's AP1 system corresponds with the architecture of a legacy system (SAP R/3 4.6c) to be migrated into the JiVS platform. In Škoda, the JiVS platform will be created using JiVS IMP software running on an application server linked with a standard database (MS SQL). Initial expectation of data considered to be migrated was 150 GB in SAP storage format and compressed. Access to migrated data will be provided by JiVS web browser-based user interface. Data migration enables a legacy system to be turned off completely. JiVS IMP will be the only location where the data will be stored until retention. The platform will not be business critical. Access to data is rare, not on daily base (mainly in case of audit). There will be a limited number of users with access to data. The platform runs on its own, not linked with any other systems (except connection with a legacy system during data migration). This implementation provides remarkable running costs savings which were calculated referenced in chapter 5. Based on IT-PEP, service agreements were prepared after POC with all the stakeholders. Service Level Agreements (SLAs) defined the service requirements from the business perspective while Operational Level Agreements (OLAs) and Underpinning Contracts (UCs) are to make sure those service requirements are fulfilled from within the IT organization.(44)
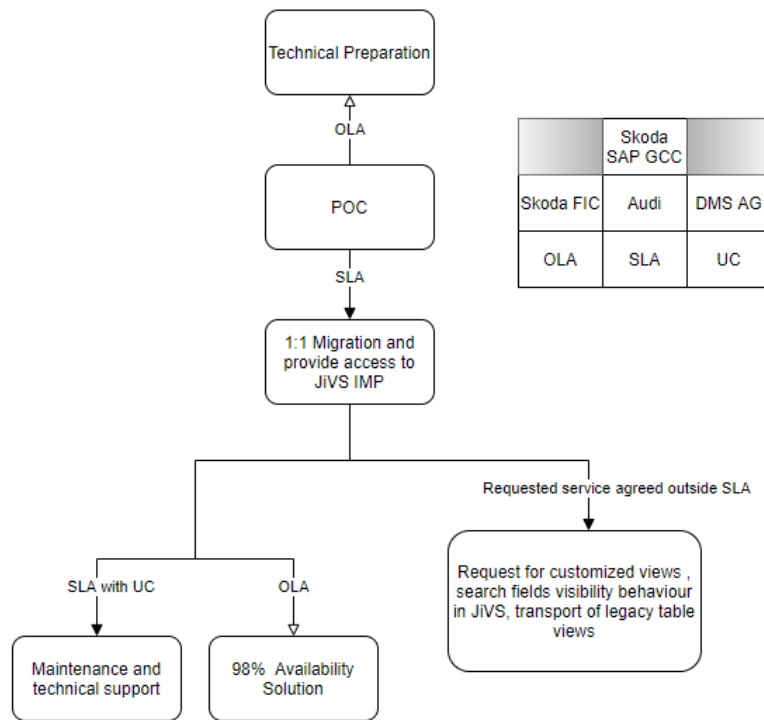
Figure 10: Service Agreements, Source:Author, as per VW IT-PEP

4.4.2 TO BE

The JiVS migration projects fall in category D which are small with project budget lower than 250,000 Euros and based on the waterfall model described in IT-PEP. Migration from a legacy system to the JiVS IMP platform is done by the JiVS migration tool.
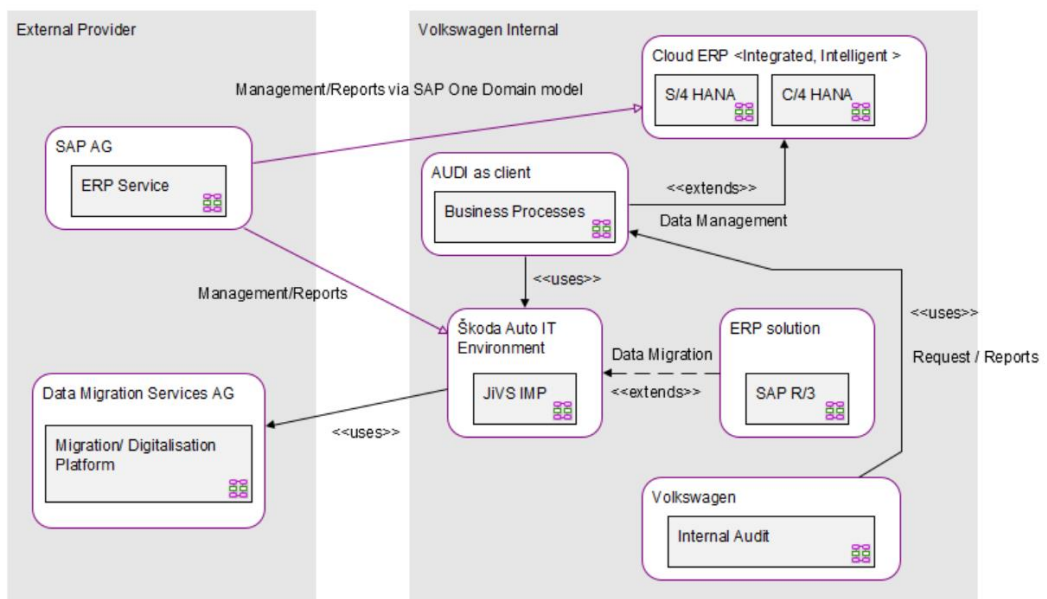

Figure 11: To Be Conceptual Architecture, Source: Craftcase Tool, Author

JiVS is a new customizable out of the box solution used for the retirement of SAP or non-SAP systems of companies within VW Group. The JiVS platform is hosted in Škoda network. The AP1 system is a SAP R/3 4.6 ERP instance which was not productively used anymore and required useful data from it has been already migrated to SAP S/4 HANA and C/4 HANA by different project. In this pilot project only, legacy data will be migrated and the AP1 system will be shut down. The project guidelines don't include any data transformation or data retention as well as target system shut down and is responsibility of the client. Here Audi takes responsibility of data quality, redundancy, type, etc. as well as definition of retention period and rules. This has to be done in cooperation with DPO or GDPR consultant. Also, AP1 system will be shut down by Audi once access to JiVS IMP is available with correctness of solution delivery.

4.4.3 Decommission Preparation

IT preparation for the JiVS Application within Škoda are as follow:

1. High Availability Solution

Application and Database Servers will be doubled to back up twice from two locations while the content is being shared. This addresses to the readiness of a Business-Critical Service for an Enterprise Environment. 100% Accessibility at all situations is the goal. Server virtualization is prepared with VMware virtual systems. To utilize resources thoughtfully, this is optional as of now and can be implemented at minimal notice.

2. Network Architecture

Škoda and Audi are in two different enterprise IT environments separated by several firewalls which makes it complicated for any kind of data transfer in between. Special exceptions in connections in between firewalls were requested and accomplished from client and provider end, respectively. Local Area Network of client having target system and target users were needed to be established with Jivs terminal implemented in Škoda Network with several trials and errors. Data transfer in between large organizations was a major challenge for Data Migration Internal as a first of its kind project for them. Addition of new servers for database and application in an Enterprise Environment was also complicated to establish due to several zones in the local networks of Škoda Portal. There are several Demilitarized Zones having several numbers of servers within VW and in-between every DMZ there are internal files with rules. Every individual application server needs to be modified to the rules to let it bypass through several firewalls within VW environment and Škoda Portal which is an extreme large network with separate segments separated by individual firewalls.

Preparation phase in Škoda will include preparation of rules for the internal files and segments to able to connect through Škoda Network to JiVS Application Server. None of the internal moderators, users will be able to connect without the rules of all internal firewalls being set to connect, import, export data in-between. Corporate rules must be met using secured connections (https) and certificates must be updated

within the JiVS server to cooperate with Škoda and VW. Change management requests were made to establish servers in Škoda IT environment to host JiVS solution. Here, the target is the legacy system AP1 while source is JiVS IMP. The source servers have validity until one year and needs to be requested for prolongation. Port 3604 is SAP System Message Server Port while 3304, 3307, and, 3308 are SAP System Gateway Ports. All servers can be identified by their destined IPs. Application servers and web server in Škoda side are VMware machines hosted in Škoda IT. Systems communicate in between themselves by these I.P. addresses and Ports and these Ports are needed to be opened. These special firewall requests are needed to re-validate every 1 year, through internal requests (*see section* 8.4).

| | High Availability DB servers | | | |
Source	Target	Protocol	Port	Validity
Skdambsvwjivsn1.mbs.skoda.vwg-10.223.96.159 <Production Server>	isap1dbz.in.audi.vwg - 10.250.22.175 <Production Server>	TCP-HTTPS	3604	1 Year
Skdambsvwjivs4t.mbs.skoda.vwg-10.223.96.159 <Test/Development Server>	isap1dbz.in.audi.vwg - 10.250.22.175 <Production Server>	TCP-HTTPS	3304	1 Year
	isap1as0.in.audi.vwg - 10.250.162.103 <Production Server>	TCP-HTTPS	3307	1 Year
Application Servers	isap1as1.in.audi.vwg - 10.250.162.104 <Production Server>	TCP-HTTPS	3308	1 Year

Table 9: Server Connectivity, Source:Author, as per Škoda guidelines

3. Complexities of SAP legacy system

SAP has several subsystems managed by admins, key users from the VW group covering all aspects of security, connectivity, end user accessibility, who will also define the rules for accessing the historical data from original system to the JiVS Solution. But the subsystem specific set of rules and administrative concepts must be unified which will be provided by supplier of solution. Here, original SAP system AP1 with its huge data must cover these unified set of rules provided by Škoda. One Project in JiVS server is the content of an original SAP system. Original key users will define the rules for accessing the to be historicized data AUDI governance team provided two user accounts to access their AP1 system. First one was Dialogue User to access transactions, tables in AP1 and the other was RFC User for data migration.
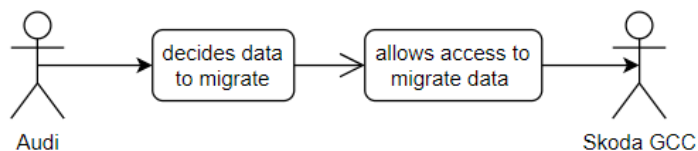
Figure 12: Legacy User hierarchy, Source:Author

4.4.4 Steps to transfer data

The steps to transfer legacy data as per the scope of Systems Decommissioning project guidelines within Skoda Auto is a plan driven process. It is customer's responsibility to perform housekeeping of their legacy system define data relevant for migration and its retention periods.

