Bei diesem Beitrag handelt es sich um einen wissenschaftlich begutachteten und freigegebenen Fachaufsatz („reviewed paper").

doi.org/10.37544/1436-4980-2026-06-27
Datum der Einreichung: 09.03.2026
Datum der Annahme: 27.03.2026
Datum der Veröffentlichung: 27.07.2026

Feasibility analysis for an industrial factory planning project in the rubber industry

Digital information continuity in factory planning

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ABSTRACT Lack of digital information continuity hinders factory planning efficiency, and current methods fall short in industry practice. This work validates the industrial applicability of a VDI-5200-based approach in a rubber industry greenfield project. The study assesses the direct information transfer shares, the out-of-the-box applicability of modules, and the automation benefits. Results show feasibility under real conditions, with future plans to extend continuity into construction and operation phases.

KEYWORDS/STICHWÖRTER

Factory Design, Digital Information Continuity, Building Information Modeling

Digitale Informationsdurchgängigkeit in der Fabrikplanung – Machbarkeitsstudie für ein industrielles Projekt in der Gummiverarbeitung

ZUSAMMENFASSUNG Fehlende digitale Informationsdurchgängigkeit reduziert die Effizienz der Fabrikplanung. Diese Arbeit validiert die industrielle Anwendbarkeit eines auf der VDI 5200 basierenden Lösungsansatzes in einem Greenfield-Projekt der Gummiindustrie. Die Studie untersucht den Anteil direkter Informationstransfers, die sofortige Anwendbarkeit der Module sowie die Automatisierungspotenziale. Die Ergebnisse zeigen die Machbarkeit unter realen Bedingungen sowie die Zukunftspotenziale durch eine Ausweitung auf die Realisierungs- und Betriebsphase.

1 Introduction

Manufacturing continues to represent a fundamental economic pillar within the German economy. In 2023, the sector provided employment to over eight million people [1] across more than 300,000 companies [2]. Its gross value added, including construction, amounted to € 1,109.21 billion [3], representing almost 30 % of national gross value added (€ 3,921.31 billion [4]). Manufacturing, therefore, is a pivotal component of Germany's economic performance and resilience.

Concurrently, factory operators face an increasingly dynamic business environment characterized by the „BANI" (brittleness, anxiety, non-linearity, and incomprehensibility) framework, marked by volatile and often unpredictable disruptions [5]. In such circumstances, factory planning can no longer be regarded as a one-off activity aimed at achieving an optimal static configuration; rather, it has become a continuous managerial task [6].

Empirical evidence indicates that the speed with which factory adaptations are implemented is a critical factor in determining profitability and capital productivity [7]. Consequently, there is a pressing need to increase the efficiency of factory planning processes to support short-cycle, ongoing reconfigurations [8].

A significant challenge to enhancing efficiency is the absence of effective collaboration across organizational divisions. A survey conducted by *Capgemini* has identified inadequate coordination between functions as the most significant challenge in strategic factory planning (32 %) [9]. The fragmented and non-transparent exchange of planning information has been demonstrated to result in losses and distortions [10], which in turn generate additional alignment effort and costs [11]. To address these frictions, it is necessary to establish robust and seamless flows of information among stakeholders and between their software tools. Recent research by *Bermpohl et al.* posits that digital information continuity (DIC) – defined as the lossless, consistent transfer of planning-relevant data across stakeholders and toolchains – functions as a pivotal catalyst for enhancing planning efficiency [12].

Building on this premise, prior research introduced a method for model-based factory planning that explicitly targets DIC across stakeholders and the heterogeneous tool landscape that supports planning activities [13]. To date, however, this method has only been demonstrated in a synthetic, laboratory setting, and its applicability and feasibility in real industrial projects remain unverified.

The present paper addresses this gap by applying the method to an industrial factory planning project in the rubber industry. Following an exposition of foundational concepts in factory planning and DIC, a review of the state of the art in methods enabling end-to-end digital information flows is presented. Subsequently, the published method is adapted for industrial deployment, a feasibility study is designed, and the method is evaluated in a real project context. The study's results informed a discussion of required adjustments to the method for industrial applicability, limitations, and avenues for future research.

2 Fundamentals

The development of a method for digital information continuity in factory planning is based on the theoretical foundation of factory planning and DIC, covered in sections 2.1 and 2.2.