1. Housekeeping - It is customer's responsibility to perform housekeeping of their legacy system define data relevant for migration and its retention periods.
2. Customer fill in the predefined questionnaire- Information about a legacy system, such as type of SAP/non-SAP system and its version, modules used, data volume, information about database used for legacy system and so on must be shared. (*see section* 4.2.2).
3. Configure Scope of project - Identify data to migrate, special requests if any must be added to POC now.
4. Prepare the route to export data - connection to systems need to be prepared (*see section* 4.4.3)
5. Determine migration timing (Project manager is responsible to collaborate with client-side stakeholders)
6. Generate projects and data templates (to execute the export job)
7. Extract from the target legacy system
8. Decide on migration-related setups
9. Define data archiving policies and procedures
10. Load/Import the data to the source system (migration platform is source requesting Export and Import)
11. Shutdown the legacy system

However according to the scope of the pilot project of establishing a migration platform for the first time, following are the project phases (*refer to section* 8.1 for Project schedule):

1. SLA preparation including OLA and UC
2. Technical specification - document approved by ŠKODA AUTO
3. HW installation - done by FIO department (ŠKODA AUTO) in accordance with previously agreed architecture
4. SAP GCC Training - 4-day training with JiVS provider for SAP GCC employees
5. JiVS installation - installation of JiVS components on previously installed HW hosted in ŠKODA AUTO
6. SAP Plug-in prerequisites - preparation of customer's legacy system for data migration
7. System access - access into customer's legacy system for service providers
8. Data transfer and customer view setup - migration of a data and creation of new views for customer (incase predefined views do not cover all of customer's requirements)

9. Functional testing - test of migration correctness and ability to access data via JiVS
10. UAT - testing with customer's representatives to verify correctness of migration and access

4.5 Design of the solution
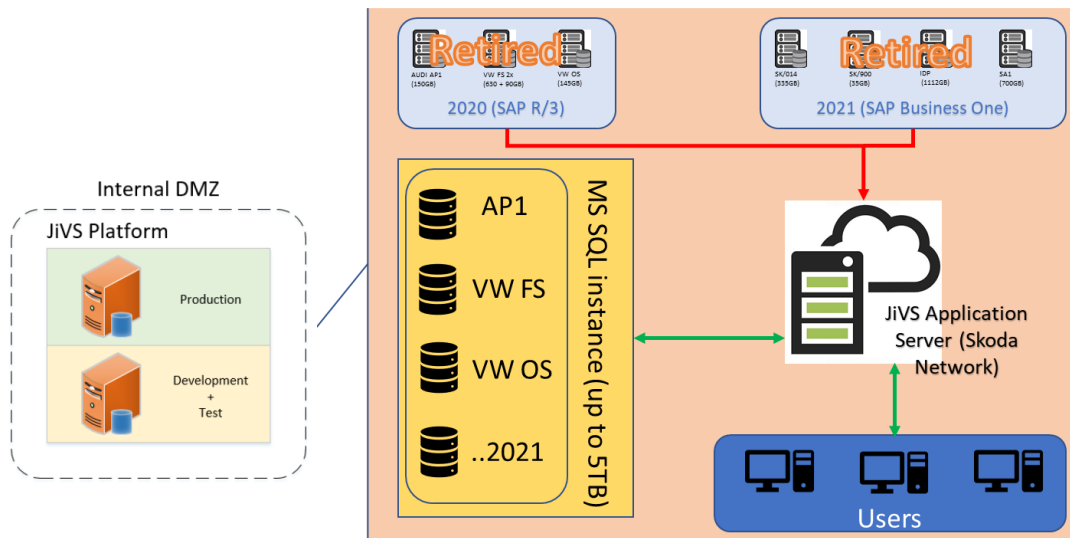
Figure 13Design of JiVS solution, Source: Author, Škoda guidelines

With establishment of the environment, connection between original system and JiVS Solution is made. In the source system the extractor tools (ZZJiVSPlugin, JCo) for SAP transport request is installed before migration. VMware JiVS application server running Windows Server 2019 is hosted in Škoda IT environment is linked to a single instance of MS-SQL database. There will be many systems planned to be historicized, but they will be divided into 1 Database of 5 TB as of now. Source and target databases sit on different networks and several firewall rules must be bypassed during data migration as discussed before. Users are provider (Škoda), client (AUDI), and vendor (Data Migration AG).

Prerequisites of JiVS IMP, which are always running in the back end.
- SAP logon pad - To initiate a user session in a desired SAP server (production, testing/development) and different SAP ERP environments <SAP GUI User interface>
- Citrix Jump Server – Allows connection to remote application server in a separate secure network zone
- Apache Tomcat v8.5 - HTTP web server allowing access to JiVS portal
- SAP Java Connector (JCO) - The JiVS-SAP-Plugins are called from the JiVS components JiVS DataTransfer and JiVS ViewDesigner via RFC function calls for which they use the SAP Java Connector (SAP JCo).
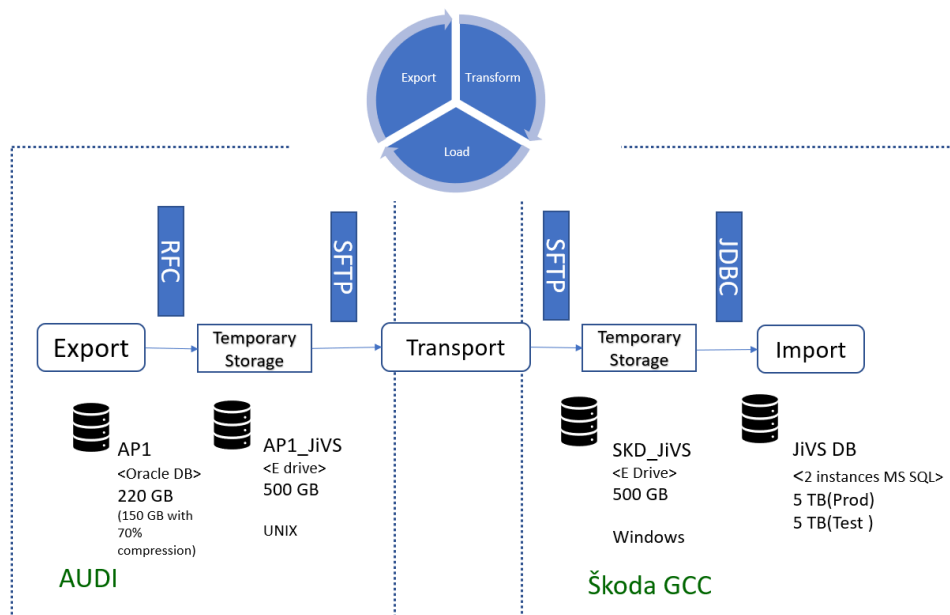
Figure 14: Connectivity of systems, Source:Author, Škoda guidelines

Data Migration service offers three methods of data transfer RFC, JDBC, and FTP. RFC connection is slow, but preferable since direct (CPIC Protocol). RFC was however not recommended by JiVS as it was found not easy to implement in VW networks. Again, FTP procedure is a complicated match for the VW internal firewalls rules because it was observed in between two different organizational IT landscape (Skoda and Audi) FTP cannot be established. Their second recommendation was to use JDBC to migrate data completely however it was not the case for the project. The solution to this was to use different connections where they are most comfortably applicable. Secured File Transfer Protocol can be used to transfer 1:1 copy of data after Export from SAP by RFC. Following data Transport, Import was performed through JDBC. For this purpose, temporary storages were created on both client and provider end and is destined to be shut down after completion of the pilot project. This is responsibility of provider, Škoda GCC team. Since direct access to AUDI test storage will be never possible SFTP was the easiest sorted way to copy and paste data directly from storage via Windows explorer. RFC connection is preferable as standard but direct data copying is an option through SFTP but slower. It was guessed specific for VW it would have been much easier to use RFC connection since FTP is complicated as it is seen during implementation requiring two extra steps.

JiVS Components are migration tools that work together to perform migration tasks and data archiving.

Component	Portability	Installation	Default Ports	Browser Support
JiVS IMP Application	High	Audi	9001	yes
JiVS BO-Server	Low	Audi	9004	yes
JiVS DataProvider	Moderate	Audi	9002	yes
JiVS IMP DataTransfer	Moderate	Škoda	nil	No
JiVS ETL	High	Škoda	nil	No

Table 10: JiVS Tools, Source: JiVS installation guidelines

4.5.1 **Export and Import**

In context of a step-by-step overview how this migration platform work, it is represented by the pilot project. Pilot project consisted of several tables to be transferred to JiVS Database. Here, we will focus only in one table called "MARA". It is one of the most common used tables in in SAP Logistics application which stores "General Material Data" data.

Table	Category	Module	Type	Columns	Transactions
MARA	Logistics	Material Master	Transparent (TRANSP)	309	MM01, MM02, MM03, SE11, SE16, SE38, SLIS, SPRO

Table 11: MARA table, source: SAP

Using the Dialogue connection, the MARA table can be overviewed. In JiVS application when connected with SAP system this table can be visible within the list of tables awaiting export or import.

Figure 15: MARA table, Source: SAP GUI

The JiVS-SAP-plugins use the local file system on the SAP-Server for all export files as default. Subsequently the files can be imported to the target database using JiVS DataTransfer. A new project is to be created, described in the following steps:

Step1:

Via Citrix Jump the application server hosting JiVS IMP (Information Management Platform) installed in Škoda side needs to be accessed for export duty. Then new project must be created within JiVS application portal to initiate export. Here, Database views can be also selected or defined from advanced settings.
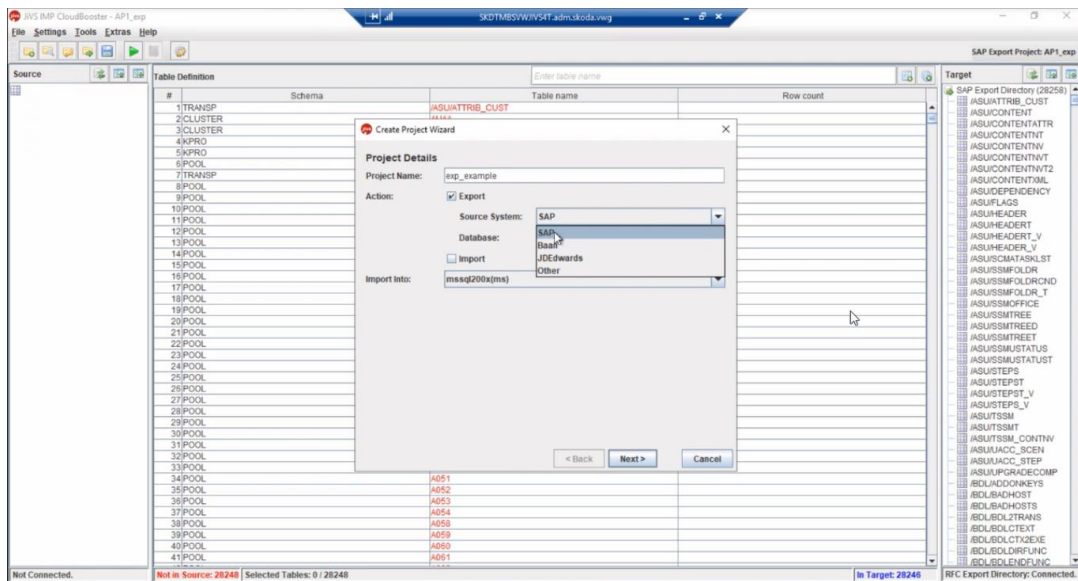
Figure 16: Project Creation (Export step 1), Source: JIVS Data Transfer

The test application server hosted in Škoda IT is used to run this application during pilot project test run. It can be noted that non-SAP systems can also be selected for data migration which was a top priority for VW while choosing the product. To choose AP1 system the RFC user login is used and the productive application server of AP1 is selected for data export. Export path is temporary storage, i.e. the data export will be further processed within AUDI IT landscape from SAP system AP1 to external drive created just for this cause. For license, selection is available in *development.jivs.com/JivsLicenseManagement.jsp.* This link takes the user to JiVS license manager where the licenses can be created, managed, updated, and, revived.

Figure 17: Project Creation (Export step 1), Source: JIVS Data Transfer
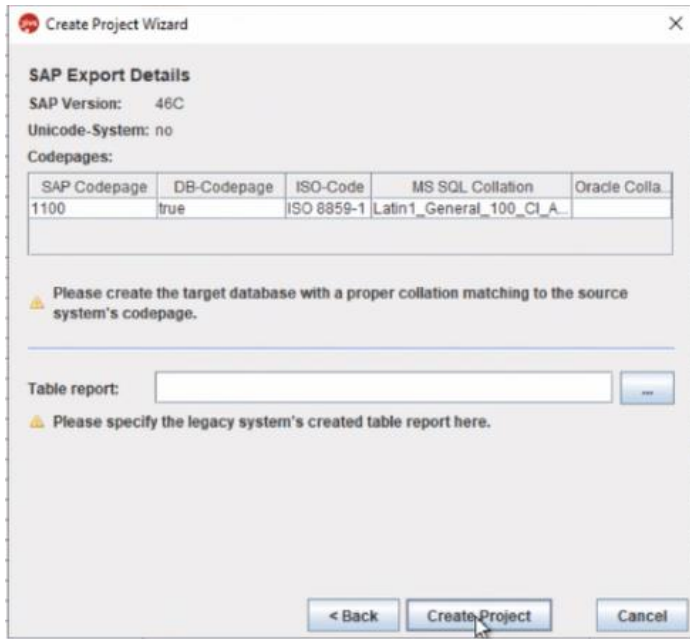
Figure 18: Project Creation (Export step 2), Source: JIVS Data Transfer

Here, the table report path can be selected for an existing project during modifying
Export or Import. This report is needed to create the JiVS Completeness Report
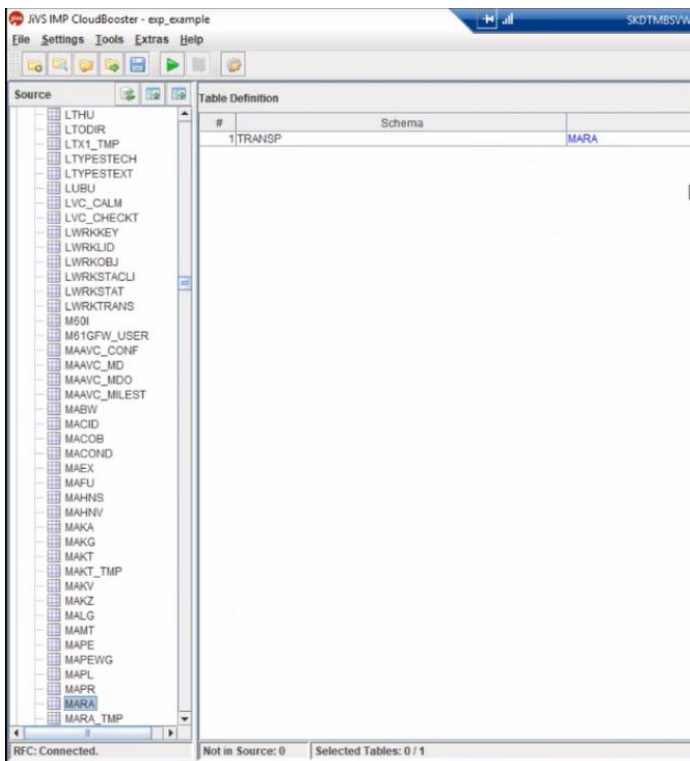which says if all tables are migrated successfully 1:1.

Step2:

Figure 19:MARA table in Target system, as viewed in JiVS Data Transfer

After creation of project, it can be modified as well. But when everything is ok MARA table is chosen and dragged into workspace from connected target AP1 system. The play button starts the export job and has a function to schedule if required.

Step3:

After Export is successful, exported data was transported to Škoda IT environment by means of SFTP from test drive in AUDI to test drive in Škoda. From, there data was imported to JiVS MS SQL Database. A new project was created, and table report path was linked to previously achieved report *"MARA.csv"* When correctly applied settings, system verifies target system and exported data linked to that. Here, host is the test application server in Škoda but, to save resources production database was use due to the pilot project being first of its kind in empty database.
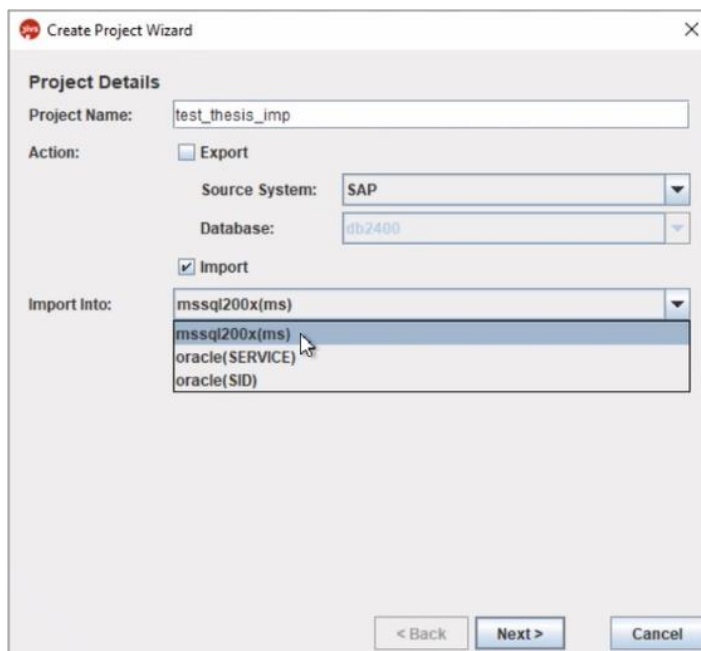
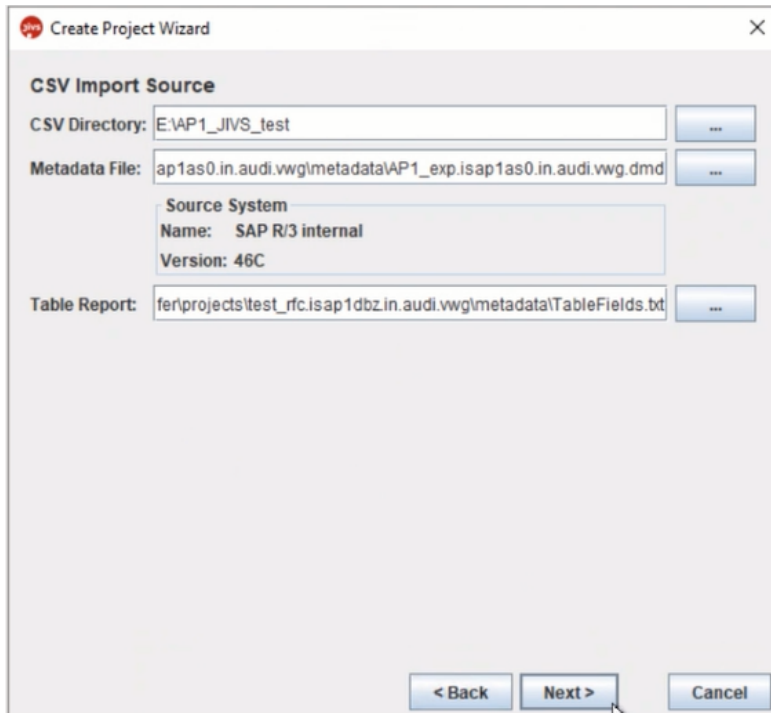*Figure 20: Import Project creation (step1), Source:JiVS Data Transfer*

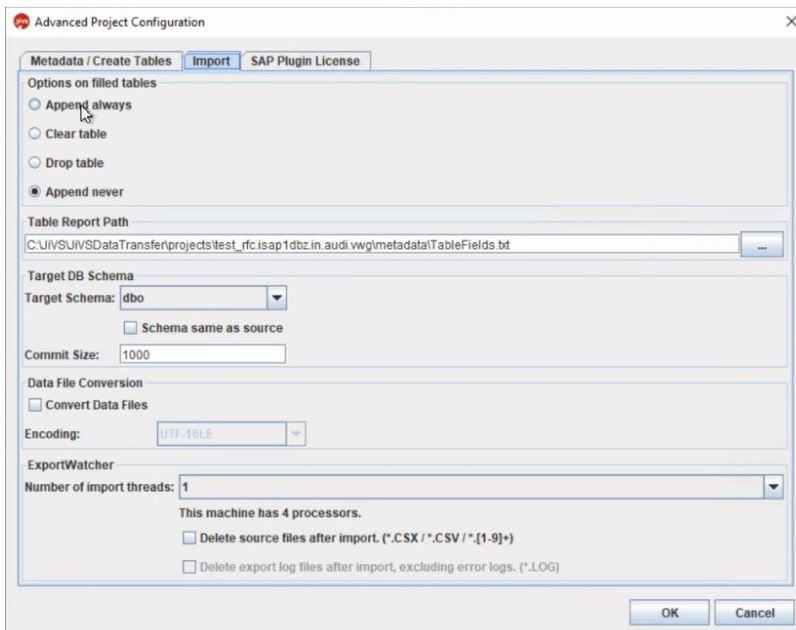*Figure 21: Import Project creation (step2), Source:JiVS Data Transfer*

Figure 22:Advanced Project settings,Source: JiVS Data Transfer

In Advanced project settings, table options like Create tables in JiVS DB, create Primary and secondary keys can be opted from. There are four Import options to choose from which decides what happens when the table in the target database contains one or more rows:

    i.   Append always
   ii.   Clear table
  iii.   Drop table

iv.   Append never

Select Append always since the import adds the data from export files to the existing data in the source table. Next MARA table will be dragged to the workspace from available list of tables in export directory and import will be started, with an option to schedule.

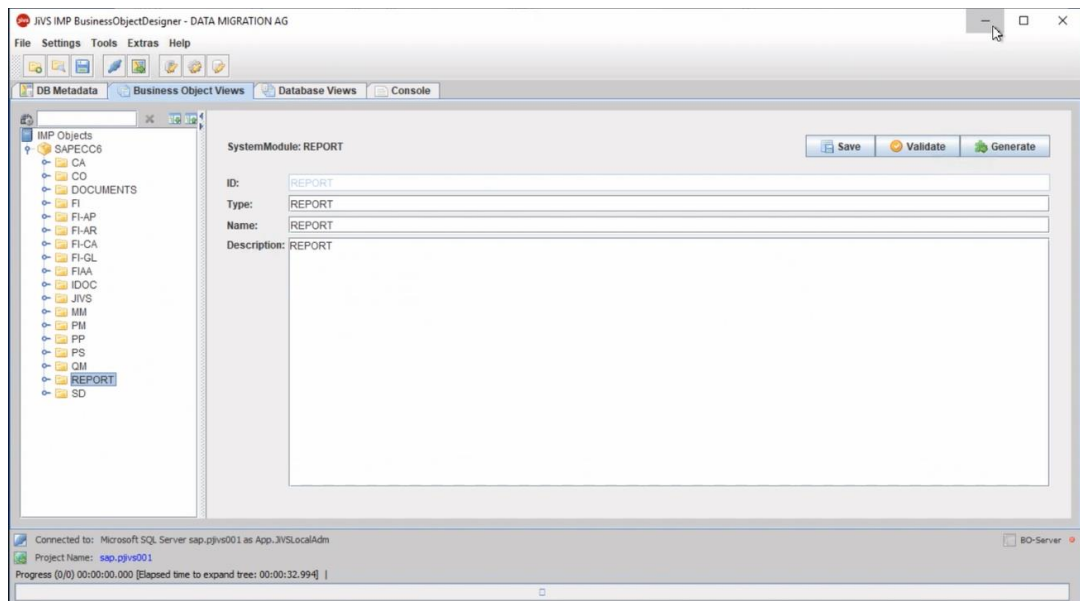## 4.5.2   Business Object Designer

Figure 23: Business Object Designer, JiVS IMP

The BusinessObjectDesigner can access all schemas of the database and generate content for it. The user can define a workspace when opening the Business Object Designer. The user can search for a value within the value assistance and it is possible to show the count in the table for each element. Default values for search fields can be defined in the project settings user interface. It is possible to Export and Import of several views in project manager.