2.1 Factory planning

Factory planning defines long-term structures in manufacturing companies and can therefore directly influence production profitability [14]. It is therefore characterized by anticipatory planning, meaning that activities and project solutions are defined before implementation [15]. Factory planning is organized along phases, where each phase comprises distinct tasks, deliverables, and decision points [16].

VDI 5200, issued by the Association of German Engineers (VDI), allows iterative execution of phases, which implies that intermediate results may trigger revisions and renewed coordination across disciplines [16]. In this paper, the focus is placed on phases up to and including detailed planning, since model-based factory planning primarily occurs within this range [13]. Accordingly, the fundamental logic spans goal definition (objectives, scope, and target system), data preparation (baseline data, constraints, and requirements), concept planning (development and assessment of variants), and detailed planning (increased planning depth and specification) [16].

The synergetic factory planning approach (SFPA) extends this production systems-focused approach by linking building planning tasks [17]. The SFPA combines building planning in accordance with the Fee Structure for Architects and Engineers (HOAI) and with production systems planning in accordance with VDI 5200 in a coordinated procedure [17]. Consequently, the nine HOAI service phases can be assigned to the planning phases of VDI 5200 [16, 18]. In this context, *Bermpohl et al.* emphasize the importance of DIC between the domains of building and production system planning in order to enable holistic digital factory planning [19].

In the context of DIC, model-based approaches become increasingly relevant. The cooperative working methodology of Building Information Modeling (BIM) for example includes digital models that support consistent capture, management, and transparent exchange of life-cycle relevant information [20]. A core element is the unified digital building model containing geometry as well as alphanumeric information and object relations, which is continuously updated over the life cycle [21, 22]. BIM is thus a methodological approach rather than a single software product, and connects planning methods through the targeted use of software tools [21, 22].

For the continuous and stakeholder-spanning exchange of digital building models in BIM-based planning, the Industry Foundation Classes (IFC) provide a vendor-neutral, standardized exchange format in accordance with DIN EN ISO 16739 [23], VDI 2552–4 [24], and *Borrmann et al.* [25]. In factory planning, BIM facilitates the linking of planning content from different trades and previously parallel data sets, and it enables early coordination, such as collision checking, based on geometric data when building and production system planning are integrated at an early stage [26].

2.2 Digital information continuity (DIC)

In general, DIC in factory planning can be described as the consistent usability of data and models across all life-cycle phases of a factory [27]. However, a uniform definition of DIC in factory planning is not yet established. Therefore, an appropriate derivation is taken from continuous engineering [28]. Continuous engineering requires that outputs of an engineering step can be reused along a value chain with minimal loss and minimal effort, avoiding redundant work steps [28]. In addition, core requirements for integrated and consistent engineering include cross-trade and cross-phase integration of engineering tools, centralized data storage with one-time data entry, and life-cycle-wide assurance of data consistency through the tool system [29, 30].

Besides, a fundamental prerequisite for DIC is the availability of uniform interfaces and standardized open data exchange formats [31]. To operationalize DIC, VDI 4499-3 proposes guiding questions that can be interpreted as four target criteria for data management maturity: end-to-end and transparent data flow between planning systems, avoidance of data redundancy, assurance of data consistency, and systematic assignment of access rights [31]. In addition, BIM enables coordinated and centralized data management using model-based platforms [32]. This is typically implemented as a common data environment (CDE), which provides the basis for consistent data exchange between stakeholders and their software tools [33]. Therefore, a CDE is a crucial element of realizing DIC.

3 State of the art

The evaluation criteria for existing approaches to DIC in factory planning are derived directly from the fundamentals outlined in section 2. Factory planning is structured along defined phases according to VDI 5200, and model-based collaboration is predominantly applied up to and including the detailed planning phase [13]. Consequently, the coverage of VDI 5200 planning phases up to and including detailed planning constitutes a primary criterion.

In the context of BIM, *Schäfer et al.* point out that digital software tools are used specifically to link planning methods with each other [22]. Therefore, tool integration constitutes a second criterion. Moreover, DIC is referred to as the consistent usability of data and models across all life-cycle phases of a factory [34], which directly motivates the third criterion degree of DIC.

The CDE concept is identified as a key structural element for ensuring consistent data exchange, reuse, and avoidance of redundancy across stakeholders and software systems [19, 32]. Accordingly, the presence of a CDE is defined as a fourth evaluation criterion. Moreover, SFPA links building planning and production systems planning [17] and early integration enables coordination, such as collision checking [26]. Therefore, production systems planning and building planning are included as two separate criteria, assessing whether approaches address both domains rather than remaining domain-specific. Finally, practical implementation is considered as an evaluation criterion, since the applicability of factory-planning methods is demonstrated particularly through validation in real industrial project scenarios [35, 36].

Based on these criteria, the search terms were derived to capture both the factory planning context and the mechanisms relevant for DIC. The terms information continuity, digital continuity, and interoperability reflect the information continuity requirement, whereas CDE and IFC, as the most relevant open data standard in the BIM context, and data exchange represent shared data environments and standardized tool interface mechanisms. Additionally, digitization was included to broaden the search towards contributions on digital transformation in factory planning. The factory context was ensured via factory planning and factory design. On this basis, the following Scopus search string was applied:

TITLE-ABS-KEY („factory planning" OR „factory design") AND TITLE-ABS-KEY („digital continuity" OR „information continuity" OR „interoperability" OR „common data environment" OR „CDE" OR „data exchange" OR „IFC" OR „digitization").

The database search returned 35 publications. Only publications were included if they describe a method with explicitly documented data handovers (e.g., defined interfaces, exchange formats, or a shared data environment), because DIC is only assessable when tool-to-tool data transfer is explicitly described. Two duplicates were removed. Five publications focusing primarily on digital twins without addressing phase-spanning information continuity were excluded. Survey and review papers without methodological implementation were also excluded. Further conceptual contributions lacking an implementable, phase-spanning method were removed.

Additional exclusions were made for publications that did not demonstrate explicit tool-to-tool data flows in factory planning contexts, including logistics routing, production chain printing, metallurgy, and geodata architectures. VR-focused approaches without planning-relevant interfaces were excluded. Finally, studies lacking systematic alignment with VDI 5200 planning phases or remaining at a purely conceptual level without implemented toolchains were removed.

The remaining set comprises approaches that document tool-to-tool data transfer with sufficient transparency for evaluation. *Burggräf et al.* develop a planning assistance for automating factory planning based on rule-based expert systems, combining an ontological information model with Semantic Web Rule Language rules and an inference component in Protégé [37]. Project data are imported from Excel via Ontop mappings, and the approach is validated in two industrial Brownfield projects with automated capacity planning and feedback of results into the knowledge base. *Neuhäuser et al.* present a BIM-based approach that integrates production systems and building planning through defined roles and process diagrams [38]. Their method relies on specified handover points using consistent IFC-based model exchanges to ensure standardized data interoperability. While continuity is evidenced through standardized handovers, concrete software toolchains, and technical integration are not explicitly described.

Büscher et al. link Condition-Based Factory Planning with the Virtual Production Intelligence (VPI) platform by defining a domain-specific information model and formalizing it as an ontology in the Web Ontology Language (OWL) [39]. An automated integration process with semantic annotation and consistency checks stores the data in VPI, providing a shared data environment and a documented data chain from templates via ontology to the platform. *Colledani et al.* describe an integrated production system design platform based on a common OWL-based data model and tool-specific connectors [40]. These connectors translate between application formats and the repository, enabling iterative exchange where models are generated, simulations executed, and results written back to the repository. *Hoffmann et al.* present a VPI-based semantic integration layer that vertically integrates planning, simulation, and optimization tools from enterprise resource planning (ERP) to shopfloor level via a shared data basis. In a layout planning use case, the platform supports iterative optimization by integrating ERP data and dynamically adapting the process chain while enabling consistent reuse of results across modules [41]. *Augustin et al.* propose a defined interface between factory planning and tugger-train routing systems, and implement it via an Excel-based exchange using helper tables and macros [42]. Manual enrichment steps and macro-based compensation of incompatibilities indicate only partial integration and only partly evidenced practical implementation.

Lange et al. introduce the Blue Print Plant Model created with MO²GO, linking factory objects, processes, and sizing methods and connecting key performance indicators to Plant Simulation via an adapter [43]. The contribution references VDI 5200 but does not document a complete phase-spanning interface chain, so digital continuity remains partially evidenced. *Bermpohl et al.* propose a VDI-5200-structured method using digital planning modules (DPMs) with defined tasks, input/output information, and assigned software tools, complemented by a database/information-interface module acting as a CDE and standardized interface for otherwise incompatible modules [13]. The method has so far been demonstrated only in a fictitious use case and reports a 6 % information loss, implying only partial fulfillment of digital continuity. **Figure 1** summarizes the state of the art using Harvey balls.