Following configuration can be added to business objects and will be moved to runtime during view generation:

1   Default personalization
2   Custom SQL definition
3   View configuration file
4   View reference groups
5   JiVS menu and field configuration(45)

4.5.3   System Administration, User Management

Once the project is accomplished, export and import has been performed users can access these data through JiVS IMP portal via htttp://localhost:8080jivs/ from any web browser. For customers, a prior requirement is accessibility and user rights

creation. All possible system administrative functions and important information like projects availability, retention period, license expiration, etc. can be overviewed here. Therefore, all tasks related to data or table view, system management, etc. can be performed through this portal.
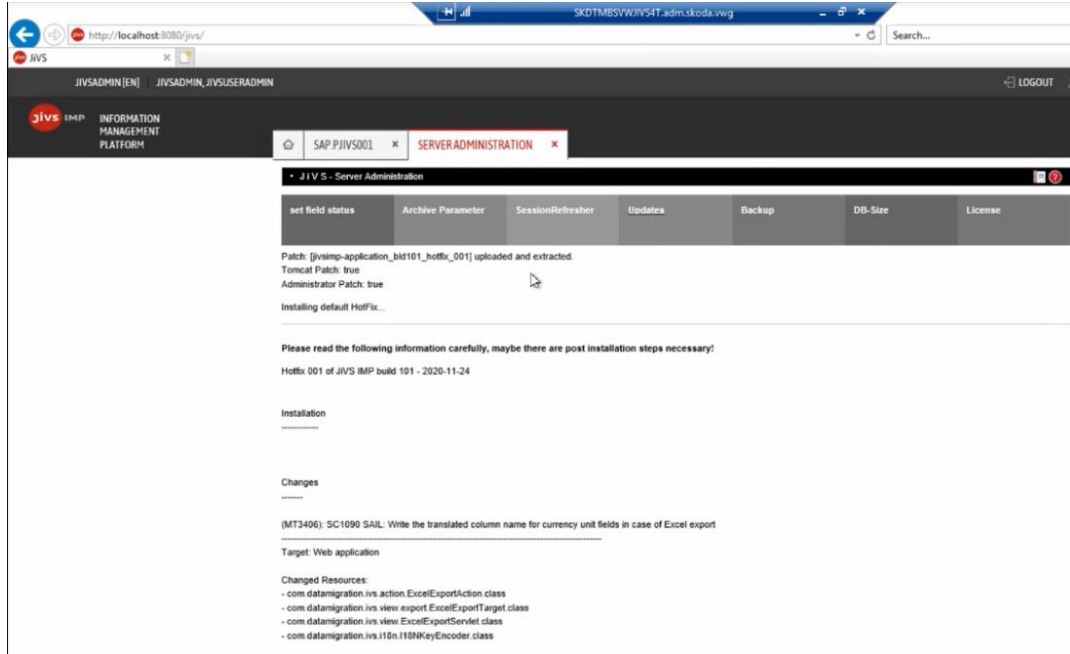

Figure 24: System Administration, JiVS webUI

5   Results and Discussion

Without errors and delays export job was accomplished in 4 mins 38 secs to be accurate. The table has 2 million rows. A comparison of results for test export task in the new established system is as follows.
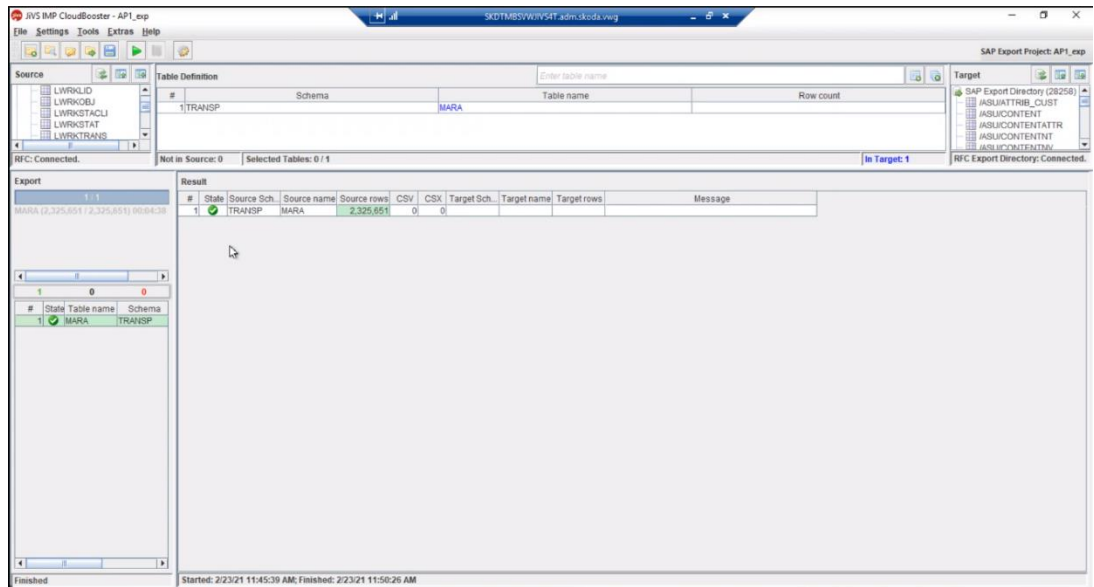
1.   Export Result
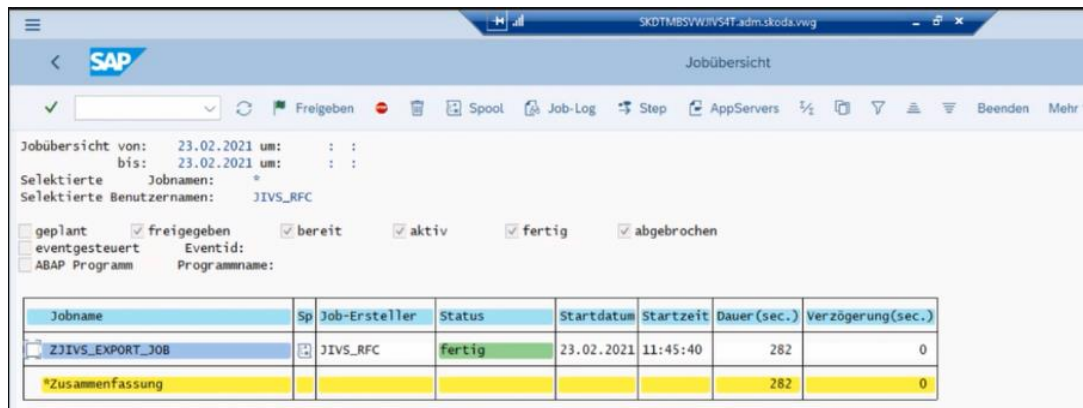

Figure 25:Export Result, Source: JiVS

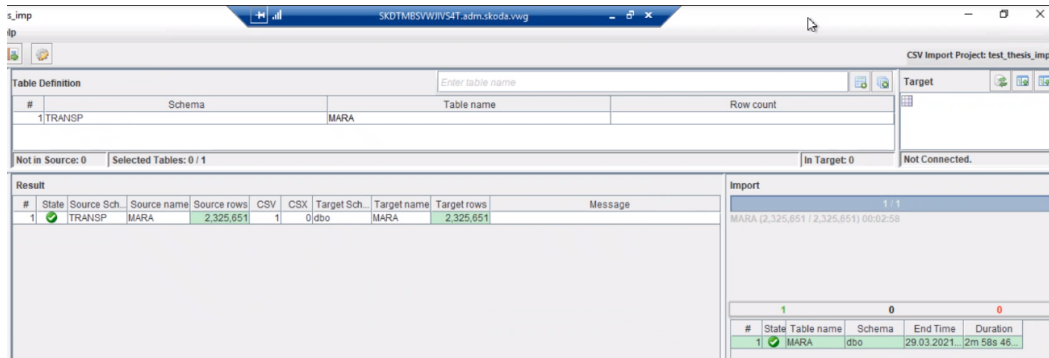*Figure 26:Export Result, Source: SAP GUI*

2.   Import result

Figure 27:Import Result, Source: JiVS

3. Completeness Report

The Completeness Report serves to verify that all the selected data is transferred from the source system to the target system (*see section* 8.4.1). It can only be performed on an Import project. Then we can determine the rows of the source system, and systems prompts destination database settings and credentials if not first time.
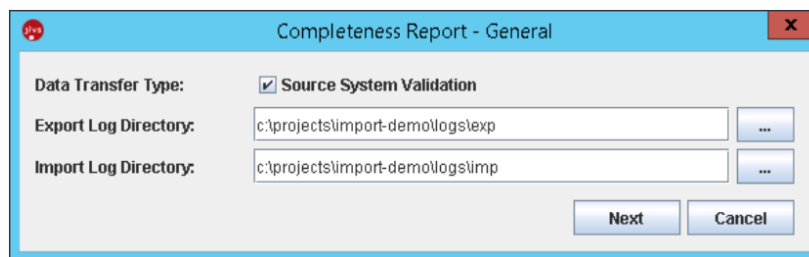

Figure 28: Completeness Report general settings, JiVS IMP

It can happen that the row count from the Import Log file don't match Export Log or if no Import Logfile is present the entry will be marked as failed. Therefore validation of Export and Import directories fail, and completeness report fails to generate (*see section* 8.4.2).