Overall, the reviewed literature does not yet provide industrial evidence for the applicability of a phase-spanning method that operationalizes DIC across heterogeneous tool landscapes under real project constraints. In particular, the VDI-5200-structured method by *Bermpohl et al.* lacks validation in a real industrial factory planning project. For that reason, this paper puts forth the thesis that the method is applicable in real industrial factory planning projects and can be adapted to project-specific conditions while maintaining digital information continuity and reducing manual data transfer effort.

4 Scientific Approach

The research objective is to assess the industrial applicability of the method for digital information continuity in a real factory planning project. The feasibility examination is situated within the applied action sciences [44]. Multiple procedures for technical feasibility studies are documented in the literature [45]. This work follows *Rösler*'s approach [46], which emphasizes answering predefined research questions that guide data collection, analysis, and evaluation. The research process comprises four phases.

● full consideration
◐ partial consideration
○ no consideration

	Colledani et al. 2013	Hoffmann et al. 2013	Büscher et al. 2016	Augustin et al. 2020	Neuhäuser et al. 2021	Lange et al. 2023	Burggräf et al. 2024	Bermpohl et al. 2025
VDI 5200 phases								
Setting of objectives	○	○	○	○	○	◐	○	●
Establishment of the project basis	◐	○	◐	○	○	◐	○	●
Concept planning	◐	●	◐	●	●	◐	●	●
Detailed planning	◐	○	◐	●	●	◐	◐	●
Domain								
Building planning	○	○	○	○	●	◐	○	●
Production system planning	●	●	●	●	●	●	●	●
Digital information continuity								
Common data environment	●	●	●	○	○	●	●	●
Degree of digital information continuity	●	●	●	◐	●	◐	●	◐
Tool integration	●	●	◐	◐	○	●	◐	●
Practical application	◐	◐	◐	◐	○	○	●	◐

Fig. 1 State of the art and research gap. *Source: Fraunhofer IGCV*

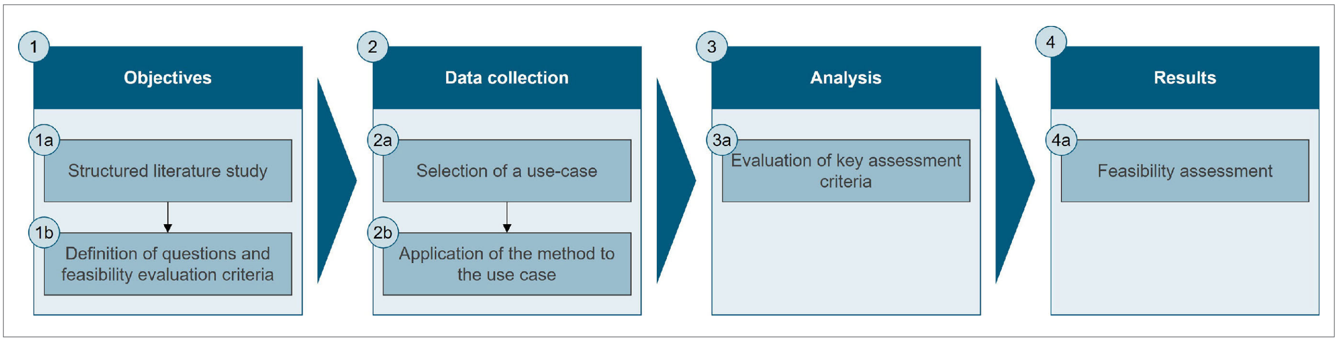

Fig. 2 Scientific approach for the feasibility assessment. *Source: Fraunhofer IGCV*

Figure 2 depicts the elements and step numbering:

- Phase 1 (Objectives): A structured literature study is conducted to operationalize "industrial applicability" and derive feasibility evaluation criteria (1a), followed by the definition of research questions aligned with these criteria (1b).
- Phase 2 (Data collection): A factory planning use case is selected (2a), and the method is applied within the ongoing planning activities of this use case (2b).
- Phase 3 (Analysis): The collected evidence is evaluated against the predefined assessment criteria to determine the key dimensions relevant to the research questions (3a).
- Phase 4 (Results): An overall feasibility assessment, including boundary conditions for applicability, is synthesized (4a).

5 Feasibility study design

The objective is to determine the extent to which the literature-identified method for DIC can be applied in a real factory planning project and under which project-specific adaptations this application is feasible. The evaluation is guided by the sub-questions and criteria presented in **table 1**.

In this context, DIC is defined as the lossless, consistent reuse of planning data across stakeholders and tools throughout the VDI 5200 phases. Direct information transfer is defined as a machine-executable handover (e.g., IFC/API/script) that requires no manual edits to the data content. By contrast, an indirect transfer requires human-mediated changes such as retyping, mapping, or coordinate conversion. Information loss is defined as the proportion of required geometry, attributes, or relations that are missing or corrupted after a transfer, measured against event-specific checklists. The values are calculated for each transfer event and then aggregated across the entire observation window, from the target definition to the detailed planning stage.

Together with the factory planning experts of ifp Consulting, a greenfield factory planning project was selected to cover both building planning and production system planning (step 2a). The observation window spans the project phases from target definition to detailed planning. The empirical use case is situated in the rubber industry and involves a German company establishing a

Table 1 Research subquestions and evaluation criteria (step 1b).

Research question (RQ)	Evaluation criteria
What degree of digital information continuity is achieved compared with the literature? (RQ1)	Share of direct and indirect digital information transfers between stakeholders/tools
What share of the method's steps/modules can be executed without adaptation to the use case? (RQ2)	Proportion of method steps implemented "out of the box" and number and type of required adaptations
To what extent do method adaptations reduce manual effort for data transfer? (RQ3)	Reduction of manual data transfer time (person-hours per period or per artifact) and increase in automated transfers (share of transfers automated)

new manufacturing site in India. **Figure 3** shows an abstracted master plan for the factory site.

6 Results

6.1 Application of the method in the industrial project (step 2b)

As the selected application case was a greenfield project, there was no existing infrastructure to be digitized at the project initiation. Consequently, no reality capture, as proposed in the reference method, was applicable. In this context, **figure 4** visualizes the interrelation of the DPMs and the deviations to the reference method. Deviations are highlighted in red.

Conversely, DPMs from concept planning, including structural planning and ideal layout planning, could be used. However, due to binding space restrictions, the ideal layout was skipped, and a real layout generated directly in visTable, transferred to Revit via Dynamo, and continued as production system modeling within the building model. Per the BIM guideline, building modeling and production system modeling ran in parallel and were coordinated via geometric clash checks. Therefore, factory model coordination was limited to collision detection. Permit planning and the module creation of necessary documents were out of scope. Two support modules (holistic digital factory model (HDFM) and project management) operated phase-spanning, using SharePoint as the CDE holding the HDFM and Teams for governance. In contrast to the reference method, simulation-based dimensioning was eplaced by static dimensioning realized in Excel during concept planning.

Table 2 summarizes the mapping of phases, DPMs, primary digital tools, key input/output artifacts, and project-specific notes.