The Completeness report shows the following:

a. Success count of succesfull transferred tables/ total count of all data files
b. Warning count of transferred tables in warning state
c. Empty count of empty tables
d. Error count of errernous tables
e. Total size and average size of all data file summarized
f. Informs which is the table with the biggest file size.(45)

5.1 Evaluation of results

5.1.1 Functional Testing

The pilot project is yet to be delivered. Live accessibility to users in client side is not created at time of preparing this thesis. There were complications in allowing users from AUDI side to connect to JiVS application hosted in Škoda, and these problems were not thought of so vastly during POC of project. However, through screen sharing and remote access to screen first-hand project delivery was performed. Key users from AUDI participated and explored the system after onboarding was provided by Škoda GCC. Using JiVS web portal SAP tables are overviewed through different view settings and filters. If there are linked documents, those can be opened directly also.
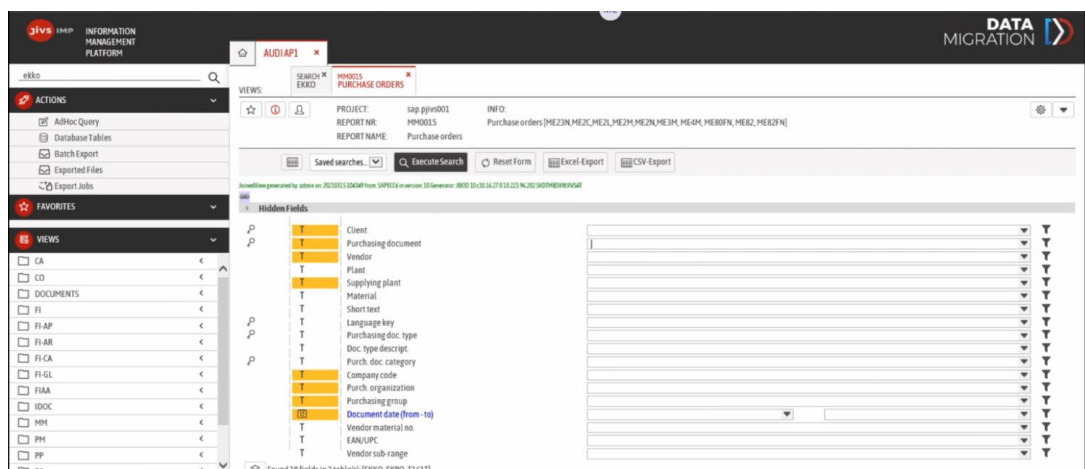
Figure 29:View settings, JiVS webUI

Here is an example in the following screen, from one sales order all connected business objects can be explored directly. (45)
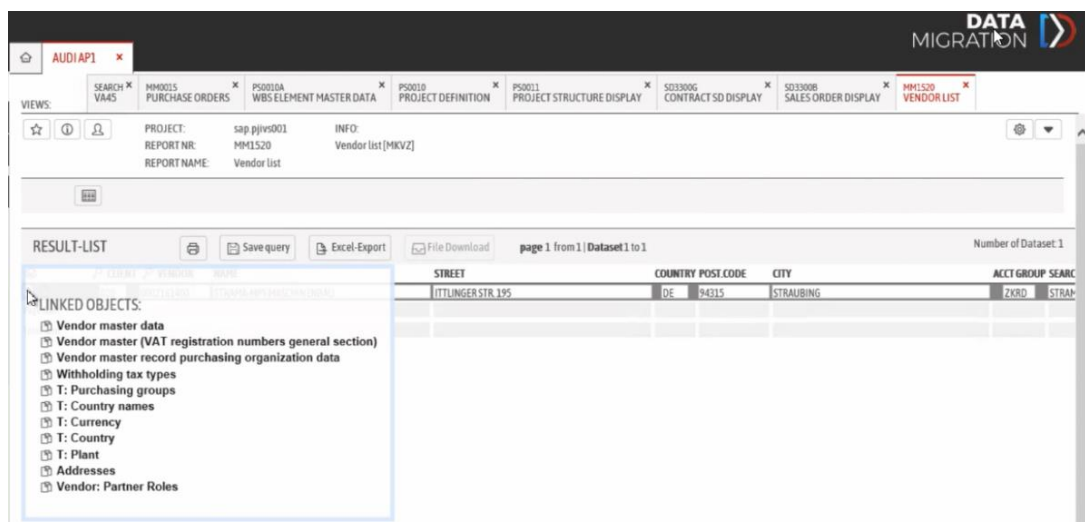
Figure 30:User table view, JiVS webUI

UAT will be closed officially from both ends once data archiving is live and provider signs off. For future lookups, it must be kept in mind only a part of data is looked up in the JiVS repository. The data is stored in long term visible format and can be scrapped when legal lifecycle of data is reached. (44, 45)

5.1.2 User case Feedbacks and Hotfixes

The pilot project has suffered lot of difficulties due to complexities in establishment of platform in-between to big organisations. The scope of these difficulties was not taken into account during the Proof of Concept. The epidemic of 2020 and its continued aftermath led further difficulties in communication and project delivery. Connectivity and Organisational Drawbacks were present but successfully addressed. Expected complete handover of project inclusive of training to client is in first week of April, 2020.

1. During Implementation problems with data transfer:

    i.   Export RFC connection was initially same as ABAP development connections, which had to be changed to a separate connection for data migration.

    ii. Export path was a confused topic, RFC was not suitable to do the complete migration. SFTP and JDBC with SAP JCo running in background was used for Export, Transport, and Import respectively. During SFTP transfer, problems were faced while using WinSCP regarding accessibility and firewall blocks to access ports which were addressed.

    iii. Miscalculation of disc space in source happened due to consideration of target system size based on its compressed date which paused the project until increment of DB partition size. JiVS team considered in POC data multiplier to be 1.5 at maximum with compressed data state in source system, which was not the case, it was almost 3.5 times the size of uncompressed AP1 SAP data. The huge factor of increment of data is because of database compression and clustered tables in target system that was overlooked. Also, several zeroes were added to frame tables according to source system due to difference in encoding with target which added to the size.

2. At UAT two negative feedbacks were recorded from client, both were resolved:

    i.   Orders concerning to the contract-number cannot be found. With change of general view settings this was resolved.

    ii. Problems are present with overviewing attached documents. According to POC the request didn't mention opening of documents. We need to execute Export and Import again to transport all attachments with tables. However, for financial documents some regulatory rules are applicable like archiving them the way they were. But archive systems don't need to generate balance but provided printable documents can be saved and make it cheaper.

However, JiVS have a plugin that may be installed to produce and view a balance sheet. All projects have an overview section which helps list out legacy systems being archived, and overview of the grid at a glance for the admins.

5.1.3 Quality Control

Any software implementation must be controlled for its quality of performance and adaptance. In Škoda SAP GCC the JiVS platform and pilot project was overviewed, controlled and, tracked for changes and updates. Quality Management in Škoda is normally divided into three process groups: Quality Planning (QP), Quality Assurance (QA) and Quality Control (QC). The Project Quality Management Plan was created after the POC The quality check was submitted twice and approved by the project manager. A documented template has been attached in the appendix for reference to the control measures and accepted variance for each point (*see section 8.3*). The Quality Assurance template documents the necessary information required to effectively manage project quality from project planning to delivery. It is defined in terms of the project's quality policies, procedures, criteria for and areas of application. Based on the criterias the quality of implementation was thoroughly reviewed once before delivery and after inital delivery with consideration of comments from clients. Based on IT-PEP quality tools like KPI Reporting, PDCA, Pareto Analysis and Fishbone Analysis used were use to measure specific attributes. Its intended audience is the project manager, project team, project sponsor and any senior leaders whose support is needed to carry out the plan for improvements from the findings.

5.1.4 Cost assumption of expenses and estimated ROI

Following is the cost of maintaining a medium sized legacy system. Here, miscellaneous expenses like cost of office space, electricity heating air-conditioning, etc. are not considered due to very low scale influence.

Provider of Service	Item	Cost of Service	Period
ŠKODA GCC	SAP BASIS support for mid-sized SAP system (also same for nonproductive system)	6,000 €	Yearly
	Extra cost for running productive system from SAP	1,500 €	Monthly
SAP AG	SAP R/3 (mid-sized for up to 100 users)	200,000 €	Yearly
	System maintenance (every system must pay for 21% of license cost)	42,000 €	Yearly
	SAP R/3 (assumption, when not used productively minimum price rule applies with SAP AG agreement)	100,000 €	Yearly
	System maintenance (every system must pay for 21% of license cost)	21,000 €	Yearly

	Storage DB (500 GB)	4,500 €	Yearly
	DB Maintenance	20,000 €	
AUDI	Supporting Architecture and Implementation Setup	10,000 €	One time
	Miscellaneous Expenses	10,000 €	Every 3-5 years

Table 12: Cost Assumptions of SAP R/3, Source: Škoda

Parameter	Factor
Number of users	0.90 per user for the first 10 users 0.80 per user for all users over 10
One-time charge	1.00
Monthly recurring charge	1.05
Maintenance included	1.00
Maintenance excluded	0.75

Table 13:Pricing factors example, Source: help.sap.com

The list price of an SAP is normally calculated based on the software license configuration and is obtained by multiplying the following:
a) Factor determined during configuration based on usage, supply, and charge parameters selected in the license
b) Pricing condition that is set in the master data.

The lowest eligible price is also according to the price protection rules if any applicable. Price protection ensures a committed price for a product or a set of products for a period of time. Price protection rules are determined in the contract with the individual customer, specified as a price agreement inclusive of enterprise discounts when applicable. For example, the HR module depends on number of employees, for FI or Procurement the KPI is number of end users on the system which defines the price tag. When the system is not used productively the license costs can be decreased with only specific agreement with SAP AG but is not an always true user case.

In contrast to the legacy systems costs, following are the costs of JiVS legacy solution.

Provider of Service	Item	Cost of Service (Customer's Expense)	Operating Expense	Period
Data Migration AG	1 License	30,000 €	30,000 €	One time
	Maintenance @ 16%	4,800 €	4,800 €	Yearly
	JiVS SW installation	3,500 €	3,500 €	One time
	JiVS training (Škoda)	4,500 €	4,500 €	One time
	Data Transfer and Import	25,000 €	25,000 €	One time
	View Configuration	10,000 €	10,000 €	One time
	Functional Testing	2,000 €	2,000 €	One time
ŠKODA GCC	Internal System Decomnissioning, Data Migration projects provider and IT support (50 MD)	1 MD = 427 € 50x MD = 21 500 €	1 MD = 210 € 50x MD = 10 500 €	One time
	JiVS training (External)	16,500 €	10,000 €	One time
	HW Maintenance	11,000 €	6,690 €	Yearly
ŠKODA FIC	2x App. Server (Rrod, Test)	11,000 €	10,000 €	Yearly
	DB - 500 GB	10,750 €	3,950 €	Yearly
	Backup	600 €	600 €	Yearly
	HW Establishment	10,500 €	7,553 €	One time

Table 14: Cost Calculations of JiVS, Source: Škoda

Table 00: Cost Calculations for the pilot project

Due to the pilot nature of the project the return of investment for Škoda is not that high but with decommissioning of more legacy systems will change this picture. It is because of some drawbacks, organizational situations, and firsthand experience of setting up the migration platform. But this pilot project helped internal employees in exploring enterprise level migration projects and learn from the mistakes. Volkswagen Group purchased 20 licenses for 600,000 € with 40% discount from Data Migration services for decommissioning 20 legacy systems. All expenses for Data Migration International was borne by VW. Here, 1MD is one man-day and is considered for 50 days for one year. Cost of service is customer's expense where operating expense are the real costs. AUDI is the bearer of customer's expenses. Following table have approximate profit for Škoda from this project.

Department	Total cost of Service	Total cost of Operations	Profit (ROI)
ŠKODA GCC	48,500 €	27,190 €	21,310 €
ŠKODA FIC	32,800 €	22,100 €	10,700 €

Table 15: Profit Calculation from pilot project, Source: Škoda

Why SAP solutions are so expensive?

Following is a table comparing cost estimations for a migration platform with a legacy system. The time period is chosen for 10 years which is a standard retention period for legacy data.

System	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
JiVS	161,150	38,150	38,150	45,200	45,200	45,200	50,600	50,600	50,600	50,600
Legacy	299,000	165,000	165,000	175,000	165,000	170,000	170,000	170,000	185,000	170,000

Table 16:Cost Assumptions, prices in €, Source: Škoda

Now, when buying licenses for SAP systems it must be kept in mind what is the profit turnover for an organization. The capital an enterprise is willing to invest depends on what goal they are trying to reach. Is that a 2.5-billion-dollar fiscal year on gross receivables? Or the organization aims to reach 3.6 billion? Or the goal is to grow operating profit by 12%?