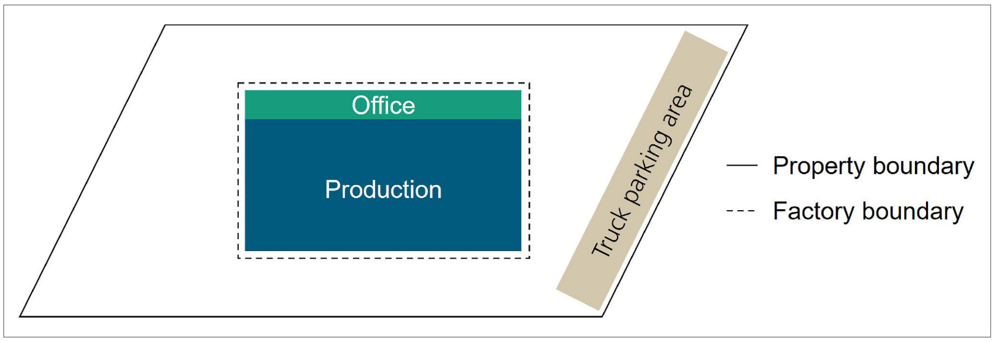

Fig. 3 Abstracted master plan for the factory site. *Source: Fraunhofer IGCV*

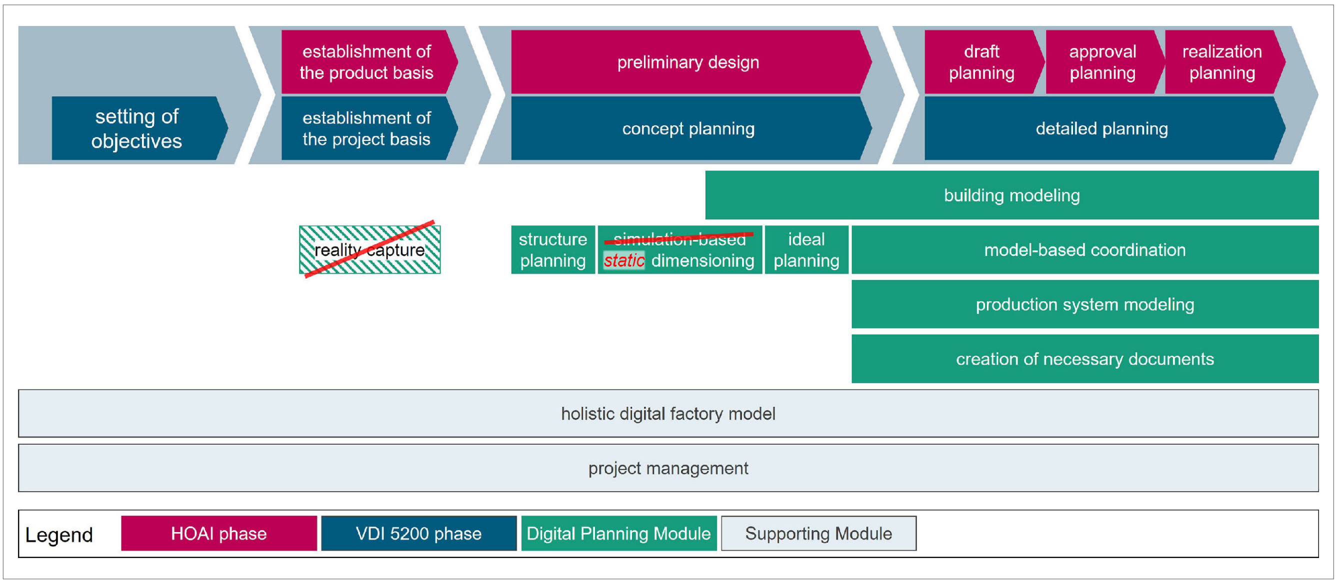

Fig. 4 Interrelation of digital planning modules and deviations to the reference method [13] (in red). *Source: Fraunhofer IGCV*

Table 2 Mapping of planning phases, digital planning modules, digital tools, key artifacts, and notes.

Phase	DPM	Primary tool(s)	Key artifacts	Notes
Phasespanning	Holistic Digital Factory Model	SharePoint, Microsoft Excel	Versioned RVT/IFC models, layouts, and Excel master data	CDE governs all models/data; Excel is used for static dimensioning and structured tables; IFC is not processed directly in Excel.
Phasespanning	Project Management	Microsoft Teams	Objectives, roles, milestones, decisions	Selects modules/tools; defines responsibilities; oversees change management.
Setting of objectives	Holistic Digital Factory Model	SharePoint, Microsoft Excel	Baseline data, constraints, and requirements tables	Centralized capture and distribution of project inputs.
Setting of objectives	Project management	Microsoft Teams	Project charter, stakeholder map	Governance and setup for subsequent phases.
Establishment of the project basis	Holistic Digital Factory Model	SharePoint, Microsoft Excel	Requirement lists, calculated tables	Structured data basis
Establishment of the project basis	Project management	Microsoft Teams	Plans, decision logs	Coordination across stakeholders and modules.
Concept planning	Structure planning	Microsoft Visio	Functional structure, area program, interface matrices	Inputs for layout generation and alignment of building and production needs.
Concept planning	Ideal layout planning (adapted to reallayout generation)	plavis visTable	Reallayout variants, object lists/geometry	Unconstrained ideal layout skipped due to space restrictions; restriction-based variants generated.
Concept planning	Static dimensioning (adaptation of simulation-based dimensioning)	Microsoft Excel (within CDE)	Calculated sizing tables (areas, logistics concept), parameter sheets	Replaces the reference "simulation-based dimensioning"; no separate simulation model used.
Detailed planning	Building modeling	Autodesk Revit	RVT master model; IFC exports (site, levels, spaces, property sets)	An authoritative building model and basis for the integrated factory model.
Detailed planning	Production system modeling (integrated)	Autodesk Revit + Dynamo	Dynamo scripts; integrated layout objects; parameter writes/IFC	visTable real layout transferred via Dynamo and carried forward in the Revit model; no separate production model.
Detailed planning	Factory model coordination (geometric clash check)	Autodesk Revit (interference check)	Clash reports; coordination views	Coordination is limited to geometric collision checking in this project.

6.2 Evaluation and quantitative results (step 3a)

The evaluation encompasses transfer events from setting of objectives to detailed planning, utilizing archived inputs and outputs. Metrics encompass shares of direct and indirect transfers, information loss, manual effort per typical layout change, iterations per phase, and derived time savings.

The interface from Microsoft Excel to Visio at the beginning of structure planning contained an indirect transfer of process and inspection steps, the deployed material handling equipment, and product- or profile-related attributes. The afterwards created block layout was transferred directly from visTable to Microsoft Excel. The importation of DWG geometry from visTable to Autodesk Revit is direct, with the origin mapped to Revit's internal origin. This process was applicable to both site and factory boundary. Conveying spatial constraints from Microsoft Excel to Autodesk Revit is an indirect process. However, when introducing automation via Autodesk Dynamo, a direct transfer of the realized layout positions (x', y') was possible from Microsoft Excel to Autodesk Revit. This transfer encompassed the assignment of parameter values to instances and the room schedule. The results concerning the DIC in comparison to the reference method are summarized in **table 3**.

The implementation of automation has been demonstrated to reduce manual effort from 43 to 8 minutes, achieving an 81 % reduction. The temporal parameters were determined within the implementation of a feasibility study, wherein experienced practitioners of ifp Consulting initially transferred information from concept planning in visTable and Microsoft Excel to detailed

Table 3 Comparison of the proportions of directly, indirectly, and lost transferred digital information: Project context versus reference method.

Criteria	Project Context	Reference Method
Directly transferred information	53.8%	58.0%
Indirectly transferred information	46.2%	36.0%
Lost digital information	0.0%	6.0%

planning in Autodesk Revit, employing the conventional, non-automated workflow. Subsequently, this transfer was executed using the Dynamo script. For a factory planning project, which typically involves five to ten iterations, this reduction translates into 175–350 minutes of time savings. The comparison of information flow in the context of DIC is as follows:

- Without automation: Direct information transfer 33.3 %, indirect information transfer 66.7 %
- With automation: Direct information transfer 53.8 %, indirect information transfer 46.2 %

Relative to the reference method, the applied toolchain differs in four points:

1. The CDE is implemented via SharePoint and not the CONTACT Elements platform.
2. Simulation-based dimensioning is replaced by static dimensioning in Excel during concept planning.
3. The real layout from visTable is transferred into Revit via Dynamo instead of maintaining a separate production model.
4. Model coordination is executed directly in Revit instead of the Building Information Cloud Software and is limited to geometric clash checks.

7 Discussion

7.1 Feasibility assessment (step 4a)

The feasibility is assessed using the three research questions defined in step 1b. The results from step 3b are then interpreted in the light of these research questions, and an overall assessment is synthesized.

The primary research question (RQ1) targets the extent to which digital information continuity is achieved in comparison with extant literature. When evaluated against the reference method outlined in the extant literature, industrial application resulted in comparable direct-transfer shares and successfully eliminated information loss. As illustrated in table 3, direct information transfers contributed 53.8 %, indirect information transfers 46.2 %, and information loss 0.0 %, representing an enhancement over the reference's 6 % loss. The results of the pre- and post-automation tests (direct 33.3 % → 53.8 %) demonstrate that implementing scripted mappings and coordinate conversion in Dynamo has effectively transformed the formerly manual, error-prone handover process into a machine-executable transfer.

The second research question (RQ2) addresses the extent to which the method's steps or modules can be executed without adaptation to the use case. In the context of the ten reference modules, four were executed immediately upon initial installation (namely, CDE, project management, structure planning, and building modeling). In contrast, three modules underwent adaptation (ideal layout planning repurposed to direct real-layout generation; production system modeling integrated into the Revit building model via Dynamo; factory model coordination limited to geometric clash checks in Revit). Finally, three modules were omitted due to their exclusion from the project's scope (namely, reality capture; simulation-based dimensioning, replaced by static dimensioning in Excel during concept planning; and the creation of necessary documents). Thus, 40 % ran out of the box, 30 % required targeted adaptations, and 30 % were not applicable in this project context.

The third research question focuses on the extent to which method adaptations mitigate the manual exertion required for data transfer. The implementation of automation has led to a substantial reduction in the manual effort required for typical layout changes, with a decrease from 43 minutes to 8 minutes, representing an 81 % reduction. It is estimated that, for 5–10 iterations per phase, 175–350 minutes will be saved per phase. The proportion of automated (direct) transfers increased by 20.5 percentage points (33.3 % to 53.8 %), driven by stable IFC/parameter conventions, saved import templates, and Dynamo-based coordinate/attribute handling.