SAP ERP can transform such goals from visualization to realization, however there's no **standard** price for SAP systems and subsystems. The licensing fees are present just like any other software product and those can be as low as $150 per concurrent user (monthly), but that doesn't get the magic of SAP. That just gets us some binary executable files. It must be understood that SAP is not just a software but when an organization buy SAP ERP solutions they are basically hiring a long-term business partner with the professional and functional experience to reach constructive achievements because they've already done it hundreds of times. According to the *"SAP experience",* SAP products can be referred more than a software product as methodologies, strategy, and business expertise tuned for specific use cases as per buyer cooperation and comes for a price.

5.1.5 Data Model

A data on archive is more complex than legacy live system, but its there only for lookups. Data model is irrelevant for data migration use case. Škoda SAP GCC as a provider of service do not recognize specific data entries, has no competency to decide about data sharing, and will have no access to data after finishing implementation. Financial data and material info will be managed in case of AP1 system while FI, CO, MM, PP and SD modules will be included. JiVS database is the only data source. Data stored in JiVS is used only for creation of views on request, it is not integrated with any other system or functionality. All of the data is migrated with references retained. Every system to be added to the platform has its own data model, which remains the same after data migration into the platform. Data is accessible for its owners only and no data is added after finish of migration. Management of data in this use case consists of creation of views on request and supervision over correctness of deletion process. Customer decide about sharing of data. Main purpose of JiVS is to provide legal required data to applicants (e.g. auditors). AP1 data anonymization is not required since, JiVS is equipped with anonymization tool and it is possible to anonymize data additionally. No data is created by the project. Only data treated in this project is data currently present in productive AP1 system. No copyrighted or licensed data is associated with this

project. No patent-related or technology-licensing-related restrictions on data is associated with this project.

5.1.6 Performance of the platform

It is determined by performance of application server and database volume. The following aspects have an impact:
  i. Number of users connected into the platform simultaneously
  ii. Volume of a data processed while creating an export or view
  iii. Volume of whole database has impact on restore duration

Since the platform is not business critical, it is not running in high-availability mode as of now, but on single server thereby saving resources. Number of users will increase depending on increase of number of legacy systems. Usually there is one user needed per one legacy system. Rare access to the platform is expected - a few times a year per one legacy system - mainly on a request from auditor. Exact number of users using the platform simultaneously is uncertain since it is accessed on request, but it is unlikely that more than one user will access a data on the platform at one moment. JiVS doesn't stay connected to legacy system after migration and doesn't program any system unecessarily. For archiving, rebuilding JiVS program is not necessary but can be necessary or rather said part of a rare liability case according to SLA with Data Migration International.

5.2 Recommendations

The pilot project was the initial small-scale implementation that was used to prove the viability of the idea of systems decommissioning and historicizing data within VW. This provided the exploration of a novel new approach or idea against the application of some standard approaches recommended by outside parties but which is new to the organization.

1. Assess where your legacy system is located and review how much of your environment is legacy.
2. Determine what categories of data you have stored on these servers. Update your inventory. Keep track of old servers that may no longer be required but are sitting in your environment and decommission them.
3. To have more compression factor. Capacity of legacy system needs to be estimated carefully, pilot project had surprised results that data is 3 times the target system, consider calculating data in non-clustered and uncompressed form in target system for estimations.
4. To ask the owners of the original systems for Authorization concepts to connect to migration solutions for end users at POC.
5. Export paths must be carefully selected with better planning of sources. It's important to explain customers at POC that to consider we need additional storage to export data.
6. t is recommended to temporarily disable the virus scan if working with processes which creates a lot of IO like importing or exporting data.

7. It is quite complicative and a challenge to transfer data in-between two big organizations in two different IT landscapes which must be considered.
8. Need to define specific view and functionalities requested to be migrated with data must be clarified during cost estimation at POC. In case of using JiVS solution if customer wants to retain specific table views, features from legacy system it will need extra development like scripting in JAVA, MS SQL, etc. which adds more cost and labor.
9. Time zone is an important aspect that must be kept in mind while archiving as it may connect to the time code of migration application, as in the case of JIVS.
10. Hotfixes for JiVS needs to restart Tomcat server to activate the fix as mandatory.
11. After archiving is live and UAT is closed legacy data can be amended but not to be considered and its better when business stakeholders in client side stay unaware of this perk.
12. Client users are created in JiVS webapp but the password rules are set in Tomcat. Users credentials can be found in context.xml

6 Conclusion

The main objective of the thesis was to overview the purpose and added value of SAP system historization. It was demonstrated by the case study of AUDI's AP1 legacy system on SAP R/3 platform. With author's participation in Volkswagen group's pilot project of establishing an application retirement platform implementation benefits, organizational mistakes, and key strategies were discussed. Among the available systems, the optimal choice of migration platform was JiVS Information Management Platform as per the decision analysis based on Volkswagen requirements. Outline of the historization project in Škoda was described briefly with step-by-step migration of data. The complete process of the live system shutdown, data migration facilities within the established database connected to the JiVS migration tool promotes how companies can get into a secure and reliable digital future. The barriers as well as benefits of such an implementation is practical or not, can be analyzed from this thesis. Enterprise Resource Planning is a multi-billion dollar industry that is changing the competitive landscape for manufacturing companies who benefit from a fully integrated, on-demand ERP solution designed to reduce cost, improve customer service, increase margins, generate new revenue streams, ensure on-time delivery and transparent operational control. However, to allow the space and budget for such upgrades we need systematic elimination of legacy systems. Therefore, application retirement and historicizing data into some low cost, low maintenance retrievable environment is a smarter move which is promoted as a part of the partial objectives of this thesis. Continuous renewal of ERP supports to the day-to-day data driven intelligence all through the lifecycle of business processes, but sizing of the system is more important yet, dependent on users. Volkswagen Group already felt this necessity to migrate their data and eliminate their operating costs. As a partial objective of this thesis it is recommended to follow such a change management as of VW at the earliest to release the resources for constructive and productive utilization. One disadvantage of JiVS is that it is a space consuming product because we are moving a lot of data from original source legacy side to the target JiVS DB. Also, it will be a major disadvantage if we forget that everything can't be archived. It must be kept in mind that project scope will be too big as well a waste of time, complex coding and system setup can be needed to avail such wider scope. Accessible historic data stored in the IMP is going to be subject-oriented, integrated, time variant, and, non-volatile that can be further processed for data reporting, forecasting, and analysis purposes as the JiVS IMP also can act as a data warehouse with single source of historic data truth for an organization. The practical implications of the findings appropriately potential future research in this topic.

7 References

1.   GARTNER GLOSSARY. Definition of Legacy Application Or System - Gartner Information Technology Glossary. *Gartner, Inc.* [online]. 2021.
[Accessed 18 February 2021]. Available from: https://www.gartner.com/en/information-technology/glossary/legacy-application-or-system

2.   FAHMIDEH, Mahdi, DANESHGAR, Farhad, BEYDOUN, Ghassan and RABHI, Fethi. Challenges in migrating legacy software systems to the cloud-an empirical study. *Information Systems*.

3.   DATA MIGRATION INTERNATIONAL. *JIVS-Storyline_2020*. Kreuzilingen, Switzerland, 2020.

4.   CAPGEMINI SE. *Application Retirement Methodology* [online]. 2013.
[Accessed 2 March 2021]. Available from: https://www.capgemini.com/wp-content/uploads/2017/07/2013-04-10_application_retirement_methodology_whitepaper_web.pdf

5.   INTIVIX. 7 Big Problems with Legacy Systems | Intivix: IT Services & IT Support. *7 Big Problems with Legacy Systems* [online]. 2021. [Accessed 3 March 2021]. Available from: https://www.intivix.com/7-big-problems-with-legacy-systems-that-everyone-should-understand/

6.   *Research-DP-Manufacturer-Product-EOL-EOS*. 2018.

7.   What is a Legacy System? *Talend* [online]. 2021. [Accessed 5 March 2021]. Available from: https://www.talend.com/resources/what-is-legacy-system/

8.   LANDERS, Garth, CHILDS, Sheila and DAYLEY, Alan. Magic Quadrant for Structured Data Archiving and Application Retirement. *Gartner* [online]. 11 June 2004. [Accessed 9 March 2021]. Available from:
https://www.gartner.com/en/documents/2765017/magic-quadrant-for-structured-data-archiving-and-applica

9.   RANI, Ranjeeta. *Secure Legacy Systems to Protect Against Cybersecurity Threats* [online]. 2020. [Accessed 14 March 2021]. Available from:
https://securityintelligence.com/posts/secure-legacy-systems-cybersecurity/

10.   KLOPTOSKY, Jon. Legacy Software Modernization: Why You Need To Audit Your Existing Software. *Gavant Software Inc* [online]. 2020. [Accessed 14 March 2021]. Available from: https://www.gavant.com/library/legacy-software-modernization-why-you-need-to-audit-your-existing-software/

11.   ALTEXSOFT. *Legacy System Modernization: How to Transform the Enterprise for Digital Future*. 2021.

12.   ERP SOLUTIONS OODLES. ERP Trends To Watch Out For In 2021. *Medium* [online]. 21 October 2021. [Accessed 14 February 2021]. Available from:
https://erpsolutionsoodles.medium.com/erp-trends-to-watch-out-for-in-2021-37c5c5a37dcc

13.   CUSICK, James J. *Business Value of ITSM-Requirement or Mirage?* [online]. New York, NY, 2020. [Accessed 13 March 2021]. Available from:
http://arxiv.org/abs/2001.00219

14.   NOGUEIRA, Rui. SAP One Domain Model – the lingua franca of the integrated intelligent suite | SAP Blogs. *blogs.sap.com* [online]. 5 June 2020.
[Accessed 15 February 2021]. Available from: https://blogs.sap.com/2020/06/05/sap-one-domain-model-the-lingua-franca-of-the-integrated-intelligent-suite/

15.   JiVS IMP. *Data Migration International* [online]. 2021.
[Accessed 31 March 2021]. Available from: https://jivs.com/

16.   JiVS IMP: the platform for digital transformation - JiVS. *Data Migration International* [online]. 2020. [Accessed 12 February 2021]. Available from: https://jivs.com/jivs-imp-the-platform-for-digital-transformation/

17.   8 Challenges Companies Face When Implementing an ERP Solution. *aACE Software* [online]. 21 November 2019. [Accessed 15 February 2021]. Available from: https://www.aacesoft.com/resources/8-challenges-companies-face-implementing-an-enterprise-resource-planning-erp-solution

18.   SINGHI, Ankit. KEY MANAGERIAL PERSONNEL UNDER THE COMPANIES ACT, 2013 - Corporate Professionals. *Corporate Professionals* [online]. 2013. [Accessed 14 March 2021]. Available from: https://www.corporateprofessionals.com/articles/key-managerial-personnel-under-the-companies-act-2013/

19.   DENNEY, Michael J., LONG, Dustin M., ARMISTEAD, Matthew G., ANDERSON, Jamie L. and CONWAY, Baqiyyah N. Validating the extract, transform, load process used to populate a large clinical research database. *International Journal of Medical Informatics* [online]. 1 October 2016. Vol. 94, p. 271–274. [Accessed 31 March 2021]. DOI 10.1016/j.ijmedinf.2016.07.009. Available from: /pmc/articles/PMC5556907/