The overall feasibility of the method is such that its industrial application is possible up to the detailed planning stage, provided that the documented adaptations are taken into account. It has been demonstrated that the system maintains lossless DIC, achieves direct-transfer shares that are comparable to those reported in the literature, and improves short-cycle responsiveness through automation. The feasibility depends on integrating a Dynamo automation at the interface between concept planning in visTable and detailed planning in Revit, and implementing standard IFC/parameter conventions. In such circumstances, the applicability of the method is feasible in a real project context.

7.2 Contribution to state of the art

This feasibility study is the first to provide industrial validation of a VDI-5200-structured, phase-spanning method that operationalizes DIC with explicit, reproducible indicators. In a real project, it demonstrates end-to-end continuity across heterogeneous tools, achieving 0.0 % information loss (compared to 6 % in the reference) and an 81 % reduction in manual effort per layout change. In addition, it provides a compact set of practical adaptations that preserve continuity while simplifying deployment, including integrated production modelling in Revit, Revit-based coordination, and static dimensioning in Excel. By transitioning from conceptual assertions to substantiated, replicable evidence, the study establishes a replicable integration pattern and evaluation approach for future research and industrial projects.

7.3 Limitations of feasibility study

Several limitations need to be acknowledged when interpreting the results of this study. The analysis was conducted within a medium-sized company, which means that transferability to larger or more complex industries remains uncertain. Also, the reported time values are based on conservative estimates rather than empirical measurements, which may affect their precision.

Additionally, this feasibility study deployed Microsoft Sharepoint as a CDE for realizing the HDFM. However, this plattform offers limited governance, version and scenario management compared to CDEs like CONTACT Elements, which was applied in the reference method. Moreover, the HDFM was mostly limited to factory-BIM models. In the context of the use case and the focus on data exchange, Sharepoint fulfilled the needs of this project. Nevertheless, a more powerful CDE could add complexity and might affect DIC.

The study focused on data flows up to the detailed planning stage; subsequent phases were not included in the analysis. In addition, no explicit material-flow modelling or simulation was performed, resulting in limited detail. Furthermore, the selection of the tool chain could have influenced the findings. Finally, the close collaboration with ifp Consulting may also have influenced project-specific adaptations, and the development of the Dynamo algorithms required specialized expertise, which could restrict broader applicability.

8 Summary and outlook

This study examined the industrial feasibility of a VDI-5200-based method for achieving digital information continuity in factory planning, and demonstrated its effectiveness in a greenfield project in the rubber industry. To adapt the method to project constraints, SharePoint was implemented as the CDE, simulation-based dimensioning was replaced with static dimensioning in Excel, production system modelling was integrated directly into the Revit via Dynamo, and model coordination was limited to Revit-based geometric clash checks.

During the observation period, from setting of objectives to detailed planning, the approach realized 53.8 % direct and 46.2 % indirect transfers with no information loss, thereby improving upon the 6 % loss of the reference method. Automation reduced the time required for a typical layout change by 81 % (from 43 minutes to 8 minutes), resulting in an estimated saving of 175–350 minutes per phase across 5–10 iterations. Four of the ten reference modules were executable out of the box, three required targeted adaptations and three were out of scope. These results show that the method is applicable up to the detailed planning stage under real project conditions, providing reproducible indicators of continuity and efficiency. At the same time, they clarify boundary conditions relating to company size, conservative time estimation, limited simulation depth and specialised Dynamo-based interface scripting expertise.

Future work should extend the method beyond the detailed planning phase to include the realization/construction and operational phases to ensure continuity of digital information across lifecycle handovers. Conservative time estimates should be replaced with instrumented measurements (e.g., time logging, version diff analytics, and automated transfer auditing). Meanwhile, IFC-schemas and parameter conventions should be standardized. In this context, the authors are currently actively contributing to "buildingSMART" within the factory planning chapter. Planning depth could be enhanced by introducing material-flow modelling and discrete-event simulation to quantify the impact on layout and logistics KPIs. Automation could evolve towards bi-directional synchronization between visTable and Revit. Besides, future work could include reusable templates and rule-based coordination that extends beyond geometry. Finally, publishing metrics, checklists, and scripts would support reproducibility and enable robustness and scalability assessments in larger organizations and more complex projects.

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