20.   What is ERP? | Oracle. *Oracle* [online]. 2021. [Accessed 3 February 2021]. Available from: https://www.oracle.com/erp/what-is-erp/

21.   MURPHY, Brian. What Data Retention Management Means To You. *Waterford Technologies* [online]. 3 November 2013. [Accessed 9 March 2021]. Available from: https://waterfordtechnologies.com/data-retention-management-what-it-means-to-you/

22.   IRWIN, Luke. GDPR & Data Retention: What Are the Rules? *IT Governance Blog* [online]. 11 January 2021. [Accessed 9 March 2021]. Available from: https://www.itgovernance.co.uk/blog/top-tips-for-data-retention-under-the-gdpr

23.   COLE, Ben. What is regulatory compliance? *Tech Target* [online]. March 2020. [Accessed 9 March 2021]. Available from: https://searchcompliance.techtarget.com/definition/regulatory-compliance

24.   MÁLEK, Jaroslav. Povinnost právnických osob uchovávat zápisy z jednání. *Companies.cz* [online]. 2021. [Accessed 9 March 2021]. Available from: https://www.companies.cz/aktuality/422-povinnost-pravnickych-osob-uchovavat-zapisy-z-jednani

25.   Retention management and the GDPR - JiVS. *Data Migration Services AG* [online]. 2021. [Accessed 9 March 2021]. Available from: https://jivs.com/usecases/retention-management-and-the-gdpr/

26.   ROBERT JACOBS, F. and "TED" WESTON, F. C. Enterprise resource planning (ERP)-A brief history. *Journal of Operations Management*. March 2007. Vol. 25, no. 2, p. 357–363. DOI 10.1016/j.jom.2006.11.005.

27.   Enterprise Resource Planning (ERP) - Gartner Information Technology Glossary. *Gartner, IT Glossary* [online]. 2021. [Accessed 9 March 2021]. Available from: https://www.gartner.com/en/information-technology/glossary/enterprise-resource-planning-erp

28.   WYLIE, Lee. A Vision of Next Generation MRP II. *Gartner Group*. 12 April 1990. P. 330–339.

29.   KHOSROW–PUOR, Mehdi. *Emerging Trends and Challenges in Information Technology Management* [online]. IGI Global, 2006. [Accessed 13 February 2021]. ISBN 978-1-61692-128-6. Available from:

https://www.researchgate.net/publication/280101087_Emerging_Trends_and_Challenges_in_Information_Technology_Management

30.   Top 5 ERP System Trends in 2020 to help plan for 2021. *Xcelpros* [online]. 24 September 2020. [Accessed 14 February 2021]. Available from: https://xcelpros.com/top-5-erp-system-trends-in-2020-to-help-plan-for-2021/

31.   SCHULZE, Holger. *CLOUD SECURITY REPORT 2020* [online]. 2020. [Accessed 12 March 2021]. Available from: https://www.checkpoint.com/cyber-hub/cloud-security/what-is-cloud-native-security/the-biggest-cloud-security-challenges-in-2021/#:~:text=Cloud%20Migration%20Issues&text=According%20to%20one%20report%2C%20the,in%20applications%20(35%20percent).

32.   *VISIBILITY AND CONTROL OF YOUR CLOUD SPEND* [online]. 2021. [Accessed 11 March 2021]. Available from: https://www.softwareone.com/en/solutions/software-lifecycle-management/cloud-cost-optimization

33.   SONI, Virendra. *6 Biggest cloud security challenges and risks in 2020 and their solutions* [online]. 2020. [Accessed 11 March 2021]. Available from: https://www.dailyhostnews.com/biggest-cloud-security-challenges-risks

34.   *2021-ERP-Report* [online]. 2021. [Accessed 12 March 2021]. Available from: https://www.panorama-consulting.com/how-to-assess-erp-software-scalability/

35.   CAPEX vs OPEX: What is the most effective cloud cost management strategy? *Softchoice* [online]. 24 February 2021. [Accessed 14 March 2021]. Available from: https://www.softchoice.com/blogs/cloud-migration-adoption-management/capex-vs-opex-what-is-the-most-effective-cloud-cost-management-strategy-

36.   KLEIN, Christian. *Intelligent Enterprises Are Integrated Enterprises*. 2020.

37.   *2020 Global data management research* [online]. 2020. [Accessed 12 March 2021]. Available from: https://www.edq.com/resources/data-management-whitepapers/2020-Global-data-management-research/

38.   APPIAN.COM. *The BPM Guide - Accelerating Digital Transformation* [online]. 2020. [Accessed 20 February 2021]. Available from: www.appian.com

39.   HERNANDEZ, Jose Antonio. *SAP R/3 Handbook* [online]. Second edition. McGraw-Hill Osborne Media, 1999. [Accessed 17 March 2021]. ISBN 0071354131. Available from: https://www.academia.edu/27814862/The_SAP_R3_Handbook

40.   SAP Support Strategy. *SAP SE, Support* [online]. February 2021. [Accessed 17 March 2021]. Available from: https://support.sap.com/en/offerings-programs/strategy.html

41.   GALER, Susan. *Interview on Extended Maintenance for SAP S/4HANA* [online]. 2021. [Accessed 17 March 2021]. Available from: https://news.sap.com/2020/02/interview-extending-maintenance-for-sap-s4hana/

42.   DATA MIGRATION SERVICES AG. *Data Migration Services increases revenue by 50 percent and expands to the U.S.* [online]. 2019. Available from: www.dms-ag.ch

43.   *SAP Extends SAP S/4HANA Maintenance Through 2040 | SAP News* [online]. Walldorf, 2020. [Accessed 31 March 2021]. Available from: https://news.sap.com/2020/02/sap-s4hana-maintenance-2040-clarity-choice-sap-business-suite-7/

44.   CHOVANEC, M. *JIVS Implementation Report*. 2021.

45.   *JiVS user manual and installation guidance*. 2020.

8 Appendix

8.1 Project Schedule
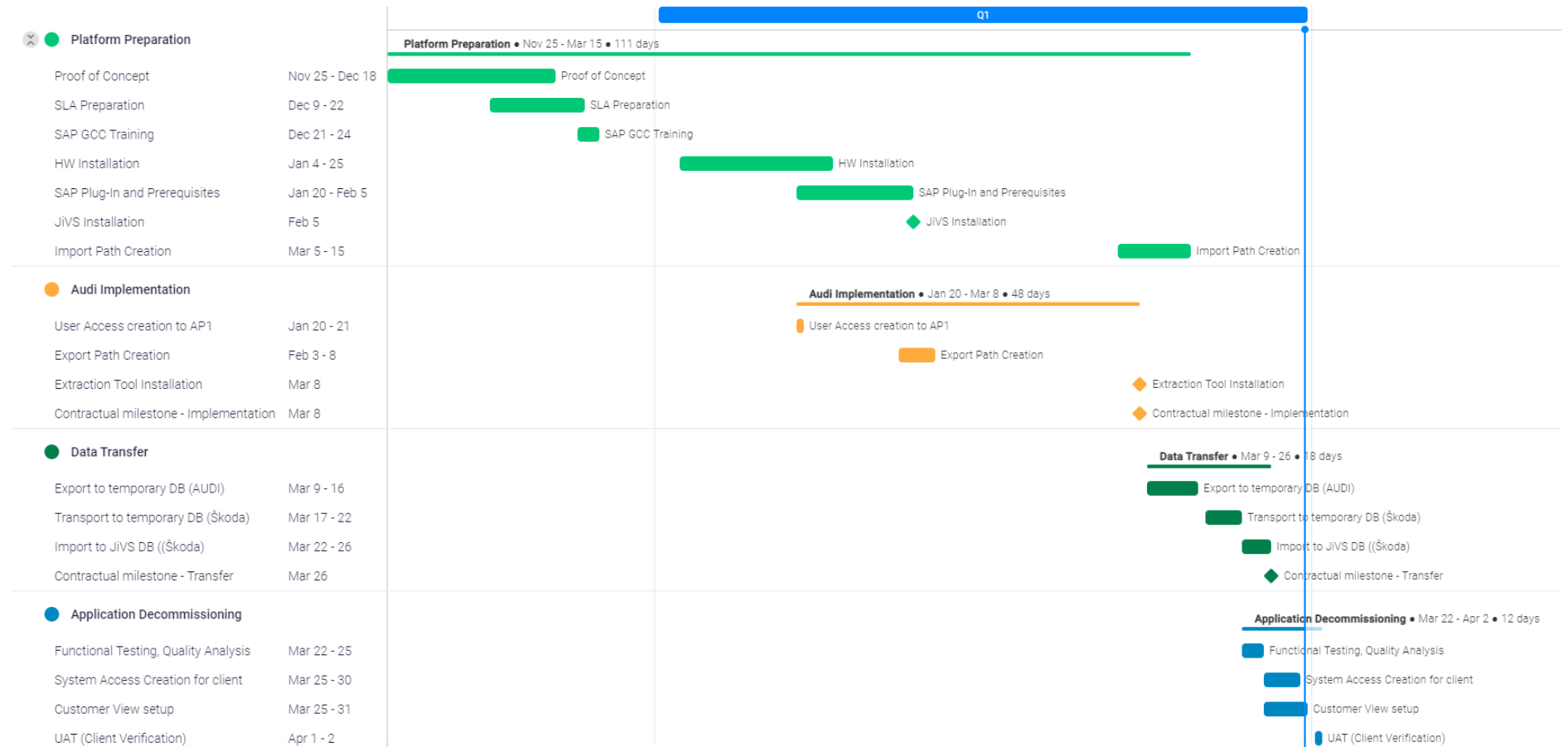
Figure 31: Project Schedule, Gnatt Chart, Source:Monday.com
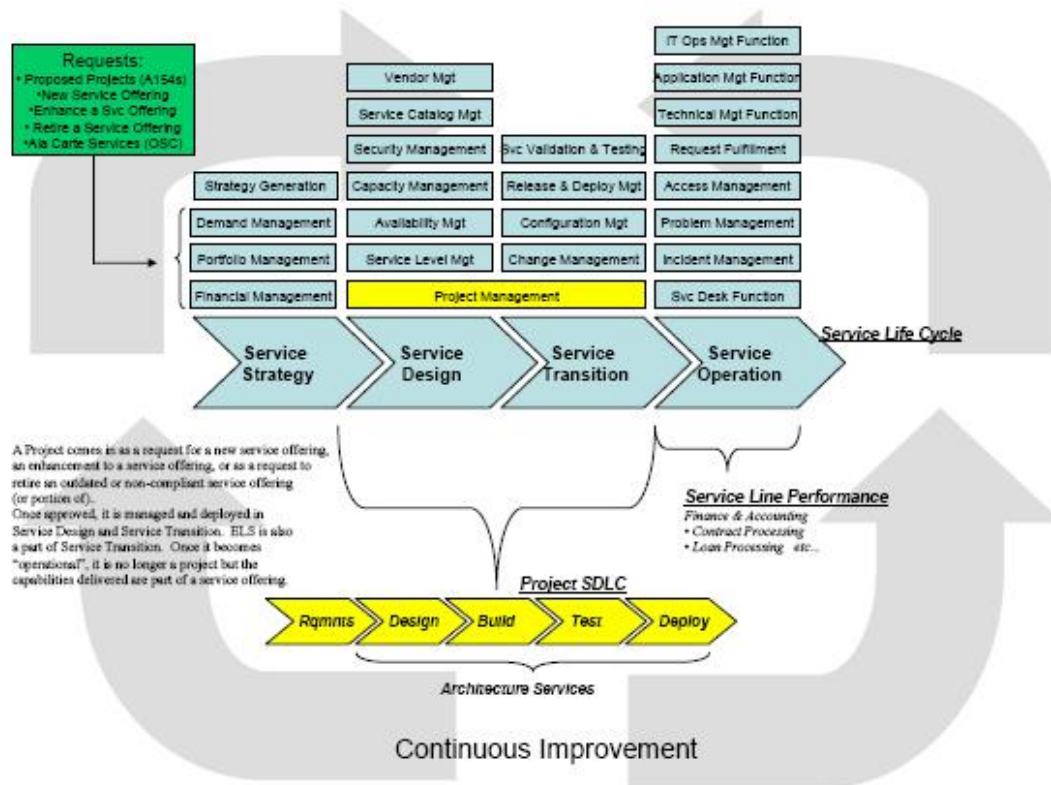
8.2 IT-PEP relation with ITSM

Figure 32: ITL3 vs Project Management, Source:Project Management Institute (pmi.org)

8.3 Quality Management Template

Quality Assurance Control			Append	Delete	Modify	
			Department	SAPP GCC		
Version #	Implemented By	Revision Date	Approved By	Approval Date	Reason	
SKD01	Suprateem D	3.3.21	Jakesch R	4.3.21	UAT precheck	
SKD02	Suprateem D	22.3.21	Jakesch R	24.3.21	UAT post check	
Project	JIVS_ AUDI (FIC2007)		Variance	1=Optimal	9= Failure/ Absent	
Tool	Fishbone	Description	Root Cause Analysis			
	Pareto Chart		With 20% effort and resources spent, 80% results and quality IT service to be achieved			
	PDCA		Plan Do Check Act, Realization of new service			
	KPI Reporting		Requirements matches achievements for final service or not			

Serial Number	Quality Characteristics	Quality Sub-Characteristics	Description of Attribute	Measurement Method	Acceptable Variance	Comments
1	**Functional Suitability**	Functional Completeness	Data completely migrated (Export and Import)	Pareto Chart	5	1:1 migration accomplished but with too much effort
2		Functional Correctness	Data verified by client	Fishbone Chart	3	UAT by screenshare, few open points to amend which was not covered in POC
3		Functional Appropriateness	All AP1 data migrated with their original functions, and views	Fishbone Chart	1	It is not covered in this project, only table data was considered in POC
4	**Performance Efficiency**	Time-behavior	System is responsive and delivers results when promised	KPI Reporting, PDCA	1	Fast comparative to other systems in market an considering the complexity of project
5		Resource Utilization	Price vs system functionalities	Pareto Chart	3	ETL Retention manager, etc. inbuilt
6	**Compatibility**	Co-existence	Connectivity	KPI Reporting, Fishbone	5	Accessibility to client is yet to be confirmed
7		Interoperability	Data Transfer	KPI Reporting, Fishbone	5	Restrictions due to inter organizational implementation; resolved
8	**Usability**	Appropriateness	System is accurate wherever needed	Pareto Chart, KPI Reporting	3	Object Designer, Views, Reports, UI; minimal system glitches present
9		Recognizability	System understands and acts on what is requested as promised	Pareto Chart	1	All functionalities were working and delivered as promised
10		Learnability	System remembers and prompts from previous settings	PDCA, Pareto Chart	2	Export, import paths, user settings selection
11		Operability	Customizable settings	Pareto Chart	2	User friendly, supports multi-language
12		User Error Protection	Extra step to confirm user actions	Pareto Chart	9	Not available

13	**Security**	User Interface Aesthetics	Protects information based on regulations, Retention rules as per user	KPI Reporting	1	
14		Accessibility	Authorization concepts and user management	KPI, PDCA	1	
15	**Reliability**	Maturity	Complex Transactions like in SAP are not required	Pareto Chart	1	99% not required in archive
16		Availability	Legacy data and general system availability	KPI Reporting	1	4 backups, rewriting oldest one weekly
17		Fault tolerance	98% is availability, 2% is tolerance as per client requirements	Pareto Chart, KPI Reporting	1	Škoda auto provides 99%
18		Recoverability	High availability server solution	KPI	1	Standby, but now not required
19	**Maintainability**	Modularity	Has more than 1 user case	KPI	1	Just 1 is used as per POC
20		Reusability	System can be reused for several Legacy systems	KPI	1	Several projects in the line this year
21		Analyzability	Recognizes system failures, user actions, etc	PDCA, KPI Reporting	5	
22		Modifiability	Plug ins, upgrades, connectivity to legacy systems	KPI Reporting	1	JiVS don't need to stay connected to legacy system after migration
23		Testability	Existence of Reports	Pareto Chart, PDCA, KPI Reporting	9	System errors in matching reports due to several trials; Not managed yet
24	**Portability**	Adaptability	SAAS On premise, Cloud WEB UI	Pareto Chart	1	On premise for Škoda GCC, SAAS for clients
25		Useability	Instances can be started with multiple user interactions until overload	Pareto Chart	1	Simultaneously 10 concurrent users can access data is good standard
26		Replaceability	End of support for Legacy system until retention	Pareto Chart	1	

8.4 Completeness Report

8.4.1 Result of Completeness Report

Figure 33: JiVS Report 1

8.4.2 Exported Completeness Report as HTML

Figure 34: JiVS Report 2

8.5 Technical Services template (Technické služby Škoda Auto a.s.)

Technical Service Request Form		*Add* Department	*Add* Employee	*Add* Project
Add Request	*Find* Request	SAP GCC	Suprateem D	FIC 2007

Technical services item	Name of technical service	Gaurantor	Capacity	Availability	Edit
MS SQL / FIO/42 – Datazáze / portálové aplikace	MS SQL		1300 GB		Edit Delete

9   6. Bezpečnost/Security

Klasifikace dat / Data classification	Hodnota/Value

Důvěrnost / Confidentiality	Veřejné/Interní/Důvěrné/Tajné Public/Intern/Confidential/Secret	Confidental
Integrita / Integrity	Nízká/Střední/Vysoká/Velmi vysoká Low/Medium/High/Very high	High
Dostupnost / Availability	Nízká/Střední/Vysoká/Velmi vysoká Low/Medium/High/Very high	Low
Nepopiratelnost / Tracebility	Nízká/Střední/Vysoká/Velmi vysoká Low/Medium/High/Very high	High

Legislativní požadavky na data		Hodnota/Value
Na data se vztahují zákonná nebo jiné externí nařízení a předpisy The data are subject to legislative or other external rules and regulations	Ne / Ano (pokud ano které) No / Yes (if yes, which)	Yes
Na data se vztahují interní předpisy The data are subject to internal rules	Ne / Ano (ON.1.022, + případné další) No / Yes (ON.1.022, + eventual other)	Yes

Číslo rizika No. of risk	Identifikace rizika Risk identification	Pravděpodobnost Probability	Dopad Impact	Scénář Scenario	Opatření Measurement
<ID>	<Risk identification>	Vysoká/High Střední/Medium Nízká/Low	Vysoký/High Střední/Medium Nízký/Low	<Jak se riziko může projevit, na které činnosti bude mít dopad.> <Which risk can present itself, which activities will it affect.>	<Jak riziko eliminujeme či snížíme.> <How to eliminate or mitigate the risk.>

10 7. Akceptace projektu/Project Acceptance

Kategorie chyby Error level	Povolená četnost Admissible frequency

Kritická/Critical	0
Vysoká/High	0
Střední/Medium	2
Nízká/Low	5

Pravidlo / Rule	Popis / Description
Systém pro podporu správy incidentů	*JIRA (alternativy v ŠA: Solman/TFS/HP QM/Excel)*
Systém pro evidenci testovacích scénářů	*Word dokumenty na teamových webech (alternativy v ŠA: JIRA/Solman/TFS/HP QM/Excel)*
Prostředí pro vykonání testů	*Testovací, testy budou probíhat z pracovních stanic EOx.*
Reporting stavu testů	*Během akceptačních testů bude na denní bázi zasílán řídícímu výboru report obsahující informace o:* • *Počtu otevřených incidentů dle kategorie* • *Stavu testovacích scénářů*
Doba pro testování	*Testování bude probíhat vždy v intervalech 8:00-11:00 13:00 – 16:30*
Release management	*Během testů je nasazení oprav možné pouze po odsouhlasení IT PM*
Change management	*Požadavky na změny identifikované během testování jsou evidovány v systému JIRA*
Data pro vykonání testů	*Pro vykonání testů bude připraven export produkčních dat / Data budou zajištěna tak, aby bylo možné opakovaně vykonat testy ve třech cyklech.*

Požadavek (potřeba) Request (need)	Cíl potřeby Objective of the need	Akceptační kritérium (splnění požadavku) Acceptance criterion (fulfilment of request)

11 **8. Plán testů/Testing Plan**

Popis / Description	Status	Datum / Date	Odpovědnost / Responsibility
Test modulu / Module test	Yes		JiVS provider
Funkční test / Functional test	Yes		JiVS provider and SAP GCC

Zátěžový test / Performance test	Yes		JiVS provider and SAP GCC
Integrační test / Integration test	No		
Systémový test / System test	No		
Test bezpečnosti / Security test	No		
Uživatelský akceptační test (UAT) / User acceptance test (UAT)	Yes		Customer and SAP GCC

12 9. Nasazení řešení/Deploying the Solution

Předmět podpory (systém, aplikace, služba, zařízení) / Subject of support (system, application, service, device):	
Datum převzetí/aktualizace formuláře (vyplní FIO/51) / Date of receipt / update of the form (to be completed by FIO/51):	
CI aplikace-Business služba / CI Application-Business Service:	
Kritičnost aplikace z BIA / Application criticality from BIA:	
Nefunkčnost aplikace ohrožuje výrobu (business) / Application malfunction threatens production (business):	
Náhradní řešení pro případ výpadku / *Alternative solution in case of failure*	
Stručný popis / Short Description:	

GEKO:

Garant SW:

V produktivním provozu od / In productive operation from:	

Kontaktní osoby (klíčoví uživatelé, GEKO) / Contact persons (key users, GEKO):

Jméno Příjmení / Name surname   *Telefon / Phone*
Od–Do / From-To   *E-mail*

Kdo je uživatel (interně oddělení / externí zákazník) / Who is the user (internally department / external customer):

Kolik je cca uživatelů / Number of users:

Kategorizace (vyplní FIO/51) / Categorization (to be completed by FIO/51):

Kontaktní místo, kde uživatel bude hlásit požadavky (nehodící přeškrtněte) / Contact point where the user will report requests (strike out what does not apply):

ServiceDesk   **UserHelpDesk**   **WatchCenter**

Incident Management: Typ nefunkčnosti / Type of malfunction	Priorita / Priority**	Od–Do / From-To*	Řešitelská skupina / Group
Aplikační podpora / Application support			
Nedostupná aplikace / Unavailable application			
Chyby v aplikaci / Application errors			
Chyby v datech / Dates errors			